＜Port Zoning Development＞

A-11　Port zoning development study results

Kingdom of Cambodia

Ministry of Public Works and Transport

The Project for Strengthening Capacity for Ports Administration

The National Port Zoning Development

November 2025

Japan International Cooperation Agency

The Overseas Coastal Area Development Institute of Japan
Oriental Consultants Global Co., Ltd.

CONTENTS

Study summary 1

1. Purpose of Study 1
2. Study methodology 1
3. Study results 2
   (1) Demand forecast 2
   (2) Case setting for cargo allocation and modal choice models 4
   (3) Container cargo modal choice 5
   (4) Bulk cargo modal choice 5
   (5) Cargo handling volume and the number of berths in each zone 7
   (6) Conceptual design of river port 11
   (7) Cost of berth and channel construction 11
   (8) Environmental assessment 13
4. Points to be noted and study limitations 14

Chapter-1 Study purpose and methodology 15

1.1 Background and purpose of the study 15
   1.1.1 Study background 15
   1.1.2 Study purpose 15
   1.1.3 Study methodology 16

Chapter-2 Container -Demand forecast and port choice 17

2.1 Container flow in Cambodia 17
   2.1.1 Current container throughput in Cambodian ports 17
   2.1.2 Distribution of container generation 19
   2.1.3 Distribution of container consumption 19
2.2 Container demand forecast method 20
   2.2.1 Historical review of GDP growth rate and container throughput 20
   2.2.2 GDP and import container throughput elasticity 20
   2.2.3 GDP and export container throughput elasticity 22

2.2.4 GDP growth rate setting: Comparison of GDP values across institutions 25
2.2.5 Cambodia's future economic targets 28
2.2.6 GDP growth rate setting 28
2.2.7 Regional GDP growth rate setting 29
2.3 Demand forecast in 2050 34
2.3.1 Demand forecast in base case 34
2.3.2 Demand forecast taking into account uncertainty in economic activities 38
2.4 Port choice: Developing a logit model 40
2.4.1 Introduction logit model 40
2.4.2 Pre-conditions and modeling 43
2.5 Modelling results 55
2.5.1 Container port choice in 2050 57
Chapter-3 Bulk cargo – Demand forecast 75
3.1 Dry Bulk (Agriculture goods) 75
3.1.1 Methodology and results of estimating dry bulk (Agriculture goods) 75
3.1.2 Dry Bulk (Paddy Rice-Agriculture goods) 80
3.1.3 Dry Bulk (Cassava-Agriculture goods) 96
3.1.4 Dry Bulk (Rubber-Agriculture goods) 106
3.1.5 Dry Bulk (Cavendish Banana-Agriculture goods) 115
3.1.6 Dry Bulk (Mango-Agriculture goods) 121
3.1.7 Dry Bulk (Cashew Nut-Agriculture goods) 130
3.1.8 Dry Bulk (Fertilizer-Agriculture goods) 138
3.1.9 Dry Bulk (Cereal-Agriculture goods) 145
3.1.10 Dry Bulk (Timber-Agriculture goods) 151
3.2 Dry Bulk (Mines and Energy) 158
3.2.1 Methodology and results of estimating dry bulk (Mines and Energy) 158
3.2.2 Mines import (Gypsum) 162
3.2.3 Mines Export 173
3.2.4 Energy resource import 183

Chapter-4 Cruise, Commuter and Fishery ports 214
4.1 Cruise and Commuters 214
4.1.1 International tourists 214
4.1.2 Port Infrastructure for Cruise Ship Tourism 217
4.1.3 Future projection of cruise ship calls in inland waterways 221
4.1.4 Future projection of cruise ship calls at the seashore 226
4.1.5 Forecast of commuter volume (Phnom Penh) 230
4.2 Fishery port 237
4.2.1 Present level of fisheries production 237
4.2.2 Future projection of fishery consumption 238
4.2.3 Allocation of fishery port 239
4.2.4 Estimating the required volume of port facilities (Fishery port) 240
4.2.5 Issues to be considered 244
Chapter-5 Estimation of Modal choice for Demand Forecast 245
5.1 Modal choice method from/to each zone 245
5.1.1 Types of modal choice models 247
5.1.2 Selection of bulk transport cargo 247
5.2 Overview of inland waterways in Cambodia 249
5.2.1 Navigation conditions in the Mekong River System 249
5.2.2 Cargo movement in the river 250
5.2.3 Inland waterway in Vietnam 251
5.3 Container cargo port choice 253
5.3.1 Case setting for a modal choice simulation 253
5.3.2 Export container port choice results 254
5.3.3 Import container port choice results 257
5.4 Bulk cargo port choice 260
5.4.1 Setting the modal share of IWT for bulk cargo 260
5.4.2 Case setting for a modal choice simulation(repost) 265
5.4.3 Setting transport means/route and IWT share by province 266

5.4.4 Inland water transport volume from/to each province by cargo item 274
5.5 Overall IWT cargo flow in Cambodia (container and bulk cargo) 282
5.5.1 IWT cargo flow in Case 0 282
5.5.2 IWT cargo flow in Case 1 (only containers) 287
5.5.3 IWT cargo flow in Case 2 289
5.5.4 IWT cargo flow in Case 3 294
Chapter-6 Increasing cargo volume and port facilities to be developed 300
6.1 Setting annual cargo handling capacity by cargo type 300
6.1.1 Container 300
6.1.2 Bulk cargo (Agriculture goods) 302
6.1.3 Bulk cargo (Mineral resources) 304
6.1.4 Bulk cargo (Energy: Liquid) 305
6.1.5 Bulk cargo (Energy: Solid) 308
6.2 The number of berths to be developed 310
6.2.1 Method for calculating the number of berths 310
6.2.2 Summary of the number of berths by zone 312
6.2.3 Container 314
6.2.4 Bulk cargo (Agriculture goods) 315
6.2.5 Bulk cargo (Mineral resources) 316
6.2.6 Bulk cargo (Energy: Liquid) 317
6.2.7 Bulk cargo (Energy: Solid) 318
Chapter-7 River Traffic Volume and Channel Capacity 320
7.1 Inland waterway capacity in the Mekong River System 320
7.1.1 Estimation of vessel traffic in each stretch 320
7.1.2 Occupancy rate of vessel traffic 322
7.2 Evaluation of channel capacity 324
7.2.1 Volume of vessel traffic in Case 2 324
7.2.2 Volume of vessel traffic in Case 3 325
Chapter-8 A conceptual river port design 326

8.1 Channel Development 326
8.1.1 Channel Design 331
8.1.2 Channel Dredging 334
8.2 River Port Development 337
8.2.1 Present Situation of Existing River Ports 337
8.2.2 Conceptual Design of River Port 339
8.3 Total project cost estimation 356
Chapter-9 Strategic Environmental Assessment 359
9.1 Background and Objective 359
9.2 Outline of the Port Zoning Plan 359
9.3 National environmental policies, strategies and plans 361
9.4 Relevant national environmental legislation 362
9.5 Environment and social status 363
9.5.1 Upper Mekong River 363
9.5.2 Tonle Sap Lake/River 366
9.5.3 Coastal area 373
9.6 Environmental risk 375
9.6.1 Risks associated with the expansion of inland navigational network 375
9.6.2 Risks associated with port development 377
9.7 Conclusion and recommendations 379
Chapter-10 Points to be noted and study limitations 382
Appendix 383
Appendix-1 Seminar on modal choice survey in the Mekong River System 383
Appendix-2 All Responses to the Modal Choice Survey 392
(1) Company A 392
(2) Company B 394
(3) Company C 395
(4) Company D 397
(5) Company E 398

(6) Company F 400
(7) Company G 402
(8) Company H 403
(9) Company I 404
(10) Company J 406
(11) Company K 408
(12) Company L 410
Appendix-3 Inland waterway transport (IWT) share by case for each bulk cargo item 411
(1) Agriculture goods: Paddy (Export) 411
(2) Agriculture goods: Raw rubber (Export) 413
(3) Mineral resources: Bauxite (Export) 415
(4) Mineral resources: Iron ore (Export) 416
(5) Mineral resources: Manganese ore (Export) 418
(6) Mineral resources: Pebbles (Export) 419
(7) Mineral resources: Sand (Export) 421
(8) Mineral resources: Stone (Export) 422
(9) Agriculture goods: Cereal (mainly feed) (Import) 424
(10) Agriculture goods: Fertilizer (Import) 425
(11) Energy: Gasoline (Import) 427
(12) Energy: Diesel (Import) 428
(13) Energy: LPG (Import) 430
(14) Energy: Lubricant (Import) 431
Appendix-4 The number of vessels per day navigating (Case 2) 433
(1) Between UM2 and upper Phnom Penh port 433
(2) Between Kampong Chhnang and upper Phnom Penh port 433
(3) Upper side of Phnom Penh port 434
(4) Between Phnom Penh port and upper mouth of the Funan Techo Canal 434
(5) Between upper mouth of the Funan Techo Canal and LM26 435
(6) Between LM26 and the Vietnam border 435

(7) The Funan Techo Canal 436
Appendix-5 The number of vessels per day navigating (Case 3) 437
(1) Between Stung Treng and Kratie 437
(2) Between Kratie and UM2 437
(3) Between UM2 and upper Phnom Penh port 438
(4) Between Chong Khneas and Kampong Chhnang 438
(5) Between Kampong Chhnang and upper Phnom Penh port 439
(6) Upper side of Phnom Penh port 439
(7) Between Phnom Penh port and upper mouth of the Funan Techo Canal 440
(8) Between upper mouth of the Funan Techo Canal and LM26 440
(9) Between LM26 and the Vietnam border 441
(10) The Funan Techo Canal 441

Abbreviations

Abbreviation	Official Term
ADB	Asian Development Bank
CFC	Cassava Federation of Cambodia
CLA	Cambodia Logistics Association
CRA	Cambodia Rubber Association
CRF	Cambodia Rice Federation
DFAT	Department of Foreign Affairs and Trade
FAOSTA	Food and Agriculture Organization Corporate Statistical Database
GDA	General Directorate of Agriculture
GDCE	General Department of Customs and Excise of Cambodia
GDP	Gross Domestic Product
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Forestry and Fisheries
MOC	Ministry of Commerce
MOP	Ministry of Planning
NIS	National Institute of Statistics
NR	Natural Resources
RCN	Raw Cashew Nuts
rGDP	Regional Gross Domestic Product
RSS	Ribbed Smoked Sheets
TSS	Technically Specified Standard
UN Comtrade	United Nations Comtrade Database
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WB	World Bank

Study summary

1. Purpose of Study

Under the Inland Water Transportation Act enacted in May 2024, MPWT is responsible for examining port plans submitted by port developers in Cambodia. For this purpose, it is important to know the future port cargo demand and port capacity required to cope with that demand. This study aims to formulate a national port zoning plan that includes port cargo demand forecast and the number of required berths by cargo type in each zone.

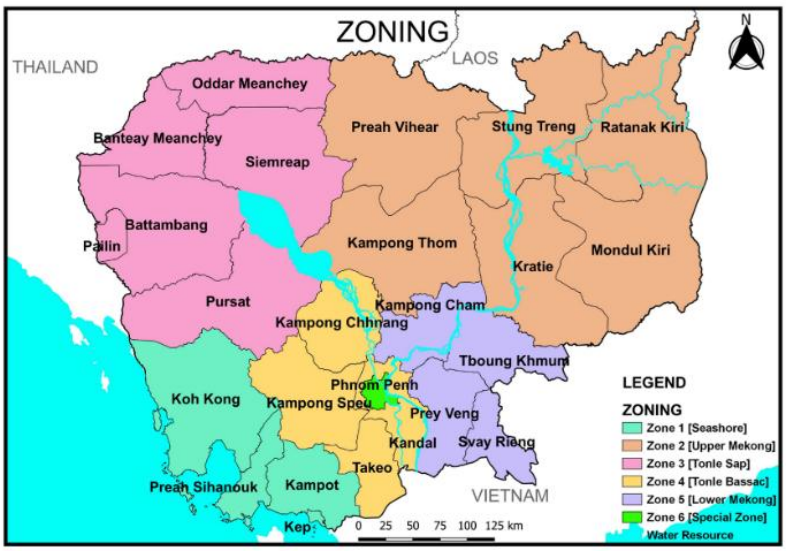


Figure (1) Port zoning map

2. Study methodology

The flow chart of the study is shown as below.

1) Target cargo items: Container, Bulk cargoes (agriculture, mineral resources, energy), passenger, cruise ship, and fishery port,
2) Target year: 2025 and 2050,
3) Zones: six zones in Cambodia,

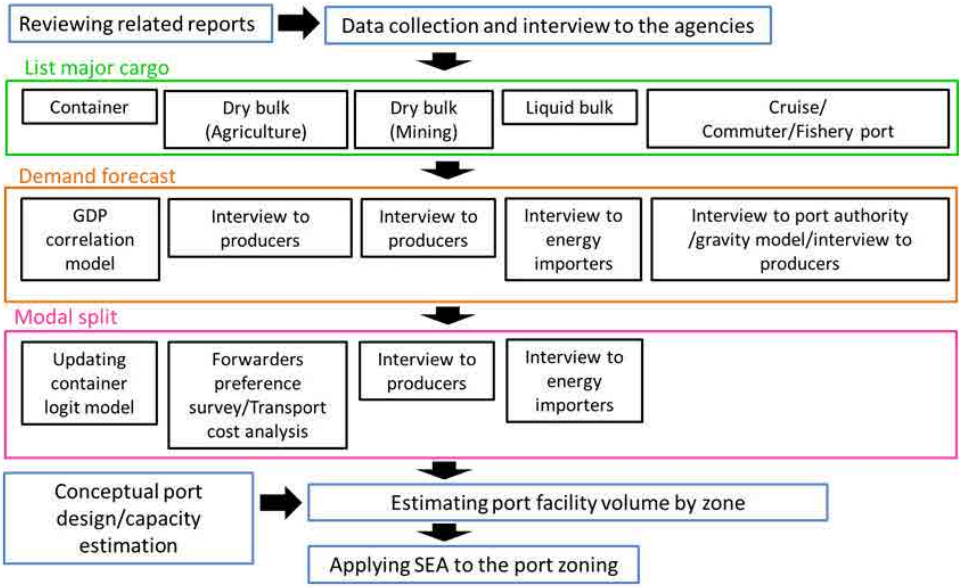


Figure (2) Flow chart of the study

3. Study results

(1) Demand forecast

The forecast method will vary depending on whether the government has established future targets. When there are no targets, we will interview producers, and/or government officials to ascertain future levels of production. The demand forecast results and forecast method are shown in the table below.

Table (1) Demand forecast result and estimation method

Cargo items	Sub items	Base year volume	Base year	Estimation volume in 2050	Import/ Export	Unit	Estimation method	Mode
Container (General)		1,063,148	2024	4,764,731	Total	TEU	Laden only	barge/trailer
		540,766	2024	1,992,806	Export	TEU	World's GDP elasticity, laden only	ditto
		522,382	2024	2,771,925	Import	TEU	Cambodia's GDP elasticity, laden only	ditto
Container (Agriculture)		0		863,755	Total	TEU	Laden only	ditto
		0		749,605	Export	TEU	Trend analysis and national policy, laden only	ditto
		0		114,150	Import	TEU	Ditto	ditto
Container (Fishery)		0		23,060	Import	TEU	Fish consumption based on population growth, laden only	ditto
Container (Total)		1,063,148		5,651,546	Total	TEU	Laden only	ditto
		540,766		2,742,411	Export	TEU	ditto	ditto
		522,382		2,909,135	Import	TEU	ditto	ditto
Agriculture	Paddy	5,180,155	2024	4,191,401	Export	Ton	trend analysis	barge/truck
	Milled Rice	675,642	2024	1,350,667	Export	Ton	trend analysis	Ditto
	Fresh Cassava	13,051,754	2024	2,488,945	Export	Ton	Cassava association interview	Ditto
	Starch Cassava	60,525	2024	1,333,364	Export	Ton	Cassava association interview	Ditto
	Cassava slice	964,682	2024	3,111,182	Export	Ton	Cassava association interview	Ditto
	Cassava residue	33,153	2024	177,782	Export	Ton	Cassava association interview	Ditto
	Mango	97,628	2020	2,178,695	Export	Ton	trend analysis	Ditto
	Cashew nut	363,476	2022	1,305,427	Export	Ton	National policy	Ditto
	Rubber	338,000	2024	132,168	Export	Ton	Policy of rubber	Ditto
	Banana	367,412	2022	367,412	Export	Ton	Select peak year data	Ditto
	Fertilizer	135,775	2022	228,677	Import	Ton	Fertilizer-Paddy Rice Production	Ditto
	Cereal	216,457	2023	198,395	Import	Ton	Cereal- Population growth	Ditto
	Timber	1,720,400	2019	1,598,101	Import	Ton	Timber- follow the GDP growth rate	Ditto
	Sub total	23,205,059		18,662,216		Ton		
Energy	Coal	4,620,431	2023	7,952,041	Import	Ton	Contingency Generation Plan / Installed Power Capacity, MME+ Cement Demand Forecasl	tanker/truck
	LNG	0	2021	4,324,548	Import	Ton	Contingency Generation Plan / Installed Power Capacity, MME	Ditto
	Fuel oil	117,000	2023	117,000	Import	Ton	Contingency Generation Plan / Installed Power Capacity, MME	Ditto
	Diesel	1,792,700	2021	5,737,951	Import	Ton	Diesel-GDP elasticity	Ditto
	LPG	325,600	2021	4,470,776	Import	Ton	LPG-GDP elasticity	Ditto
	Gasoline	636,400	2021	2,705,322	Import	Ton	Gasoline-GDP elasticity	Ditto
	Jet fuel	67,100	2021	2,946,988	Import	Ton	Jet Fuel-GDP elasticity	Ditto
	Lubricant	13,400	2021	22,286	Import	Ton	Lubricant-GDP elasticity	Ditto
	Black oil	33,500	2021	124,884	Import	Ton	GDP increasing	Ditto
	Sub total	2,985,700		28,401,796		Ton		
Mineral resources	Gypsum	348,869	2023	2,182,080	Import	Ton	Gypsum-GDP elasticity	barge/truck
	Sand	28,000,000	2023	45,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	barge
	Bauxite mining	-	-	10,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	barge/truck
	Iron ore	5,000,000	2024	9,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	Barge
	Mable mining	-	-	3,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	Barge
	Pebbles	-	-	1,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	barge/truck
	Manganese ore	40,012	2023	40,012	Export	Ton	Selected the highest of history data	Barge
	Stone	10,651,924	2024	11,664,644	Export	Ton	Assumed increasing rate 0.35%	Barge
	Sub total	44,040,805		81,886,736		Ton		
Cruise	Inland waterway	746	2024	2,797		# of call	Assumed increasing rate 8%	Cruise ship
		36,312	2024	531,430		# of passenger		Ditto
	Seashore (PAS)	23	2024	233		# of call	Assumed increasing rate 8%	Ditto
		19,448	2024	246,196		# of passenger		Ditto
	Seashore (Kampot)	-	-	3,333		# of call	China-aided Project of the Intermodal Transport Master Plan for Cambodia	Ditto
		-	-	1,000,000		# of passenger		Ditto
	sub total (#of calls)	769		6,363		# of call		
	sub total (#of passengers)	55,760		1,777,626		# of passenger		
Commuter		16,062	2022	19,330	Domestic	Passengers	Population growth	Ferry
Fishery		601,200	2019	753,366	Domestic	Ton	Fish consumption based on population growth	Fishing boat
GDP		47.6	2030	118.2		B. US$	Modified GDP growth rate based on Pentagonal strategy	
Population		16,078,660	2019	21,728,446			National policy	

(2) Case setting for cargo allocation and modal choice models

In this section, we will discuss how to allocate the estimated cargo in each province and to select transportation modes (river or road) from/to each zone.

① Modal choice models

In Cambodia, containerization is already a well-established commercial practice. We will use a logit model that is commonly used for container cargo allocation. On the other hand, statistical data for bulk cargo is extremely limited and does not cover whole Cambodian provinces. Therefore, when estimating the modal choice for bulk cargo, we refer to survey results on modal preference, and set transport modes, routes and inland waterway share by province.

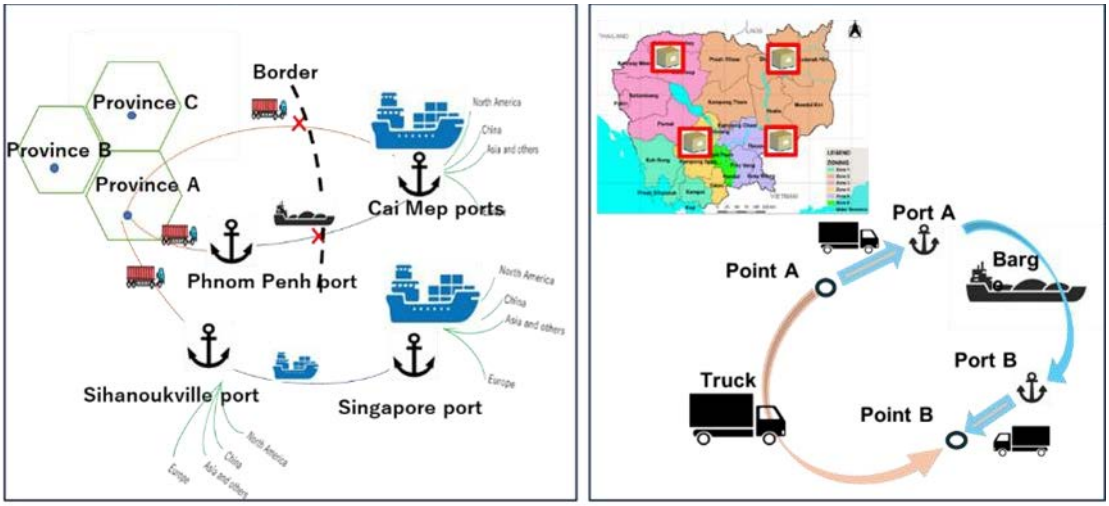


Figure (3) Conceptual diagrams of estimating modal choice (left: Logit model, right: Individual port selection model)

② Case setting for the modal choice model

We set the case for modal choice simulation on bulk cargoes as well as containers (Table (2)).
Case 0: The current transportation condition in 2023. Land and inland water transportation is the same as in 2023.
Case 1: The future infrastructure projects will significantly improve Cambodia's logistics network.
Case 2: Funan Techo canal will also be realized in addition to the improvements in the road network and port operation.
Case 3: A 3,000DWT or 5,000 DWT class vessel can navigate up to the upper Mekong River and Tonle Sap Lake in addition to the transport conditions in Case 2.

Table (2) Case settings for the modal choice model

Logit model	Individual port selection	Remarks
Case 0	Case 0	Current transportation condition in 2023
Case 1	N/A	Port and road improvement without Funan Techo Canal
Case 2	Case 2	Port and road improvement with Funan Techo Canal
Case 3	Case 3	Entire canal and riverports development by MPWT

(3) Container cargo modal choice

Figure (4) below shows the results of the logit model, illustrating the share of container cargo's port choice for each case. The results of Case 2 and Case 3 indicate that the Funan Techo Canal route will attract a significant amount of cargo that was previously transported by barge to Vietnamese ports. The results also show that Cambodia's infrastructure and waterway development will reduce the container traffic that currently requires transshipment at neighboring ports, including both truck transport to Vietnam and Thailand and barge transport to Vietnam.

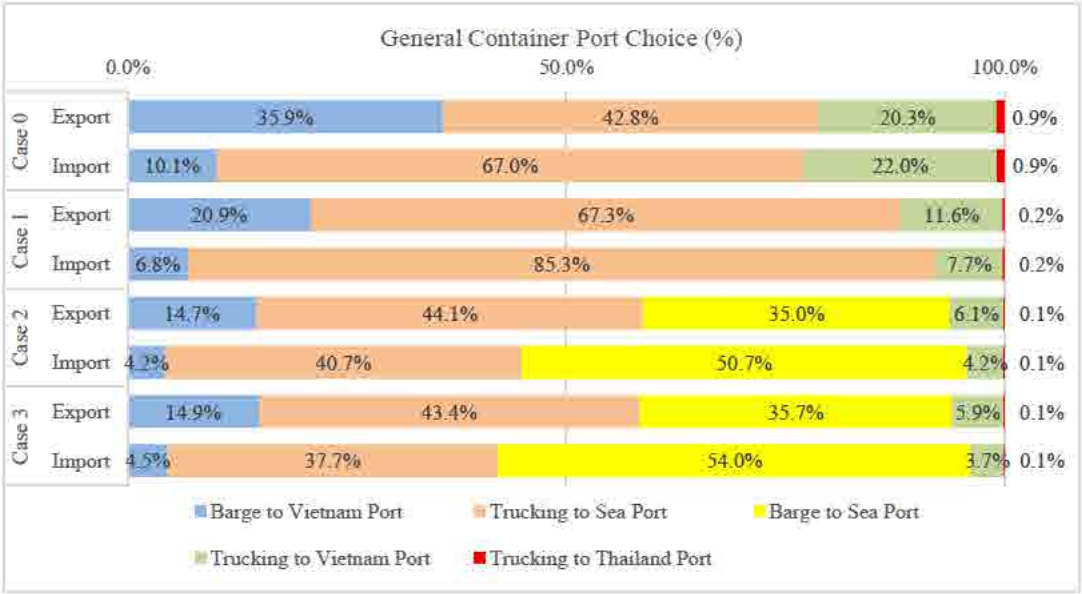


Figure (4) Share of container cargo's port choice (share %)

(4) Bulk cargo modal choice

① Channel navigation scenario setting

MPWT requested that the Funan Techo Canal development, currently in the pipeline, be included in the case settings. The same request was made for the development of river ports including the channel in Kampong Chhnang-Chong Khneas and UM2-Stung Treng sections, which allows

3,000 to 5,000 DWT class vessels to navigate. The Funan Techo Canal is scheduled to be open by 2028. On the other hand, the upper Mekong and Tonle Sap Lake development involves hydraulic issues that need to be addressed in the future. JICA expert team does not unreservedly endorse this development.

Based on channel navigation scenarios, we conducted a modal preference survey of cargo owners and forwarders.

Table (3) Channel navigation scenario setting for the modal preference survey

Stretch	Scenario 1		Scenario 2
	Rainy season	Dry season	All season
Stung Treng~Kratie	50DWT	20DWT	3,000DWT
Kratie~UM2	400DWT	80DWT	3,000DWT
UM2~Phnom Penh	4,000DWT	2,000DWT	5,000DWT
Chong Khneas~Kampong Chhnang	150DWT	20DWT	5,000DWT
Kampong Chhnang ~ Phnom Penh ~ LM26	4,000DWT	2,000DWT	5,000DWT
Takeo~Phnom Penh	50DWT	20DWT	5,000DWT
Kep ~ Phnom Penh (Funan Techo Canal)	N/A	N/A	5,000DWT

② Setting inland waterway transport preference level

Based on the stakeholders' modal preference survey, we set the level of IWT (inland waterway transport) use below. As the volume of data is not sufficient to differentiate by distance, we will set a single number in each scenario to simplify the modal choice simulation.

a) Level of IWT use in Scenario 1 is 10% (also applied to Case 0)

b) Level of IWT use in Scenario 2 is 60% (also applied to Case 2 and Case 3)

③ Method for conducting bulk cargo modal choice

The JICA expert team will select the transport route and modes from each province when the production area is close to the river. The detailed selection criteria are shown below. Since the majority of paddy are currently exported to rice mill factories in Vietnam, paddy exports will not use the canal even if it is materialized in Case 2 or Case 3. The method is as follows:

a) Identify provinces where shippers potentially use barge transport, (in other words, exclude provinces where production areas are too far from river ports),

b) Select the nearest river port in the province, and

c) Apply the level of IWT preference (10% for Case 0, and 60% for Case 2 and Case 3).

An example of route selection, transport mode and inland water transportation levels in the case of raw rubber is shown in the table below.

Table (4) Transport means/route and IWT share for Case 0, Case 2 and Case 3 (raw rubber)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	IWT share		
						Case0	Case2	Case3
1	Kampot	Truck	→	→	SHV			
	Kep	Truck	→	→	SHV			
	Koh Kong	Truck	→	→	SHV			
	Preah Sihanouk	Truck	→	→	SHV			
2	Kampong Thom	Truck	UM2	Barge	Zone1 sea port	10%	60%	60%
	Kratie	Truck	Kratie	Barge	Zone1 sea port	10%	60%	60%
	Mondul Kiri	Truck	→	→	Vietnam			
	Preah Vihear	Truck	Stung Treng	Barge	Zone1 sea port	10%	60%	60%
	Ratanak Kiri	Truck	→	→	Vietnam			
	Stung Treng	Truck	Stung Treng	Barge	Zone1 sea port	10%	60%	60%
3	Banteay Meanchey	Truck	→	→	Thai			
	Battambang	Truck	→	→	SHV			
		Truck	Chong Khneas	Barge	Zone1 sea port		60%	60%
	Oddar Meanchey	Truck	→	→	Thai			
	Pailin	Truck	→	→	Thai			
	Pursat	Truck	→	→	SHV			
	Siem Reap	Truck	Chong Khneas	Barge	Zone1 sea port	10%	60%	60%
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Zone1 sea port	10%	60%	60%
	Kampong Speu	Truck	→	→	SHV			
	Takeo	Truck	→	→	SHV			
5	Kampong Cham	Truck	UM2	Barge	Zone1 sea port	10%	60%	60%
	Prey Veng	Truck	LM26	Barge	Zone1 sea port	10%	60%	60%
	Svay Rieng	Truck	LM26	Barge	Zone1 sea port	10%	60%	60%
	Tboung Khmum	Truck	UM2	Barge	Zone1 sea port	10%	60%	60%
6	Kandal	Truck	PPP	Barge	Zone1 sea port	10%	60%	60%
	Phnom Penh	Truck	PPP	Barge	Zone1 sea port	10%	60%	60%

(5) Cargo handling volume and the number of berths in each zone

The following table shows inland waterway transport volume by zone and by cargo type in Case 2 (Table (6)) and Case 3 (Table (8)). Please note that the results of Case 0 and Case 1 will be omitted from following discussion as these transportation conditions are supplementary ones.

① Inland waterway transport and marine port cargo handling volume by zone

For containers in Case 2(Table (6)), the total demand in Cambodia amounts to8,307,507 TEUs. Of this, 4,964,498 TEUs will be load/unload from mother vessels at seaports in Zone 1, after which 2,308,807 TEUs will be transported by truck to/from each zone. The remaining 2,655,691 TEUs will be loaded onto barges at seaports in Zone 1 and transported to/from each zone through the Funan Techo Canal. Additionally, 432,125 TEUs of the total volume will be transshipped by barge from/to Cai Mep ports through the lower Mekong River. These containers from the Canal or the lower Mekong River will head for or come from the following river ports: Kampong Chhnang port in Zone 4 (326,609 TEUs), UM2 or LM26 in Zone 5(810,304 TEUs) and Phnom Penh port in Zone 6 (1,949,172 TEUs), respectively. In addition, 254,914 TEUs will cross the border by truck from/to foreign ports (Cai Mep or Laem Chabang).

Other cargo in Case2 or Case 3 flow have similar patterns but are not described in detail here for the sake of brevity.

② The required number of berths by zone

Here, we will mainly discuss container berths and bulk berths (agriculture goods) because these berths will be located at public terminals. The other berths (Mineral resource, Energy (Liquid) and Energy (Solid) will be handled mainly in dedicated private terminals.

First, to calculate the required number of berths by zone, we will set the unit cargo handling capacity by cargo type (see Table (5)). These numbers will be obtained by arranging the number of cargo handling cranes and vessel load capacity.

Table (5) Unit cargo handling capacity by cargo type.

	Container (1,000TEU/year/ berth)	Bulk (1,000ton/year/berth)			
		Agriculture goods	Mineral resources	Energy	
				Liquid	Solid
Berth for mother vessel	330	2,628	31,536	10,061	5,694
Berth for feeder vessel	136	263	5,256	2,100	-
Berth for river vessel	81	263 130*	5,256	2,100	-

Table (6) and Table (8) show the increased cargo handling volume (from 2023 to 2050) by zone in Case 2 and Case 3, respectively. When dividing the cargo volume by the cargo handling capacity by cargo type, we can obtain the number of berths by zone by cargo type as shown in Table (7) (Case 2) and Table (9) (Case 3), respectively.

Table (7) (Case 2) indicates that 13 container berths, 20 feeder berths and 33 river port berths are needed for container transportation. One mother vessel berth, 1 feeder berth and 5 river port berths are required for bulk agriculture goods transportation. Berths will be newly developed on the Shoreline (Zone 1) and in the Lower Mekong (Zones 4, 5 and 6).

Table (9) (Case 3) indicates that 13 container berths, 21 feeder berths and 35 river port berths are needed for container transportation. One mother vessel berth, 1 feeder berth and 23 river port berths are required for bulk agriculture goods transportation. It will become possible to transport agricultural goods between the Upper Mekong (Zone 2) and Tonle Sap area (Zone 3).

Table (6) Total (export and import) container and bulk cargo volume through IWT (Case 2)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	4,964,498 (barge 2,655,691) (truck 2,308,807)	215,446 (barge 215,446)	31,704,656 (barge 31,704,656)	28,401,796 (barge 5,599,507)
2	0	0	0	0
3	0	0	0	0
4	328,609	205,938	0	615,973
5	810,304	321,119	31,704,656	1,735,170
6	1,949,172	84,229	45,000,000	3,248,364
Sub total (Seaports and riverports in Cambodia)	8,052,583	826,732	108,409,312	34,001,303
Transported by truck to/from foreign ports	254,924	-	-	-
Grand total	8,307,507	826,732	108,409,312	34,001,303
Included number				
Consumed in Vietnam	-	395,840	45,000,000	0
Transshipped to/from Vietnam through the Mekong river	432,125	0	0	0

Table (7) The estimated number of berths by zone in 2050 (Case 2)

Zone	Container (Number of berth)			Bulk (Number of berth)											
				Agriculture			Mineral resources			Energy (Liquid)			Energy (Solid)		
	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
1	13	20	-	1	1	-	2	7	-	3	3	-	2	-	-
2	-	-	0	-	-	0	-	-	0	-	-	0	-	-	-
3	-	-	0	-	-	0	-	-	0	-	-	0	-	-	-
4	-	-	5	-	-	2	-	-	0	-	-	1	-	-	-
5	-	-	10	-	-	2	-	-	7	-	-	1	-	-	-
6	-	-	18	-	-	1	-	-	0	-	-	2	-	-	-
Total	13	20	33	1	1	5	2	7	7	3	3	4	2	-	-

Table (8) Total (export and import) container and bulk cargo volume through IWT (Case 3)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	4,969,502 (barge 2,841,510) (truck 2,127,992)	259,357 (barge 259,357)	31,704,656 (barge 31,704,656)	28,401,796 (barge 6,287,517)
2	256,139	169,532	31,704,656	435,691
3	379,459	813,083	0	1,081,510
4	230,230	302,413	0	222,473
5	593,226	930,738	0	1,299,479
6	1,832,039	418,637	45,000,000	3,248,364
Sub total (Seaports and riverports in Cambodia)	8,260,595	2,893,760	108,409,312	34,689,313
Transported by truck to/from foreign ports	232,461	-	-	-
Grand total	8,493,056	2,893,760	108,409,312	34,689,313
Included number				
Consumed in Vietnam	-	2,375,046	45,000,000	0
Transshipped to/from Vietnam through the Mekong river	449,583	0	0	0

Table (9) The estimated number of berths by zone in 2050 (Case 3)

Zone	Container (Number of berth)			Bulk (Number of berth)											
				Agriculture			Mineral resources			Energy (Liquid)			Energy (Solid)		
	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
1	13	21	-	1	1	-	2	7	-	3	3	-	2	-	-
2	-	-	4	-	-	2	-	-	7	-	-	1	-	-	-
3	-	-	5	-	-	7	-	-	0	-	-	1	-	-	-
4	-	-	3	-	-	3	-	-	0	-	-	1	-	-	-
5	-	-	7	-	-	7	-	-	0	-	-	1	-	-	-
6	-	-	16	-	-	4	-	-	0	-	-	2	-	-	-
Total	13	21	35	1	1	23	2	7	7	3	3	6	2	-	-

The following figures show vessel traffic volume per day in Case 2 and Case 3. These traffic volumes are less than channel capacity as the occupancy rate of vessel traffic is less than the congestion threshold of 60%.

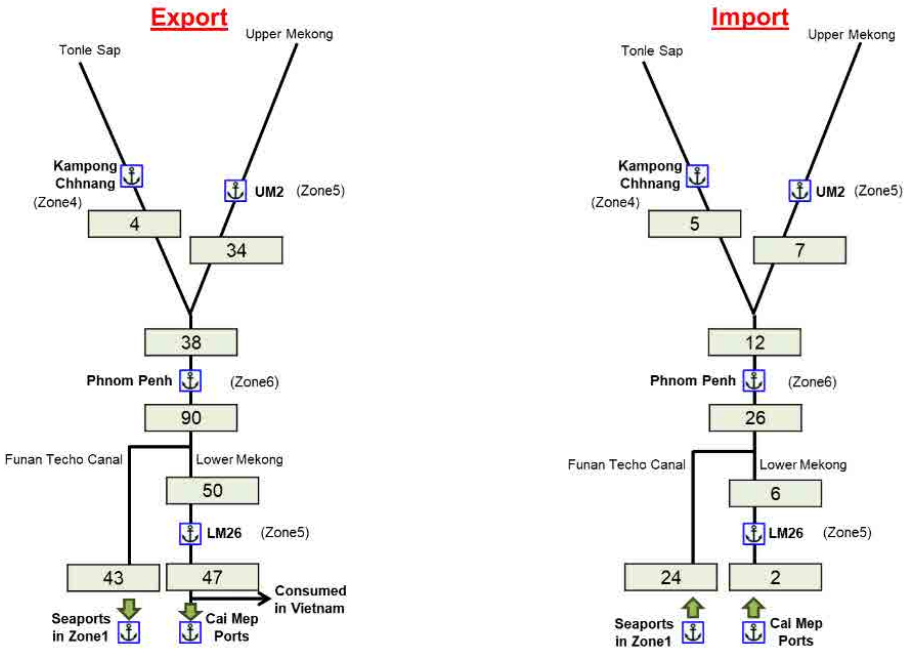


Figure (5) Flow of inland waterway vessel traffic (Case 2, the number of vessels per day)

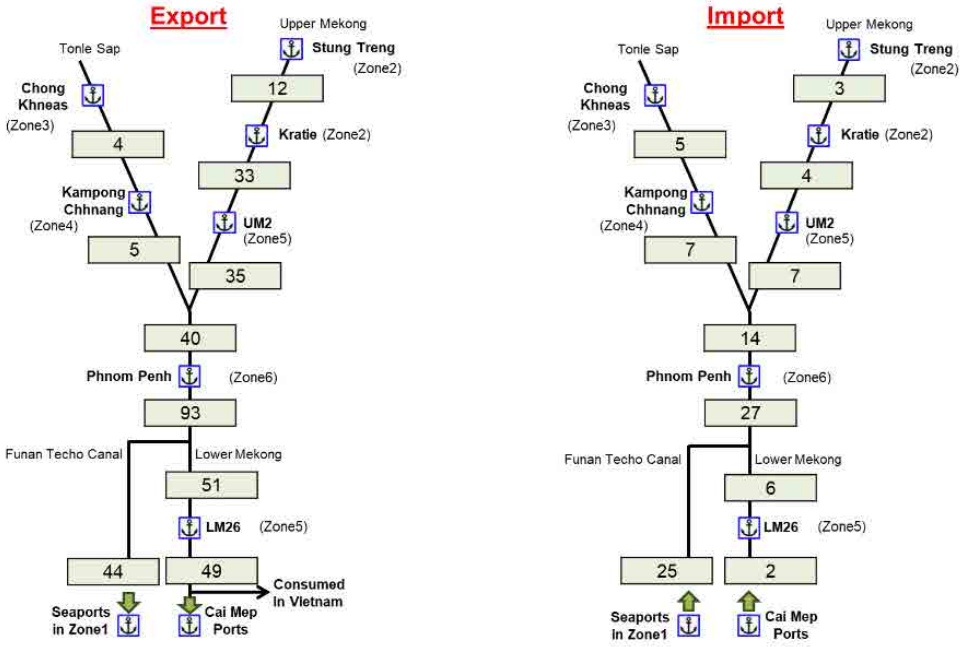


Figure (6) Flow of inland waterway vessel traffic (Case 3, the number of vessels per day)

(6) Conceptual design of river port

Assuming that the maximum navigable ship type for the Funan Techo Canal is the target, the ship types and depths shown in Table (10) below were used as the design conditions.

Table (10) Conceptual Design River Vessel Size and Wharf Water Depth

River Barge	LOA （m）	Breadth (m)	Draft (m)	Tonnage (DWT)	Wharf Depth (m)
Container Barge	80	15	4.7	3,000	5.4
Bulk Barge	87	14.3	5.3	3,000	6.0

Note: Wharf Water depth:Below L.L.W.L at candidate port site as indicated in the river Chart based on the Hatien MSL (Mean Sea Level))

To resist the residual water levels and the strong horizontal forces caused by large fluctuations in river water levels, the coupled raking-pile type is considered an appropriate structural form. Terminal yards such as the container marshalling yard and warehouses behind it need to set the top elevation considering allowance for past high-water levels, resulting in a significant difference in height compared to the berth depth on the river side. To account for this height difference, it is economical for the wharf to be of the detached type and connected to the land yard via access bridge(s) to maintain a distance that ensures slope stability.

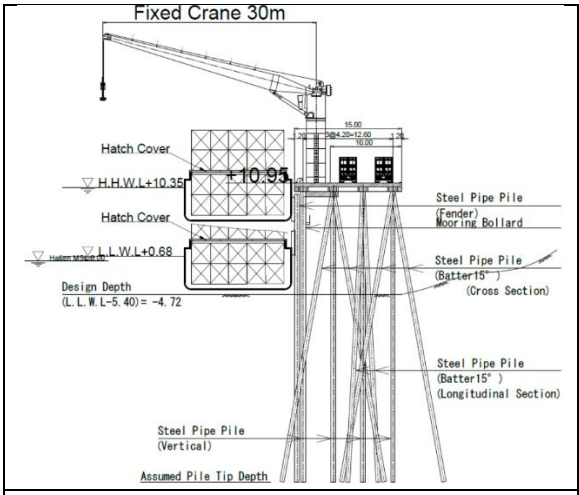


Figure (7) Typical cross section of a container berth

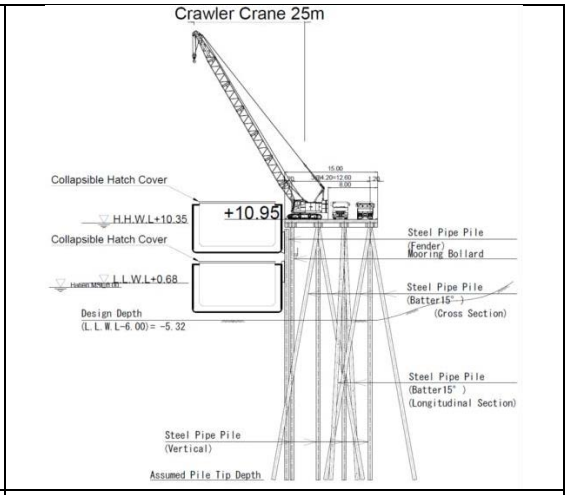


Figure (8) Typical cross section of a bulk berth (agriculture goods)

(7) Cost of berth and channel construction

In this sub section, the construction cost of each berth and channel construction cost is calculated, focusing mainly on container berths and bulk berths (agriculture goods) which will be located at public terminals. The other berths (Mineral resource, Energy (Liquid) and Energy (Solid) will be handled mainly in dedicated private terminals.

The total construction cost of container and bulk berths is US$5.0 billion as shown in the table below. Container berths account for most of the cost (US$4.2 billion).

Table (11) Total construction cost of container and bulk berths(agriculture)

Cost	Container			Bulk (Agriculture)		
Zone	Marine berth	Feeder berth	River berth	Marine berth	Feeder berth	River berth
1	US$2,539,333,333	US$703,872,000	US$0	US$103,333,333	US$24,168,000	US$0
2	US$0	US$0	US$0	US$0	US$0	US$0
3	US$0	US$0	US$0	US$0	US$0	US$0
4	US$0	US$0	US$146,640,000	US$0	US$0	US$40,280,000
5	US$0	US$0	US$315,980,000	US$0	US$0	US$46,528,000
6	US$0	US$0	US$527,904,000	US$0	US$0	US$20,140,000
Sub total	US$2,539,333,333	US$703,872,000	US$990,524,000	US$103,333,333	US$24,168,000	US$106,948,000
Sub total	US$4,233,729,333			US$234,449,333		

Cost	Cruise			Commuter	Fishery
Zone	River berth	Marine berth	Kampot berth	River berth	Marine and River port
1	US$0	US$35,000,000	US$100,000,000	US$0	US$16,000,000
2	US$0	US$0	US$0	US$0	US$24,000,000
3	US$50,000,000	US$0	US$0	US$0	US$48,000,000
4	US$10,000,000	US$0	US$0	US$0	US$32,000,000
5	US$0	US$0	US$0	US$0	US$40,000,000
6	US$80,000,000	US$0	US$0	US$18,000,000	US$48,000,000
Sub total	US$140,000,000	US$35,000,000	US$100,000,000	US$18,000,000	US$208,000,000
Sub total	US$275,000,000			US$18,000,000	US$208,000,000
Grand total	US$4,969,178,666				

In addition, regarding the opening of the channel, it is estimated that the draft of the target vessel will be 5.4 meters. The JICA expert team calculated the cost of excavation between Kratie - Kampong Cham and Kampong Cham - Phnom Penh. The total amount is US$210 million. Since the amount of sediment stagnation is unknown for each year's maintenance dredging, if we assume that 15% of the initial investment is the annual maintenance dredging cost, US$32 million per year will be required.

Although nautical charts are available in the stretch between Kampong Chhnang and Phnom Penh, the actual depth is unknown due to frequent dredging work. However, as with the Lower Mekong, the cost is assumed to be almost zero. In addition, the development cost for the stretch between Stung Treng and Kratie cannot be calculated because nautical charts are not available.

Table (12) Construction costs associated with the opening of the route

Channel development and maintenance	Kratie - Kampong Cham	Kampong Cham - Phnom Penh	Total
Development cost	US$209,348,472	US$784,963	US$210,133,435
Maitenanace cost per year	US$31,402,271	US$117,744	US$31,520,015

As the study team estimated three cases of container demand forecast (base, high and low). Based on three cases, we calculate the berth development cost. Note that we estimate only one case for

the bulk cargo as cargo volume estimation uncertainty of bulk is much more than that of container. In addition, we cannot estimate the cost of container or bulk cargo in case 3 as the geographic and hydraulic condition in the upper Mekong and Tonle Sap is not available.

Table (13) Sensitive cost analysis (2035/2050, Low/Base/High) in Case 2

(Unit: Billion US$)	2035			2050		
	Low	Base	High	Low	Base	High
Total cost (Case 2)	1.8	2.1	2.4	4.2	5.0	5.9
(Included Container berth cost)	1.2	1.5	1.8	3.5	4.2	5.2

(8) Environmental assessment

Strategic Environmental Assessment (SEA) is a systematic process for evaluating the potential environmental consequences of proposed development policies, plans, or programs, and is now a requirement under the Code on Environment and Natural Resources (2023).

The main findings of the risk assessment are outlined as follows:

a) The environmental risks in Zone 1 (coastal area) are similar between Scenarios 1 and 2, as the required scale of port development is nearly the same under both scenarios. Nevertheless, the overall environmental risks remain high due to the following factors:
   i. Zone 1 will require extensive port development, which may lead to substantial loss and degradation of ecologically sensitive areas—such as coral reefs, seagrass beds, mangrove forests, and protected areas—distributed along the coastline.
   ii. Zone 1 will involve the export of mineral resources (e.g., bauxite, iron ore) by bulk carriers, which may introduce invasive species through ballast water discharge.
   iii. Zone 1 will involve the import and handling of liquid energy (e.g., fuel oil), increasing the risk of major oil spills.
   iv. A wide range of international and domestic vessels will operate in Zone 1, potentially causing water pollution from uncontrolled discharges of ship-generated wastewater.

b) The environmental risks in Zones 2 and 3 differ significantly between Scenarios 1 and 2. Scenario 2 poses considerably higher risks for both zones, as it is likely to involve port development and operations in ecologically sensitive areas such as the upper Mekong River (Zone 2) and Tonle Sap Lake (Zone 3).

c) The environmental risks in Zones 4, 5, and 6 for both scenarios are relatively lower than those in Zones 1 to 3, primarily because these areas do not contain notable ecologically sensitive zones.

4. Points to be noted and study limitations

Finally, the JICA expert team notes that it will be necessary to further refine the port zoning development study after confirming/addressing the following issues.

1) In estimating future cargo volumes, the government should have data on future domestic production, demand, and overseas trade volume for each commodity. Unfortunately, the Cambodian government does not fully specify the target of future cargo demand and supply for many cargo items. The JICA expert team estimated future cargo volumes by setting several hypotheses based on interviews and discussions with relevant ministries and organizations. However, it will be necessary to revise the future cargo volumes after the government's policy is disclosed.
2) There are many hydraulic challenges in developing river ports and waterways in Tonle Sap Lake and the upper Mekong. Our study assumes that these issues will be overcome.
3) The presence of Cambodian inland water transport operators is essential for the river port network to effectively function in Cambodian territorial waters. Otherwise, Cambodia will still rely on foreign operators for domestic water transport. When allocating cargoes, the expert team assumes that Cambodia operators will be able to successfully compete with land transport and Vietnamese inland waterway business operators.
4) The development of the Funan Techo Canal is expected to allow Cambodia to reduce dependency on southern Vietnamese ports for inland waterway. The expert team assumes that the transportation conditions of the Funan Techo Canal in terms of freight rates and time will be competitive with ports in southern Vietnam.
5) To improve the efficiency of container and bulk cargo transportation through the Funan Techo Canal, it is necessary to develop a barge system that allows barges to navigate in both inland waterways and coastal routes, rather than transshipping the cargo between inland waterways and coastal shipping routes. Our study assumes that this new barge system will be materialized.

Chapter-1 Study purpose and methodology

1.1 Background and purpose of the study

1.1.1 Study background

JICA study team has been carrying out "The project for strengthening capacity for port administration" since June 2022. The project was originally expected to be completed in November 2024. However, the formulation of a new national port zoning plan is urgently needed to cope with the rapid growth in cargo volumes in Cambodia. Under these circumstances. MPWT has requested JICA to formulate "A national port zoning plan" in Cambodia, which covers future cargo volume and required facility volume by zone. A national port zoning plan will allow MPWT to effectively examine future port plans. Therefore, MPWT and JICA agreed to add the new works to the current project and extend the term of the project from November 2024 to December 2025.

1.1.2 Study purpose

In this study, the JICA expert team will estimate river and marine cargo volume in 2050 and calculate the number of required berths by carto type in each zone. Cambodia will be separated into six zones in this study. Cargo will be allocated by the team to the six zones rather than individual ports. This port zoning study will be a valuable reference for MPWT reference when examining whether submitted port plans meet the government's cargo volume quota.



Figure 1-1 port zoning map

1.1.3 Study methodology

The study methodology is presented in the flow chart below. First, the team will list the major cargoes to be handled in marine or river ports in Cambodia by cargo type and item. Second, the team will carry out the demand forecast for each cargo item. The forecast method will vary depending on whether the government has established future targets. If a government policy on a particular cargo item exists, we will use it. If not, we will interview producers, NGOs and/or government officials to ascertain future levels of production and the carry out the demand forecast based on our findings.

The estimated cargo volume will be allocated by zone and mode of transport (i.e., by truck or waterway) using a logit model or another modal preference survey. The number of required berths for each cargo type will be determined based on the volume of cargo to be transported by water. The team will also design a standard river port facility suitable for the Mekong river's hydraulic conditions and estimate the cost of river port development. Finally, the team will carry out a strategic environmental assessment (SEA) in the port zoning area to identify issues that should be addressed in the implementation stage.

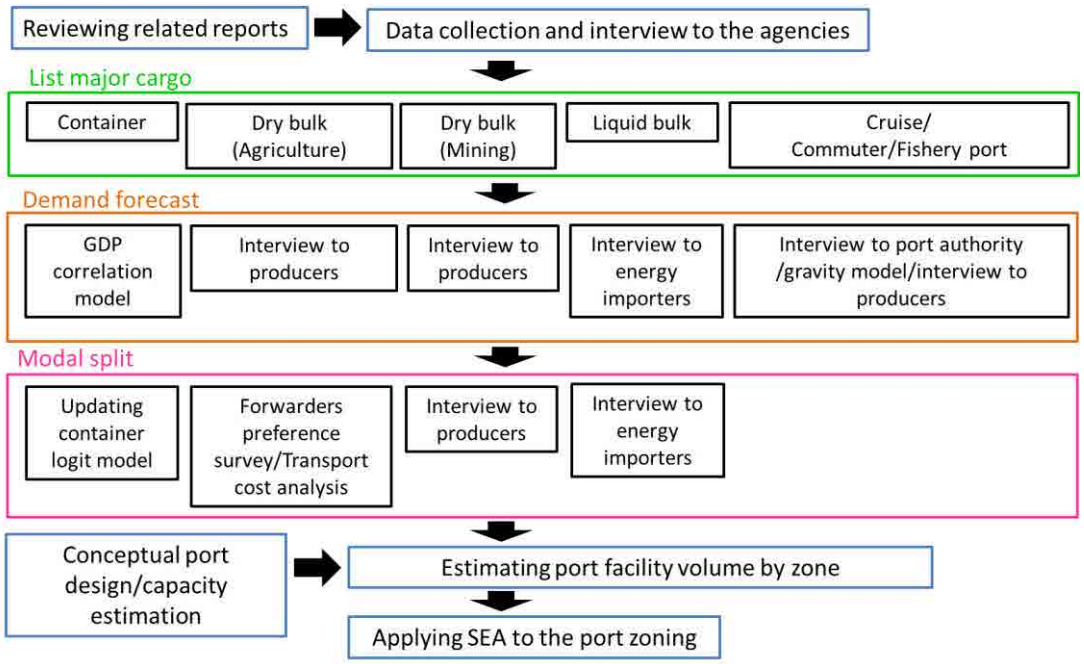


Figure 1-2 Flow chart of the study

Chapter-2 Container -Demand forecast and port choice

2.1 Container flow in Cambodia

2.1.1 Current container throughput in Cambodian ports

Prior to forecasting future container demand, we reviewed past container throughput in Cambodia, namely, shipments to and from overseas. Since Cambodia currently has only two public international trade ports (Sihanoukville Port and Phnom Penh Port), we treated the combined throughput of these two ports as the national total.

Table 2-1 shows container throughput at Sihanoukville Port. The throughput from 2010 onward increases year by year, with the volume reaching 1.0 million TEU in 2024.

Table 2-2 shows container throughput at Phnom Penh Port. The volume has increased from 60,000 TEU in 2010 to almost 500,000 TEU in 2024.

Table 2-3 shows Cambodia's national container throughput which is the aggregate of the volumes handled at Sihanoukville and Phnom Penh. Total throughput reached 1.5 million TEU in 2024.

Table 2-1 Sihanoukville Port container throughput

YEAR	IMPORT (TEUS)			EXPORT (TEUS)			TOTAL
	LADEN	EMPTY	TOTAL	LADEN	EMPTY	TOTAL	(IMPORT & EXPORT)
2010	96,005	20,293	**116,298**	62,371	44,259	**106,630**	**222,928**
2011	106,364	19,158	**125,522**	70,153	42,266	**112,419**	**237,941**
2012	121,023	13,695	**134,718**	69,607	51,053	**120,660**	**255,378**
2013	128,688	19,388	**148,076**	89,802	48,572	**138,374**	**286,450**
2014	152,640	20,399	**173,039**	103,074	57,791	**160,865**	**333,904**
2015	167,125	28,729	**195,854**	121,463	74,502	**195,965**	**391,819**
2016	174,637	23,872	**198,509**	129,820	71,858	**201,678**	**400,187**
2017	206,734	26,889	**233,623**	148,096	78,120	**226,216**	**459,839**
2018	248,750	28,003	**276,753**	173,438	91,037	**264,475**	**541,228**
2019	312,961	17,059	**330,020**	179,476	129,715	**309,191**	**639,211**
2020	295,631	25,011	**320,642**	200,058	121,142	**321,200**	**641,842**
2021	340,567	39,578	**380,145**	221,485	130,757	**352,242**	**732,387**
2022	343,152	51,962	**395,114**	218,913	136,121	**355,034**	**750,148**
2023	361,371	41,262	**402,633**	238,633	156,512	**395,145**	**797,778**
2024	466,046	70,971	**537,017**	297,583	197,591	**495,174**	**1,032,191**

Table 2-2 Phnom Penh Port container throughput

YEAR	IMPORT (TEUS)			EXPORT (TEUS)			TOTAL
	LADEN	EMPTY	TOTAL	LADEN	EMPTY	TOTAL	(IMPORT & EXPORT)
2010	21,369	5,940	**27,309**	24,276	10,671	**34,947**	**62,256**
2011	25,344	10,124	**35,468**	35,696	10,467	**46,163**	**81,631**
2012	29,627	12,877	**42,504**	41,961	10,868	**52,829**	**95,333**
2013	28,924	22,068	**50,992**	49,501	10,007	**59,508**	**110,500**
2014	39,412	22,693	**62,105**	59,003	12,558	**71,561**	**133,666**
2015	45,751	28,575	**74,326**	58,756	11,731	**70,487**	**144,813**
2016	49,123	25,852	**74,975**	66,156	10,650	**76,806**	**151,781**
2017	56,895	32,614	**89,509**	80,089	15,207	**95,296**	**184,805**
2018	60,424	41,935	**102,359**	91,325	19,887	**111,212**	**213,571**
2019	76,136	58,014	**134,150**	125,011	21,884	**146,895**	**281,045**
2020	80,456	58,041	**138,497**	131,366	20,994	**152,360**	**290,857**
2021	69,940	93,273	**163,213**	171,048	14,637	**185,685**	**348,898**
2022	63,115	129,662	**192,777**	209,295	15,624	**224,919**	**417,696**
2023	54,652	131,475	**186,127**	196,314	13,784	**210,098**	**396,225**
2024	56,336	168,372	**224,708**	243,183	12,309	**255,492**	**480,200**

Table 2-3 Total container throughput in Cambodia

YEAR	IMPORT (TEUS)			EXPORT (TEUS)			TOTAL
	LADEN	EMPTY	TOTAL	LADEN	EMPTY	TOTAL	(IMPORT & EXPORT)
2010	117,374	26,233	**143,607**	86,647	54,930	**141,577**	**285,184**
2011	131,708	29,282	**160,990**	105,849	52,733	**158,582**	**319,572**
2012	150,650	26,572	**177,222**	111,568	61,921	**173,489**	**350,711**
2013	157,612	41,456	**199,068**	139,303	58,579	**197,882**	**396,950**
2014	192,052	43,092	**235,144**	162,077	70,349	**232,426**	**467,570**
2015	212,876	57,304	**270,180**	180,219	86,233	**266,452**	**536,632**
2016	223,760	49,724	**273,484**	195,976	82,508	**278,484**	**551,968**
2017	263,629	59,503	**323,132**	228,185	93,327	**321,512**	**644,644**
2018	309,174	69,938	**379,112**	264,763	110,924	**375,687**	**754,799**
2019	389,097	75,073	**464,170**	304,487	151,599	**456,086**	**920,256**
2020	376,087	83,052	**459,139**	331,424	142,136	**473,560**	**932,699**
2021	410,507	132,851	**543,358**	392,533	145,394	**537,927**	**1,081,285**
2022	406,267	181,624	**587,891**	428,208	151,745	**579,953**	**1,167,844**
2023	416,023	172,737	**588,760**	434,947	170,296	**605,243**	**1,194,003**
2024	522,382	239,343	**761,725**	540,766	209,900	**750,666**	**1,512,391**

2.1.2 Distribution of container generation

The distribution of container generation was recorded by the General Department of Customs and Excise (GDCE). The Figure 2-1 shows the volume of containers generated by each province in Cambodia. This volume of generated containers comes almost entirely from manufactured goods destined for export around the world. As the figure shows, the dark green areas represent the highest container volume, while the light green areas indicate a lower volume. Specifically, Phnom Penh City, Sihanoukville, and Svay Rieng Province account for the highest volume of containers generated, totaling around 93% of all containers generated in Cambodia.

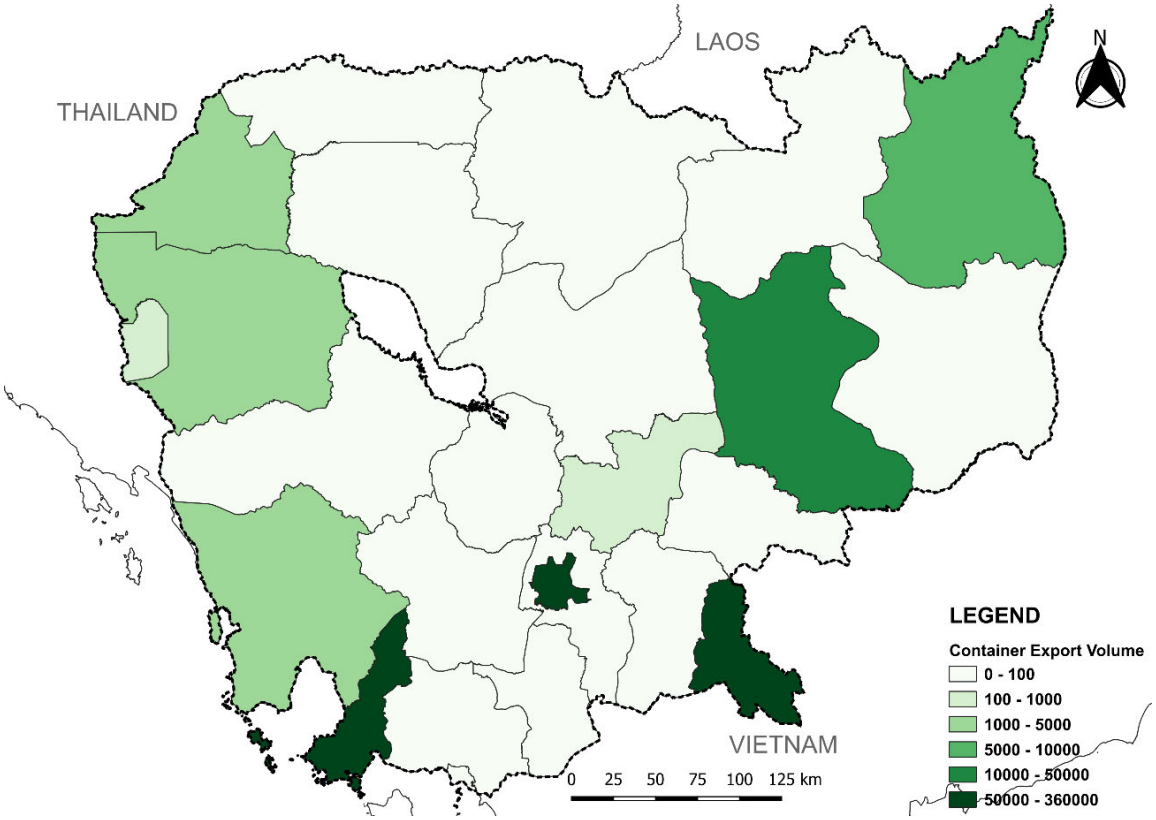


Figure 2-1 The GDCE data container export volume of each province

2.1.3 Distribution of container consumption

The GDCE also records the container import volume for each province. The Figure 2-2 shows this volume of container imports per province. As the figure shows, the dark green areas represent the highest container volume, while the light green areas indicate a lower volume. Specifically, Phnom Penh city, Sihanoukville, and Svay Rieng province account for the highest volume of container imported, totaling around 87% of all containers imported to Cambodia. However, the container import volume recorded by the GDCE may not represent the actual container consumption of each province, as the container imports to a given province are subsequently

distributed to other provinces for final consumption. Therefore, the JICA Expert team will estimate the container consumption of each province using regional GDP.

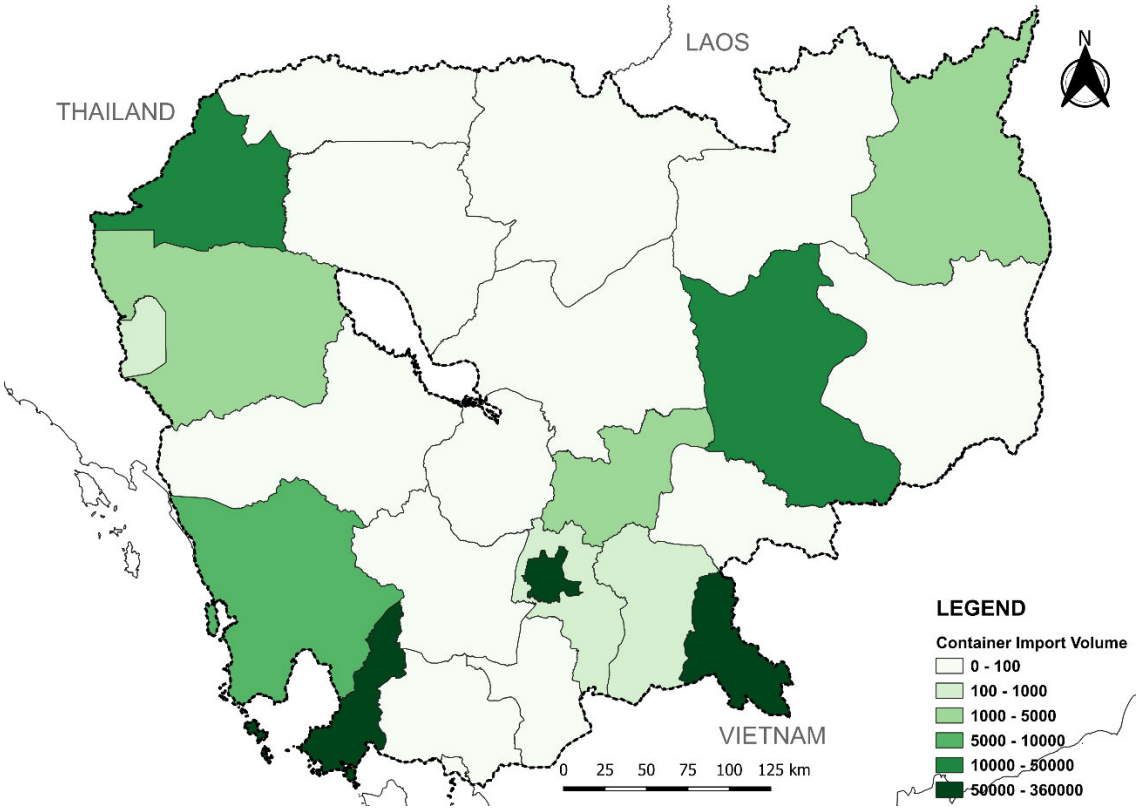


Figure 2-2 The GDCE data container import volume of each province

2.2 Container demand forecast method

2.2.1 Historical review of GDP growth rate and container throughput

We assume that container throughput is closely related to economic and consumption activities at home and abroad. When domestic consumption becomes more active and the economy grows, demand rises and imports of containers increase. For exports, we also assume that demand for export items is related to economic activity overseas. Therefore, we forecast container throughput using a method based on the elasticity of container throughput with respect to GDP growth. GDP has nominal and real values. Nominal GDP includes price increases, while real GDP excludes them. When analyzing the link with container throughput, we assume price increases do not affect container counts, so we use real GDP.

2.2.2 GDP and import container throughput elasticity

Figure 2-3 shows Cambodia's import container throughput and the import container throughput growth rate calculated from it. Figure 2-4 shows Cambodia's real GDP in U.S. dollars and its real

GDP growth rate, derived from the IMF data used in Section "2.2.6 GDP growth rate setting" We then plot the import container throughput growth rate and the real GDP growth rate in Figure 2-5. Here, container throughput refers only to loaded containers, which we regard as tied to economic activity.

We introduce the idea of GDP elasticity of container throughput. This is defined as the container throughput growth rate divided by the GDP growth rate. It shows how much container throughput grows for a given percentage growth in GDP. Below, we simply call this the GDP elasticity. The slope in Figure 2-5 corresponds to the GDP elasticity.

Looking at the import container series in Figure 2-3, the growth rate, which had ranged between 5% and 30%, fell into negative territory in 2020 (likely due to the impact of COVID-19), then stayed below 5% until it rebounded sharply to about 25% in 2024,

GDP growth (see Figure 2-4) also turned negative in 2020 and then gradually recovered, but it has yet to return to its pre-COVID level; it stood at 5.8% in 2024. This is also likely due to COVID-19. We expect GDP growth to keep recovering and return to its pre-COVID level.

Because we expect COVID-19 effects to fade over time, we exclude the values from 2020 to 2024 from the plot in Figure 2-5. For reference, the dotted line shows the slope, which corresponds to the GDP elasticity. Although the plotted points are scattered, we assume a GDP elasticity of 2.0 for imports.

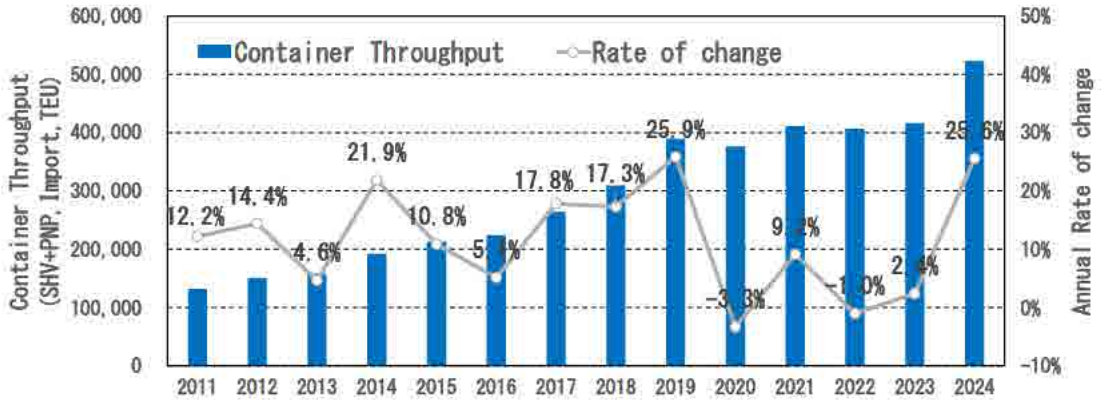


Figure 2-3 Cambodia's import container throughput and its growth rate



Figure 2-4 Cambodia's real GDP and real GDP growth rate

2.2.3 GDP and export container throughput elasticity

We set the elasticity for exports in the same way, using the link between the world real GDP growth rate and export container throughput. Figure 2-6 shows Cambodia's export container throughput and the export container throughput growth rate computed from it. Figure 2-7 shows world GDP based on IMF data, namely nominal GDP in U.S. dollars and the real GDP growth rate. Because the IMF's world GDP dataset does not include a real GDP level in U.S. dollars or a nominal GDP growth rate, Figure 2-7 shows the nominal GDP level in U.S. dollars and the real GDP growth rate. We use the IMF data because the GDP elasticity is defined with the real GDP growth rate.

Looking at Figure 2-6, export container throughput shows negative growth in 2020, remains low through 2023, and then jumps to 25.6% in 2024. From Figure 2-7, world GDP growth is negative in 2020, rebounds to 6.6% in 2021, and then returns to around 3% as in 2019 and earlier. Because these patterns are likely due to COVID-19, we exclude the 2020–2024 values, as we did for imports, when computing the GDP elasticity. As with imports, container throughput here refers only to loaded containers.

Figure 2-8 plots the export container throughput growth rate against the real GDP growth rate. From its slope, we assume a GDP elasticity of 4.0 for exports.

Using these assumed GDP elasticities and the future GDP growth rates projected in Section "2.2.6 GDP growth rate setting", we forecast container throughput. Because the GDP elasticity gives the container throughput growth rate for a given GDP growth rate, the product of the future GDP growth rate and the elasticity gives the container throughput growth rate. We then apply this annual container growth rate to the base-year container throughput and compound it year by year to obtain future container throughput up to the year 2050.

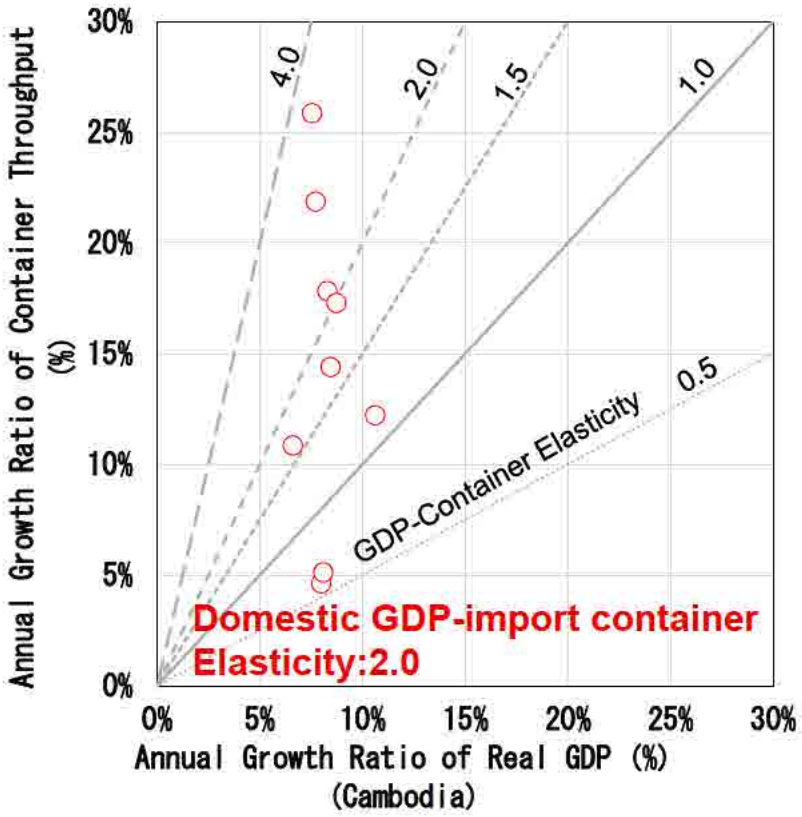


Figure 2-5 Import container throughput growth rate and Cambodia's real GDP growth rate

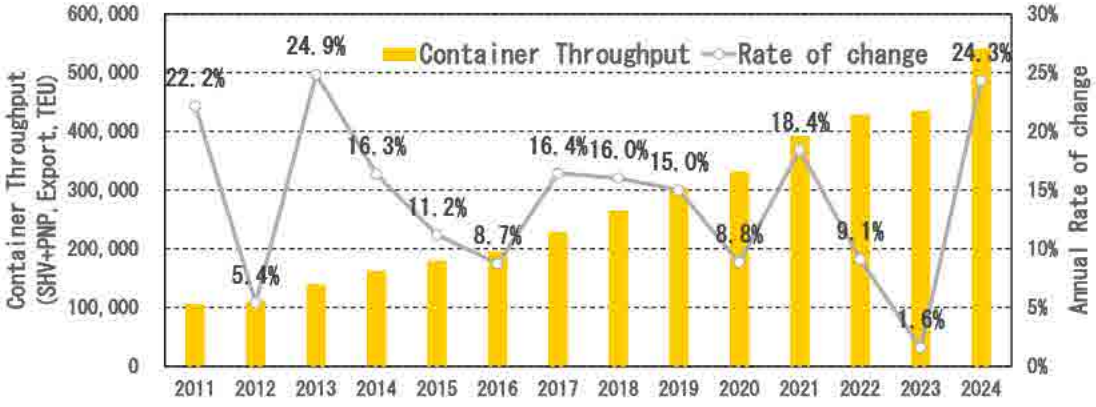


Figure 2-6 Cambodia's export container throughput and its growth rate

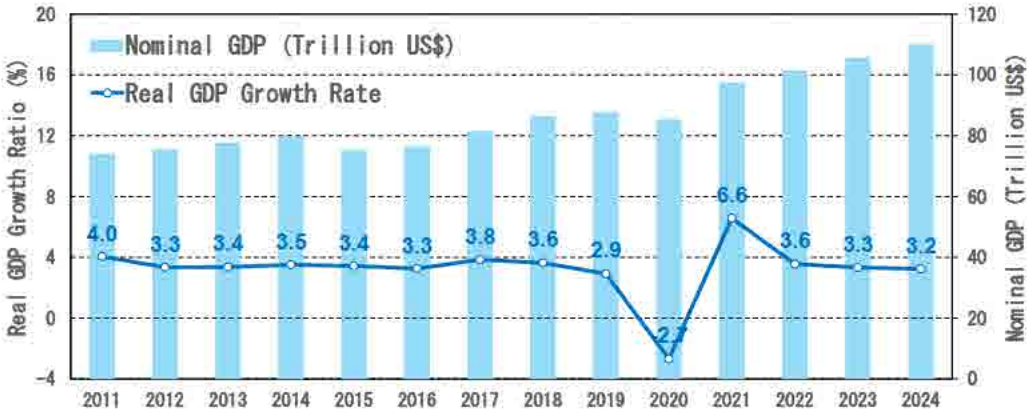


Figure 2-7 World real GDP and real GDP growth rate

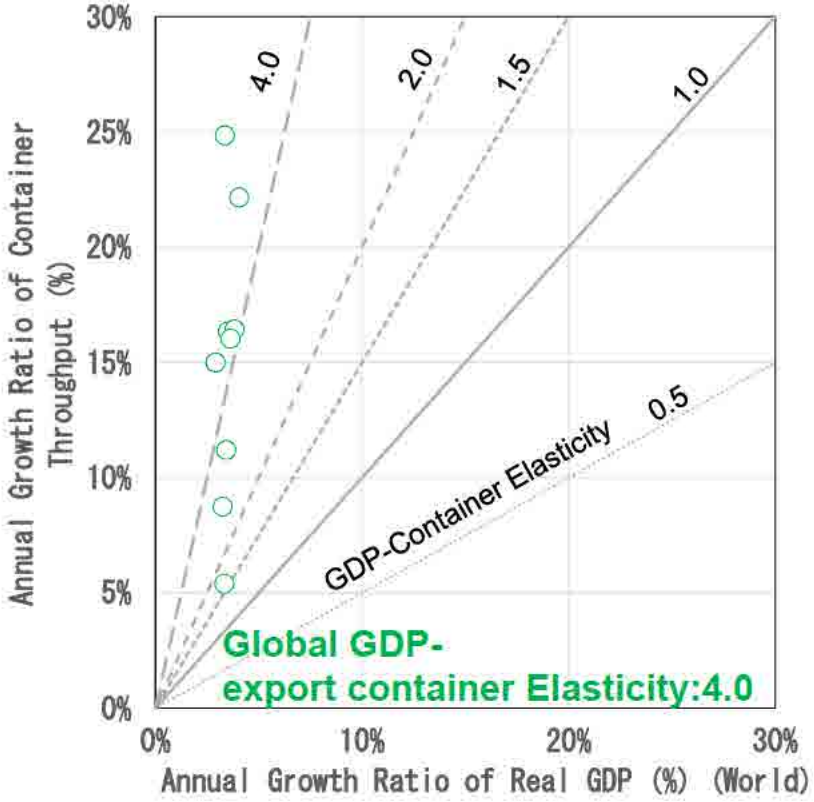


Figure 2-8 Export container throughput growth rate and world real GDP growth rate

2.2.4 GDP growth rate setting: Comparison of GDP values across institutions

Demand forecasting for cargo volumes requires selecting an appropriate method for each commodity. For some commodities, domestic consumption and overseas demand are related to overall economic activity. Therefore, to increase the accuracy of the demand forecast, we prepared projections for Cambodia's domestic GDP and for world GDP.

To determine which GDP series to use in the demand forecast, we compared GDP values published by international institutions and by the Government of Cambodia (Table 2-4). The following datasets were reviewed: (i) the IMF's World Economic Outlook (WEO) database, October 2022[1] and October 2024 vintages[2], (ii) the Government of Cambodia's National Strategic Development Plan 2019–2023[3] (NSDP), (iii) the Statistical Yearbook of Cambodia 2021[4] published by the Ministry of Planning in December 2021, (iv) the United Nations "UNdata[5]" portal, and (v) the World Bank's Open Data[6].

The available series of data from the IMF include nominal GDP in Cambodian riel, real GDP, real GDP growth, the GDP deflator, and nominal GDP in U.S. dollars. Real GDP and real GDP growth in U.S. dollars are derived by deflating nominal GDP using the GDP deflator. Because the deflator is Cambodia Riel-based, we assume that the exchange rate between the riel and the U.S. dollar moves in tandem over the long run and that short-term fluctuations are small.

Comparing the two IMF vintages shows that the real-GDP base year was updated from 2000 to 2014. As a result, even for the same calendar year, the October 2024 vintage with a 2014 base reports real-GDP levels that are roughly double those in the earlier vintage. Nominal GDP also differs between vintages, though by less than real GDP. These differences reflect the emphasis on timeliness in GDP publication. Preliminary estimates are released first and are subsequently revised, sometimes for several years. Changes in statistical methods and updates to source data can also affect the values. The IMF provides projections as of each publication date, through 2027 in the October 2022 vintage and through 2029 in the October 2024 vintage.

The NSDP series reports real GDP with a 2000 base year and is consistent with the IMF's October 2022 vintage. The Statistical Yearbook does not specify whether its GDP is nominal or real. However, its levels align with the IMF's October 2024 nominal series, which suggests that they are nominal.

[1] https://www.imf.org/en/Publications/WEO/weo-database/2022/October
[2] https://www.imf.org/en/Publications/WEO/weo-database/2024/October
[3] http://cdc-crdb.gov.kh/en/strategy/documents/nsdp-2019-2023_en.pdf
[4] https://www.nis.gov.kh/nis/yearbooks/StatisticalYearbookofCambodia2021.pdf
[5] https://data.un.org/
[6] https://data.worldbank.org/

UNdata provides nominal and real GDP in riel and in U.S. dollars. For nominal GDP in both currencies, values match those of the IMF. For real GDP, the base year is 2015, which is one year later than the IMF's 2014 base, but the levels do not differ materially.

World Bank Open Data provides nominal GDP, real GDP, and the GDP deflator in riel, as well as nominal and real GDP in U.S. dollars. The real-GDP base year is 2014 for riel-based series and 2015 for U.S.-dollar-based series. Real GDP growth is also published, the currency is not indicated, and it uses a 2015 base year, which is consistent with the U.S.-dollar-based real GDP. Across both currencies and for both nominal and real GDP, there are no major differences from the IMF. The World Bank also publishes GNI and population, which we include in Table 2-4 for reference.

In summary, when base years are similar, all sources produce broadly comparable values. Because the IMF also provides forward projections, we adopt the IMF's October 2024 WEO data, which use a 2014 real-GDP base and include projections through 2029, for use in our demand forecasts.

Table 2-4 GDP Series Published by Each Institution

		Unit	scale	base year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
IMF(Oct.2022)	Nominal GDP	riels	Billions		14,083	15,633	16,781	18,535	21,438	25,754	29,849	35,042	41,968	43,057	47,048	52,069	56,682	61,327	67,437	73,423	81,242	89,831	99,544	110,014	103,512	109,311	118,982	130,387	143,043	156,740	171,945	188,569		
	Nominal GDP	USD	Billions		3.67	3.99	4.29	4.67	5.33	6.29	7.27	8.63	10.34	10.39	11.23	12.82	14.06	15.23	16.70	18.08	20.04	22.21	24.60	27.09	25.19	26.31	28.33	30.71	33.32	36.12	39.19	42.51		
	real GDP	riels	Billions	2000	14,029	15,230	16,232	17,613	19,434	22,009	24,380	26,870	28,668	28,692	30,403	32,553	34,933	37,503	40,182	43,009	45,961	49,177	52,850	56,578	54,807	56,455	59,334	63,028	67,173	71,489	76,154	81,176		
	real GDP growth ratio	%			9.58	8.56	6.58	8.51	10.34	13.25	10.77	10.21	6.69	0.09	5.96	7.07	7.31	7.36	7.14	7.04	6.86	7.00	7.47	7.05	-3.13	3.01	5.10	6.23	6.58	6.43	6.53	6.59		
	real GDP(calc)	USD	Billions	2000	3.65	3.89	4.15	4.43	4.84	5.37	5.94	6.62	7.06	6.92	7.26	8.01	8.66	9.31	9.95	10.59	11.34	12.16	13.06	13.93	13.34	13.59	14.13	14.84	15.65	16.47	17.36	18.30		
	real GDP growth ratio(calc)	%				6.46	6.68	6.85	9.08	11.10	10.49	11.49	6.75	-1.97	4.82	10.40	8.11	7.49	6.87	6.43	7.05	7.21	7.43	6.67	-4.25	1.88	3.96	5.07	5.42	5.27	5.37	5.43		
	deflator(calc)	%			100.38	102.65	103.38	105.24	110.31	117.02	122.44	130.42	146.40	150.06	154.75	159.95	162.26	163.52	167.83	170.71	176.76	182.67	188.35	194.45	188.87	193.63	200.53	206.87	212.95	219.25	225.79	232.30		
	deflator	%			100.38	102.65	103.38	105.24	110.31	117.02	122.44	130.42	146.40	150.06	154.75	159.95	162.26	163.52	167.83	170.71	176.76	182.67	188.35	194.45	188.87	193.63	200.53	206.87	212.95	219.25	225.79	232.30		
IMF(Oct.2024)	Nominal GDP	riels	Billions													65,068	71,894	79,768	88,992	98,334	107,785	118,907	134,280	148,985	142,503	150,793	164,059	177,719	192,975	209,966	229,412	250,431	273,110	297,734
	Nominal GDP	USD	Billions													16.02	17.83	19.81	22.04	24.22	26.59	29.39	33.18	36.68	34.90	36.80	39.84	43.30	47.15	51.16	55.75	60.69	66.01	71.76
	real GDP	riels	Billions	2014												70,968	76,397	82,400	88,992	95,406	102,948	111,262	121,026	130,632	125,987	129,880	136,508	143,331	151,205	159,968	169,915	180,270	191,117	202,576
	real GDP growth ratio	%														7.29	7.65	7.86	8.00	7.21	7.91	8.08	8.78	7.94	-3.56	3.09	5.10	5.00	5.49	5.80	6.22	6.10	6.02	6.00
	real GDP(calc)	USD	Billions	2014												17.47	18.95	20.46	22.04	23.50	25.40	27.50	29.91	32.16	30.85	31.69	33.15	34.92	36.94	38.98	41.29	43.69	46.19	48.83
	real GDP growth ratio(calc)	%															8.45	7.99	7.73	6.61	8.09	8.29	8.73	7.55	-4.07	2.72	4.59	5.36						
	deflator(calc)	%														91.69	94.11	96.81	100.00	103.07	104.70	106.87	110.95	114.05	113.11	116.10	120.18	123.99	127.62	131.26	135.02	138.92	142.90	146.97
	deflator	%														91.69	94.11	96.81	100.00	103.07	104.70	106.87	110.95	114.05	113.11	116.10	120.18	123.99	127.62	131.26	135.02	138.92	142.90	146.97
National Strategic	real GDP	riels	Billions	2000									28,668					61,525					98,786											
Development Plan	real GDP	USD	Billions	2000									7.06					15.19					24.37											
	real GDP growth ratio	%			8.80	8.10	6.60	8.50	10.30	13.30	10.80	10.20	6.70					7.60					7.50											
Statistical Yearbook	GDP	riels	Billions														56,682	61,327	67,740	73,423	81,242	89,831	99,544	110,014										
of Cambodia 2021	GDP growth ratio	%															8.90	8.20	10.50	8.40	10.60	10.60	10.80	10.50										
	GDP	USD	Billions														14.05	15.23	16.81	18.24	20.16	22.19	24.49	27.03										
	GDP growth ratio	%															8.40	8.40	10.40	8.50	10.50	10.10	10.30	10.40										
Undata	Nominal GDP	riels	Billions		14,539	16,208	17,668	20,156	24,028	29,275	34,396	40,717	49,885	53,032	57,470	65,224	71,605	79,257	88,992	97,776	107,426	117,803	132,894	146,133	140,865	148,224	162,505	176,035						
	Nominal GDP	USD	Billions		3.79	4.14	4.52	5.07	5.98	7.15	8.38	10.04	12.30	12.81	13.73	16.07	17.75	19.68	22.04	24.04	26.47	29.08	32.80	35.98	34.42	36.16	39.62	42.82						
	real GDP	riels	Billions	2015	30,171	32,401	34,431	37,971	41,562	47,092	52,245	57,678	61,990	64,516	67,791	72,731	78,295	84,447	91,203	97,776	105,506	114,026	124,033	133,877	129,117	133,106	139,899	146,892						
	real GDP	USD	Billions	2015	7.42	7.97	8.46	9.33	10.22	11.58	12.84	14.18	15.24	15.86	16.67	17.88	19.25	20.76	22.42	24.04	25.94	28.03	30.49	32.91	31.74	32.72	34.39	36.11						
World Bank	Nominal GDP	riels	Billions		14,237	16,268	17,631	20,081	23,629	28,919	34,264	41,081	49,357	51,754	57,788	65,068	71,894	79,768	88,992	98,334	107,785	118,907	134,280	148,985	142,503	150,793	164,059	174,027						
	Nominal GDP	USD	Billions		3.69	4.15	4.50	5.05	5.88	7.07	8.35	10.13	12.17	12.50	13.81	16.03	17.83	19.81	22.04	24.17	26.56	29.36	33.15	36.69	34.82	36.79	39.99	42.34						
	real GDP	riels	Billions	2014	29,440	31,615	33,596	37,051	40,555	45,950	50,979	56,280	60,487	62,952	66,148	70,968	76,397	82,400	88,992	95,406	102,948	111,262	121,026	130,632	125,987	129,880	136,508	143,279						
	real GDP	USD	Billions	2015	7.46	8.01	8.51	9.39	10.28	11.64	12.92	14.26	15.33	15.95	16.76	17.98	19.36	20.88	22.55	24.17	26.09	28.19	30.67	33.10	31.92	32.91	34.59	36.30						
	real GDP growth ratio	%		2015	9.99	7.39	6.27	10.28	9.46	13.30	10.94	10.40	7.48	4.07	5.08	7.29	7.65	7.86	8.00	7.21	7.91	8.08	8.78	7.94	-3.56	3.09	5.10	4.96						
	deflator (riel base)	%			48.36	51.45	52.48	54.20	58.26	62.94	67.21	72.99	81.60	82.21	87.36	91.69	94.11	96.81	100.00	103.07	104.70	106.87	110.95	114.05	113.11	116.10	120.18	121.46						
	Nominal GNI	riels	Billions		13,774	15,713	16,897	19,377	22,769	27,743	32,957	39,761	47,631	49,888	56,117	62,906	69,155	76,445	85,233	94,282	103,528	114,289	128,909	142,305	137,977	144,686	157,699	170,113						
	Nominal GNI	USD	Billions		3.57	4.00	4.31	4.87	5.67	6.78	8.03	9.80	11.75	12.05	13.41	15.50	17.15	18.98	21.11	23.18	25.51	28.22	31.82	35.04	33.71	35.30	38.44	41.38						
	real GNI	riels	Billions		28,551	30,600	32,250	35,834	39,205	44,248	49,198	54,611	58,379	60,797	64,268	68,599	73,429	78,897	85,233	91,412	98,852	106,869	116,039	124,435	121,578	124,137	130,786	139,831						
	real GNI	USD	Billions	2015	7.24	7.76	8.18	9.09	9.94	11.22	12.47	13.85	14.80	15.42	16.30	17.39	18.62	20.00	21.61	23.18	25.06	27.10	29.42	31.55	30.83	31.48	33.16	35.45						
	Nominal GNI (Atlas method)	USD	Billions		3.67	3.93	4.14	4.87	5.73	6.82	7.90	9.30	10.94	12.05	13.19	14.64	16.55	18.60	20.54	22.27	24.51	27.18	31.19	34.63	34.22	35.98	38.99	41.66						
	Nominal GNI per capita (Atlas method)	USD			290	310	320	370	430	510	580	670	780	840	910	990	1,110	1,230	1,330	1,430	1,550	1,690	1,920	2,100	2,050	2,120	2,270	2,390						
	SDR deflator in US$ terms	%			247	245	242	250	268	286	296	305	317	325	327	332	336	339	339	332	326	321	330	334	338	352	369	373						
	Population		Millions		12.46	12.66	12.86	13.05	13.24	13.44	13.64	13.84	14.05	14.28	14.50	14.72	14.95	15.17	15.40	15.62	15.85	16.07	16.27	16.48	16.73	16.97	17.20	17.42						
					295	310	322	373	433	507	579	672	778	844	909	994	1,107	1,226	1,334	1,426	1,546	1,691	1,917	2,101	2,046	2,120	2,267	2,391						

2.2.5 Cambodia's future economic targets

In August 2023, the Government of Cambodia formulated the *Pentagonal Strategy – Phase I*[7]. Under this strategy, Cambodia sets an ambitious goal of attaining upper-middle-income status by 2030 and high-income status by 2050. The World Bank defines high-income economies as those with nominal gross national income (GNI) per capita above USD 13,845[8]. This implies that Cambodia envisages per capita GNI reaching USD 13,845 by 2050. As of 2022, Cambodia's nominal GNI per capita was USD 1,658[9]. Given the projected 2050 population of 20,368,188[10], Cambodia's total GNI in 2050 would amount to USD 281,997 million in nominal terms. Although GNI is GDP adjusted for net primary income from the rest of the world, such net primary income flows are currently expected to be small for Cambodia. Accordingly, we use the projected 2050 total GNI as a proxy for total GDP.

2.2.6 GDP growth rate setting

Figure 2-9 shows the projected path of GDP growth, and Figure 2-10 shows the GDP value. The red line indicates nominal values and the blue line indicates real values. The IMF provides GDP growth projections through 2029. Based on those projections, we extended the nominal GDP growth-rate curve so that it reaches the targeted level of total nominal GDP in 2050. We then derived the real GDP growth rate by applying the average inflation rate for 2015–2024, 2.5%, and subtracting it from the nominal rate.

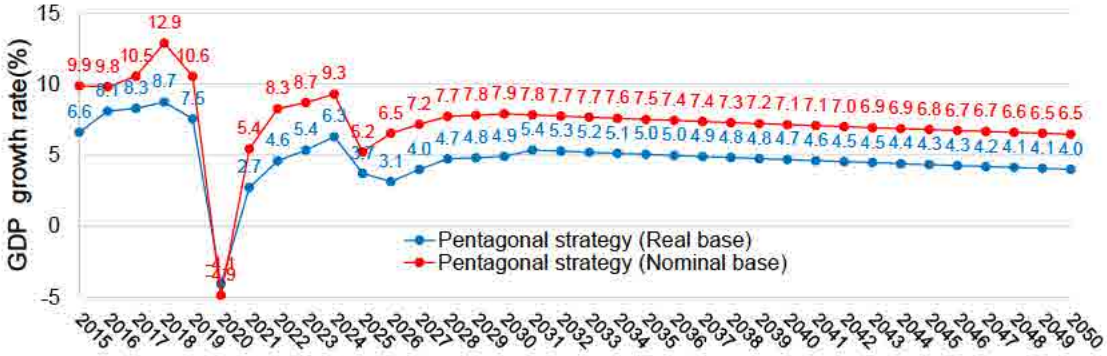


Figure 2-9 GDP Growth Rate Projections

[7]Pentagonal Strategy - Phase I, The National Council for Sustainable Development, https://www.mfaic.gov.kh/files/uploads/1XK1LW4MCTK9/EN%20PENTAGONAL%20STRATEGY%20-%20PHASE%20I.pdf

[8] World Bank Group country classifications by income level for FY24 https://blogs.worldbank.org/en/opendata/new-world-bank-group-country-classifications-income-level-fy24

[9] Undata, record view, GNI at current prices - US dollars https://data.un.org/

[10] General Population Census of Cambodia 2019 Series Thematic Report on Population Projection https://www.nis.gov.kh/nis/Census2019/Population%20Projection.pdf

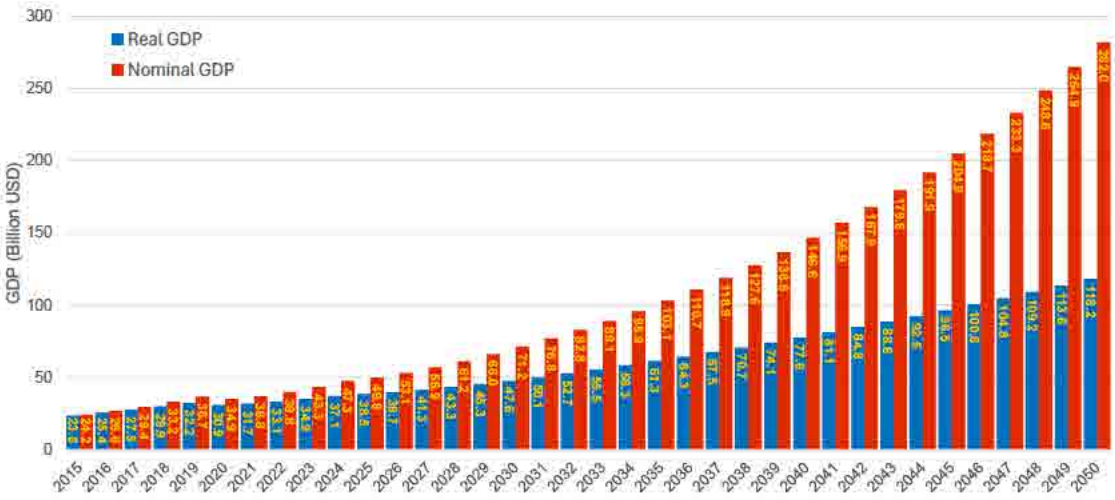


Figure 2-10 GDP Projections

2.2.7 Regional GDP growth rate setting

In order to capture regional economic activities, we estimated the regional GDP (rGDP). Since official statistics on provincial GDP in Cambodia are not sufficiently developed, we adopted an estimation method utilizing nighttime light data. Nighttime light data provide objective and quantitative information that can be consistently obtained over time and across regions, and previous studies (e.g., Barriga Cabanillas et al., 2023; Keola et al., 2015; Martínez et al., 2020) have also confirmed a strong correlation between nighttime light intensity and regional economic activity. Specifically, the estimation was conducted using the following data:

- Satellite data: VIIRS nighttime light data from 2014 to 2022
- Population and area data: Statistics from international organizations and the Cambodian government
- GDP baseline: Provincial GDP estimates available for 2021 (used to adjust each province's rGDP share relative to national GDP)

The estimation model employed provincial nighttime light intensity (total light, average light, and standard deviation) as well as population and area as explanatory variables and applied multiple regression analysis to estimate each province's rGDP. In particular, the standard deviation of light intensity was calculated as follows, representing the degree of spatial variation in brightness and serving as an effective indicator of urbanization and industrial concentration in the target region:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

where ρ is the standard deviation of light intensity, N is the number of pixels in the area, x_i is the nighttime radiance of each pixel, and μ is the average radiance of pixels within the area.

The results of the rGDP estimation are presented in

Table **2-5**. As expected, Phnom Penh shows an outstandingly high nighttime light intensity, reflecting its dominant share in the national economy. Battambang Province, a major agricultural and industrial region, also demonstrates a considerable rGDP. Furthermore, Sihanoukville Province (Preah Sihanouk), which hosts Cambodia's only deep-sea international port, indicates a higher economic scale than other coastal provinces.

Table 2-5 Estimated Results of rGDP using nighttime lights

Province/City	rGDP (Billion US$, 2021)	Share of rGDP (%, 2021)	rGDP (Billion US$, 2023)	Share of rGDP (%, 2023)
Banteay Meanchey	1.46	4.0	1.83	4.2
Battambang	2.21	6.0	1.68	3.9
Kampong Cham	1.78	4.8	1.42	3.3
Kampong Chhnang	1.03	2.8	0.94	2.2
Kampong Speu	2.00	5.4	1.63	3.8
Kampong Thom	1.01	2.8	0.98	2.3
Kampot	1.34	3.6	1.02	2.4
Kandal	3.08	8.4	2.35	5.4
Kep	0.06	0.2	0.07	0.2
Koh Kong	0.27	0.7	0.21	0.5
Kratie	0.62	1.7	0.46	1.1
Mondul Kiri	0.19	0.5	0.19	0.4
Oddar Meanchey	0.31	0.8	0.35	0.8
Pailin	0.15	0.4	0.13	0.3
Phnom Penh	9.97	27.1	21.85	50.5
Preah Sihanouk	1.84	5.0	1.06	2.5
Preah Vihear	0.34	0.9	0.35	0.8
Prey Veng	1.72	4.7	0.91	2.1
Pursat	0.71	1.9	0.79	1.8
Ratanak Kiri	0.35	0.9	0.37	0.9
Siem Reap	1.90	5.2	1.48	3.4
Stung Treng	0.30	0.8	0.25	0.6
Svay Rieng	1.04	2.8	0.93	2.1
Takeo	1.71	4.7	1.23	2.8
Tboung Khmum	1.42	3.9	0.83	1.9
Total	36.80	100.0	43.30	100.0

The share of rGDP in Cambodia's total GDP varies between 2021 and 2023. Because we use this share to allocate cargo volumes in the demand forecast, we use the two-year average. We calculated the 2024 rGDP by multiplying the IMF total GDP by the average rGDP share from 2021 and 2023. The 2024 rGDP and its share appear in the second and third columns of Table 2-6.

Using the 2024 rGDP as the base, we forecast rGDP for 2035 and 2050. For future national GDP, we use the values calculated in "2.2.6 GDP growth rate setting." Urban areas have many kinds of industries and active consumption, while rural areas mostly rely on agriculture, leading to a disparity in economic activity between them. This can also be seen in the 2024 rGDP. As Cambodia grows, these regional gaps and income gaps need to be reduced. "National Strategic Development Policy 2019-2023"[11] aimed to reduce the poverty rate from 13.5% in 2014 to 5.5% by 2023.

To measure income inequality, we use the Gini coefficient. First, we sort households by income from lowest to highest. Next, the cumulative share of households is plotted on the x-axis and the cumulative share of income on the y-axis to obtain the Lorenz curve. If income were perfectly equal, this curve would coincide with the 45-degree line (the line of perfect equality). In practice, the Lorenz curve lies below this line. The Gini coefficient is defined as the area between the Lorenz curve and the line of perfect equality divided by the area under the line of perfect equality. Figure 2-11 shows a schematic of the Gini coefficient. The Gini equals the area between the two lines divided by the area of triangle A + B.

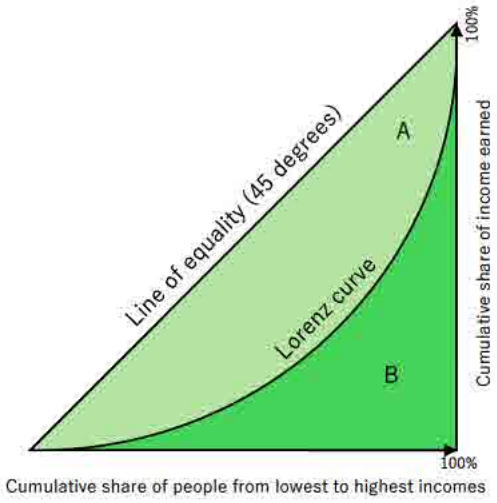


Figure 2-11 Schematic of the Gini Coefficient

To ease uneven economic growth across Cambodia, we decided to apply the idea of Gini analysis to the rGDP forecast. In principle, the Gini coefficient uses paired data of household size and household income. However, we could not obtain such paired data. Therefore, in this study, since

[11] http://cdc-crdb.gov.kh/en/strategy/documents/nsdp-2019-2023_en.pdf

we also wanted to look at the balance across provinces, we made a graph with provincial population on the x-axis and rGDP on the y-axis (see Figure 2-12).

The provincial Gini coefficient in 2024 is calculated at 0.27. Assuming that gaps across provinces will shrink in the future, we assumed increases in the 2050 shares of rGDP for provinces whose cumulative rGDP share is under 75 percent. Starting from the lower-rGDP provinces, we increased rGDP by factors from 1.4 down to 1.0. The Lorenz curve after this adjustment for 2050 is shown in Figure 2-12. The Gini coefficient falls from 0.27 in 2024 to 0.20.

According to interviews with the Council for the Development of Cambodia (CDC), many investment projects such as special economic zones (SEZs) are planned across the country. To reflect the effects expected from these projects, for each province (excluding Phnom Penh) with more than 20 planned projects, we raised its 2050 rGDP share by 0.1 percentage point and deducted the total increase from Phnom Penh's share.

For the 2050 rGDP levels, we allocate the 2050 national GDP calculated in Section "2.2.6 GDP growth rate setting" using the computed rGDP shares. For the 2035 rGDP shares, we linearly interpolate between the 2024 and 2050 shares. For the 2035 rGDP levels, we likewise allocate the 2035 national GDP from Section "2.2.6 GDP growth rate setting" using the computed shares.

Table 2-6 shows the resulting rGDP levels and shares.

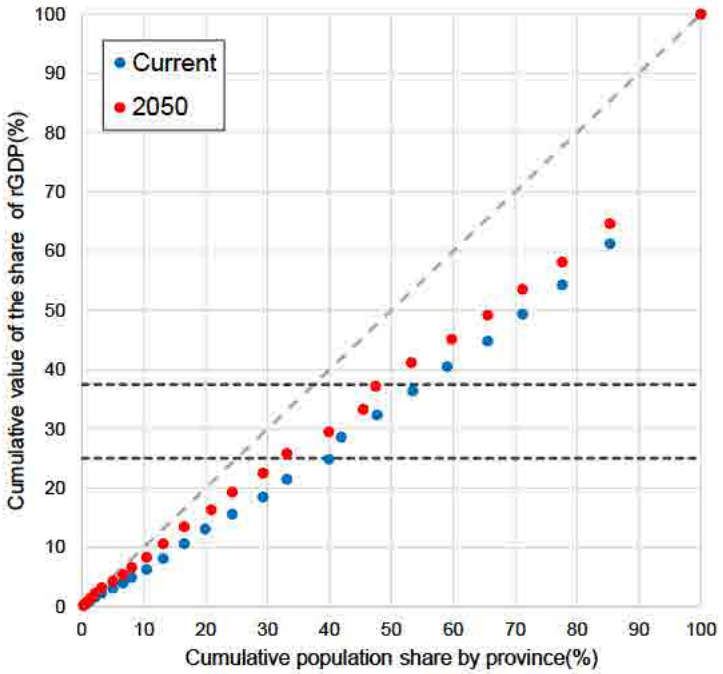


Figure 2-12 Relationship between Cumulative Provincial Population and Cumulative rGDP

Table 2-6 Results of rGDP Projections

Provice/City	rGDP (Billion US$, 2024)	Share of rGDP (%, 2024)	rGDP (Billion US$, 2035)	Share of rGDP (%, 2035)	rGDP (Billion US$, 2050)	Share of rGDP (%, 2050)
Banteay Meanchey	1.52	4.1	2.43	4.0	4.49	3.8
Battambang	1.83	4.9	2.94	4.8	5.41	4.6
Kampong Cham	1.51	4.1	2.48	4.0	4.79	4.1
Kampong Chhnang	0.92	2.5	1.62	2.6	3.39	2.9
Kampong Speu	1.71	4.6	2.73	4.4	5.15	4.4
Kampong Thom	0.93	2.5	1.64	2.7	3.41	2.9
Kampot	1.12	3.0	1.92	3.1	3.92	3.3
Kandal	2.56	6.9	4.10	6.7	7.67	6.5
Kep	0.06	0.2	0.11	0.2	0.27	0.2
Koh Kong	0.23	0.6	0.43	0.7	1.08	0.9
Kratie	0.51	1.4	0.93	1.5	2.04	1.7
Mondul Kiri	0.17	0.5	0.33	0.5	0.75	0.6
Oddar Meanchey	0.31	0.8	0.58	0.9	1.28	1.1
Pailin	0.13	0.4	0.25	0.4	0.57	0.5
Phnom Penh	14.40	38.8	23.04	37.6	41.77	35.4
Preah Sihanouk	1.38	3.7	2.31	3.8	4.66	3.9
Preah Vihear	0.32	0.9	0.60	1.0	1.33	1.1
Prey Veng	1.26	3.4	2.13	3.5	4.26	3.6
Pursat	0.69	1.9	1.25	2.0	2.68	2.3
Ratanak Kiri	0.34	0.9	0.62	1.0	1.40	1.2
Siem Reap	1.60	4.3	2.55	4.2	4.71	4.0
Stung Treng	0.26	0.7	0.49	0.8	1.11	0.9
Svay Rieng	0.92	2.5	1.63	2.7	3.51	3.0
Takeo	1.39	3.7	2.33	3.8	4.68	4.0
Tboung Khmum	1.07	2.9	1.86	3.0	3.81	3.2
Total	37.13	100.0	61.28	100.0	118.15	100.0

2.3 Demand forecast in 2050

2.3.1 Demand forecast in base case

Both the GDP growth rate and the GDP elasticity of container demand are known to decline as economies develop. Referring to "The Kingdom of Cambodia Preparatory Survey for Sihanoukville Port New Container Terminal Expansion Project," we assume that world GDP growth gradually decreases to 1.4 percent by 2050. For the GDP elasticity of container demand, we assume that both exports and imports decline to 1.1 percent by 2050.

Figure 2-13 shows the future GDP growth rate for Cambodia projected in Section "2.2.6 GDP growth rate setting". Figure 2-14 shows the future GDP elasticity of import containers, set to converge to 1.1 by 2050. Multiplying these two gives the growth rate of import container throughput. Figure 2-15 shows the future import container throughput obtained by applying the annual growth rate year by year starting from 2024. This throughput covers laden containers only. As a result, import laden container throughput in 2050 is 2,771,925 TEU.

In the same way, we forecast future demand for export containers. Figure 2-16 shows the world real GDP growth rate set to converge to 4.0 percent by 2050. Figure 2-17 shows the future GDP elasticity of export containers set to converge to 1.1 by 2050. As with imports, multiplying the world real GDP growth rate by the GDP elasticity yields the growth rate of export container throughput. Figure 2-18 shows the future export container throughput obtained by applying the annual growth rate year by year starting from 2024. This throughput covers laden containers only. As a result, export laden container throughput in 2050 is 1,992,806 TEU.

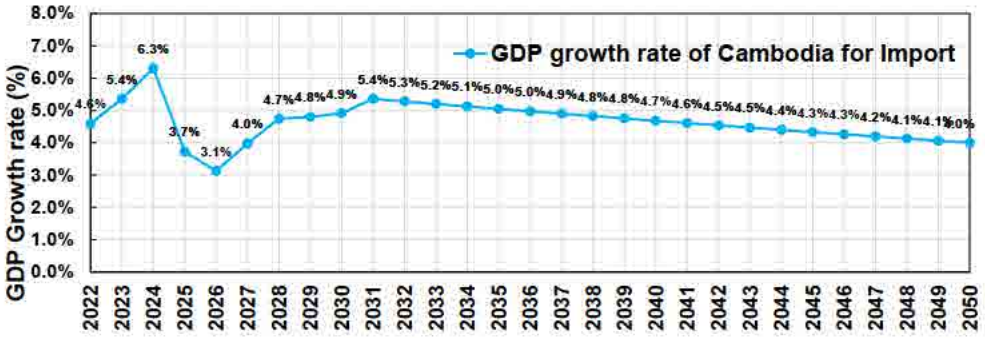


Figure 2-13 Cambodia's real GDP growth rate forecast

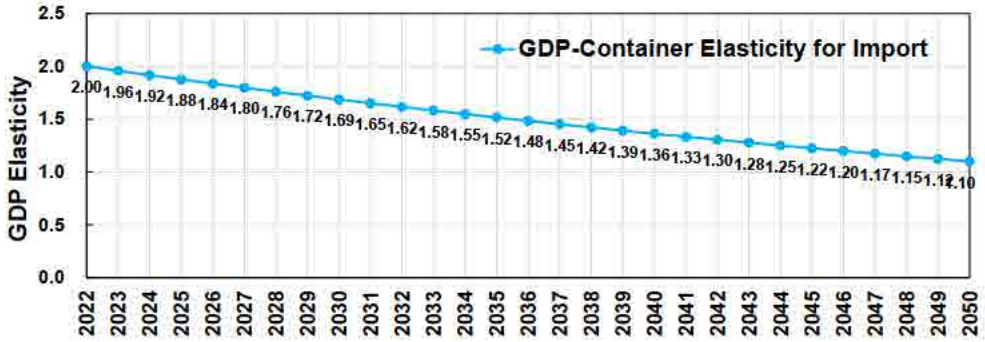


Figure 2-14 GDP elasticity forecast for import containers

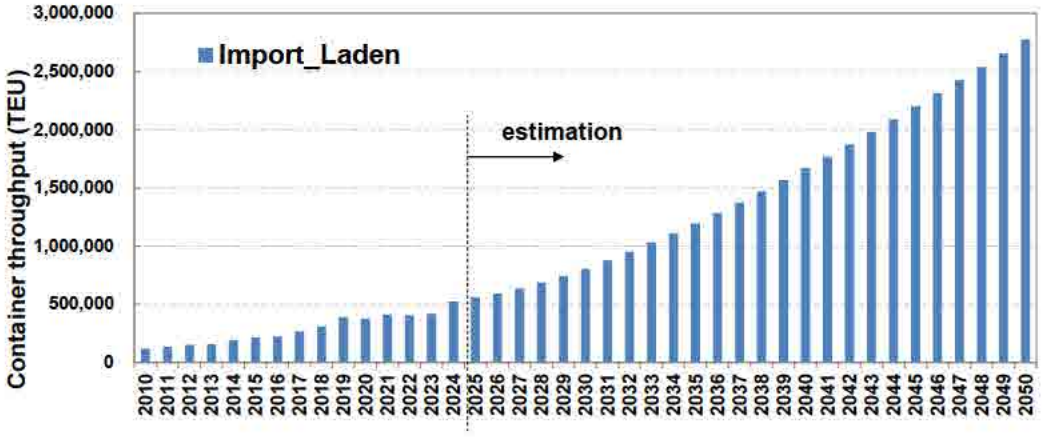


Figure 2-15 Demand forecast for import container throughput (laden)

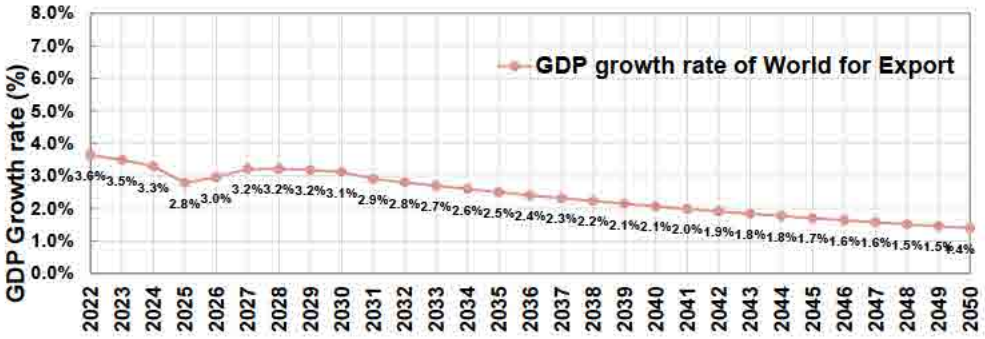


Figure 2-16 World real GDP growth rate forecast

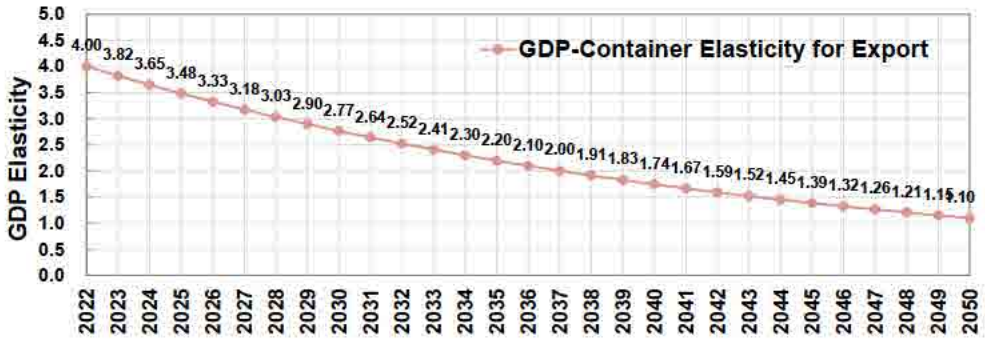


Figure 2-17 GDP elasticity forecast for export containers

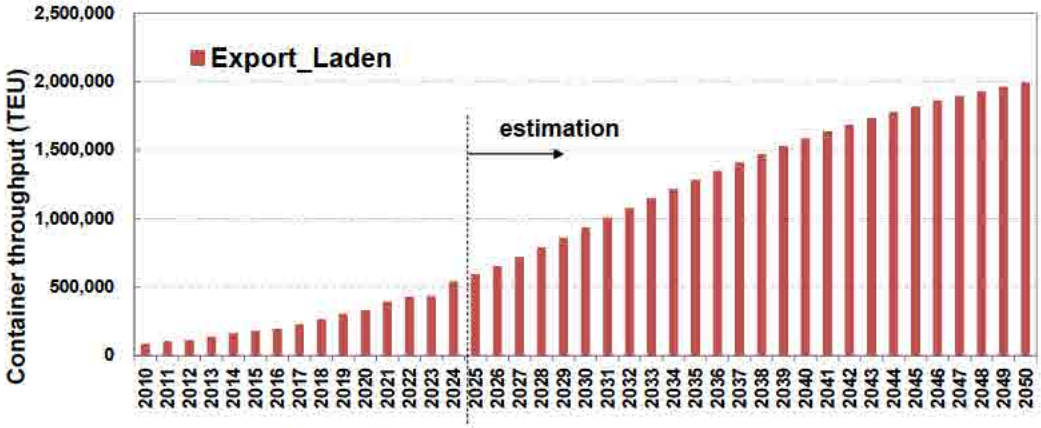


Figure 2-18 Demand forecast for export container throughput (laden)

Eventually, total container throughput must account for both laden and empty containers. Using data from 2020–2024, we estimate the share of empty containers at 27 percent. We therefore apply the same 27 percent when converting projected laden-container throughput to total throughput. The combined results (laden + empty) are presented in Figure 2-19 and Table 2-7. On this basis, total container throughput in 2050 is forecasted to reach 6,527,029 TEU.

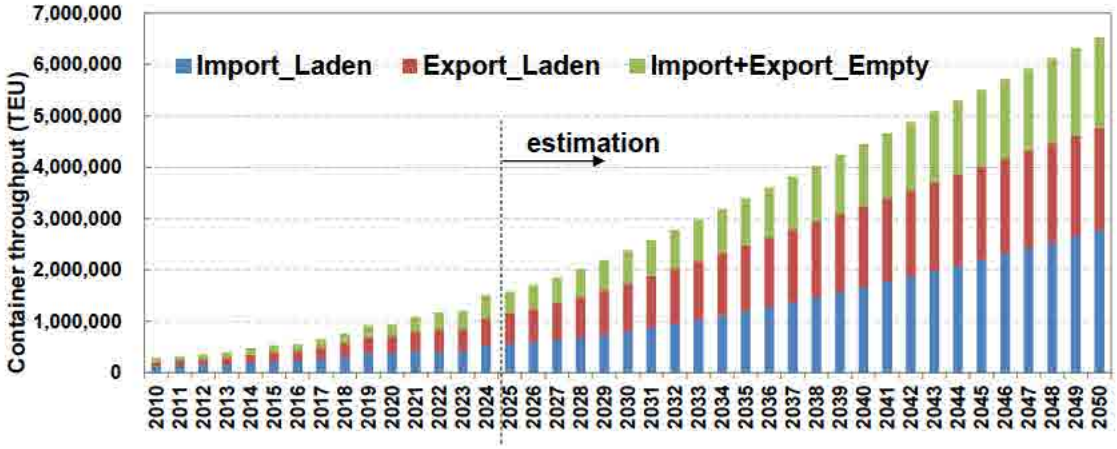


Figure 2-19 Demand forecast results for container throughput

Table 2-7 Container demand forecast in 2050

	Laden	Empty	Target year value in 2024	Forecast value for 2035	Forecast value for 2050	2050 / 2024
Import	2,771,925	1,025,233	761,725	1,636,535	3,797,158	5.0
Export	1,992,806	737,065	750,666	1,758,388	2,729,871	3.6
Total	**4,764,731**	**1,762,298**	**1,512,391**	**3,394,923**	**6,527,029**	**4.3**

2.3.2 Demand forecast taking into account uncertainty in economic activities

Given the uncertainty in the outlook for economic activities, we prepared three scenarios using the container throughput estimated in Section "2.3.1 Demand forecast in base case" as the Base Case. The High Case assumes GDP growth 0.5 percentage points higher than the Base Case throughout the period, and the Low Case assumes GDP growth 0.5 percentage points lower.

Estimates were produced under these assumptions. For import container throughput, we applied the High and Low Cases to Cambodia's real GDP growth rate shown in Figure 2-20. For export container throughput, we applied the High and Low Cases to the world real GDP growth rate shown in Figure 2-21.

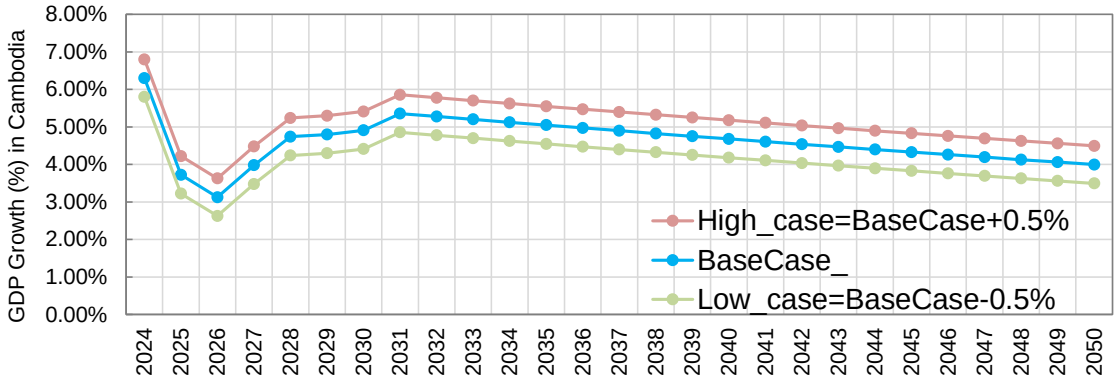


Figure 2-20 Cambodia's Real GDP Growth Rate Scenarios

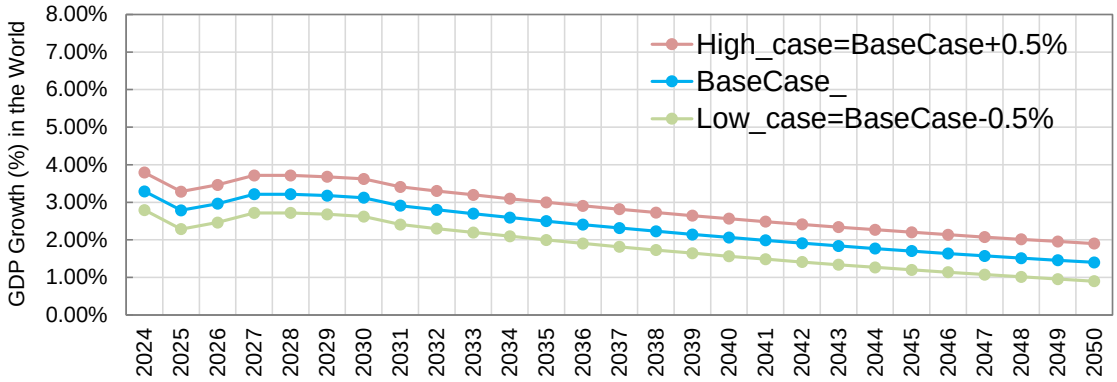


Figure 2-21 World Real GDP Growth Rate Scenarios

As in Section "2.3.1 Demand forecast in base case", we set the empty-container share at 27 percent and present the demand-forecast results for each case (see the figure and table below). By 2050, total container throughput is projected to increase to about 8.2 million TEU in the High Case and about 5.3 million TEU in the Low Case.

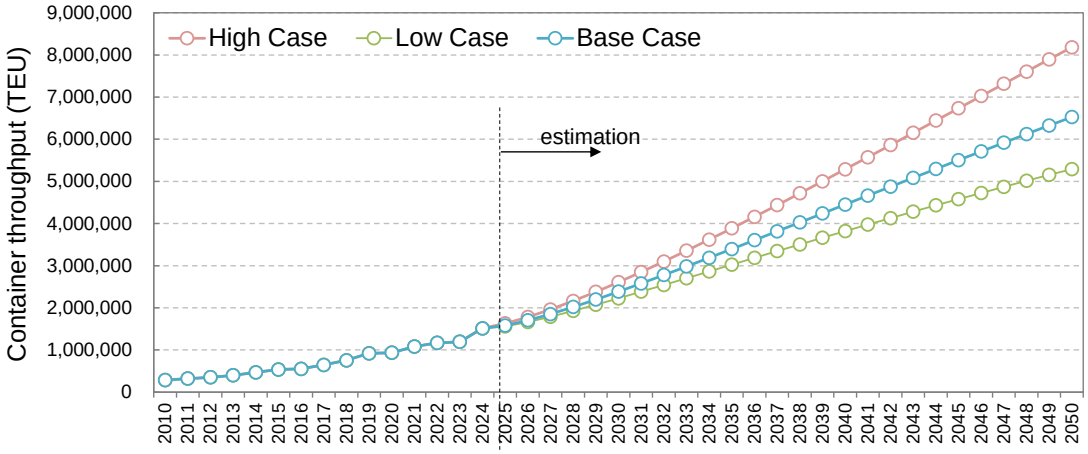


Figure 2-22 Container throughput demand forecast results by case

Table 2-8 Demand forecast by scenario

	Container Throughput in 2035	**Container Throughput in 2050**
Low Case	**3,025,210**	**5,292,438**
Base Case	**3,394,923**	**6,527,029**
High Case	**3,886,525**	**8,182,996**

2.4 Port choice: Developing a logit model

2.4.1 Introduction logit model

Logit model is a statistical technique used to forecast the probability of a binary event, meaning an outcome with only two possible results. Instead of predicting a continuous value like linear regression, a logit model is designed for classification, calculating the likelihood that an event will happen. It accomplishes this by taking a linear equation's output and applying a logistic function to it, which converts the result into a probability value.

Expert team uses this method to estimate container distribution in Cambodia and neighboring countries based on the development planning and future road network improvement. This model is prepared to estimate container distribution for import and export containers among the four destination port utilities: Phnom Penh Autonomous Port (LM17), Sihanoukville Autonomous Port (PAS), Cai Mep Port (CMP), and Leam Chabang Port (LCP). The parameters of the logit model equation were calibrated using the actual container distribution in 2023. The overall concept of the logit model is illustrated in Figure 2-23.

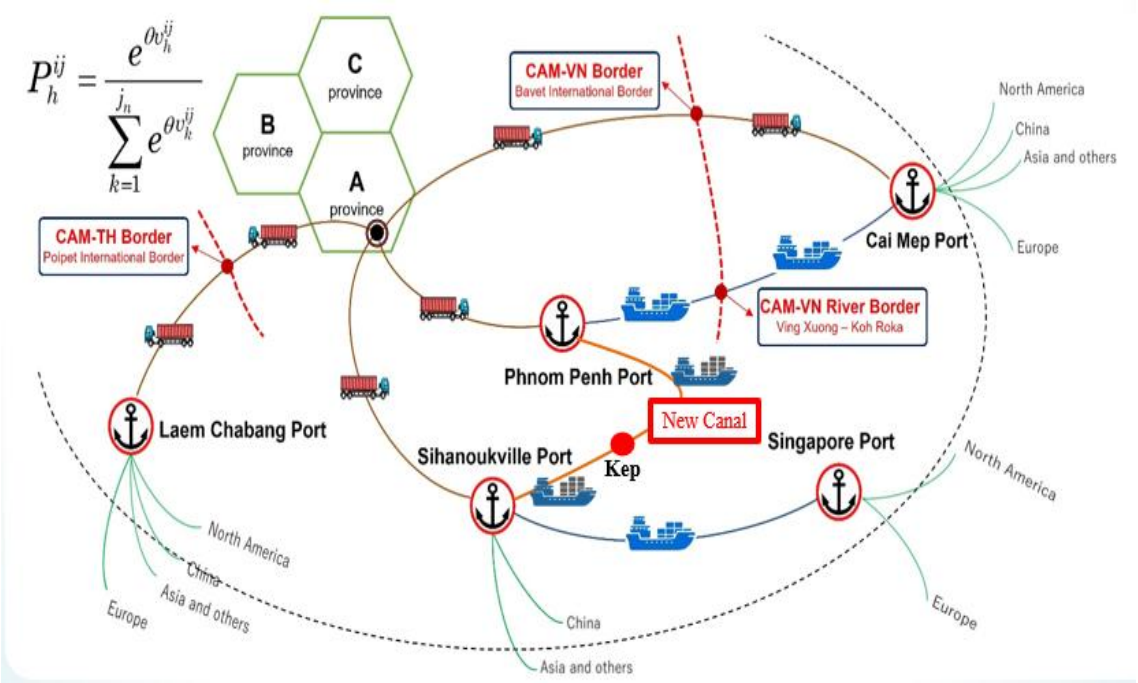


Figure 2-23 Logit model concept for port choice

In this study, there are four port destinations: A; Asia and other, B; China, C; Europe, D; North America. The distributions of container cost (USD $/TEU) and time (hour) consumption are fundamental inputs for developing the model. The probability of choosing a port and port utility function are defined as Eq. 2.1 and Eq. 2.2, respectively. The overall input of modelling is detailed in Figure 2-24.

Probability of choosing a port:

$$P_h^{ij} = \frac{e^{\theta V_h^{ij}}}{\sum_{h=1}^{n} e^{\theta V_h^{ij}}} \qquad \textbf{Eq. 2.1}$$

$$v_h^{ij} = -\underbrace{(LTc_{ij} + PTc_{ij} + MTc_{ij} + ... + \varepsilon_{c(h)i}^{ij})}_{\text{Cost Input (USD/TEU)}} - vt \underbrace{(LTt_{ij} + RTt_{ij} + DTt_{ij} + ... + \varepsilon_{t(h)}^{ij})}_{\text{Time Input (hour)}} \qquad \textbf{Eq. 2.2}$$

Where, $\sum_{h=1}^{n} P_h^{ij} = 1$; a total probability of single direction.

- P_h^{ij} ; Probability of port choice by using route (h) from origin (i) to destination (j).
- n ; Number of route selection.
- v_h^{ij} ; The deterministic term of each route selection.
- θ ; Time consumption coefficient of each route selection.

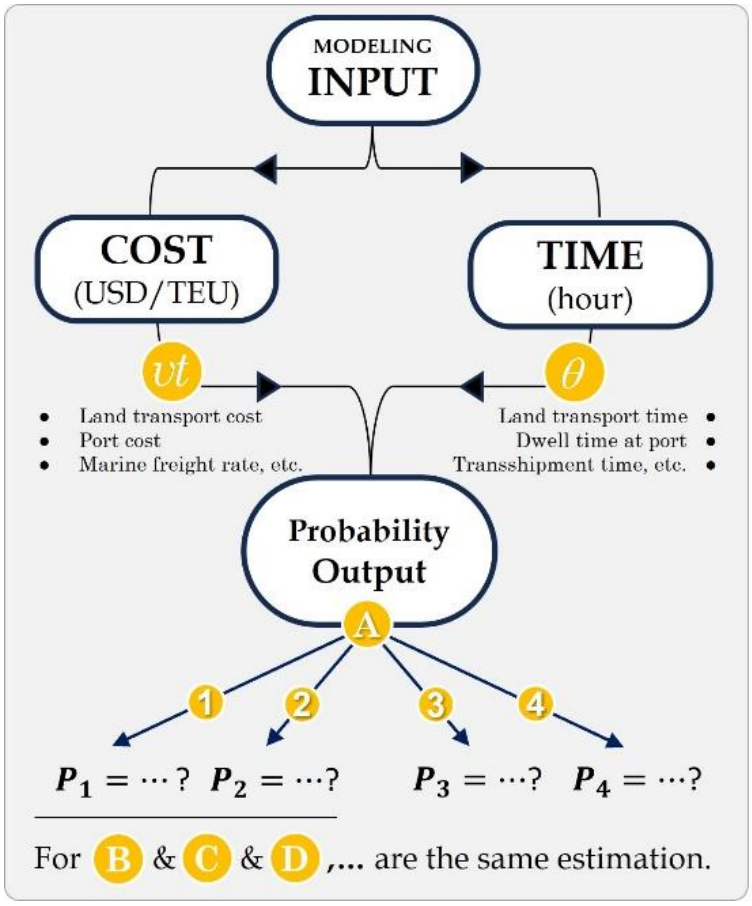


Figure 2-24 Modelling input concept

Figure 2-24 shows the modelling concept applied in this logit model. In this modeling concept there are two important aspects: the cost and time in transporting/shipping a container between the provinces of Cambodia and the final destination as mentioned in the modelling concept matrices for export and import in Figure 2-25 and Figure 2-26.

Figure 2-25 shows four export routes in which containers are transported from the provinces to destination ports in Cambodia (PPAP/PAS) or neighboring countries (CMP/LCP) via truck and then transported via waterway to their final destination.

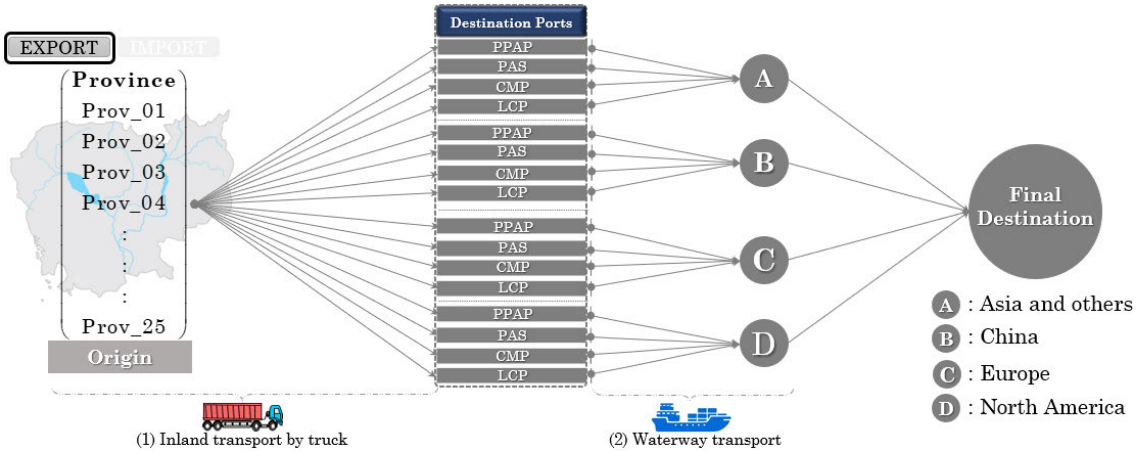


Figure 2-25 Modelling concept matrix for export

Figure 2-26 shows the routes in which containers are imported from foreign countries (the points of origin) to their final destinations within Cambodia's provinces. Containers are transported by waterway from the origin country to a destination port in Cambodia. From there, containers are transferred onto a truck for inland transport to the final destination.

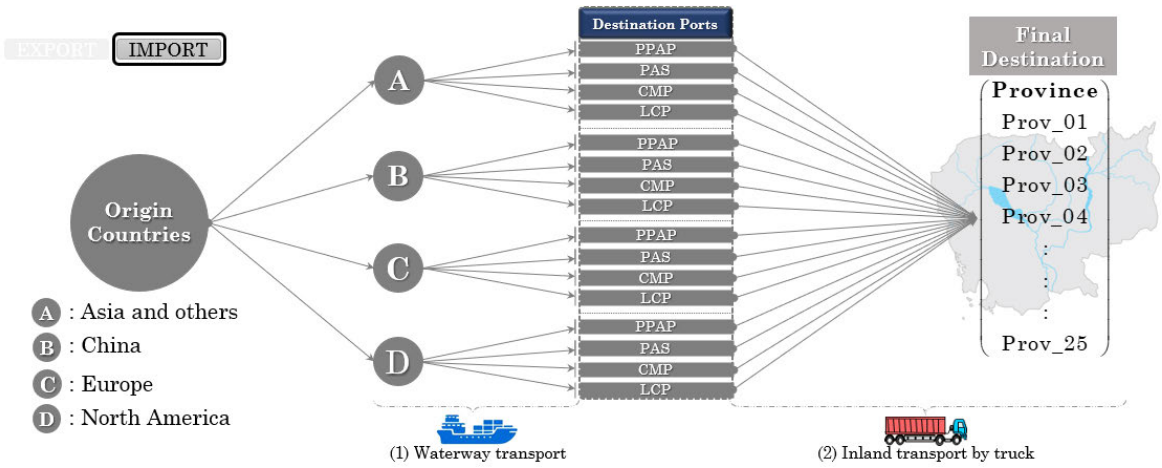


Figure 2-26 Modelling concept matrix for import

Furthermore, regarding the modelling, the overall concepts of exporting and importing a container to/from a province of Cambodia are identified, while the challenges and competitiveness of port utilities, as well as inland transport cost and time in the present and future, are also defined within this model.

a) Predictive probability of port selection for each province of Cambodia
b) Allocate and understand the number of provincial container throughputs in Cambodia
c) Optimize the route selection leading to the port for each province for export and import
d) Identify the value of VT and θ in terms of export and import for Cambodia and their goodness-of-fit in setting pre-conditions for the present study
e) Develop a model to estimate the share (%) and control volume (TEU) of port choices
f) Be ready for accountability and capacity-building related to port capacity and facility, etc.

2.4.2 Pre-conditions and modeling

(1) Flowchart of logit model

The Figure 2-27 Flowchart of logit model shows the process used to estimate the future share of destination ports in 2050. Container statistics from 2023 were collected from GDCE, PPAP, and PAS, and then compiled into Origin–Destination (OD) data from GDCE. These OD data were separated into export and import flows and combined with cost and time inputs obtained from a transportation data survey. Using these inputs, a base model for 2023 was developed to generate parameters for export (VtEX, θEX) and import (VtIM, θIM) flows. At the same time, future route transport development was incorporated by applying cost and time regressions to transportation distance. This made it possible to estimate transportation cost in US$/TEU and transportation time in hours. The regressions established in 2023 were adopted to ensure consistency in future projections using Vt and θ. The resulting transportation cost and time estimates were then linked back to the export and import flows, allowing the distribution of containers among potential destination ports ($P1$, $P2$, $P3$, $P4$, …) to be calculated. Finally, this process provided an estimate

of the share of destination ports in 2050.

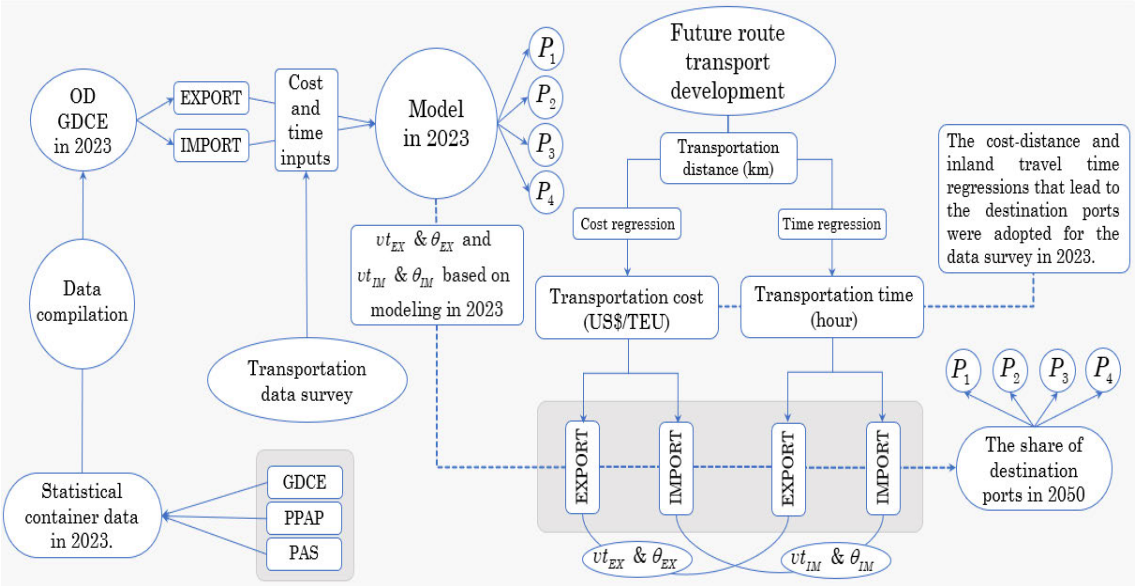


Figure 2-27 Flowchart of logit model

(2) Data input

The data from the PPAP and PAS covers container imports and exports via the Mekong River, passing through Vietnamese ports, and through Cambodia's seaports. However, the data from these ports does not cover all of Cambodia's container trade, as some containers are transported by truck to neighboring ports in Thailand and Vietnam. Since all import and export points require customs clearance, it's expected that the General Department of Customs and Excise (GDCE) data would cover all container trade in Cambodia. The expert team, therefore, examined if the GDCE data aligned with the container data from PAS and PPAP. As shown in Table 2-9, the analysis reveals that the difference in values between the GDCE and the port authorities in 2023 is less than 5%. This result allowed the expert team to confirm the reliability of the data.

Table 2-9 Comparison of data from GDCE with PPAP and PAS

2023		Ports	Import (Laden)	Export (Laden)	Total (Laden)	Total (Empty)	Total (Laden+ Empty)
PPAP & PAS	(a)	PPAP	54,652	196,314	250,966	145,259	396,225
	(b)	PAS	361,371	238,633	600,004	197,774	797,778
	(c)	Total	416,023	434,947	850,970	343,033	1,194,003
GDCE	(d)	PPAP (The third countries via ports in Vietnam)	53,763	195,576	249,339		
	(e)	PAS	354,969	233,015	587,984		
	(f)	Sub Total (PPAP + PAS)	408,732	428,591	837,323		
	(g)	Vietnam bounded by truck	54,560	6,255	60,815		
	(h)	Thailand bounded by truck	60,302	9,640	69,941		
	(i)	Transshipped at Vietnam	112,826	110,599			
	(j)	Transshipped at Thailand	4,645	4,916			
	(k)	Total	641,065	560,000	968,079		
Comparison	(d)/(a)		0.98	1.00	0.99		
	(e)/(b)		0.98	0.98	0.98		
	(f)/(c)		0.98	0.99	0.98		

(a) General Department of Customs and Excise of Cambodia data

The analysis of GDCE container data conducted by the expert team (refer to Figure 2-28) revealed that the shares of containers exported from Cambodia are as follows:

- 34.9% of exports are from Phnom Penh to Vietnamese ports by barge
- 41.6% of exports are from Sihanoukville Port
- 23.4% of exports via trucking to Thailand ports or Vietnamese ports, or were destinated to Thailand and Vietnamese. (19.7% of exports are via truck transport to Vietnamese ports, 0.9% of exports are via truck transport to Thailand ports, only 1.7% of exports were destined for Thailand and 1.1% for Vietnam).

The analysis also shows the share of containers imported into Cambodia from foreign countries:

- 8.4% of imports arrived in Phnom Penh from Vietnamese ports by barge
- 55.4% of imports arrived at Sihanoukville Port
- 36.2% of imports via trucking from Thailand ports or Vietnamese ports, or were destinated to Thailand and Vietnamese. (17.6% of imports are via truck transport from Vietnamese ports, 0.7% of imports are via truck transport from Thailand ports, 9.4% of imports were originated from Thailand and 8.5% from Vietnam).

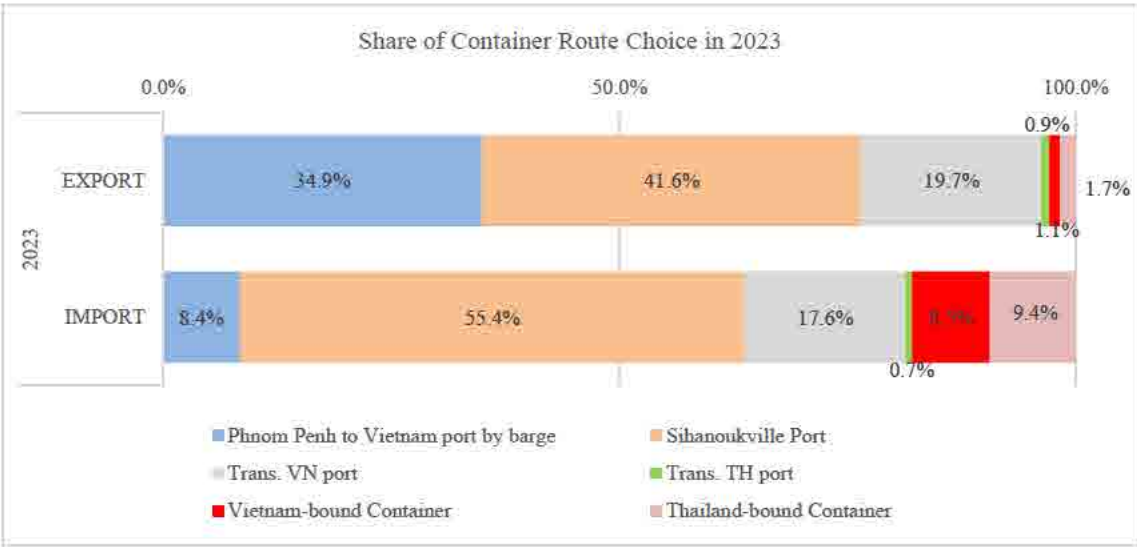


Figure 2-28 Share of container route choice in 2023

The provincial container throughputs in Cambodia in 2023 were classified and input into logit model using the latest GDCE statistical data on container customs clearance from 2020 to 2023. The TEU container share of each province is re-calibrated to estimate the probability of port selection in the present study as well as the simulation in 2050. Table 2-10, presents an analysis of GDCE data, detailing the container imports and exports for each province. However, in this study, the exported containers will be allocated to the provinces of Cambodia based on the provincial customs data, while imported containers will be allocated to the final destination province by Regional GDP (rGDP). Moreover, to address setting pre-conditions of the model to the actual share of laden container at the destination ports in 2023, the statistical container data from GDCE, PPAP, and PAS were compiled and converted to TEU accordingly.

Table 2-10 Customs clearance data on containers in 2023

No.	Province	Export in 2023		Import in 2023	
		% Share	TEUs	% Share	TEUs
01	Banteay Meanchey	0.36%	2,017	6.95%	44,525
02	Battambang	0.21%	1,199	0.24%	1,530
03	Kampong Cham	0.14%	786	0.54%	3,438
04	Kampong Chhnang	0.00%	-	0.00%	-
05	Kampong Speu	0.00%	-	0.00%	-
06	Kampong Thom	0.00%	-	0.00%	-
07	Kampot	0.00%	-	0.00%	-
08	Kandal	0.00%	12	0.15%	938
09	Kep	0.00%	-	0.00%	-
10	Koh Kong	0.64%	3,595	1.41%	9,023
11	Kratie	3.51%	19,633	2.08%	13,333
12	Mondul Kiri	0.00%	-	0.00%	-
13	Oddar Meanchey	0.00%	-	0.00%	15
14	Pailin	0.11%	608	0.10%	670
15	Phnom Penh	64.05%	358,662	19.88%	127,426
16	Preah Sihanouk	14.47%	81,027	47.69%	305,734
17	Preah Vihear	0.00%	-	0.00%	-
18	Prey Veng	0.00%	-	0.09%	595
19	Pursat	0.00%	-	0.00%	-
20	Ratanak Kiri	1.56%	8,743	0.75%	4,830
21	Siemreap	0.00%	-	0.00%	-
22	Stung Treng	0.00%	-	0.00%	-
23	Svay Rieng	14.95%	83,716	20.12%	129,009
24	Takeo	0.00%	-	0.00%	4
25	Tboung Khmum	0.00%	-	0.00%	-
	TOTAL	100.0%	559,997	100.0%	641,067

For both export and import, the provincial share of container in 2023 is concentrated by the customs official at each province based on the General Department of Customs and Excise of Cambodia (GDCE). Within GDCE data, for container throughputs in Cambodia are recorded in feet, while the container size will be converted to TEU as shown in the table below.

Table 2-11 The conversion of container size

Container Size	Coefficient/TEU(20F)
10F	0.5
20F	1
40F	2
45F	2.25

In addition, important information such as country transit, country of destination, and country of export of the container between Cambodia and foreign countries are also provided in the GDCE data.

(b) Regional GDP data

The volume of imported containers in each Cambodian province is determined by its regional GDP (rGDP). The expert team assumes that cargo demand in each zone is proportional to its rGDP. When a region's rGDP is low, consumption is primarily focused on basic commodities such as food and clothing. As rGDP increases, however, higher-priced goods like automobiles, housing, and personal computers become more common. Concurrently, non-cargo businesses, such as finance and information technology (IT), also begin to emerge.

Since regional GDP data is not currently available in Cambodia, the expert team employed a substitute method. In other reports, population data is often used, but the team chose to estimate rGDP using the night light intensity from satellite images of Cambodia in 2023. This method has become increasingly popular as satellite resolution improves and is now commonly used in countries where official regional GDP data is unavailable.

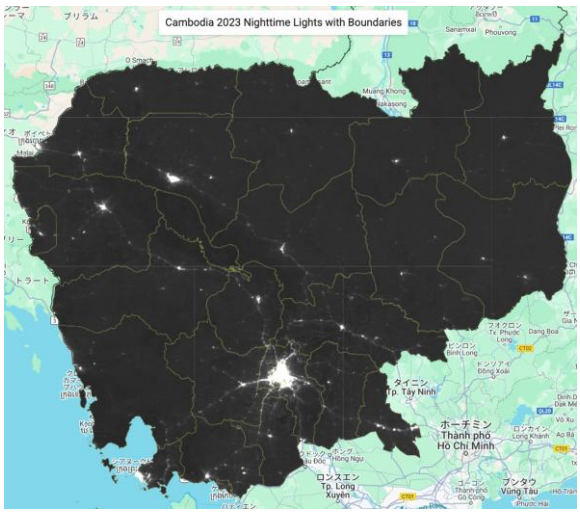


Figure 2-29 Night light intensity of Cambodia in 2023

Table 2-12 Regional GDP of Cambodia in 2023 by night light intensity

Province	Share (%)
Banteay Meanchey	4.10%
Battambang	4.94%
Kampong Cham	4.05%
Kampong Chhnang	2.48%
Kampong Speu	4.60%
Kampong Thom	2.50%
Kampot	3.01%
Kandal	6.90%
Kep	0.16%
Koh Kong	0.61%
Kratie	1.37%
Mondul Kiri	0.47%
Oddar Meanchey	0.82%
Pailin	0.35%
Phnom Penh	38.78%
Preah Sihanouk	3.72%
Preah Vihear	0.86%
Prey Veng	3.38%
Pursat	1.87%
Ratanak Kiri	0.91%
Siemreap	4.30%
Stung Treng	0.71%
Svay Rieng	2.49%
Takeo	3.75%
Tboung Khmum	2.89%
Total	**100.00%**

(3) Data compilation

The GDCE database, which contains all the laden container throughputs in Cambodia in 2023, was mainly used to set the origin-destination (OD) and provincial shares as well as size of containers. The terms of "data compilation" was used to determine the number of container throughputs in 2023, based on currently observed route choices:

- Phnom Penh Autonomous Port (PPAP): This container route involves transportation through Vietnam's ports via the Mekong River.
- Sihanoukville Autonomous Port (PAS): This container route involves direct transportation to international destinations or transshipment at third countries, such as Singapore, Malaysia, etc.
- Vietnam port transportation by truck: This is a container route that utilizes the services of Vietnamese ports, requiring the container to be transported by truck to/from the Vietnam port.
- Vietnam bounded: This refers to containers whose origin or destination is Vietnam.
- Thailand port transportation by truck: This is a container route that utilizes the services of Thai ports, requiring the container to be transported by truck to/from the Thailand port.

- Thailand bounded: This refers to containers whose origin or destination is Thailand.

(a) Fitting the present model

Based on GDCE data on container throughput, the total volume of container exports and imports between Cambodia and foreign countries in 2023 were estimated at 559,997 TEUs and 641,067 TEUs, respectively. However, when excluding the portion of container throughput that is bound for Vietnam and Thailand, those figures become 544,106 TEUs and 526,203 TEUs, respectively, which we adopted for the logit model. The share of all laden container throughputs in Cambodia by using destination ports in 2023 is shown in Figure 2-30. The export and import containers transported from Phnom Penh to Vietnam port by barge account for at 35.94% and 10.22%, respectively. In 2023, Sihanoukville port played a large role in the container distribution between Cambodia and final destinations in third countries, accounting for 42.83% in terms of exports and 67.46% in the case of imports. However, the share of containers between Cambodia and third countries using Vietnamese ports is also fairly high in 202 (20.33% in the case of exports and 21.44% in the case of imports), especially compared to the use of ports in Thailand.

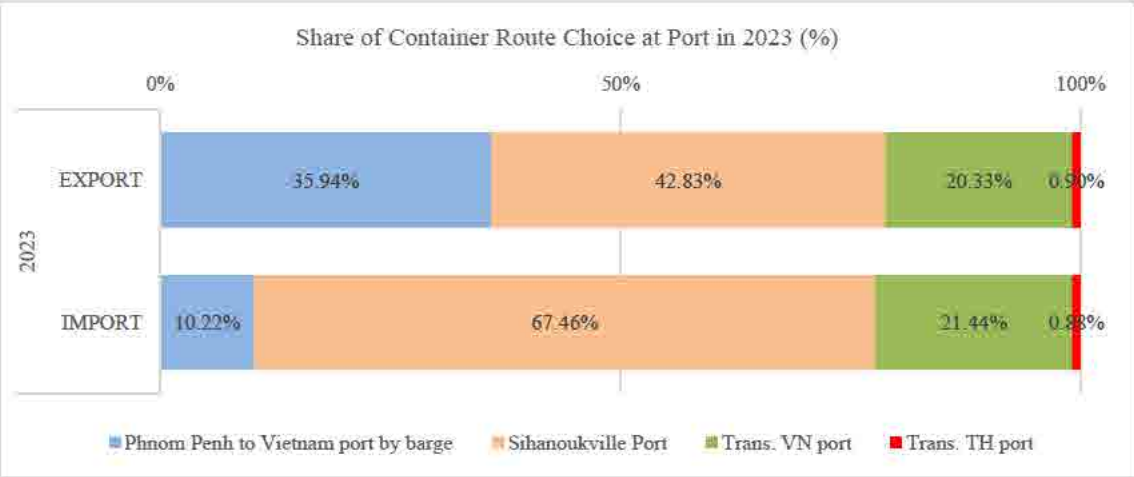


Figure 2-30 Share of laden containers at destination ports in 2023

Regarding inland transportation cost input for this model, the cost from a province to each port destination was estimated by the cost-distance regressions separately in terms of export and import (JICA data survey). It is assumed that there was no difference in marine sailing time from the four destination ports to the final destination regions which are: Asia and others, China, Europe, and North America, to reduce the complexity in maximizing the value of Vt and θ.

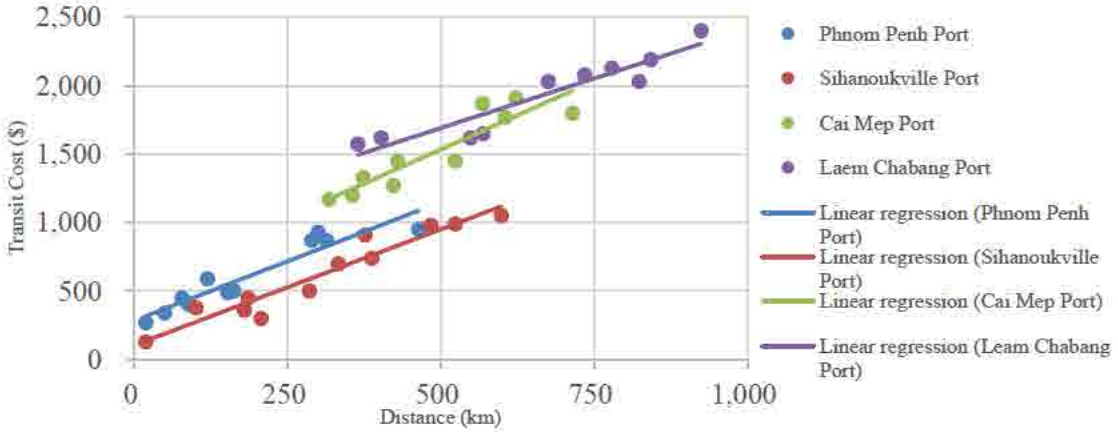


Figure 2-31 Inland transport cost regression-export

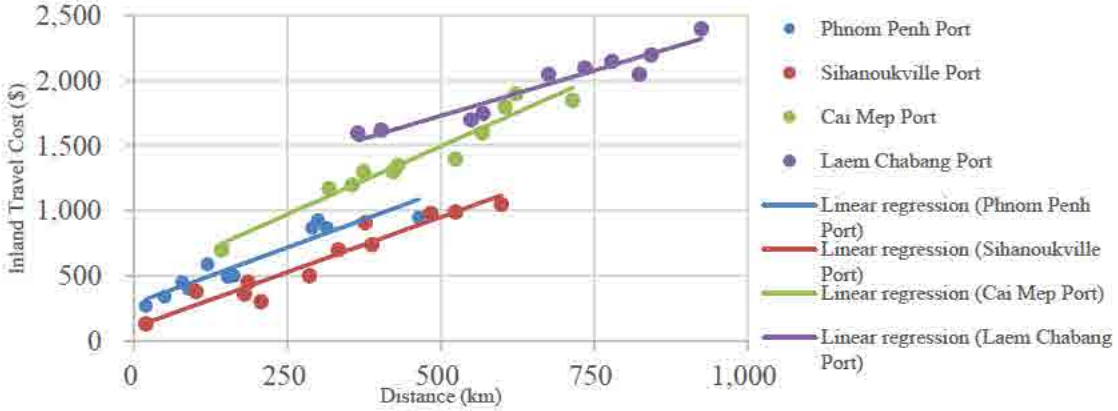


Figure 2-32 Inland transport cost regression-Import

In addition to the inland transport cost, there are other costs such as:

- Terminal handling charge (THC): A port charge levied by terminal operators or port authorities on shippers or shipping lines to cover the costs of handling cargo containers at the port or terminal.
- Port charge LO/LO: A charge for moving or lifting a container at a facility away from the main port.
- Infrastructure Fee: A charge applied when a container is trucked to or from a Vietnamese port, primarily to fund local road and port infrastructure development and maintenance.
- Toll fee through MOC BAI border: An official charge levied by local Vietnamese government authorities at the Moc Bai international border gate (Tay Ninh province) for commercial vehicles, particularly container trucks, crossing into or out of Vietnam.
- Customs Clearance fee: is a crucial charge in international logistics, but it is important to understand that is a service fee collected by an intermediary, separate from government-imposed taxes and duties. It is always a charge levied by a Customs broker or freight forwarder for handling the complex administrative process of moving goods.

- Transit Customs Clearance fee: A charge for the process of allowing goods to pass through a country (the transit country, e.g., Vietnam) without being formally imported or consumed there. The fee is charged by a customs broker or forwarder for a transit shipment.
- Documentary: A charge in shipping and logistics referring to the administrative costs of processing key paperwork, covering items like the Bill of Lading (BL), Filing Fees, and Telex Release.
- Other Pay: A catch-all for local, administrative, and miscellaneous surcharges not part of the main freight line item, such as Agency Fee, Container Seals at Dry Ports, Lift-On/Lift-Off for empty containers, and Lift-On/Lift-Off fees at borders.
- Ocean Freight rate: is charge for the core charge by a shipping line or carrier to transport goods by sea from the designated port to origin to the destination port.
- Sanitary and Phytosanitary (SPS) Transit fee: is a mandatory surcharge applied to agriculture and food products that temporarily pass through a country port (such as those in Vietnam or Thailand) to cover the costs of inspecting the cargo and ensuring it does not introduce any foreign pests or diseases into the transit territory. Based on interviews with a transportation company and a related association, the SPS payment is always reported to be around $30-$35 per ton, and this cost is understood to be an unofficial payment (or informal cost).

The JICA Expert Team also collected quotations from transportation and shipping companies. Table 2-13 and Table 2-14 show the payments in addition to the inland transportation cost.

Table 2-13 other payment in addition to the inland transport cost (USD)

Port	THC	Port charge LO/LO	Infra structure fee	Toll fee through MOC BAI border	Customs clearance fee	Transit Customs clearance fee	Documentary fee	Other Pay
Phnom Penh port	150	50	0	0	190	80	95	65
Sihanoukville port	150	50	0	0	235	0	85	120
Vietnam port	150	90	100	100	245	220	130	195
Thailand port	120	75	0	0	235	460	100	110

Table 2-14 Ocean Freight rate

Port	Marine transport cost (USD) in 2023							
	Asia and others		China		Europe		North America	
	Export	Import	Export	Import	Export	Import	Export	Import
Phnom Penh port	350	515	80	420	500	150	1,550	2,215
Sihanoukville port	400	415	50	150	500	600	1,500	2,115
Vietnam port	220	65	40	260	450	200	1,500	1,125
Thailand port	320	210	300	260	450	300	1,650	1,125

Moreover, transportation time is also considered in the logit model. The JICA Expert Team collected time information from transportation companies, shipping lines, and related associations. This model includes the current transportation time, such as:

- inland travel time: is defined as the time needed to truck containers to or from a port from their origin or destination province. The JICA Expert Team collected actual travel times between provinces and four ports (Phnom Penh, Sihanoukville, Vietnam, and Thailand) and then created a regression (Figure 2-33) using this actual time against Google Maps data for input into the logit model.

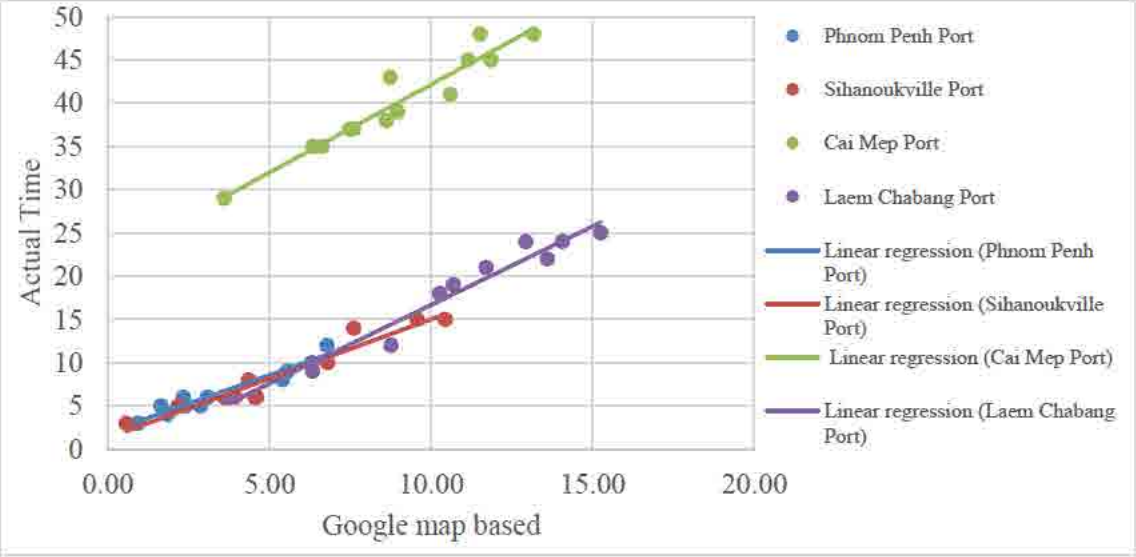


Figure 2-33 Time input regression

- Transit container at border: is the time spent on the processing of documents and the loading/unloading or physical handoff of container at a border, especially when trucking container from Cambodia to a neighboring country port. As interview with transport

company, it will take around 3 hours at the border Cambodia-Vietnam or Cambodia-Thailand.

- Dwell time at port: is the total time a container spends idle in a terminal, from the moment it is unloaded from or loaded onto a vessel until it exits the terminal gate. Table 2-15 shows the dwell time at four ports; this data was collected from transportation companies in 2023.

Table 2-15 Dwell time at port

No.	Destination Ports	Export		Import	
		day	hour	day	hour
1	Phnom Penh port	5	120	5	120
2	Sihanoukville port	4	96	4	96
3	Vietnam Port	2	48	2	48
4	Thailand Port	2	48	2	48

- River transportation time: refers to the travel time on a river, typically utilizing barges, from a river port to a seaport or vice versa. The single established route is the Mekong River from Cambodia to a Vietnam port. Based on information from the Phnom Penh Autonomous Port, this Mekong River from the Port at Lower Mekong (LM17) to a Vietnam port takes 21 to 35 hours, covering a distance of 345–373 km.



Figure 2-34 Phnom Penh Autonomous Port (PPAP) Container Terminal LM17

- Marine travel time: is the duration a container vessel takes to travel by sea from a seaport to its final destination port. The marine travel times from the four ports to the final

destinations are shown in the table below, compiled from interviews with transportation companies and validated using the Fluent Cargo website.

Table 2-16 Marine travel time

Port	Asia and other		China		Europe		North America	
	days	hours	days	hours	days	hours	days	hours
Phnom Penh port	8.58	206	8.04	193	33.04	793	21.71	521
Sihanoukville port	13.00	312	6.42	154	34.17	820	27.63	663
Vietnam port	6.58	158	6.04	145	31.04	745	19.71	473
Thailand port	10.38	249	5.92	142	38.58	926	28.04	673

2.5 Modelling results

The modelling results for exports and imports in 2023 are shown in Table 2-17 below. The logit model calibration results are highly accurate for container traffic, with the Mean Absolute Error (MAE) being only 0.00% for exports and 0.01% for imports. This indicates the model achieved nearly perfect accuracy on the evaluated data. The calibrated parameters (Vt equal to 1.25 and θ equal to 0.005) will be used for future simulations.

Table 2-17 Results of modelling in 2023

	Port Destination	Calculation Based		Control Volume in 2023	
		TEUs	Share (%)	TEUs	Share (%)
EXPORT	Phnom Penh to Vietnam port by barge	195,585	35.95%	195,576	35.94%
	Sihanoukville port	232,972	42.82%	233,015	42.83%
	Trans. VN port	110,638	20.33%	110,599	20.33%
	Trans. TH port	4,910	0.90%	4,916	0.90%
	Total	**544,106**	**100.00%**	**544,106**	**100.00%**
	Vt	**1.25**			
	θ	**0.005**			
	MAE	**0.00%**			
	Port Destination	**Calculation Based**		**Control Volume in 2023**	
		TEUs	Share (%)	TEUs	Share (%)
IMPORT	Phnom Penh to Vietnam port by barge	53,762	10.22%	53,763	10.22%
	Sihanoukville port	355,008	67.47%	354,969	67.46%
	Trans. VN port	112,773	21.43%	112,826	21.44%
	Trans. TH port	4,659	0.89%	4,645	0.88%
	Total	**526,203**	**100.00%**	**526,203**	**100.00%**
	Vt	**1.25**			
	θ	**0.005**			
	MAE	**0.01%**			

2.5.1 Container port choice in 2050

(1) Model case setting in container port choice

The future container distribution will be incorporated into this model by applying Cambodia's development plans on a case-by-case basis. The table below outlines the specific cases that will be applied to the model:

- Case 0: This case models future container distribution with no additional development. Cambodia has only two ports.
- Case 1: This case includes infrastructure development. Cambodia still has two ports.
- Case 2: This case models future distribution with infrastructure development and waterway development. Cambodia has five ports.
- Case 3: This case includes infrastructure development and waterway development. Cambodia has eight ports.

Table 2-18 Future development Cases for logit model application

Case	Infrastructure	Waterway	Ports
Case 0	Current	Current	-LM17 -PAS
Case 1	Development	Currently	-LM17 -PAS
Case 2	Development	-Funan Techo Canal. -Dredging the Navigation Channel from Phnom Penh to Kampong Chhnang.	-LM17 -PAS -LM26 -UM2 (Kampong Cham) -Kampong Chhnang
Case 3	Development	-Funan Techo Canal. -Dredging the Navigation Channel from Phnom Penh to Stung Treng. -Dredging Navigation from Phnom Penh to Siemreap.	- LM17 - PAS - LM26 - UM2 - Kampong Chhnang - Stung Treng - Kratie - Chong Khneas

(a) Modification inputs for modelling in 2050

Based on the route selection distance and input applied by the latest survey data in 2023, the probability output of choosing each port will be defined. The main outputs of the modelling are as follows:

- Probability of port selection for each province of Cambodia
- Maximization of Vt and θ in present container throughputs
- Estimation of annual share (%) and control volume (TEU) of port choices and the future provincial container throughputs based on the present study, etc.

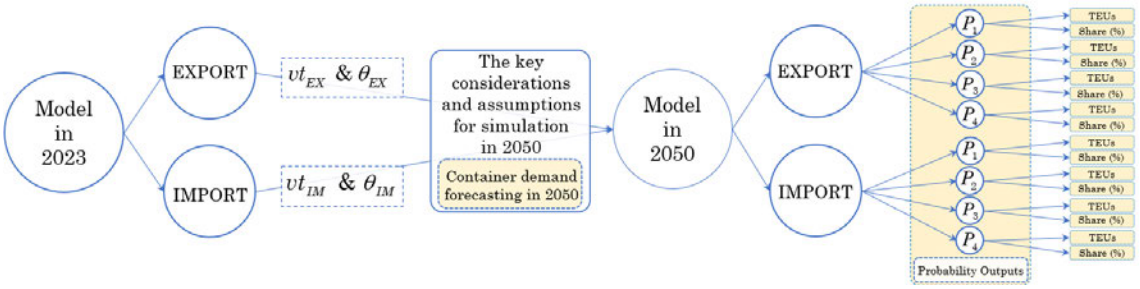


Figure 2-35 Concept of modelling outputs

Furthermore, regarding the modelling, the overall concepts of exporting and importing a container to/from a province of Cambodia are identified, while the challenges and competitiveness of port utilities, as well as inland transport cost and time in the present and future, are also defined within this model.

a) Predictive probability of port selection for each province of Cambodia
b) Allocate and understand the number of provincial container throughputs in Cambodia
c) Optimize the route selection leading to the port for each province for export and import
d) Identify the value of VT and θ in terms of export and import for Cambodia and their goodness-of-fit in setting pre-conditions for the present study
e) Develop a model to estimate the share (%) and control volume (TEU) of port choices
f) Be ready for accountability and capacity-building related to port capacity and facility, etc.

For the model in 2050, there are some up-to-data modifications in modelling as follow:

a) The model in 2050 will be updated based on the container demand for Cambodia in 2050, recent and future route transport development, expected improvements in efficiency at destination ports, etc. For example, the inland travel time from Phnom Penh Special Economic Zone (PPSEZ) to Sihanoukville Autonomous Port (PAS) is assumed to decrease from 6 hours to 4 hours in this study, while the inland travel time from Phnom Penh Special Economic Zone (PPSEZ) to Phnom Penh Autonomous Port (LM17) via Ring Road number 3 (RR3) will take up to 1.5 hours (truck speed: 40-50 km/h along RR3). The inland transportation cost (USD $/TEU) is assumed to be reduced after the rehabilitation and maintenance project along National Road number 4 (NR4) (Work Bank) is completed and due to the development of a Bypass along National routes 5, 6, and 11.
b) For modelling in 2050, the route selection distance (km) between the origin provinces of Cambodia and the destination ports is assumed to be the same distance (km) for both

export and import. In the survey data, there are abnormal data and outliers of distribution of the dataset, hence the data was treated by normalization to ensure normality of regressions for cost-distance and transportation time.

c) Furthermore, the development of the port master plan for PAS will be considered in the model, as well as the direct transshipment from PAS to European countries and North America – which would increase the attractiveness of PAS by 2050.

In addition, waterway development is also considered in the model. We assume the cost for waterway transport will be calculated by adding to the current transport cost and time,

(b) Newly developed road network

For inland transportation input, the inland transportation cost and time are estimated for modelling based on the cost-distance and time regression of the destination ports, respectively. Ring Road number 3 will be beneficial for the transportation sector, especially in terms of container distribution (as it will no longer be necessary to enter the city), and easing the traffic congestion in Phnom Penh city (Figure 2-36).

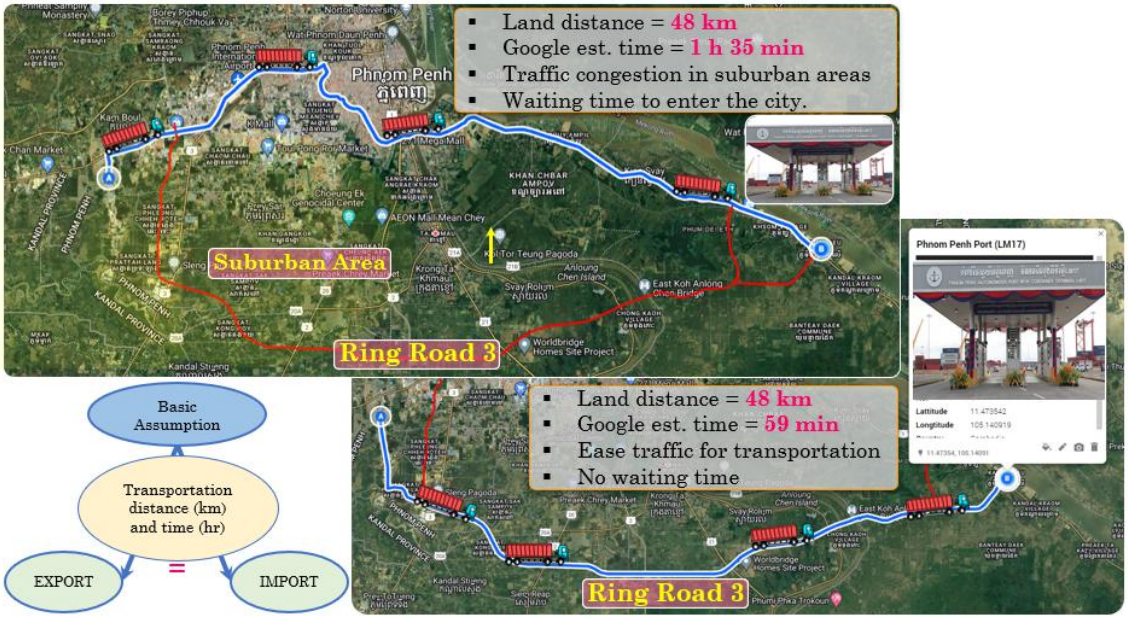


Figure 2-36 Difference between Ring Road 3 and a route that crosses the Phnom Penh city

For the model in 2050, "Simulation in 2050" is a long-term model that allocates the number of containers in each province based on the value of Vt and θ in present condition, while the demand forecasting of container throughputs Cambodia in 2050 (JICA, 2025) will be applied to this model. Plans outlined in the Royal Government of Cambodia's "Comprehensive Master Plan on

Cambodia Intermodal Transport and Logistics System 2023-2030"[12] such as the development of a comprehensive road network (Figure 2-37) and multiple logistics centers (Figure 2-38) by 2050 are considered in the model.

This road network will be patterned with nine radial roads, six horizontal roads, and six vertical roads, totaling 25,412 km in length. In the shorter term, the length of national and provincial roads is projected to reach 21,000 kilometers by 2033.

a) 9 Radial Roads: Think of these roads as spokes on a wheel, all extending outward from the center of the country, Phnom Penh. Their main purpose is to connect the capital to key provinces and international borders.
    i. International Borders: Roads 1, 6, and 8 connect Phnom Penh directly to major border gates to Vietnam, Thailand, and Laos, respectively.
    ii. Seaports: Roads 3 and 4 link Phnom Penh to the two main port cities on the coast, Kampot and Sihanoukville.
    iii. Other Provinces: The remaining radial roads (2, 5, 7, and 9) connect the capital to important provinces like Sihanoukville, Siem Reap, and the eastern provinces.
b) 6 Horizontal Roads: These roads run across the country from west to east. These are crucial for connecting the northern provinces and providing cross-country access without having to go through Phnom Penh.
    i. Connecting Regions: This link key provinces like Battambang, Siem Reap, and Ratanak Kiri, providing vital routes for tourism and agriculture.
    ii. Border Access: This link also provides direct access to international border gates, such as the O'Yadao border gate with Vietnam.
    iii. Efficient Travel: These roads create a more efficient network, allowing people and goods to move horizontally across the country, saving time and reducing travel distances.
c) 6 Vertical Roads: These roads run down the length of the country from north to south. These are connecting provinces in the north to those in the south.
    i. Connecting Inland to Coast: They link provinces like Banteay Meanchey and Oddar Meanchey in the north to coastal areas like Koh Kong and Kampot.
    ii. Supporting Industry: The vertical roads are essential for transporting products like rice and other agricultural goods to the seaports for export.
    iii. Regional Connectivity: They create a grid system with the horizontal roads, forming a comprehensive network that supports all major provinces, making it easier to travel and transport goods throughout the country.

[12] Comprehensive Master Plan on Cambodia Intermodal Transport and Logistics System 2023-2030 by Royal Government of Cambodia.



Figure 2-37 Road network development plan of Cambodia in 2050

The multiple logistics center[12] (Figure 2-38) will provide logistic services including warehouses, distribution services, transfer goods, operation services, and port services. Multiple logistics center such as:

a) Logistics complexes are Cambodia's primary international freight gateways. Situated in Phnom Penh and Sihanoukville, these locations are strategic due to their dense population, high economic growth, and concentration of industrial activity. They serve as the central points for international trade and are a major source of demand for sophisticated logistics services.

b) Logistics parks are located at the major international border crossings of Poipet (Cambodia-Thailand) and Bavet (Cambodia-Vietnam). As vital entry and exit points, these two cities play a crucial role in consolidating a variety of services, including dry ports, customs bonded warehouses, inventory management, distribution, and packaging. Their high economic growth is driven by cross-border trade and the associated logistics demands.

c) Main logistics centers are strategically placed in provinces with high economic potential and growing demand for logistics services.

    i. Siem Reap is a major center for tourism with a large population, creating a high demand for services to support business activities like food and daily commodities.

ii. Kampot is experiencing rapid industrial development and has a port, generating demand for logistics services for products such as limestone and cement.

iii. Kampong Cham is an agricultural hub with significant potential for rubber and rice production, requiring strong logistics support.

iv. Battambang, Banteay Meanchey, Pursat, and Kampong Thom are also significant agricultural provinces. Their potential for paddy rice, rice exports, and other agricultural products makes them crucial centers for logistics services in the country's central and western regions.

With Cambodia's economy rapidly expanding and connecting with ASEAN and the Belt and Road Initiative (BRI), a new era of industrial development is on the horizon. This growth is driving a push for greater industrial diversification and higher value-added production. As a result, new regions that were previously undeveloped are becoming ripe for industrial growth.

To fuel this expansion, Cambodia is strategically establishing new logistics centers. These hubs are essential to support the rising demand for transport and services, ensuring that as industries spread across the country, they remain connected to both regional and international markets. In short, more industries mean more logistics, and these new centers are the key to unlocking the full potential of Cambodia's economic future.

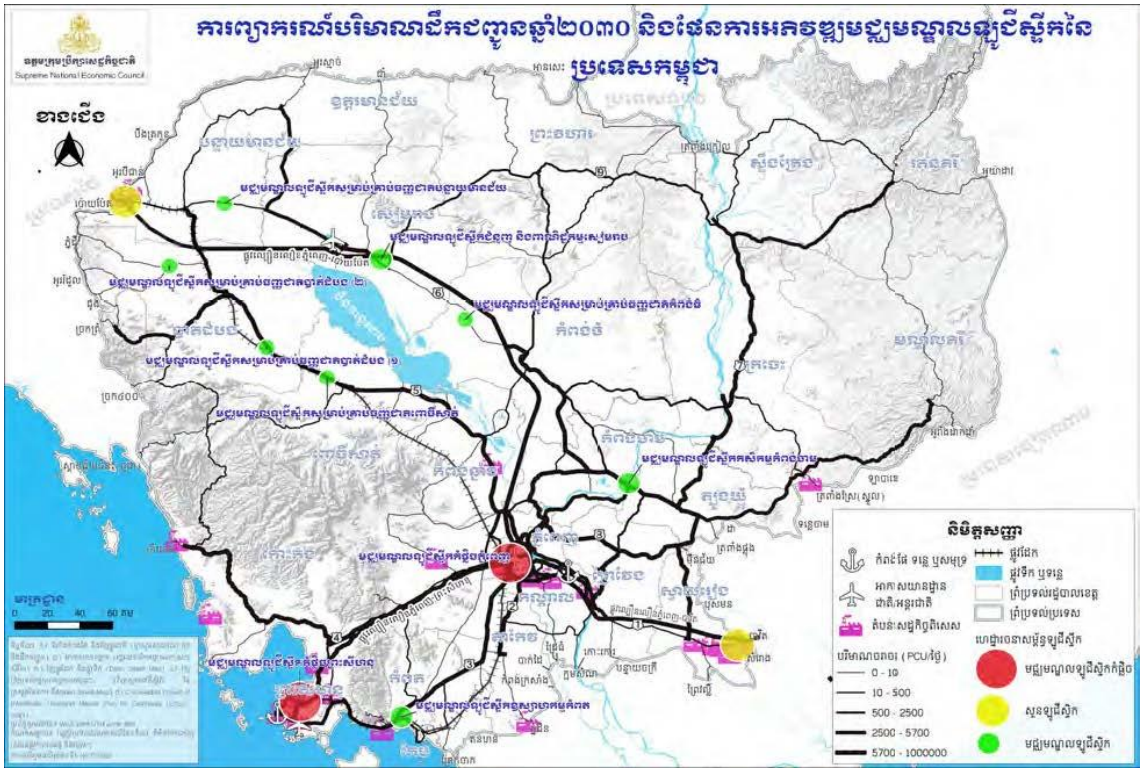


Figure 2-38 Logistics center development plan in 2030

(c) Improving port efficiency

It is thought that Cambodia sea ports will be able to increase the efficiency of port operations and reduce waiting times for vessels, leading to lower operational costs and increased competitiveness with neighboring countries. Likewise, the dwell time of import and export cargoes at PPAP-LM17 and Sihanoukville port is expected to decrease as shown in the table below.

Table 2-19 The expected dwell time at PPAP and PAS

Dwell Time at Port	Export	Import
PPAP-LM17	from 5 to 3 days	from 5 to 3 days
Sihanoukville Port	from 4 to 2 days	from 4 to 2 days

When PAS is able to provide deeper berths, large/mother vessels will be able to enter the new container terminal (NCT 1-3) for container transshipment. As the new terminals enter operations in the coming years, PAS will be able to ship goods directly to the US and European Union (EU) markets without any transshipment through Singapore or elsewhere. Phase 1 of NCT-1, which will have a water depth of 14.5 m, is expected to be completed in 2026, thereby enabling 93 percent of large vessels in the Asia Pacific region to call PAS. NCT-2, scheduled to open in 2028, will have a water depth 16.5 m while NCT-3, scheduled to open in 2029, will have a water depth of 17.5 m.



Figure 2-39 Master Plan of Sihanoukville port development up to 2030

a) The connectivity of Ring Road number 3: it is assumed that this connectivity will facilitate the container distribution between Phnom Penh city and other provinces. With

good road conditions and less traffic volume, trucks will be able to travel smoothly at speeds up to 40-50 km/h along the RR3 segment, saving both time and transportation costs. This includes savings on fuel consumption, labor costs, waiting time, food, etc.

b) Rehabilitation of National road 4: under the World Bank project along NR4 which entails (1) Cambodia road connectivity improvement and (2) Cambodia road asset management (RAMP II), NR4 will be upgraded, and the travel time from Phnom Penh Special Economic Zone (PPSEZ) to Sihanoukville port is assumed to decrease from 6 to 4 hours.

c) 10% travel time reduction in 3 countries: it is assumed that all land transportation networks among the 3 countries (Cambodia, Vietnam, and Thailand) will be improved, resulting in a travel time reduction of 10%. Accordingly, the travel cost will also be reduced.

(d) Waterway development

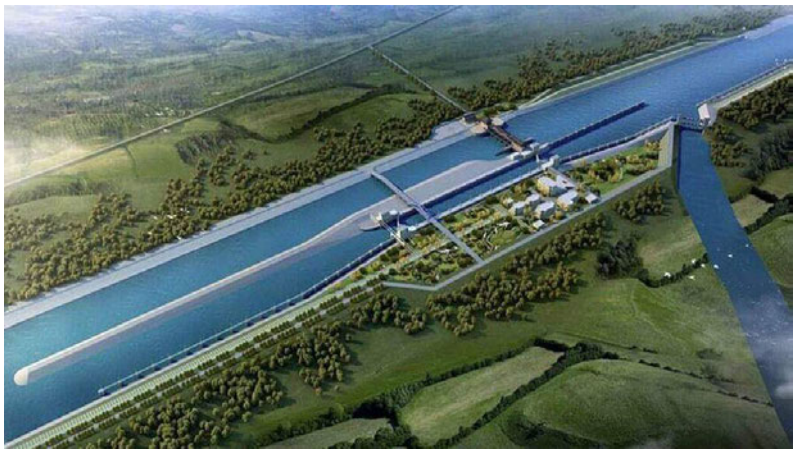
The "Comprehensive Master Plan on Cambodia Intermodal Transport and Logistics System 2023-2030"1 outlines plan for developing navigation connectivity. This includes strengthening links between Phnom Penh and the upper Mekong River, Tonle Sap Lake, the lower Mekong River, and Cambodia's coastal regions. The Ministry of Public Works and Transport (MPWT) also provided detailed information on future waterway development, with plans that include:

a) Funan Techo Canal will connect inland waterways to coastal regions, making transportation more effective and reducing costs. This new route will also ensure the independence of Cambodia's transportation sector.

b) The waterway rehabilitation project between Phnom Penh and Tonle Sap is expected to help collect cargo from the northwestern provinces and make the route more appealing for tourism.

c) The waterway rehabilitation project between Phnom Penh and the upper Mekong River (Stung Treng) is expected to serve as a vital export route for cargo. It will be particularly beneficial for mining products from Cambodia's western regions, enabling their direct export to international markets.

d) In line with Cambodia's future economic growth, the Funan Techo Canal is being constructed to become a vital new economic route. It will allow for the direct transport of goods and containers from inland regions to international markets via inland waterways that connect to Cambodia's seaports. To maximize the efficiency of this transportation corridor, the canal's development must be supported by the construction of additional ports along the waterway and an increase in the water level to ensure safe navigation. Therefore, the future transportation routes, distance (Km) and time (hour) for the simulation in 2050.



- **Figure 2-40 Funan Techo Canal**

Funan Techo Canal is a new waterway route connecting ports in Cambodia with the ocean. An outline of the project including its expected benefits is as follows:

a) This navigation canal was developed with an investment of 1.7 billion USD$ under the BOT model.
b) The total length of this canal is 168 km and it has a water depth of 5.4 meters.
c) The width is 80 meters in the lower reaches and 100 meters in the upper reaches
d) The expected travel time is 7.5 hours from upstream to downstream and 8.5 hours from downstream to upstream.
e) This section is expected to accommodate ships up to 3,000 DWT in the dry season and 5,000 DWT in the rainy season. 3,000 DWT-barges are expected to transport 100 to 120 TEUs of containers in convoys (four barges and one tug).

Table 2-20 Funan Techo Canal information

Funan Techo Canal	
Length	168 Km
Depth Water	5.4 meters (8-9 m in Rainy Season)
Width at lower reaches	80 meters
Travel Time	7.5 to 8.5 hours
Ship accommodates	3,000 to 5,000 DWT

Waterway rehabilitation: According to interviews with the Department of Waterway and Maritime Transport and the Port of the Ministry of Public Works and Transport, Cambodia is planning to rehabilitate the waterways from Phnom Penh to the upper Mekong River and from Phnom Penh to Tonle Sap Lake. Currently, the water depth of these rivers is insufficient for transporting cargo from the upper Mekong River and Tonle Sap Lake to the seaports in Cambodia or Vietnam. The planned waterway rehabilitation aims to accommodate ships with a capacity of 3,000 DWT

(deadweight tons).

For the waterway rehabilitation to be applied in the logit model, it is necessary to input the priority of river port locations to distribute containers to and from those regions.

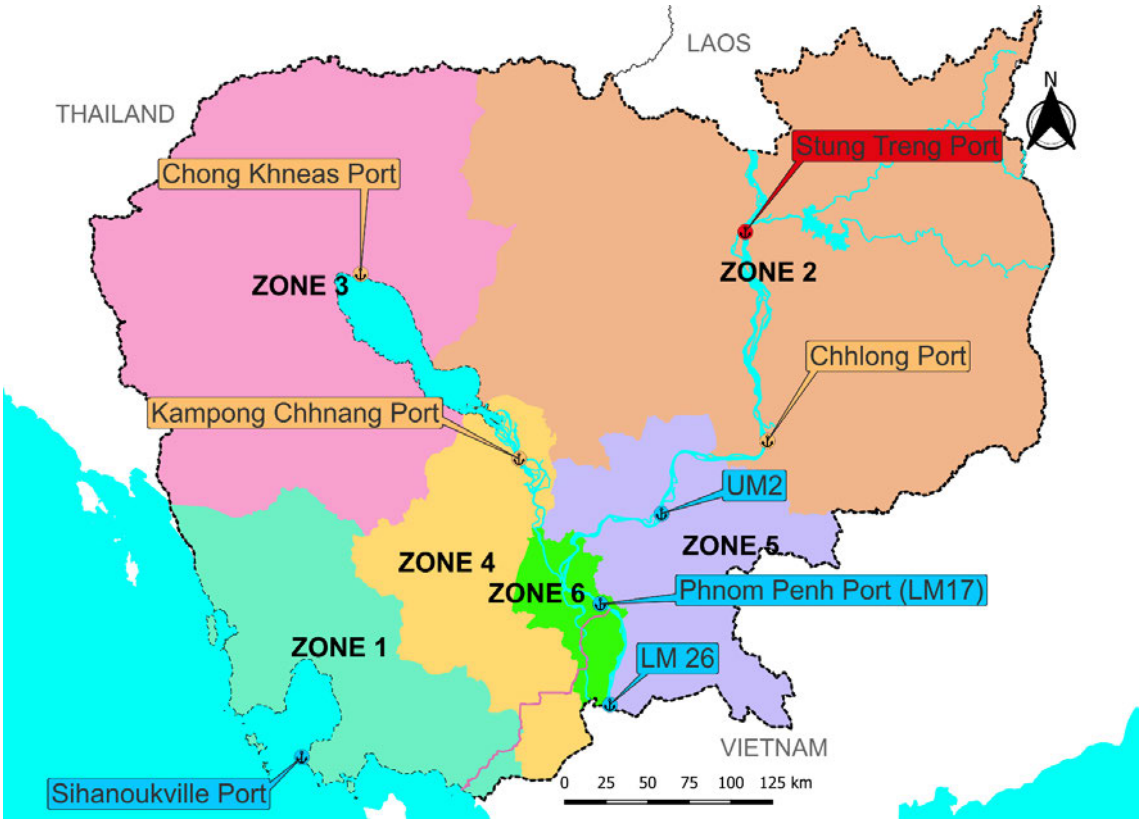


Figure 2-41 Port location applied in the logit model

(e) Transportation cost setting

Container transportation, both for export and import, involves the following key payment categories:

a) Inland Transport Cost: This is the cost for trucking containers from an origin (or to a final destination) to a port.
b) Terminal Handling Charge (THC): A fee paid for the loading, unloading, and other handling of a container at a port terminal.
c) Port Charge (LO/LO): A specific fee for the "Lift On and Lift Off" of containers at a port.
d) Infrastructure Fee: A fee that is typically paid when a container is trucked to a Vietnamese port.
e) Toll Fee (Mộc Bài Border): A toll fee paid for containers that are trucked across the Mộc Bài border to Vietnam.
f) Customs Clearance (Export): A payment for the processing of customs documents

required for exporting goods.

g) Customs Import Permit (Import): A fee for processing the customs permit documents required for importing goods.
h) Transit Customs Clearance: A fee for document processing at a neighboring country's port for transshipment.
i) Documentation: A payment for various documents, including Delivery Order (D/O), Bill of Lading (BL), Telex Release, filing fees, and container inspection charges (CIC).
j) Other Payments: This category includes various fees such as agency fees, container seals at dry ports, lift-on fees for empty containers, and lift-on/lift-off fees at borders.
k) Ocean Freight Rate: This fee covers the cost of waterway transportation, transshipment at a Vietnamese port, and ocean transportation.
l) Sanitary and Phytosanitary (SPS) Transit: A fee required when agricultural products are transshipped through a port in Vietnam or Thailand.

Table 2-21 below shows the total export costs to Rotterdam from Phnom Penh and Svay Rieng Province via four different routes: Phnom Penh Port, Sihanoukville Port, Vietnam Port, and Thailand Port. These costs are from quotations obtained during the JICA survey.

Table 2-21 Total export cost to Rotterdam of each route

Province	Route	Total export cost
Phnom Penh	Phnom Penh Port	1,498
	Sihanoukville Port	1,601
	Vietnam Port	2,819
	Thailand Port	3,498
Svay Rieng	Phnom Penh Port	1,579
	Sihanoukville Port	1,840
	Vietnam Port	2,539
	Thailand Port	3,667

(f) Cost comparison between Funan Techo Canal and Mekong River to Vietnam

The cost of shipping from Phnom Penh Autonomous Port to Rotterdam via a Vietnamese port versus that of shipping via Sihanoukville Autonomous Port and the Funan Techo Canal is compared below. Initially, the benefit of using the Funan Techo canal is relatively small: only 90$/TEU. However, in the future, when mother vessels come directly to Sihanoukville to handle containers, it will no longer be necessary to transship cargo in Singapore or elsewhere. Consequently, the portion of ocean freight costs associated with transit will be reduced. This indicates that the cost saving due to the Funan Techo Canal will increase from 90$/TEU to 173$/TEU.

Furthermore, if Vietnam does not comply with other agreements between Cambodia and Vietnam on transportation such as the legal framework for freedom of navigation, reduced restrictions and

streamlined procedures, most favored nation treatment, and border gates and ports etc., or if Vietnam does not allow Cambodian cargo to be exported to foreign countries, Cambodia has another option: The Funan Techo Canal.

(g) Transportation time setting

Container transportation, for both export and import, involves several key stages associated with travel times:

a) Inland Travel Time: This is the time required for trucking containers from their origin to a port, or from a port to their final destination.
b) Transit at Border: This is the time spent on the processing of documents and the loading/unloading of containers at a border, especially when trucking containers from Cambodia to a neighboring country's port.
c) Dwell Time at Port: This is the total time a container spends in a terminal, from the moment it is unloaded from or loaded onto a vessel until it is moved.
d) River Transportation Time: This refers to the travel time on a river, from a river port to a seaport or vice versa.
e) Marine Travel Time: This is the time taken to travel from a seaport to the final destination port by sea.

Table 2-22 Total transportation time to Rotterdam of each route

Province	Route	Total (hours)	Total (Days)
Phnom Penh	Phnom Penh Port	952	39.7
	Sihanoukville Port	922	38.4
	Vietnam Port	833	34.7
	Thailand Port	993	41.3
Svay Rieng	Phnom Penh Port	953	39.7
	Sihanoukville Port	928	38.7
	Vietnam Port	827	34.5
	Thailand Port	998	41.6

(h) Travel time comparison between Funan Techo Canal and Mekong River to Vietnam

The time required for shipping from Phnom Penh Autonomous Port to Rotterdam via a Vietnamese Port and shipping via Sihanoukville Autonomous Port is compared below. The expert team based this comparison on current transportation methods. In addition, this comparison includes several assumptions because the Funan Techo Canal is not yet constructed.

Based on current conditions, experts calculate that the route via the Funan Techo Canal takes 11 hours longer than the route to a Vietnamese port. However, when NCT 3 is constructed at Sihanoukville Autonomous Port, large mother vessels will be able to dock directly. This will

eliminate the need to spend time traveling to and transshipping at ports like Singapore. It is also expected that Sihanoukville Autonomous Port's dwell time will be reduced from 96 hours (4 days) to 48 hours (2 days), while Phnom Penh Autonomous Port's dwell time is expected to decrease from 120 hours (5 days) to 72 hours (3 days). With the reduced dwell time at both Cambodian ports, the route via the Funan Techo Canal is projected to save approximately 132 hours (5.5 days) compared to the route to a Vietnamese Port.

(2) Results of Container port choice

(a) Container (General)

Based on the current quotations, the expert team used a logit model to distribute containers. After calibration, the model provided Vt and θ to predict future development scenarios. Figure 2-42 shows the results of the logit model, illustrating the general container port choice (in share %) for each case. The results of Case 2 and Case 3 indicate that the Funan Techo Canal route will be a strong competitor to the barge route to Vietnamese ports. The results also show that Cambodia's infrastructure and waterway development will reduce the container traffic that currently requires transshipment at neighboring ports, including both truck transport to Vietnam and Thailand and barge transport to Vietnam.

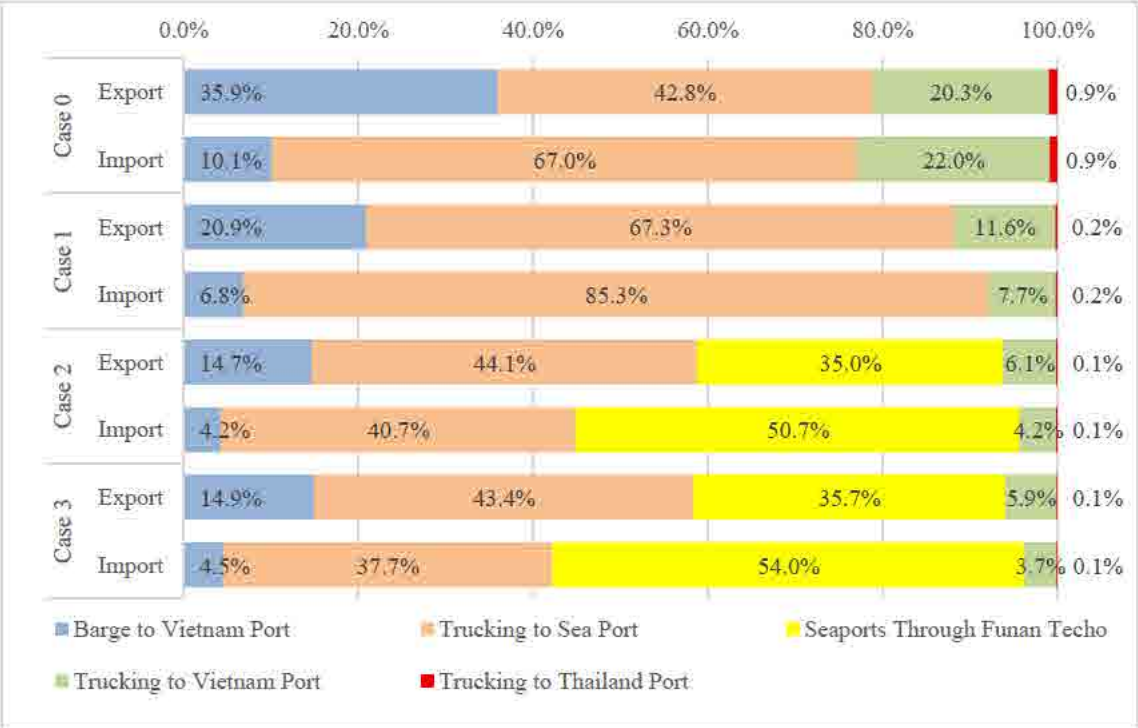


Figure 2-42 General container port choice (share %)

The total number of laden general containers is 4,764,731 TEUs, including 2,771,925 TEUs for export and 1,992,806 TEUs for import. According to projections, once the Funan Techo Canal

and waterway improvements are successfully completed, the container throughput capacity at the river port is expected to increase to 2.6 million TEUs, while the capacity at the seaport (Sihanoukville Autonomous Port) will increase to 4.1 million TEUs (Figure 2-43).

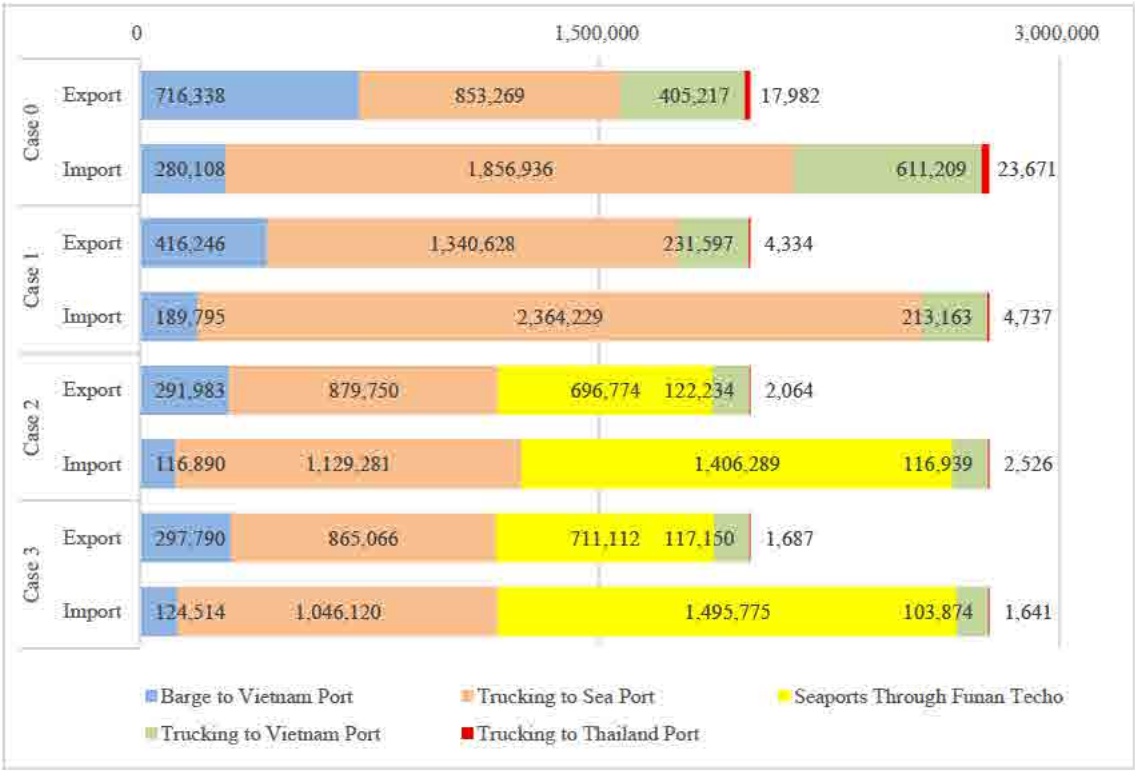


Figure 2-43 General container port choice (TEUs)

(b) Container (Agricultural goods)

The term "agriculture container" refers to agricultural products transported by both standard and refrigerated containers. As shown in Figure 2-44, the results for agriculture exports in Case 0 reveal that 75.0% are transported by truck to Cambodian seaports, 15.8% are trucked to seaports in neighboring countries, and 9.2% are transported by barge to a Vietnamese port. For imports in Case 0, 67.0% are transported by truck to Cambodian seaports, 29.2% are trucked from neighboring countries' seaports, and 10.1% are transported by barge from a Vietnamese port.

In Case 3, which includes infrastructure and waterway development, the results for agriculture container exports show that 96.5% will be transported through Cambodian seaports (by both truck and barge), while only 3.5% will be exported via transshipment at neighboring countries' ports. For agriculture imports, 91.7% will be transported through Cambodian seaports, and 8.3% will be imported from neighboring countries' ports.

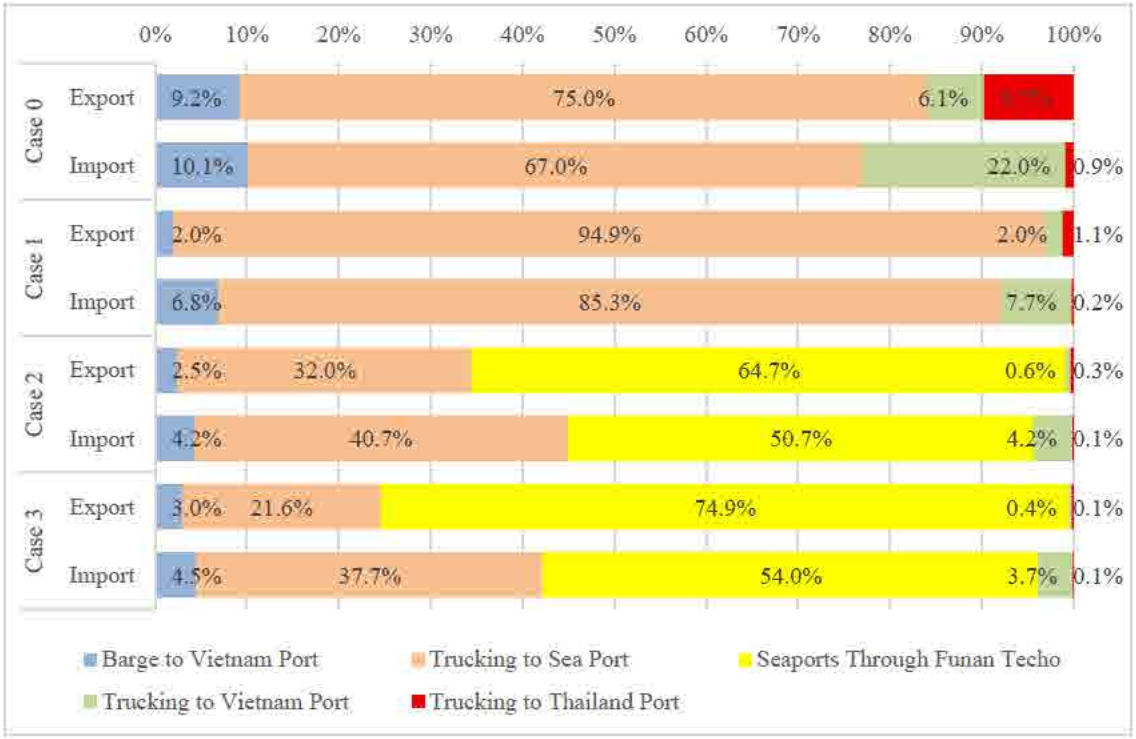


Figure 2-44 Agriculture container port choice (share %)

The total number of agricultural containers in the future is projected to be 863,755 TEUs, including 749,605 TEUs for export and 114,150 TEUs for import. As shown in Figure 2-45, the results of the logit model for the number of agricultural containers for both export and import are as follows:

- Case 0 Exports: 562,165 TEUs are exported by truck to Cambodian seaports, 68,767 TEUs are exported via barge to a Vietnamese port, and 118,673 TEUs are exported by truck to neighboring countries' ports.
- Case 0 Imports: 76,470 TEUs are imported by truck from Cambodian seaports, 11,535 TEUs are imported via barge from a Vietnamese port, and 26,145 TEUs are imported by truck from neighboring countries' ports.

In Case 3, which includes future development, the results show:

- Exports: 723,491 TEUs are exported via Cambodian seaports, while 26,114 TEUs are exported via transshipment at neighboring countries' ports.
- Imports: 104,677 TEUs are imported via Cambodian seaports, and 9,474 TEUs are imported via transshipment at neighboring countries' ports.



Figure 2-45 Agriculture container port choice (TEUs)

(c) Container (Total)

Container (Total) refer to general container and agriculture container combine together around 5.6 million TEUs included export around 2.7 million TEUs and import around 2.8 million TEUs. As shown in Figure 2-46, The graph below shows the total container share for each route, for both exports and imports. In Case 2, most containers are transported by waterway. Specifically, 11.3% of exports and 4.2% of imports are barged to Vietnamese ports, while 43.1% of exports and 50.7% of imports are barged to sea ports. Additionally, 40.8% of exports and 40.7% of imports are transported by truck to sea ports in Cambodia, and 4.6% of exports and 4.2% of imports are trucked to neighboring countries. There is a slight difference in results when comparing Case 3 with Case 2; specifically, the seaport throughput through the Funan Techo Canal is projected to increase by approximately 3% to 4% in Case 3.

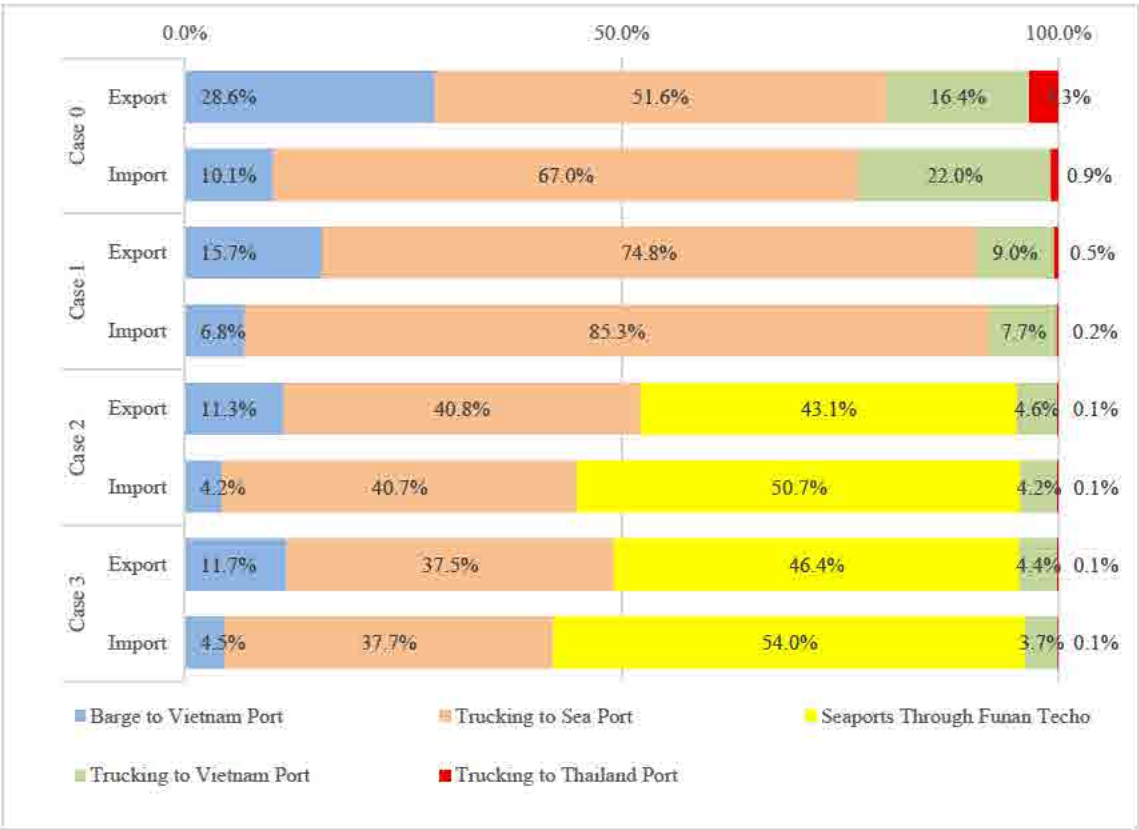


Figure 2-46 Container (Total) port choice (share %)

As shown in Figure 2-47, The graph below shows the total container share for each route, for both exports and imports. In Case 2, most containers are transported by waterway. Specifically, 310,421 TEUs of exports and 121,704 TEUs of imports are barged to Vietnamese ports, while 1,181,667 TEUs of exports and 1,464,201 TEUs of imports are barged to sea ports. Additionally, 1,119,787 TEUs of exports and 1,175,785 TEUs of imports are transported by truck to sea ports in Cambodia, and 122,600 TEUs of exports and 109,861 TEUs of imports are trucked to neighboring countries. There is a slight difference in results when comparing Case 3 with Case 2; specifically, the seaport throughput through the Funan Techo Canal is projected to increase by approximately 3% to 4% in Case 3.

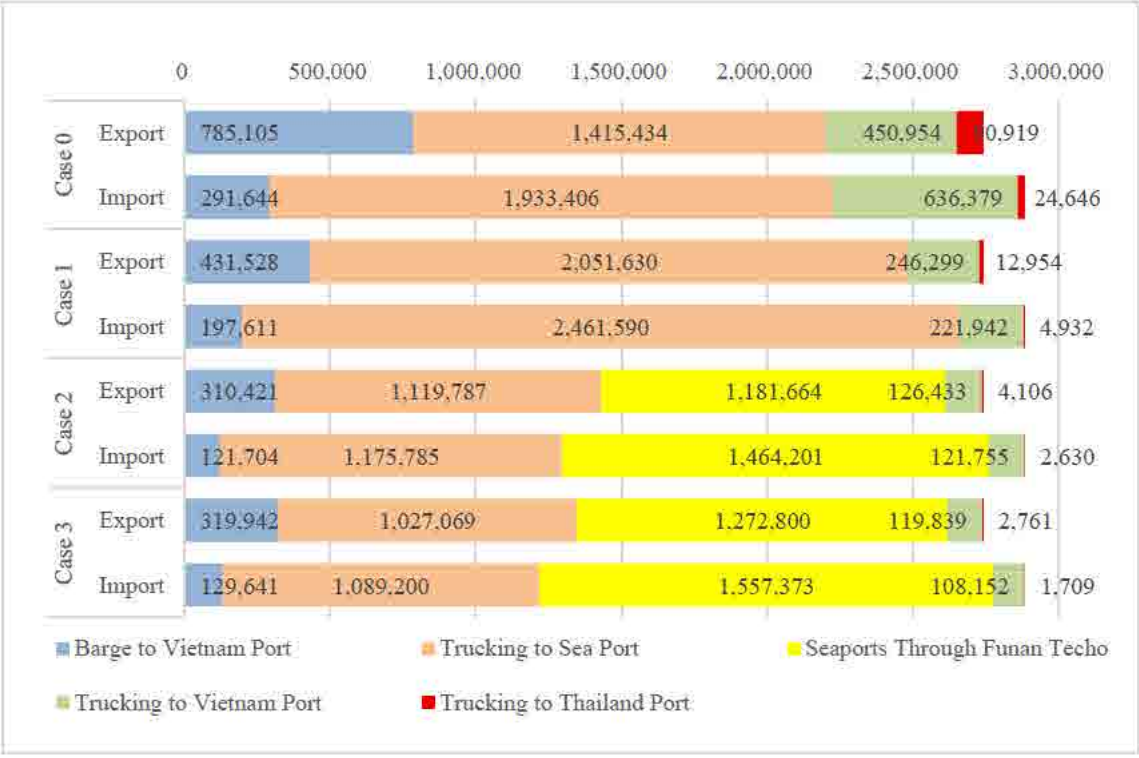


Figure 2-47 Container (Total) port choice (TEUs)

Chapter-3 Bulk cargo – Demand forecast

3.1 Dry Bulk (Agriculture goods)

3.1.1 Methodology and results of estimating dry bulk (Agriculture goods)

(1) Methodology of estimating dry bulk (agriculture goods)

To forecast demand for agricultural commodities, we adopt the following method. First, we ensure that our forecast assumptions are consistent with national policy. If no relevant national policy exists, we interview stakeholders from relevant ministries and agricultural associations to understand the production environment and future trends. Additionally, when we lack sufficient statistics on certain agricultural commodities, data from open sources such as Food and Agriculture Organization Corporate Statistic Database (FAOSTAT), United Nation Comtrade Database (UN Comtrade) and others are used to complete forecasts.

The table below shows the required data, main data sources, datasets used, and specific forecasting methods such as time-series analysis and interviews with stakeholders. Key commodities such as rice, cassava, and others are highlighted, along with their production data from various years. We also address commodities imports and provide supporting data for commodity value chains and socio-economic indicators such as GDP. Our approach combines data with insights from relevant parties to increase the accuracy of the forecasting work and better grasp production trends.

Table 3-1 Required data on agricultural commodities and forecasting methods

No	Required Data	Main Sources	Dataset Date	Forecasting Method
1	Export Commodities			
1.1	Rice Production, Domestic & export & Trade	MAFF, CRF	Rice production from 2011 to 2024 (MAFF) Rice& Paddy export from 2018-2024 (CRF)	Time Series Analysis (Trend), Interviews
1.2	Cassava Production & Trade	MAFF, GDA, CFC	Cassava production from 2015 to 2024 (MAFF) cassava export from 2020-2024 (GDA)	Time Series Analysis (Trend), Interviews
1.3	Rubber Production & Trade	GDR	Rubber production, planation and export from 2010 to 2024	Time Series Analysis (Trend), Interviews
1.4	Cavendish banana Production & Trade	MAFF, FAOSTAT, GDA	Cavendish banana production from 2016 to 2021 (FAOSTAT) Cavendish banana production by provinces 2023 (MAFF) Cavendish banana export from 2020-2023 (GDA)	Time Series Analysis (Trend), Interviews, Policy Impact Assessment

No	Required Data	Main Sources	Dataset Date	Forecasting Method
1.5	Cashew Nut Production & Trade	MAFF, GDA, CAC	Cashew nut production from 2019 to 2022 (CAC) cashew nut production by provinces 2023 (MAFF) Cashew nut export from 2020-2024 (GDA)	Time Series Analysis (Trend), Interviews, Policy Impact Assessment
1.6	Keo Romeat Mango Production & Trade	MAFF, FAOSTAT, GDA	Mango production and export from 2016 to 2020 (GDA, FAOSTAT) Mango production by provinces 2023 (MAFF) Mango export from 2020-2024 (GDA)	Time Series Analysis (Trend), Interviews, Policy Impact Assessment
2	Import Commodities			
2.1	Fertilizer Imports	FAOSTAT	2011 to 2022	Trends, Rice production-based Demand Forecasting
2.2	Timber Imports	GDCE, UN Comtrade	2011 to 2019	Trends, GDP-based Demand Forecasting, Market Analysis
2.3	Cereals Imports	GDCE, UN Comtrade	2014 to 2023	Time Series Analysis and Demographic-driven Demand Forecasting (Population-based)
3	Supporting Data			
3.1	Commodity Value Chain & Processing Stages	CRF, CLA, CFC, MAFF, GDA, CRA, and GDR Interviews		
3.2	Agricultural Policies	MAFF, Government Reports, Interviews		Policy Review, Qualitative Insight
3.3	GDP and rGDP	JICA team estimate GDP and rGDP in 2050		JICA team projection to 2050
3.4	Population projection	NIS, JICA team projection population by province in 2050		NIS projection to 2050

Major trade cargo commodities used in the demand forecast are selected based on 2023 statistics of the General Department of Customs and Excise (GDCE). Regarding exports, the total volume of agricultural commodities was 21.3 million tons in 2023. For paddy and milled rice exports, we combine milled rice export data from GDCE and paddy export data from the Cambodia Rice Federation (CRF), which together cover 66% of the total agricultural commodities for export trade in 2023. The commodities finally selected for the demand forecast are rice, cassava, rubber, banana, mangoes and cashew nut, which cover 97% of the total export trade of agricultural commodities.



Figure 3-1 Shares of main export agricultural commodities in 2023

In 2023, the total volume of imported agricultural commodities reached 1.7 million tons according to GDCE data. The largest import commodity was fertilizer, accounting 48% of the total followed by timber at 21% (timber includes sawn wood products, sheets used for veneering, fiberboard, plywood etc.). Cereals, including wheat, maize, and rice accounted for 13% of total imports. The remaining 18% of imported agricultural commodities consisted of various items. It is noteworthy that the combined share of fertilizers, timber, and cereals accounted for a substantial 82% of the overall import trade of agricultural commodities.

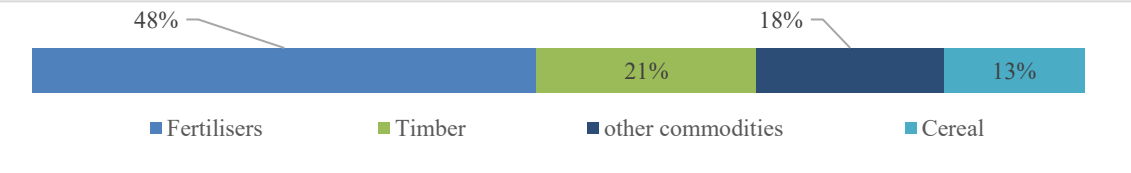


Figure 3-2 Main import agricultural commodities in 2023

Additionally, Cambodia has recently started exporting durian to China. However, it's hard to predict how much durian China will buy in the future due to the lack of historical data. In addition, there is insufficient data on the volume of durian that Cambodia has produced and sold to other countries to identify a clear pattern.

(2) Results of estimating dry bulk (agriculture goods)

The table below provides an overview of how the demand for certain Cambodian agricultural products and their transport methods are expected to change by the year 2050.

Table 3-2 Assumptions used in the demand forecast of agricultural commodities

Cargo Items		Forecasting assumptions	Assumed transport mode in 2050
Export of Agricultural Commodities			
Paddy	Scenario 1	If Cambodia does not develop rice milling industry, there will be no increase in milled rice exports even though more paddy rice is produced. Most paddy will be export to Vietnam as paddy 75% and 25% as milled rice.	Barge
Milled Rice			Container
Paddy	Scenario 2	If the rice milling industry expands, less paddy will be exported compared to Scenario 1. Half of milled rice export.	Barge
Milled Rice			Container
Fresh Cassava		Fresh cassava exports will account for around 14% of the total, and 80% will be exported as sliced and starch cassava. Only 1% is cassava residue. It is assumed that Cambodia will expand local production rather than exporting fresh roots. Moreover, fresh produce will spoil if it isn't transported to the destination on time.	Road
Starch Cassava			Container
Cassava Slice			Container
Cassava Residue			Container
Raw Rubber		From 2024 to 2035, we estimate a growth rate of 4.5% in rubber production, with a maximum yield of 1.5 tons per ha.	Truck/Barge
Rubber Production		From 2035 to 2050, rubber yield will remain unchanged due to the maximum plantation area being capped at 0.4 ha. For processed rubber, it means the rubber is processed in Cambodia into products such as car tires or others, and then exported in containers.	Container
Banana		We assume that banana production and exports will remain unchanged from 2022 to 2025. 2022 stands out as the peak production year, with exports accounting for 92% of the total.	Refrigerated containers
Mango		60% is exported as fresh mango. We assume 3% growth in mango production from 2020 to 2050, with most varieties such as Keo Romeat being exported fresh.	Refrigerated containers
Raw Cashew Nuts		Cashew nut production is forecast to increase by 50% from 2022 to 2032 based on national policy. After end policy, we assume that growth rate is 1% from 2033 to 2050 due to agricultural uncertainty.	Container
Cashew Nut Processing			Container
Import of Agricultural Commodities			
Fertilizer		Import of fertilizer is connected with Paddy rice which has the highest harvest area in Cambodia. The average growth rate for total paddy rice production is 1.7%; therefore, we will apply this rate of 1.7% to forecast fertilizer imports.	Barge
Cereal		Our assumption regarding cereal imports is based on population growth. By 2050, maize is forecast to account for 85% of imports, followed by wheat and meslin at 8%, and rice at 7%.	Barge
Timber		Actual data from the UN comtrade database is available from 2011 to 2019. Our forecast demand is based on the GDP growth trend from 2020 to 2050.	Container

The table below summarizes the export and imports volumes of various agricultural commodities. It shows a comparison of the "base year" volume with the "forecast volume in 2050" for various commodities as well as the forecasting method.

Table 3-3 Summary of Dry Bulk-Agriculture Forecast Trade Volumes

Export of agricultural commodities						
Sub items of Agriculture		Base year volume	Base year	Forecast volume in 2050	Unit	Forecast method
Paddy	Scenario 1	5,180,155	2024	6,351,538	Ton	Trend analysis
Milled Rice		675,642	2024	675,642	Ton	Trend analysis
Paddy	Scenario 2	5,180,155	2024	4,191,549	Ton	Trend analysis
Milled Rice		675,642	2024	1,350,667	Ton	Trend analysis
Fresh Cassava		13,051,754	2024	2,488,945	Ton	Cassava association interview
Starch Cassava		60,525	2024	1,333,364	Ton	Cassava association interview
Cassava slice		964,682	2024	3,111,182	Ton	Cassava association interview
Cassava residue		33,153	2024	177,782	Ton	Cassava association interview
Raw Rubber		338,000	2024	132,168	Ton	Government policy
Rubber Productions		69,209	2024	528,672	Ton	Government policy
Banana		367,412	2022	367,412	Ton	Select peak year data
Mango		97,628	2020	2,178,695	Ton	Trend analysis
Raw cashew nuts		670,000	2022	652,713	Ton	National policy
Cashew nut processing		20,000	2022	176,233	Ton	National policy
Import of agricultural commodities						
Sub items of Agriculture		Base year volume	Base year	Forecast volume in 2050	Unit	Forecast method
Fertilizer (N, P, K)		135,775	2022	228,677	Ton	Fertilizer-Paddy Rice Production
Cereal (Wheat, Maize, Rice)		216,457	2023	198,395	Ton	Cereal- Population growth
Timber		1,720,400	2019	1,598,101	Ton	GDP

3.1.2 Dry Bulk (Paddy Rice-Agriculture goods)

(1) Present paddy rice production and distribution

Currently, Cambodia is home to a wide range of rice varieties including Premium Fragrant or Cambodian Jasmine Rice, Fragrant, Long Grain White or Premium White, White, and Brown. The highest paddy production of 13 million tons was recorded in 2024. Statistical data on paddy production from 2010 to 2024 is shown in the figure below.

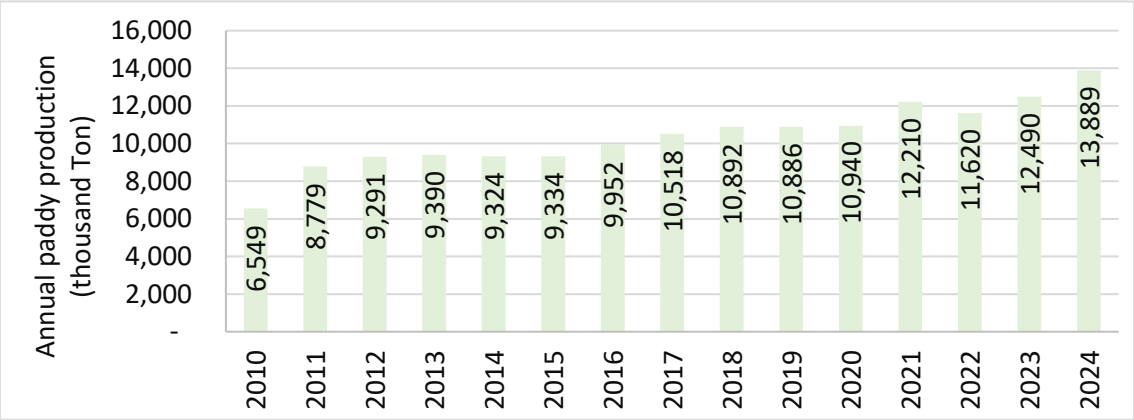
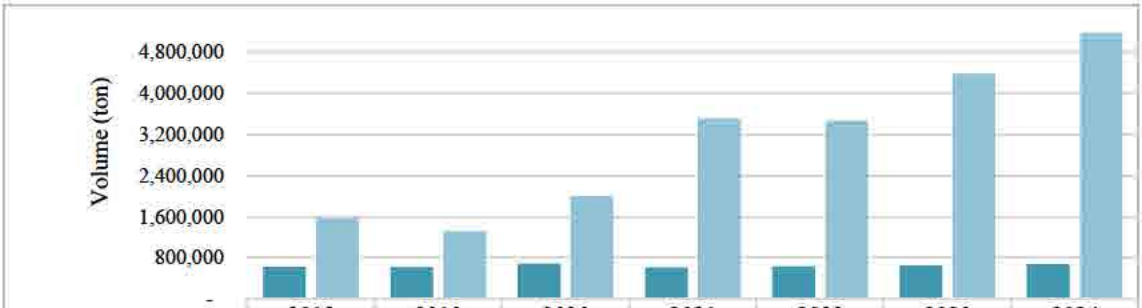


Figure 3-3 Paddy production from 2010 to 2024[13]

Based on interviews with representatives from CRF (Cambodia Rice Federation), paddy exports are primarily destined for neighboring countries such as Vietnam and Thailand. However, since 2018, the vast majority of paddy exports have been directed solely to Vietnam. In terms of rice exports, Cambodian rice reaches approximately 30 countries worldwide. Key export destinations include various countries in Europe, Malaysia, Singapore, China, and Thailand. Smaller quantities are also exported to Australia and New Zealand. A significant portion of these rice exports, approximately 90%, are shipped through Sihanoukville port, while the remaining 10% are exported via Phnom Penh Port. This highlights the importance of Sihanoukville port as a major gateway for Cambodian rice exports.

[13] Source: Ministry of Agriculture, Forestry and Fisheries (MAFF)



	2018	2019	2020	2021	2022	2023	2024
Milled rice export	626,225	620,106	690,829	617,069	637,004	656,323	675,642
Paddy export	1,572,991	1,319,500	2,003,347	3,519,035	3,467,886	4,387,363	5,180,155

Figure 3-4 Milled Rice and Paddy exports from 2018 to 2024[14]

According to data from the CRF, there are currently 214 milling facilities and export companies operating in Cambodia. Of these, only 133 companies possess the capacity to export. The milling capacity of these companies is approximately 14,000 tons per day, with a total storage capacity of 2 million tons. The drying capacity is around 42,000 tons of wet paddy per day. The milled rice processing involves several key steps. Initially, paddy must be collected rapidly to prevent moisture retention. The paddy is then sent to dryers within 72 hours. Milling companies typically utilize mechanical dryers to ensure quality. However, farmers may opt to dry the paddy using traditional sun-drying methods. After drying, the paddy is transformed into brown paddy rice, retaining its bran layer. A milling machine is then employed with multiple passes to achieve the desired level of whiteness. The milled rice is classified into grades, with broken grains being separated. The final processing step involves packaging the rice in bags, typically weighing 50 kg or 1 ton, before transporting the milled rice to markets. According to MAFF (Ministry of Agriculture, Fishery and Forestry) and the CRF, only high-quality rice is eligible for export. It requires approximately 3.2 to 3.5 kg of paddy to produce 1 kg of milled rice that meets this standard. However, for domestic consumption, 1 kg of paddy converts to 0.64 kg of milled rice.

[14] Source: Cambodian Rice Federation (CRF)

Table 3-4 Location and number of Rice Mill Companies[15]

No	Province Name	Region	Number of Rice Mill Companies Surveyed
1	Battambang	Tonle Sap	40
2	Prey Veng	Plain	9
3	Banteay Meanchey	Tonle Sap	22
4	Kampong Cham	Plain	11
5	Kampong Speu	Plateau/Mountain	4
6	Kampong Thom	Tonle Sap	10
7	Phnom Penh	Plain	9
8	Takeo	Plain	2
9	Pursat	Tonle Sap	4
10	Kandal	Plain	4
11	Tboung Khmum	Plain	8
12	Kampong Chhnang	Tonle Sap	3
13	Siemreap	Tonle Sap	5
14	Ratanak kiri	Plateau/Mountain	1
15	Oddar Meanchey	Tonle Sap	1
Total			133

Battambang Province currently leads in paddy rice production in Cambodia, benefiting from two annual rice growing seasons. Other provinces with significant paddy rice production include Prey Veng, Banteay Meanchey, Kompong Thom, and Pursat. While other areas have fewer rice fields, they contribute to agricultural production through crops such as cassava, rubber plantations, and other agricultural products. The map below illustrates paddy rice production across Cambodia, highlighting that the largest harvest zones are concentrated in areas with access to irrigation systems, particularly those utilizing the Mekong River as a water supply. Paddy rice production is lower in areas located further from these irrigation systems. Notably, the map also reveals that the Tonle Sap area, characterized by a flood forest, lacks rice fields due to its unique ecological conditions.

[15] Source: Cambodian Rice Federation (CRF)

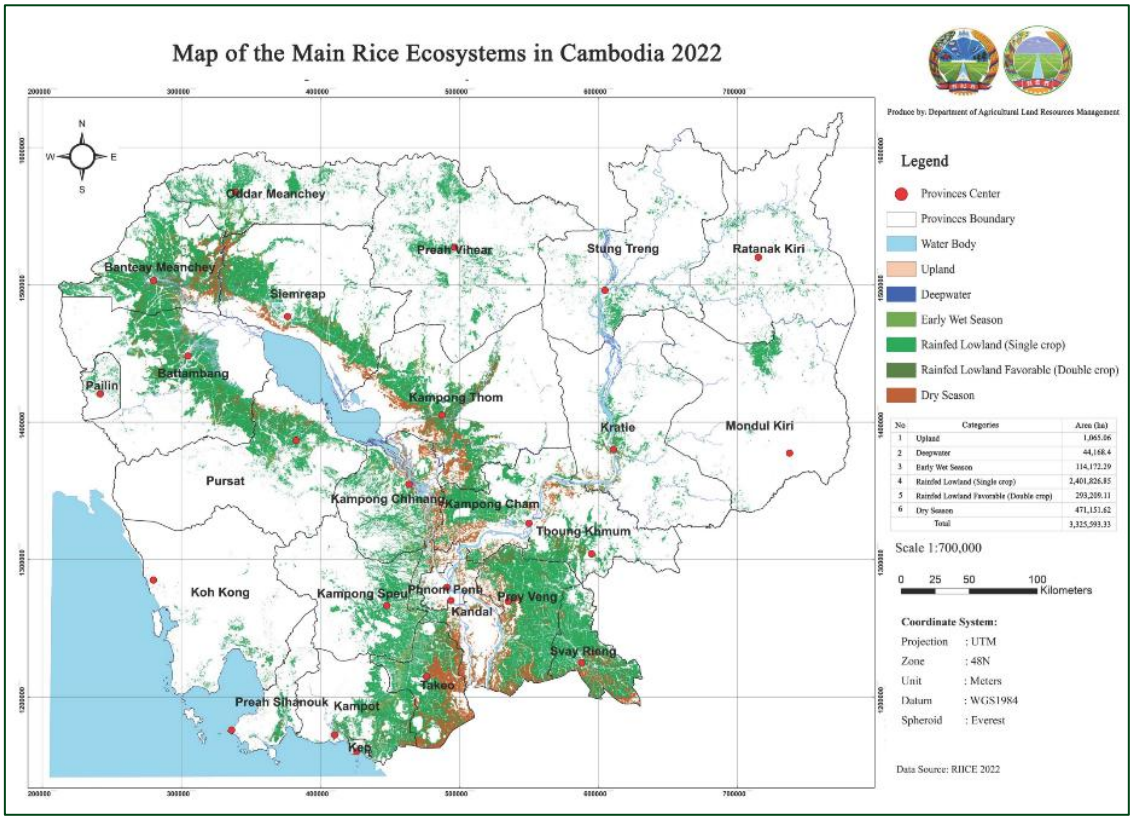


Figure 3-5 Maps of the Rice Ecosystems in Cambodia (2022)

(2) Future projection of paddy rice production

(a) Forecasting paddy rice production in 2050

Analysis of annual paddy production data from 2011 to 2024 reveals an average paddy growth rate of 3.4% during that period. However, for the projection period from 2024 to 2050, we are assuming a more conservative growth rate of 1.7% per year. This adjustment reflects anticipated challenges related to a potential shortage of water supply and the limited availability of additional rice fields for expansion. While historical trends indicate a robust growth rate, these constraints are expected to moderate future increases in paddy production. The reduced growth rate acknowledges the need for sustainable resource management and adaptation to potential environmental limitations.

As the paddy production volume has fluctuated over the years, we set the base year volume in 2024 as 10.3 million tons by averaging the data from 2011 to 2024. The paddy rice production in 2050 is 16 million tons, an increase of 1.2 times from 2024.

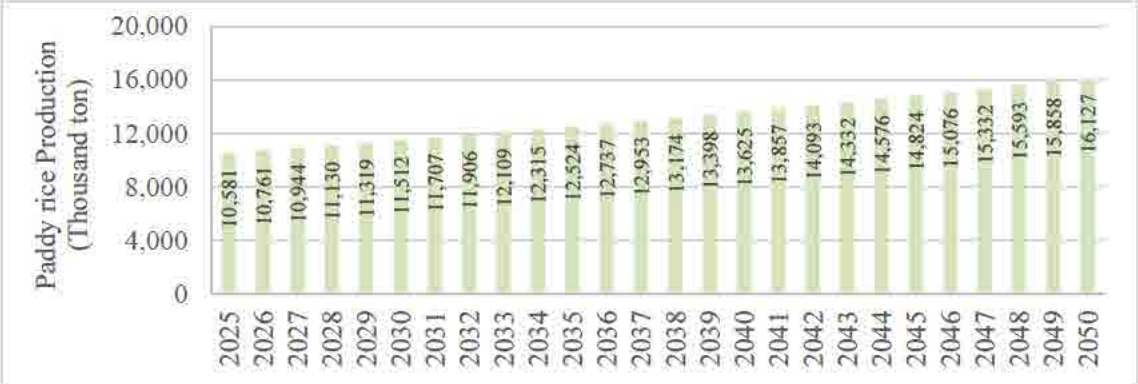


Figure 3-6 Forecasting of paddy rice production to 2050

(b) Estimation of domestic rice consumption volume

Domestic consumption of rice is estimated based on population growth projection from 2019 to 2050. Daily per capita rice consumption in Cambodia ranges from 0.3g to 0.4g per capita according to MAFF. Therefore, the total volume of rice consumption, expressed in paddy weight equivalent, is obtained using the methodology shown in the table below. The total rice consumption in Cambodia is 6,074,642 tons (paddy weight base) in 2024.

Table 3-5 Estimation of domestic rice consumption

Items	Estimation
Rice consumption per capita	
Average volume per day	
Total volume per year	0.3 kg/day x 365 days
Rice consumption in Cambodia	
Total consumption for domestic use	Population x Rice consumption per capita
Rice conversion in Cambodia	
Conversion rate for domestic consumption	1 kg of Paddy = 0.64 kg of Milled Rice
Conversion rate for export	3.2 kg of Paddy = 1 kg of Milled Rice

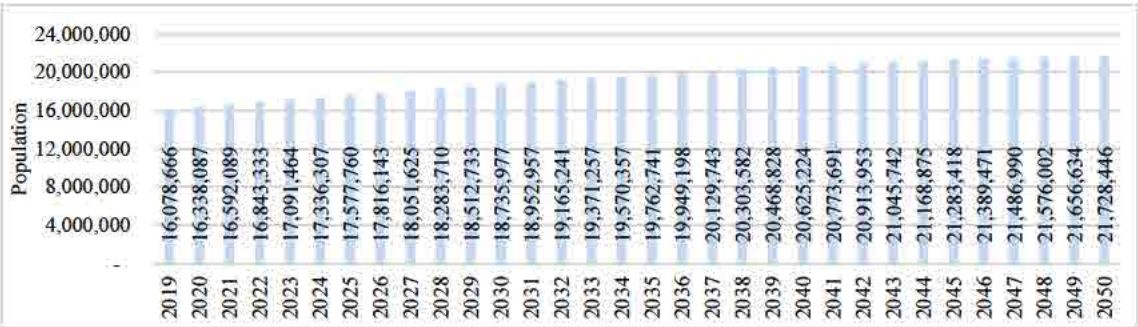


Figure 3-7 Total population projection to 2050[16]

[16]Source: Population projection from 2019 to 2050, from National Institute of Statistic (NIS) of MOP

Based on population growth projections from the NIS, Cambodia's population is expected to increase from 17,336,307 in 2024 to 21,728,446 by 2050. This population growth will naturally impact the demand for rice, the country's staple food. Paddy rice consumption is forecast to increase from 6,074,642 tons in 2024 to 7,613,647 tons in 2050. Looking ahead to 2050, the total volume of paddy production is projected to reach 16,127,240 tons. After accounting for the total volume of domestic consumption, estimated at 7,613,647 tons, the remaining paddy available for export is projected to be 8,513,592 tons. This highlights Cambodia's potential to maintain a significant role in the international rice market, even while meeting the growing domestic demand.

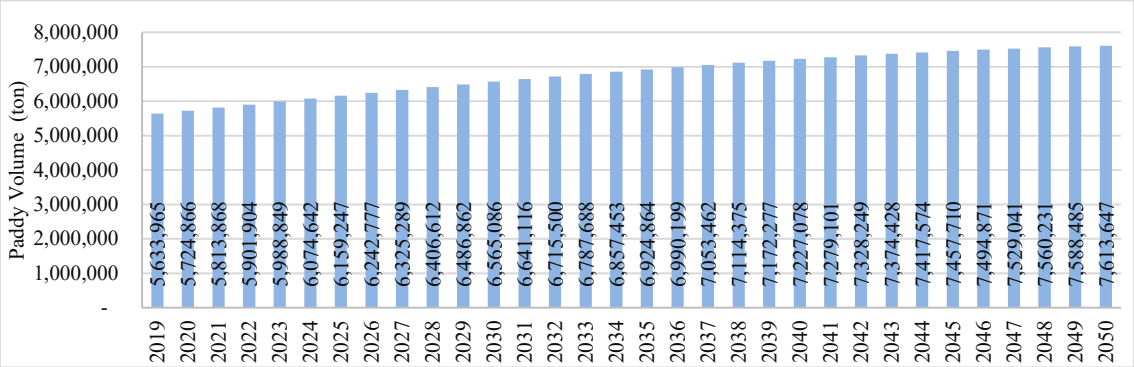


Figure 3-8 Paddy rice domestic consumption in Cambodia to 2050

Given that rice is the staple food in Cambodia, our forecasting will prioritize estimating the total volume of rice consumption within the country. Once domestic consumption requirements are met, the remaining rice production can then be allocated for export purposes.

(c) Forecast of paddy rice export volume

For paddy rice exports, Cambodia has export paddy and milled rice. Currently, a significant portion of paddy is exported to Vietnam due to a shortage of milling and drying facilities within Cambodia. This situation limits the potential economic benefits, as milled rice commands a higher value than paddy. Expanding the domestic rice milling and drying industry would allow Cambodia to capture more of the value chain and increase export profits. To address this, our expert team has developed two export scenarios.

Scenario 1: Milling industry envelopment in Cambodia does not significantly expand. In this scenario, milled rice exports remain stagnant, with no substantial increase despite higher paddy production. The majority of the increased paddy production is exported as raw paddy. Cambodia continues to primarily function as a supplier of raw materials, limiting potential revenue gains from value-added processing.

Scenario 2: Growth of the rice milling industry in Cambodia is actively promoted. In this scenario,

the volume of paddy exported is reduced, as more rice is processed domestically. Cambodia becomes a more significant player in the global milled rice market, capturing greater economic value and increasing export revenue. These scenarios highlight the strategic importance of investing in and developing Cambodia's rice milling industry to maximize export potential and economic benefits.

a) Scenario 1

Under Scenario 1, where the milling capacity in Cambodia remains stagnant at 2024 levels through 2050, a significant portion of the paddy production will be exported to Vietnam for processing. In 2024, Cambodia exported 675,642 tons of milled rice, which is equivalent to approximately 2,162,054 tons of paddy. Assuming this milling capacity remains unchanged, the same amount of paddy (2,162,054 tons) will be processed and exported as milled rice in 2050. Given the projected total paddy production of 16,127,240 tons in 2050 and the domestic consumption of 7,613,647 tons, the remaining paddy available for export is 8,513,592 tons. Since only 2,162,054 tons can be processed into milled rice within Cambodia, the remaining 6,351,538 tons (8,513,592 - 2,162,054) of paddy will be exported to Vietnam for milling and drying. This scenario underscores the limitations by the lack of milling and drying capacity and the reliance on external processing, potentially reducing the overall economic benefits for Cambodia.

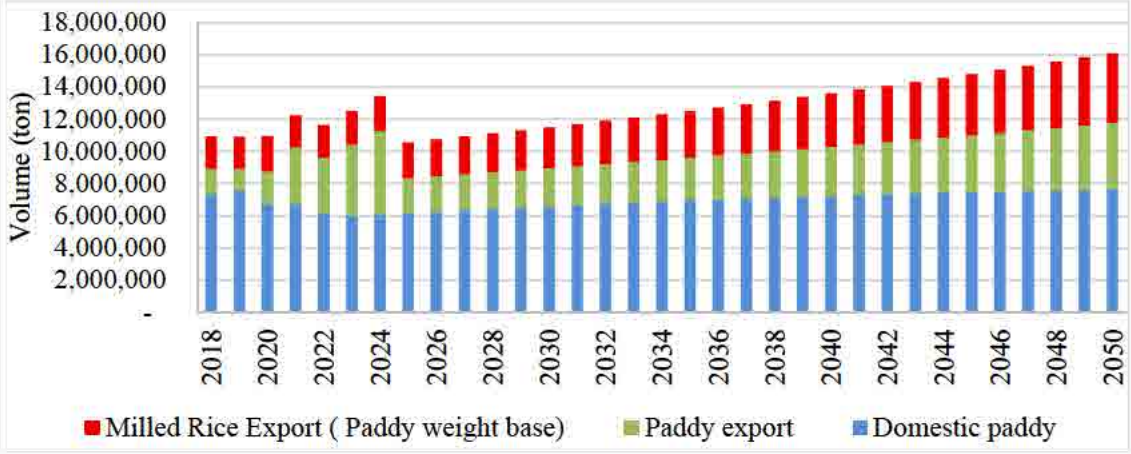


Figure 3-9 Forest of paddy production (Scenario 1)

b) Scenario 2

In Scenario 2, a significant expansion of Cambodia's rice milling capacity is envisioned. Specifically, an increase of over 4 million tons in paddy milling capacity is projected, representing more than half of the potential exportable paddy volume in 2050. This expansion drives a substantial increase in milled rice exports, with an average growth rate of 2.7% per year from 2025 to 2050. As a result, by 2050, Cambodia is projected to export 1.3 million tons of milled rice, which is equivalent to approximately 4.3 million tons of paddy. This increased local processing significantly reduces the volume of paddy that needs to be exported. Consequently,

only 4.1 million tons of paddy are projected to be transported to Vietnam and other countries for milling in 2050. The transportation methods for these exports differ. Paddy rice is typically transported in bulk using barges or bulk vessels. In contrast, milled rice is packed into bags and loaded onto containers for export, reflecting the higher value and more refined nature of the product. This scenario highlights the potential for Cambodia to become a major exporter of milled rice, capturing more value within its borders and reducing its reliance on external processing.

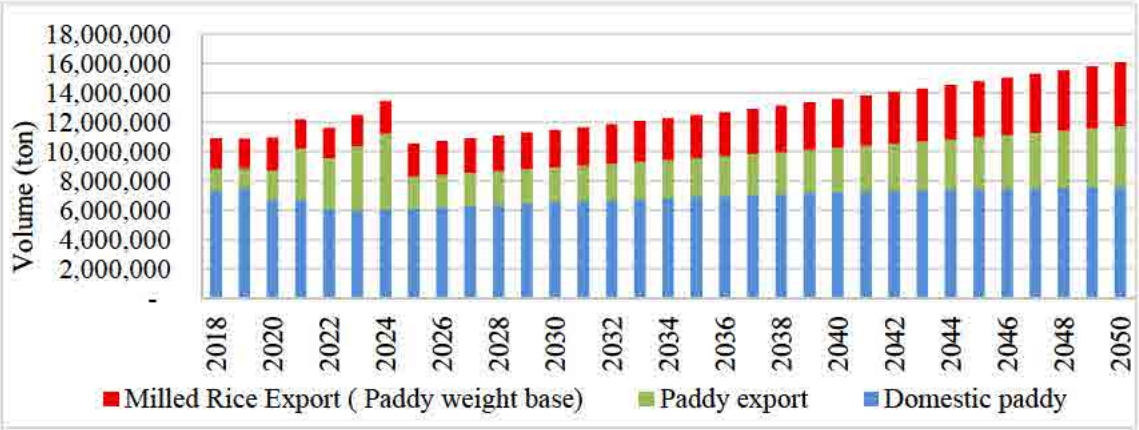


Figure 3-10 Forest of paddy production (Scenario 2)

When exporting rice abroad, we prepare two options: one is to export paddy, and the other is to export milled rice. As Cambodia currently has a shortage of milled factories, a large amount of paddy is forced to be transported to Vietnam, and milled there. The milled rice is much more valuable than paddy. The more milled rice factories are developed in Cambodia, the more profit will be expected in Cambodia. The expert team, therefore, will prepare two scenarios to export rice.

Table 3-6 Summary of paddy rice demand forecast[17]

	Actual volume in 2024(ton) (i)	Forecast in 2050 (ton) (ii)	Increase rate (2050/2024) (ii)=(ii)/(i)
(a)Total Paddy production in Cambodia	13,889,562	16,127,240	1.16
Total Population in Cambodia	17,336,307	21,728,446	1.25
(b) Paddy rice domestic consumption	6,074,642	7,613,647	1.25
(c)Total volume of paddy available for export after subtracting domestic consumption, (c)=(a)-(b)	7,324,358	8,513,592	1.16
Scenario 1			
(d) Milled rice export	675,642	675,642	1.00
(e) Milled rice export converts to paddy volume weight based, (e)=(d)*3.2	2,162,054	2,162,054	1.00
(f) Paddy Export, (f)=(c)-(e)	5,180,155	6,351,538	1.23
(g) Milled rice export by container (1TEU= 14 ton), (g)=(d)/14		48,260	-
Scenario 2			
(d) Milled rice export	675,642	1,350,667	2.00
(e) Milled rice export converts to paddy volume weight based, (e)=(d)*3.2)	2,162,054	4,322,133	2.00
(f) Paddy Export, (f)=(c)-(e)	5,180,155	4,191,459	0.81
(g) Milled rice export by container (1TEU= 14 ton), (g)=(d)/14		96,476	-

(3) Allocating export paddy volume by zone

In Cambodia, every province is involved in paddy rice production. To determine how much paddy will be exported from each province in the future, we assume that the export shares in 2050 will be based on the production shares from 2024. By 2050, it is estimated that the total amount of paddy rice for export will reach 8.4 million tons after subtracting domestic consumption. Battambang province is expected to have the largest share of this export, accounting for 11.6% of the total. Following closely is Prey Veng province, which is projected to have an export share of 10.7%. Accordingly, these provinces will have a significant role in Cambodia's rice export market in the coming years.

[17] 3.2 kg of paddy=1 kg of milled rice

Table 3-7 Volume of paddy exports in 2050 by province

Province/City	Paddy Production share by province in 2024 (ton)	Total Export Paddy in 2050 (ton)	Paddy Production share by province
	(a)	(b)=(a)*(c)	(c)
Banteay Meanchey	1,199,868	735,458	8.64%
Battambang	1,914,199	1,173,306	13.78%
Kampong Cham	677,582	415,323	4.88%
Kampong Chhnang	823,933	505,029	5.93%
Kampong Speu	409,186	250,810	2.95%
Kampong Thom	1,006,674	617,040	7.25%
Kampot	482,841	295,957	3.48%
Kandal	428,481	262,637	3.08%
Kep	12,309	7,545	0.09%
Koh Kong	27,094	16,607	0.20%
Kratie	238,234	146,025	1.72%
Mondul Kiri	112,590	69,012	0.81%
Oddar Meanchey	246,686	151,206	1.78%
Pailin	33,335	20,433	0.24%
Phnom Penh	14,127	8,659	0.10%
Preah Sihanouk	39,542	24,237	0.28%
Preah Vihear	297,335	182,251	2.14%
Prey Veng	1,910,535	1,171,060	13.76%
Pursat	801,063	491,011	5.77%
Ratanak kiri	97,719	59,897	0.70%
Siem Reap	718,118	440,170	5.17%
Stung Treng	78,482	48,105	0.57%
Svay Rieng	615,123	377,039	4.43%
Takeo	1,364,541	836,394	9.82%
Tboung Khmum	339,965	208,381	2.45%
Total	**13,889,562**	**8,513,592**	**100.0%**

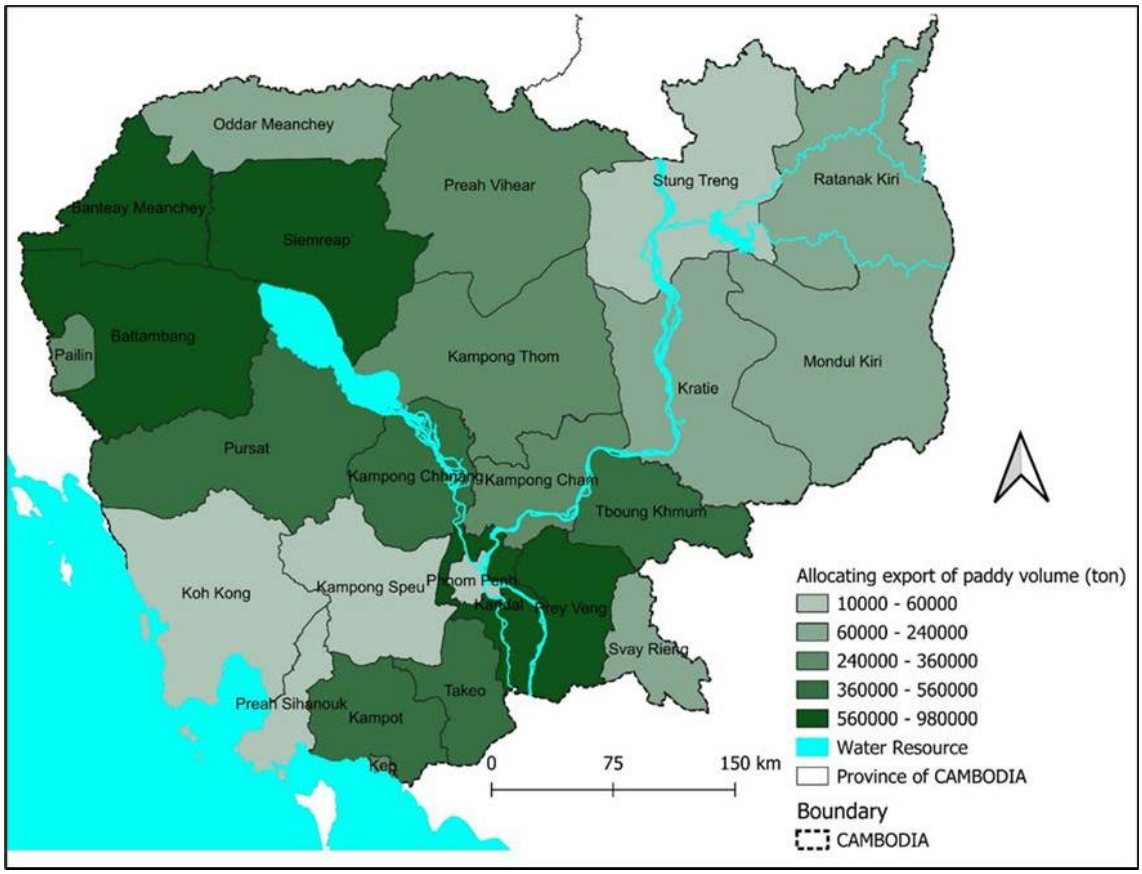


Figure 3-11 Allocation of paddy export volume in 2050 by province

(4) Paddy rice transport route

(a) Current paddy and milled rice transport routes

Paddy rice is produced in various provinces, with local collectors transporting it to mills in Phnom Penh and Battambang. Major transport routes include NR5 (National Road 5) and NR6[18]. After milling, white rice is transported from milled rice factories to Phnom Penh or Sihanoukville port for export to other countries. Paddy rice can also be collected from the northern side of the country via multiple barges and transported as bulk cargo to a single location for packaging, where the packaged goods then get loaded on to a container and are exported out through Vietnam to Europe or the U. S.[19] Most of paddy is sold directly to traders for export, primarily to Vietnam. In provinces near the Vietnam border, such as Svay Rieng, paddy is transported by truck directly to Vietnam due to the short distance. In other provinces, export to Vietnam may occur via barge, as Vietnam has milling facilities along the canal bank that facilitate easy pumping of paddy to dryers using machines. Paddy at Svay Rieng is served by one canal called Prey Vor, located 7 km from the Vietnam border. This canal transports paddy to Vietnam.

[18] Source: The project for Improving the Logistic system of Cambodia, JICA report, May 2023
[19] Interview with Cambodia Logistics Association. (CLA)

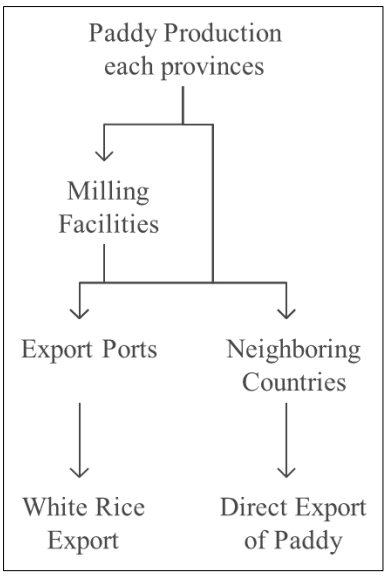


Figure 3-12 Paddy Rice Transportation and Export Pathways in Cambodia

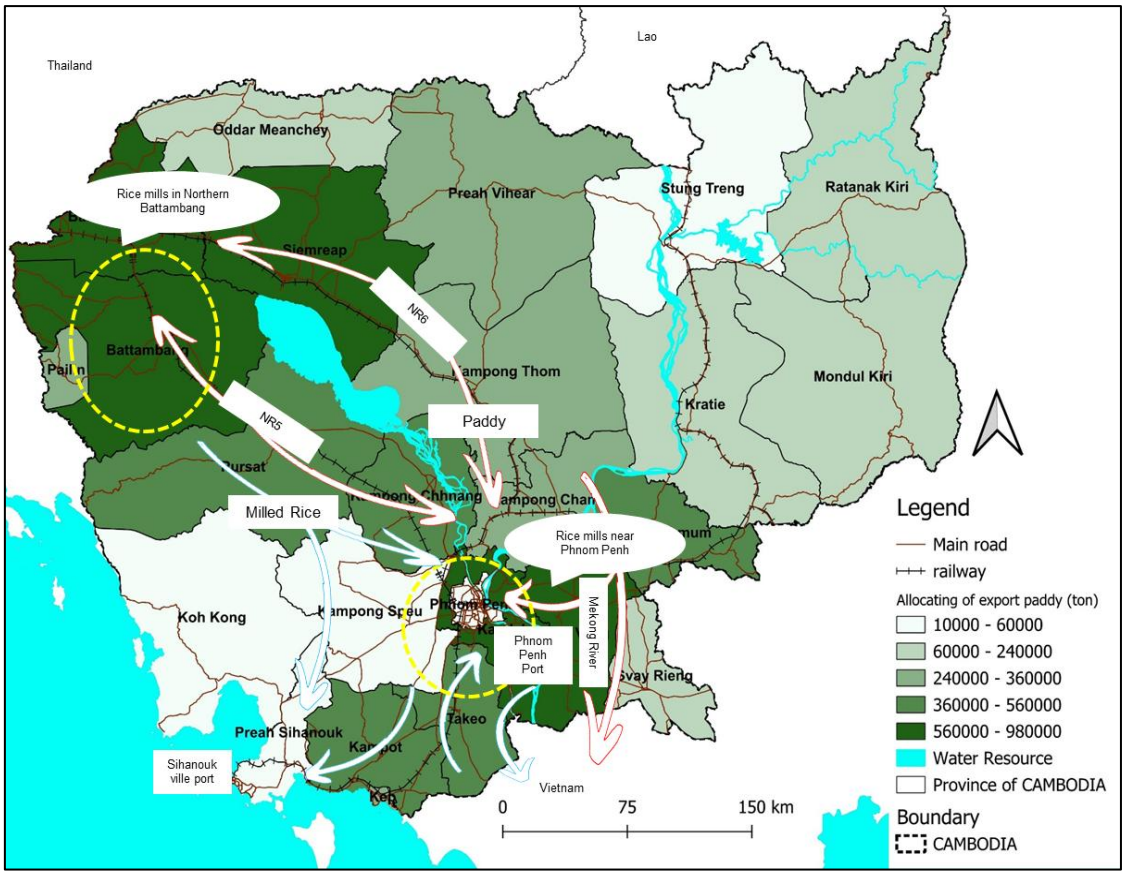


Figure 3-13 Current transportation route of paddy and milled rice

(b) Future paddy and milled rice transport routes

The expert team explores two possible rice transportation routes based on the milled rice processing scenarios mentioned previously.

Scenario 1: Raw agricultural goods (Paddy) will be transported in the same manner as at present. Majority of Paddy will be transported to Vietnam, then dried and milled in Vietnam.
Scenario 2: Milled rice factories will be constructed along the Tonle Sap River to reduce land transportation costs.

Scenario 2 will allow people to conveniently utilize inland waterways, eliminating expenses associated with truck transport and loading. Additionally, expanding the milled rice processing capacity in Cambodia will bring several benefits such as enhancing economic efficiency, creating jobs, supporting local farmers, and reducing paddy exports to Vietnam, which are priced lower compared to milled rice exports. As half of paddy production will be processed in Cambodia, logistics hubs will be developed near major production areas and ports to streamline the processing, storage, and distribution of milled rice. These hubs can improve coordination among transporters, millers, and exporters. And exports to foreign countries can be transported in containers.

a) Future paddy and milled rice transport route (scenario 1)

In 2050, the total paddy production is 16,127,240 tons, with domestic consumption accounting for 7,613,647 tons, (47% of the total paddy production). This leaves 8,513,592 tons available for export, which represents 53% of the overall production. Additionally, milled rice exports account for 14% of the total paddy production. Since milled rice is exported by container, we need to convert the unit from tons to TEU. Meanwhile, paddy exports make up 39% of the total paddy production and are mostly transported by barge or truck, so the unit used is tons. This overview highlights the relationship between domestic consumption and exports, as well as the processing of paddy into milled rice for export.

Table 3-8. Volume of paddy and milled rice export in 2050

Province/City	Paddy Production by province (Ton)	Scenario 1			
		Milled Rice Export by paddy weight in 2050 (Ton)	Milled Rice Export by container in 2050 (Ton)	Milled Rice Export by container in 2050 (TEU)	Paddy export by barge in 2050 (ton)
	(a)	(b)	(c) =(b)*3.2	(d)=(c)/14	(e)[20]
Banteay Meanchey	1,393,173	186,772	58,366	4,169	548,686
Battambang	2,222,586	297,965	93,114	6,651	875,341
Kampong Cham	786,744	105,473	32,960	2,354	309,850
Kampong Chhnang	956,673	128,254	40,079	2,863	376,775
Kampong Speu	475,108	63,694	19,904	1,422	187,116
Kampong Thom	1,168,854	156,699	48,969	3,498	460,341
Kampot	560,629	75,159	23,487	1,678	220,798
Kandal	497,511	66,698	20,843	1,489	195,939
Kep	14,292	1,916	599	43	5,629
Koh Kong	31,459	4,217	1,318	94	12,390
Kratie	276,615	37,084	11,589	828	108,942
Mondul Kiri	130,729	17,526	5,477	391	51,486
Oddar Meanchey	286,428	38,399	12,000	857	112,807
Pailin	38,705	5,189	1,622	116	15,244
Phnom Penh	16,403	2,199	687	49	6,460
Preah Sihanouk	45,912	6,155	1,923	137	18,082
Preah Vihear	345,237	46,283	14,464	1,033	135,968
Prey Veng	2,218,332	297,395	92,936	6,638	873,666
Pursat	930,118	124,694	38,967	2,783	366,317
Ratanak kiri	113,462	15,211	4,753	340	44,686
Siem Reap	833,810	111,783	34,932	2,495	328,387
Stung Treng	91,126	12,217	3,818	273	35,889
Svay Rieng	714,222	95,750	29,922	2,137	281,289
Takeo	1,584,375	212,405	66,377	4,741	623,989
Tboung Khmum	394,735	52,919	16,537	1,181	155,462
Total	**16,127,240**	**2,162,054**	**675,642**	**48,260**	**6,351,538**

b) Future paddy and milled rice transport route (scenario 2)

In Scenario 2, the total export paddy production is 8,513,592 tons, which is 53% of the total production. Milled rice export is 27% of total paddy rice production. Since milled rice is exported by container, we need to convert the unit from tons to TEU. Additionally, paddy export is 26% of total export paddy production are mostly transported by barge or truck, so the unit used is tons.

[20] e=Total paddy- domestic paddy-(b)

Table 3-9. Volume of paddy and milled rice export in 2050

Province/City	Paddy Production by province (Ton)	Scenario 2			
		Milled Rice Export by paddy weight in 2050 (Ton)	Milled Rice Export by container in 2050 (Ton)	Milled Rice Export by container in 2050 (TEU)	Paddy export by barge in 2050 (ton)
	(a)	(b)	(c) =(b)*3.2	(d)=(c)/14	(e)[21]
Banteay Meanchey	1,393,173	373,373	116,679	8,334	362,085
Battambang	2,222,586	595,658	186,143	13,296	577,649
Kampong Cham	786,744	210,849	65,890	4,706	204,474
Kampong Chhnang	956,673	256,390	80,122	5,723	248,639
Kampong Speu	475,108	127,330	39,791	2,842	123,480
Kampong Thom	1,168,854	313,255	97,892	6,992	303,784
Kampot	560,629	150,250	46,953	3,354	145,707
Kandal	497,511	133,334	41,667	2,976	129,303
Kep	14,292	3,830	1,197	85	3,714
Koh Kong	31,459	8,431	2,635	188	8,176
Kratie	276,615	74,133	23,167	1,655	71,892
Mondul Kiri	130,729	35,036	10,949	782	33,976
Oddar Meanchey	286,428	76,763	23,989	1,713	74,443
Pailin	38,705	10,373	3,242	232	10,060
Phnom Penh	16,403	4,396	1,374	98	4,263
Preah Sihanouk	45,912	12,305	3,845	275	11,933
Preah Vihear	345,237	92,524	28,914	2,065	89,727
Prey Veng	2,218,332	594,517	185,787	13,270	576,543
Pursat	930,118	249,274	77,898	5,564	241,737
Ratanak Kiri	113,462	30,408	9,503	679	29,489
Siem Reap	833,810	223,463	69,832	4,988	216,707
Stung Treng	91,126	24,422	7,632	545	23,684
Svay Rieng	714,222	191,413	59,817	4,273	185,626
Takeo	1,584,375	424,616	132,692	9,478	411,778
Tboung Khmum	394,735	105,790	33,059	2,361	102,591
Total	**16,127,240**	**4,322,133**	**1,350,667**	**96,476**	**4,191,459**

(5) Issues to be addressed

a) Shortage of irrigation Systems: Provinces with high rice production are near major water sources like the Mekong and Tonle Sap Rivers. Improving irrigation is crucial for future rice field projections and boosting production.

b) Electricity Costs: Higher electricity prices in Cambodia increase rice processing (such as

[21] e=Total paddy- domestic paddy-(b)

milling and drying) costs, making neighboring countries such as Vietnam or Thailand, where cheaper electricity is available, more attractive. Additionally, logistics costs in Cambodia are higher than in neighboring countries such as Vietnam and Thailand, affecting competitiveness in international markets.

c) Forecasting with Historical Data: Accurate projections must consider improvements in irrigation, logistics, and electricity costs. These factors are vital for the future growth of rice exports from Cambodia.
d) Capital Shortages for Rice Mills: Many rice mills struggle to secure funding to buy rice during peak harvest times, leading to large amounts being sold to neighboring countries instead.
e) Seed Supply Issues: There is a scarcity of pure seeds, especially for high-value fragrant rice varieties.
f) Water Scarcity: Many farmers lack sufficient water for irrigation during the dry season, relying mainly on rainwater in the wet season.
g) Environmental Practices: Farmers have not widely adopted eco-friendly farming techniques, such as better land preparation and careful use of fertilizers and pesticides. Planting schedules are not adjusted for climate change, increasing the risk of droughts and floods.
h) Crop Planning: There are no specific crop planting maps to ensure expected yields and quality at reasonable prices.

3.1.3 Dry Bulk (Cassava-Agriculture goods)

(1) Present cassava production and distribution

Cassava is the second largest crop in Cambodia after rice. It is grown mainly by smallholder farmers for food to supplement the rice diet, for animal feed and for extraction of starch from its roots, but mainly for export as fresh roots to the international markets. Most of the cassava roots produced in the country are exported to overseas markets through either Thailand or Vietnam and; only a small percentage is used in local cassava processing plants in Cambodia. Cassava's high-water content causes 1% weight loss daily. Dry cassava chips need <14% moisture for 6-month storage; higher moisture (15-17%) leads to spoilage within 2 weeks. Chips are processed as "single-peeled" or "double-peeled" (for cyanide removal). Drying methods (ground/shelves) affect chip appearance. Cambodian farmers sell fresh cassava to Vietnam/Thailand factories. Collectors process fresh roots into dry chips for factories; most fresh roots go to flour production. Fresh cassava has a high moisture content, and there is many processing steps involved in converting fresh cassava into starch. The removal of moisture and non-starch components results in weight loss of approximately 75%. Annual cassava production increased by 1.8% from 2015 to 2024, or from 13 million tons in 2015 to 15.5 million tons in 2024.

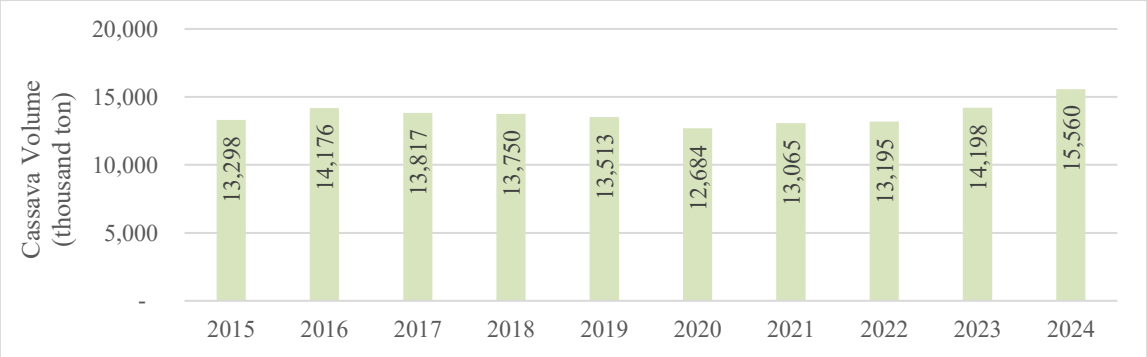
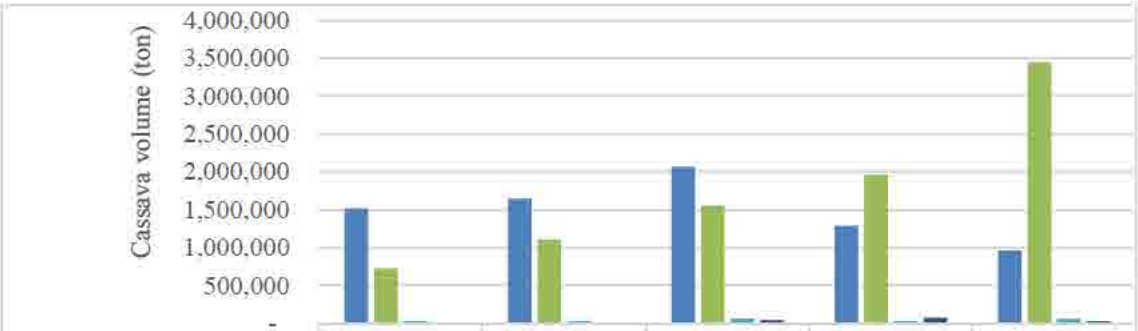


Figure 3-14 Cassava production from 2015 to 2025[22]

The main harvest season for cassava is from January to June, particularly in February, March, and April. It is planted in May and harvested between November and the end of February each year. Currently, cassava prices are dropping due to lower demand. Statistics on cassava exports comprise four types: fresh cassava, cassava slices, cassava starch, and residual cassava. All of these are official exports; however, there is also unofficial export to neighboring countries across the borders.

[22] Source: Statistical Year book of Cambodia 2021, NIS of MOP and MAFF annual report 2024



	2020	2021	2022	2023	2024
Cassava slice Export	1,516,476	1,644,592	2,068,086	1,289,739	964,682
Fresh cassava Export	723,590	1,104,220	1,550,400	1,961,375	3,443,760
Cassava starch Export	34,935	35,863	66,396	36,257	60,525
Cassava residue Export	13,526	9,055	42,665	74,796	33,153

Figure 3-15 Casava exports from 2020 to 2024[23]

In 2024, according to the Cassava Federation of Cambodia (CFC), domestic consumption accounts for around 4-5% or 778,029 tons of the total production volume of 15,560,580 tons. The remaining cassava is exported to other countries. According to data of the General Directorate of Agriculture (GDA), fresh cassava exports amount to 3,443,760 tons (22.1% of the total), followed by sliced cassava at 1,591,725 tons (10.2%), starch cassava at 105,919 tons [24] (0.7%), and residual cassava at 33,153 tons (0.2%). Therefore, there are 9,607,994 tons of fresh cassava weight based remaining, which is 61.7 % of the total cassava production and can be considered as unofficial exports.

Currently, a large proportion of Cambodia's cassava production is exported, primarily to Vietnam and Thailand. A significant portion of these exports are informal and may not be accurately reflected in official trade statistics. Therefore, Cambodian should shift towards processed cassava exports to formalize trade, increase export value, and improve the overall sustainability of Cambodia's cassava industry.

Table 3-10 Official and unofficial exports of casava production in 2024

	Volume (2024)	Percentage share
Cassava slice Export	964,682	10.2%
Cassava slice Export (fresh weight)	1,591,725	
Fresh cassava Export	3,443,760	22.1%
Cassava starch Export	60,525	
Cassava starch Export (fresh weight)	105,919	0.7%
Cassava residue Export	33,153	0.2%
Domestic consumption	778,029	5.0%
Unofficial export	9,607,994	61.7%
Cassava production	15,560,580	100%

[23] Source: General Directorate of Agriculture (GDA) of MAFF

[24] 1 kg fresh cassava = 0.35 kg of slice cassava, 1 kg of fresh cassava = 0.25 kg of starch cassava

(2) Future projection of cassava production

(a) Forecasting cassava production in 2050

Cassava is one of the major export commodities in Cambodia. The average growth rate of the cassava production (MAFF) from 2015 to 2024 is 1.8%. In general, future cassava production should be forecast based on the national policy on cassava production. However, while projections are included in the cassava policy for 2020 to 2025, there are no projections beyond 2025. However, CFC mentioned during the interview that future projections for cassava production are unclear because MAFF, UNDP, USAID, DFAT, World Bank, and ADB believe that cassava farming negatively impacts the environment through soil degradation and deforestation. Consequently, in the forecasting, the expert team sets the annual growth rate of cassava at 1.0%, a modest figure, as the production volume has fluctuated over the years. We establish the base year volume in 2024 at 13.5 million tons by averaging the data from 2015 to 2024.

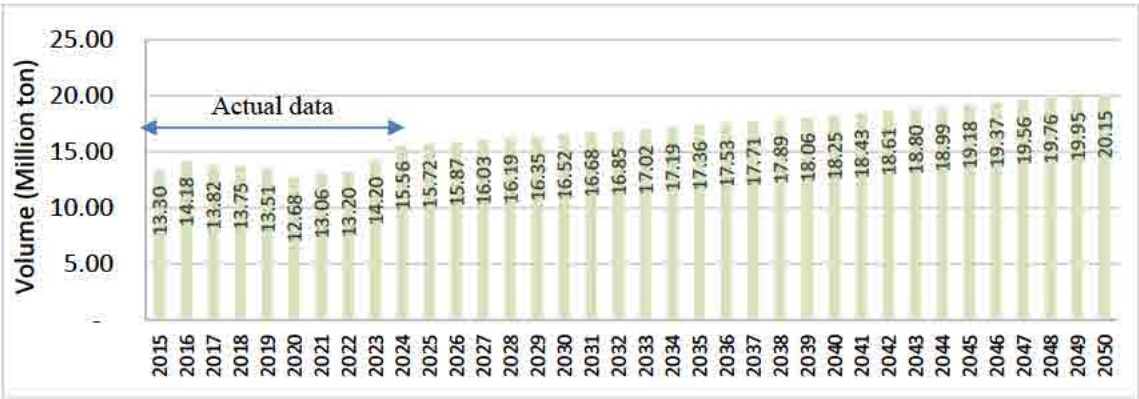


Figure 3-16 Forecasting of cassava production to 2050

(b) Forecasting cassava exports to 2050

There are four types of cassava exports, namely, fresh cassava, sliced cassava, starch cassava and residual cassava. Currently, approximately 95% - 96% of cassava production is exported. The expert team assumes that Cambodia will export sliced (dried chip) cassava and starch instead of fresh cassava in the future. According to the CFC, domestic consumption remains at only 5% in 2024, and we assume that this domestic consumption rate will be maintained up to 2050. Fresh cassava accounts for 14% of the total, with 80% being exported as sliced and starch cassava. Only 1% is cassava residue, and this trend is expected to remain unchanged in the future. These assumptions are made based on the idea that Cambodia will expand local processing rather than exporting fresh roots.

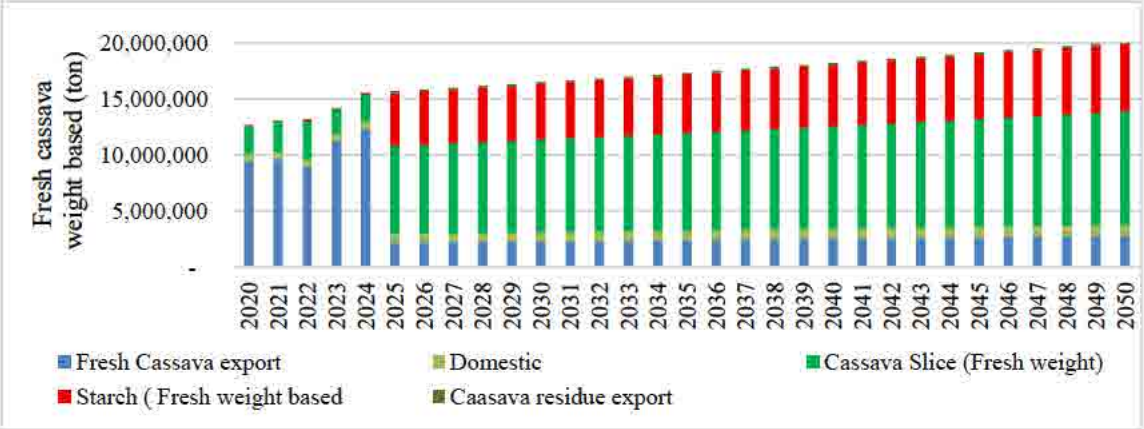


Figure 3-17 Forecasting of export and domestic consumption to 2050[25]

In 2024, Cambodia's fresh cassava exports reached a peak of approximately 12.2 million tons if GDA data on fresh cassava exports and the estimated unofficial export volume are combined. However, the perishable nature of fresh cassava, which dries out quickly, makes it less suitable for long-distance transportation. Furthermore, the price of fresh cassava is significantly lower compared to processed cassava products like starch and dried chips. Given these factors, experts anticipate a shift in Cambodia's cassava export strategy, with a focus on increasing the export of cassava starch and dried chips, rather than fresh cassava. While fresh cassava exports dominate currently, the long-term strategy will prioritize processed products. The processing of cassava results in significant weight reduction. Sliced cassava loses approximately 65% of its fresh weight, while cassava starch loses around 75% of its fresh weight. Despite this weight reduction, dried cassava chips and starch offer several advantages: they are easier to transport, have a longer shelf life, and can be efficiently shipped by barge from Cambodian ports to various international destinations.

Table 3-11 Forecast volume of cassava production

	Actual volume in 2024(ton)	Forecast in 2050 (ton)	Increase rate (2050/2023)
(a) Total Cassava Production	15,560,580	17,778,181	1.14
(b) Domestic consumption, (b)= 0.05*(a)	778,029	888,909	1.14
(c) Total export of cassava, (c)= (a)-(b)	14,782,551	16,889,272	1.14
(d) Fresh Cassava export, (d)= 0.14*(a)	13,051,754	2,488,945	0.19
(e) Cassava slice export, (e)=0.5*(a)	964,682	3,111,182	3.23
(f) Cassava slice export (fresh cassava weight based), f=(e)*0.35	2,756,234	8,889,091	3.23
(g) Starch Cassava export, (g)=0.3*(a)	60,525	1,333,364	22.03
(h) Starch Cassava export (fresh cassava weight based), (h)=(g)*0.25	242,100	5,333,454	22.03
(i) Cassava residue export, (i)=0.01*(a)	33,153	177,782	5.36

[25] Source: GDA of MAFF and historical data on domestic consumption from CFC; future estimates by the JICA team

(3) Allocating export cassava volume by zone

When allocating the volume of export cassava in each zone, we assume that the share of export cassava in 2050 will mirror the share of cassava production in 2023. In 2050, cassava exports are projected to reach 17.7 million tons, with Battambang accounting for 14.5% of the total and Banteay Meanchey for 14.4%.

Table 3-12 Volume of cassava exports in 2050 by province

Province/City	Cassava Production share by province in 2023	Total Export Cassava in 2050 (ton)	Cassava Production share by province
	(a)	(b)=(a)*(c)	(c)
Banteay Meanchey	2,044,314	2,561,423	14.41%
Battambang	2,059,629	2,580,612	14.52%
Kampong Cham	515,974	646,490	3.64%
Kampong Chhnang	8,608	10,785	0.06%
Kampong Speu	30,139	37,763	0.21%
Kampong Thom	1,158,513	1,451,559	8.16%
Kampot	6,363	7,973	0.04%
Koh Kong	625	783	0.00%
Kratie	1,529,781	1,916,739	10.78%
Mondul kiri	320,942	402,124	2.26%
Oddar Meanchey	1,506,400	1,887,444	10.62%
Pailin	499,438	625,771	3.52%
Phnom Penh	20	25	0.00%
Preah Vihear	680,040	852,056	4.79%
Prey Veng	8,874	11,119	0.06%
Pursat	904,820	1,133,694	6.38%
Ratanak Kiri	422,510	529,384	2.98%
Siem Reap	789,270	988,916	5.56%
Stung Treng	599,097	750,639	4.22%
Svay Rieng	75,990	95,212	0.54%
Takeo	4,545	5,695	0.03%
Tboung Khmum	1,023,168	1,281,978	7.21%
Total	**14,189,060**	**17,778,181**	**100%**

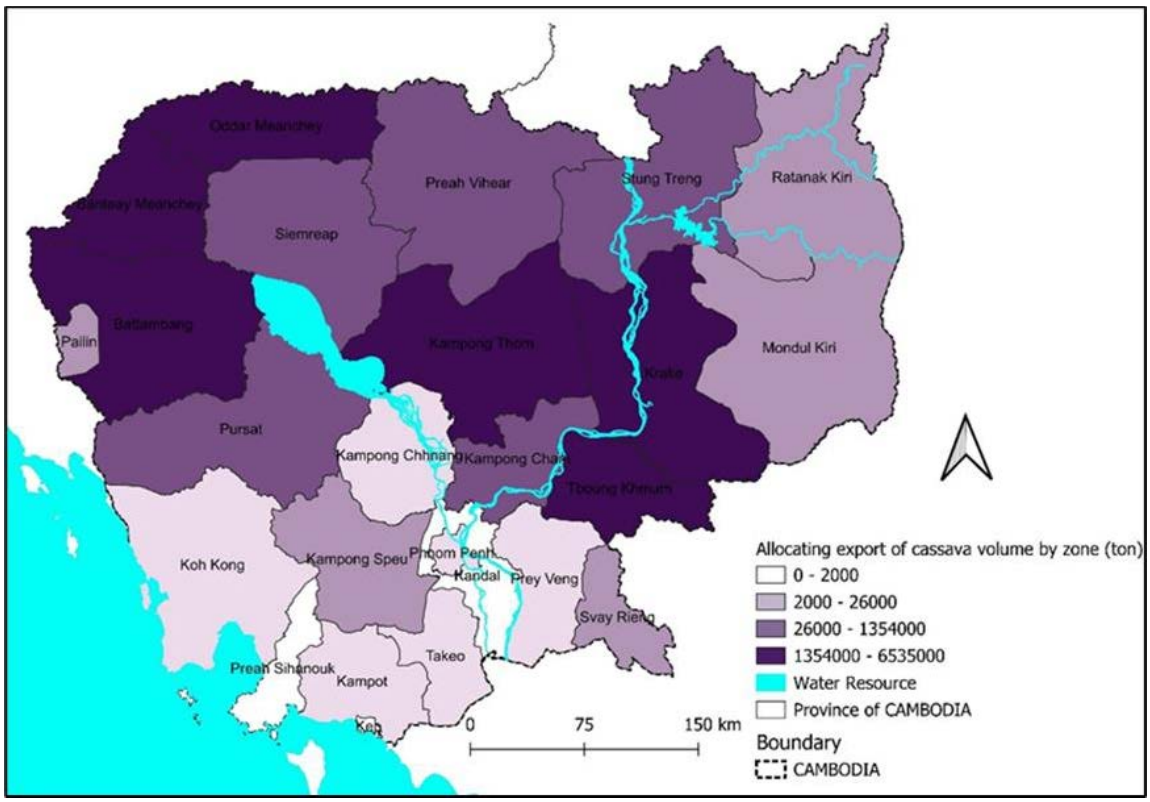


Figure 3-18 Allocation volume of cassava export in 2050 by province

(4) Cassava production transport route

(a) Current cassava transport routes

Cambodia exports cassava to Vietnam and Thailand. The majority of fresh cassava roots are transported across borders. These collectors have sub-collectors who visit collecting points to buy cassava directly from farmers. Cassava is mainly transported by truck, particularly from production areas to processing factories and export points. For export slice and starch cassava to China, using containers isn't practical due to certification requirements. Transport by barge is more common.[26]

[26] Interview with Cassava Federation Cambodia and Cambodia Logistic Association

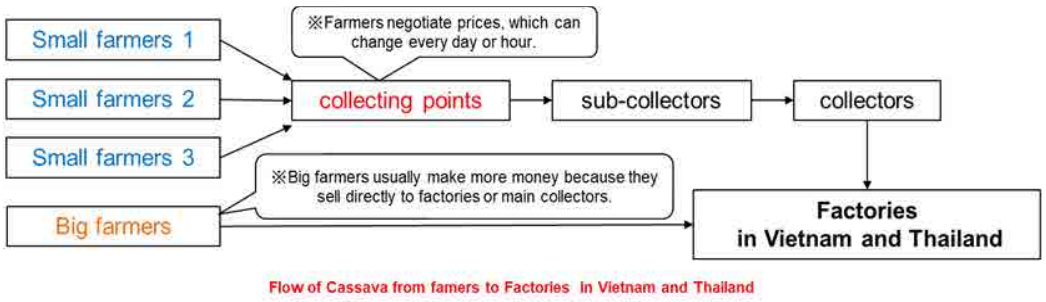


Figure 3-19 Flow of cassava collection processing[27]

Factories in Vietnam and Thailand buy cassava from Cambodian farmers through collectors. These collectors have sub-collectors who visit collecting points to buy cassava directly from farmers. In the provinces, there are many collecting points where small farmers bring their harvested cassava. Big farmers sell directly to the factory if they are close to the border or they just sell directly to the bigger collectors. When prices are higher in Vietnam, farmers in the western provinces send their cassava there. If prices are better in Thailand, farmers in the eastern provinces will sell there. The domestic price also changes depending on these factors.



Figure 3-20 Cassava production and transport in Cambodia (Source: Cassava Federation Cambodia)

(b) Future cassava transport routes

Fresh cassava exports, currently accounting for 14% of the total, will be export to Vietnam by cross border. And about 80% of fresh roots are converted to cassava slices and starch. Developing drying and processing facilities near major production areas would increase profitability for cassava products, making transport easier and more convenient for farmers, exporters, and processors. Additionally, fluctuations in prices and competition for raw materials from

[27] Interview with Cassava Federation of Cambodia and Cambodia Logistic Association

neighboring countries would no longer affect supply stability for local processors. Ideally, bulk transport is best. Establishing drying facilities could enable break-bulk transport to nearby countries or container shipments to Europe and the U.S.

By 2050, total cassava production is projected to reach 17,778,181 tons, with domestic consumption at 888,909 tons (5% of total production) and total cassava exports at 16,889,272 tons (95% of total production). Fresh cassava may still be exported by truck in tonnage, while processed cassava products such as slices, starch, and residues will be packaged and then loaded into containers, converting tonnage to TEU.

Table 3-13 Volume of cassava export by barge/truck and container in 2050

Province/City	Cassava Production share by province in 2050 (ton)	Fresh export Cassava in 2050 (ton)	Starch Export			Slice Export			Export Residual Cassava	
			Fresh weight Based (ton)	Starch weight based (ton), 75% moisture loss	Starch weight based (TEU)	Fresh weight Based (ton)	Slice weight based (ton), 65% moisture loss	Slice weight based (TEU)	Export Residual Cassava in 2050 (ton)	Export Residual Cassava in 2050 (TEU)
	(a)	(b)=(a)*0.14	(c)=(a)*0.3	(d)=(c)*0.25	(e)=(d)/14	(f)=(a)*0.5	(g)=(f)*0.35	(g)=(f)/14	(h)=(a)*0.01	(i)=(h)/14
Banteay Meanchey	2,561,423	358,599	768,427	192,107	13,722	1,280,712	448,249	32,018	25,614	1,830
Battambang	2,580,612	361,286	774,184	193,546	13,825	1,290,306	451,607	32,258	25,806	1,843
Kampong Cham	646,490	90,509	193,947	48,487	3,463	323,245	113,136	8,081	6,465	462
Kampong Chhnang	10,785	1,510	3,236	809	58	5,393	1,887	135	108	8
Kampong Speu	37,763	5,287	11,329	2,832	202	18,881	6,608	472	378	27
Kampong Thom	1,451,559	203,218	435,468	108,867	7,776	725,779	254,023	18,144	14,516	1,037
Kampot	7,973	1,116	2,392	598	43	3,986	1,395	100	80	6
Koh Kong	783	110	235	59	4	392	137	10	8	1
Kratie	1,916,739	268,343	575,022	143,755	10,268	958,369	335,429	23,959	19,167	1,369
Mondul Kiri	402,124	56,297	120,637	30,159	2,154	201,062	70,372	5,027	4,021	287
Oddar Meanchey	1,887,444	264,242	566,233	141,558	10,111	943,722	330,303	23,593	18,874	1,348
Pailin	625,771	87,608	187,731	46,933	3,352	312,885	109,510	7,822	6,258	447
Phnom Penh	25	4	8	2	0	13	4	0	0	0
Preah Vihear	852,056	119,288	255,617	63,904	4,565	426,028	149,110	10,651	8,521	609
Prey Veng	11,119	1,557	3,336	834	60	5,559	1,946	139	111	8
Pursat	1,133,694	158,717	340,108	85,027	6,073	566,847	198,396	14,171	11,337	810
Ratanak Kiri	529,384	74,114	158,815	39,704	2,836	264,692	92,642	6,617	5,294	378
Siem Reap	988,916	138,448	296,675	74,169	5,298	494,458	173,060	12,361	9,889	706
Stung Treng	750,639	105,089	225,192	56,298	4,021	375,319	131,362	9,383	7,506	536
Svay Rieng	95,212	13,330	28,563	7,141	510	47,606	16,662	1,190	952	68
Takeo	5,695	797	1,708	427	31	2,847	997	71	57	4
Tboung Khmum	1,281,978	179,477	384,593	96,148	6,868	640,989	224,346	16,025	12,820	916
Total	**17,778,181**	**2,488,945**	**5,333,454**	**1,333,364**	**95,240**	8,889,091	3,111,182	222,227	177,782	12,699
Percentage share		**14%**	**30%**			**50%**			**1%**	

(5) Issues to be addressed

Based on an interview with CFC, future cassava projections are not clear because the MAFF and UNDP, USAID, DFAT, World Bank, and ADB believe that cassava farming harms the environment through soil degradation and deforestation. Accordingly, the future of cassava production seems uncertain. Currently, cassava prices are dropping. On the other hand, electricity costs present a significant constraint for agricultural development in Cambodia. High electricity prices lead to elevated transportation costs, and most fresh cassava roots are exported to neighboring countries for processing. Additionally, logistics costs in Cambodia are higher compared to neighboring countries like Vietnam and Thailand, further impacting the competitiveness of Cambodian Cassava in international markets.

3.1.4 Dry Bulk (Rubber-Agriculture goods)

(1) Present rubber production and distribution

Cambodia's rubber plantations can be categorized into two types: family-owned plantations and agro-industrial plantations. Family-owned plantations primarily focus on exporting raw rubber. By contrast, agro-industrial plantations possess the capabilities to both export raw rubber and process it locally, adding value to the product before export. This distinction highlights the potential for further development of the rubber processing industry within Cambodia.



Figure 3-21 Types of rubber plantation[28]

Based on interviews with Cambodia Rubber Association (CRA), General Directorate of Rubber (GDR) and historical statistic data, production from rubber plantations in Cambodia peaked from 2007 to 2014, as many people grew rubber due to high prices, coinciding with the establishment of economic land concessions. However, the area of rubber plantation has stable between 400,000 and 430,000 hectares since 2016, with the peak year for rubber plantation occurring in 2018.

[28] Source: General Directorate of Rubber (GDR) of MAFF

Table 3-14 Area and Tapped area of rubber and yield of rubber production[29]

Year	Total area (ha)	Tapped area (ha)	Rubber Production (ton)	Yield (t/Ha/Year)	Rubber export (ton)
	(a)	(b)	(c)	(d)=(c)/(b)	(e)
2000	53,722	42,698	42,007	0.98	40,066
2001	51,458	37,680	38,562	1.02	35,672
2002	55,582	36,773	32,384	0.88	36,774
2003	53,527	33,696	32,382	0.96	32,764
2004	54,209	31,590	33,770	1.07	33,558
2005	60,406	30,402	29,464	0.97	29,950
2006	69,994	32,390	32,077	0.99	31,184
2007	82,059	30,491	32,975	1.08	33,121
2008	107,901	34,313	37,050	1.08	36,000
2009	127,723	34,135	37,380	1.10	36,500
2010	181,433	38,406	42,250	1.10	42,000
2011	213,104	45,163	51,339	1.14	44,969
2012	280,355	55,361	64,525	1.17	59,917
2013	328,771	78,493	85,244	1.09	86,052
2014	357,809	90,545	97,054	1.07	100,151
2015	388,955	111,232	126,861	1.14	128,047
2016	432,735	126,996	145,200	1.14	145,100
2017	436,339	170,230	193,286	1.14	188,832
2018	436,682	201,949	220,100	1.09	217,500
2019	405,671	250,477	287,638	1.15	282,071
2020	404,159	292,497	349,300	1.19	338,300
2021	404,044	310,193	368,000	1.19	366,300
2022	404,578	315,332	382,000	1.21	372,900
2023	407,172	320,184	391,800	1.23	368,048
2024	425,443	330,259	407,209	1.23	338,000

In 2024, total production area for rubber exceeded 0.425 million ha including a tapped area of around 0.33 million ha (covering 78% of the total area). A total of 0.407 million tons of rubber was produced in 2024. Currently, there are 6 car tire companies which operate only 3 companies and the number of car tire companies will be increase to 7 within the SEZs. Recently, various new tire factories have been established throughout Cambodia, particularly by Chinese companies, to meet the demand for rubber abroad. Accordingly, rubber exports to China and elsewhere are expected to increase.

(Natural rubber value chain and Transport[30])

First, rubber latex (converted to cup lump) is tapped from rubber trees and collected from farms using trucks and small vehicles. These vehicles travel on rural roads in provinces like Thong Khmum, Kampong Cham, Kratie, and Ratanak Kiri. Next, the collected cup lump is taken to processing facilities by trucks traveling along provincial roads to reach places that turn raw

[29] Source: General Directorate of Rubber (GDR) of MAFF

[30] Interview with Cambodia Rubber Association (CRA)

materials into semi-finished rubber such as Technically Specified Rubber (TSR) and Smoked Rubber Sheets (RSS). These processing units focus on rubber production, where the natural rubber is transformed into usable forms. After processing, the products need to be exported. Currently, natural rubber exports are mostly transported by trucks, with routes passing through the border crossing, which connects to Vietnam. Another important location is Sihanoukville port, where goods are prepared for sea export.

Rubber produces two main types of raw rubber: Natural Rubber (NR) and processing rubber such as TSR and RSS. Ultimately, rubber can lose up to 50% to 70% of its moisture after processing, leaving only 30% to 50% usable.



Figure 3-22 (a) Rubber latex and cup lump[31]



Figure 3-23 (b) TSR type[32]



Figure 3-24 (c) RSS type[33]



Figure 3-25 (d) Car tyre[34]

Figure 3-26 Natural rubber value chain (from to (a) to (b) or (c) then become (d)

(2) Future projection of rubber production

(a) Forecasting of rubber production

Based on an interview with a rubber expert, rubber production cannot increase every year until 2050 because the total area available for plantations is limited. In this estimate, we use the peak rubber plantation area from 2018, which reached 436,682 hectares, to forecast production from 2025 to 2035. Rubber yield cannot increase beyond 1.5 tons per hectare. Therefore, our estimate assumes a 4.5% increase from 2025 to 2035, and from 2036 to 2050, rubber production will remain steady due to limitations in plantation area and yield.

[31] Source: Cambodia's rubber exports earn more than $200 million, up nearly 40% - Khmer Times
[32] Source: Cambodia Rubber Association
[33] Source: Cambodia Rubber Association
[34] Source: Largest Cambodia Tire Manufactures - Frico Tires

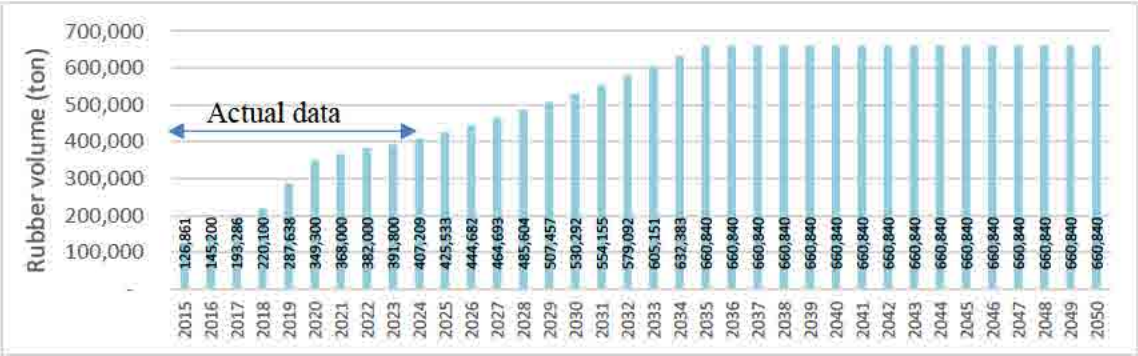


Figure 3-27 Forecast of rubber production to 2050

(b) Forecasting of rubber export in 2050

There are two types rubber[35] such as Natural Rubber (NR) and processing rubber as TSR and RSS. For raw rubber can lose 50% to 70% of its moisture during processing. In terms of domestic demand, domestic tire factories consumed approximately 58,000 tons of rubber in 2024, which was about 14-15% of total rubber production that year (407,209 tons). However, in 2025, with more tire factories operating and under construction, domestic demand is expected to increase sharply. For example, Sailun Tire Cambodia alone may require around 100,000 tons of rubber latex in 2025, with other factories having similar demands. This could raise domestic consumption to about 40-45% or more of total rubber output.

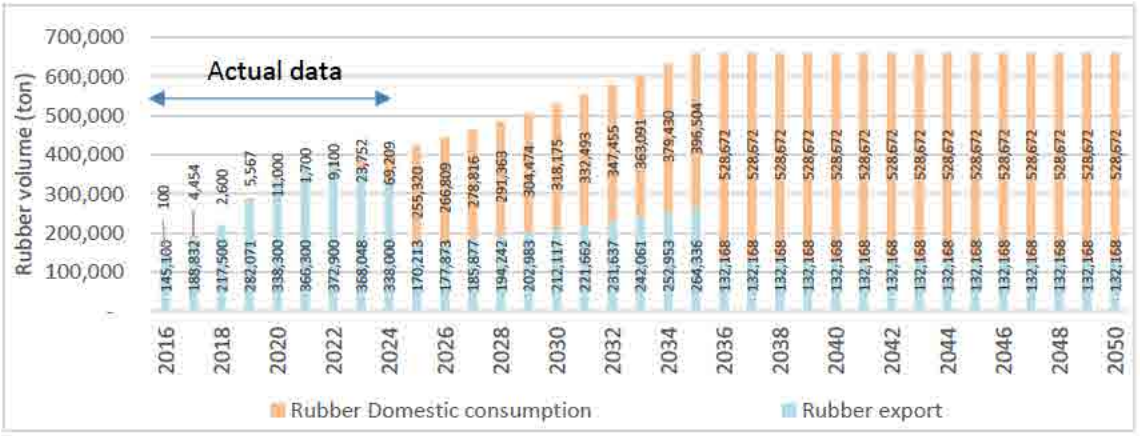


Figure 3-28 Forecasting rubber domestic consumption and export to 2050

Rubber production in Cambodia is limited to the area tapped. Therefore, rubber production is expected to increase to 660,840 tons by 2050 from 407,209 tons in 2024, an increase of about 0.6 times. Rubber is exported as raw rubber to Vietnam or other neighboring countries. In our forecast, from the current year until 2035, we expect that 40% of total rubber will still be exported, with the remaining 60% being consumed domestically. Additionally, from 2036 to 2050, we forecast that natural rubber exports

[35] Interview with Cambodia Rubber Association (CRA)

will decrease to 20% due to an increase in industries in Cambodia (primarily in SEZs) processing natural rubber into semi-finished rubber and final products, especially car tires and others. In the future, all production derived from Cambodia's natural rubber will also be exported, but as finished products. Therefore, exports of natural rubber will decrease 0.4 times from 2024 to 2050. Moreover, the rubber domestic consumption will increase 7.6 time from 2024 to 2050.

Table 3-15 Forecast of rubber production and export

	Actual volume in 2024(ton)	Forecast in 2050 (ton)	Increase rate (2050/2024)
(a) Total rubber production	407,209	660,840	1.62
(b)Export of rubber	338,000	132,168	0.39
(c) Domestic consumption of rubber, (c)=(a)-(b)	69,209	528,672	7.64

(3) Allocating rubber production and export

When allocating the volume of export natural rubber in each zone, we assume that the share of rubber exports in 2050 will mirror the share of rubber plantation area in 2024. In 2050, rubber exports are projected at 132,168 tons, with Kampong Thom accounting for 18.36% of the total and Kratie 17.3%.

Table 3-16 Allocation of rubber production and export

Province/city	Rubber plantation shares by province in 2023 (ton)	Total Export Rubber in 2050 (ton)	Rubber Production share by province
	(a)	(b)=(a)*(c)	(c)
Banteay Meanchey	170	53	0.04%
Battambang	2,531	786	0.59%
Kampong Cham	29,169	9,062	6.86%
Kampong Chhnang	500	155	0.12%
Kampong Speu	536	167	0.13%
Kampong Thom	78,092	24,260	18.36%
Kampot	441	137	0.10%
Kandal	-	-	0.00%
Kep	-	-	0.00%
Koh Kong	7,562	2,349	1.78%
Kratie	73,586	22,860	17.30%
Mondul Kiri	30,597	9,505	7.19%
Oddar Meanchey	14,581	4,530	3.43%
Pailin	2,083	647	0.49%
Phnom Penh	-	-	0.00%
Preah Sihanouk	822	255	0.19%
Preah Vihear	12,061	3,747	2.83%
Prey Veng	1,575	489	0.37%
Pursat	3,905	1,213	0.92%
Ratanak Kiri	61,222	19,019	14.39%
Siem Reap	3,236	1,005	0.76%
Stung Treng	13,123	4,077	3.08%
Svay Rieng	2,772	861	0.65%
Takeo	-	-	0.00%
Tboung Khmum	86,878	26,990	20.42%
Total	**425,443**	**132,168**	**100.00%**

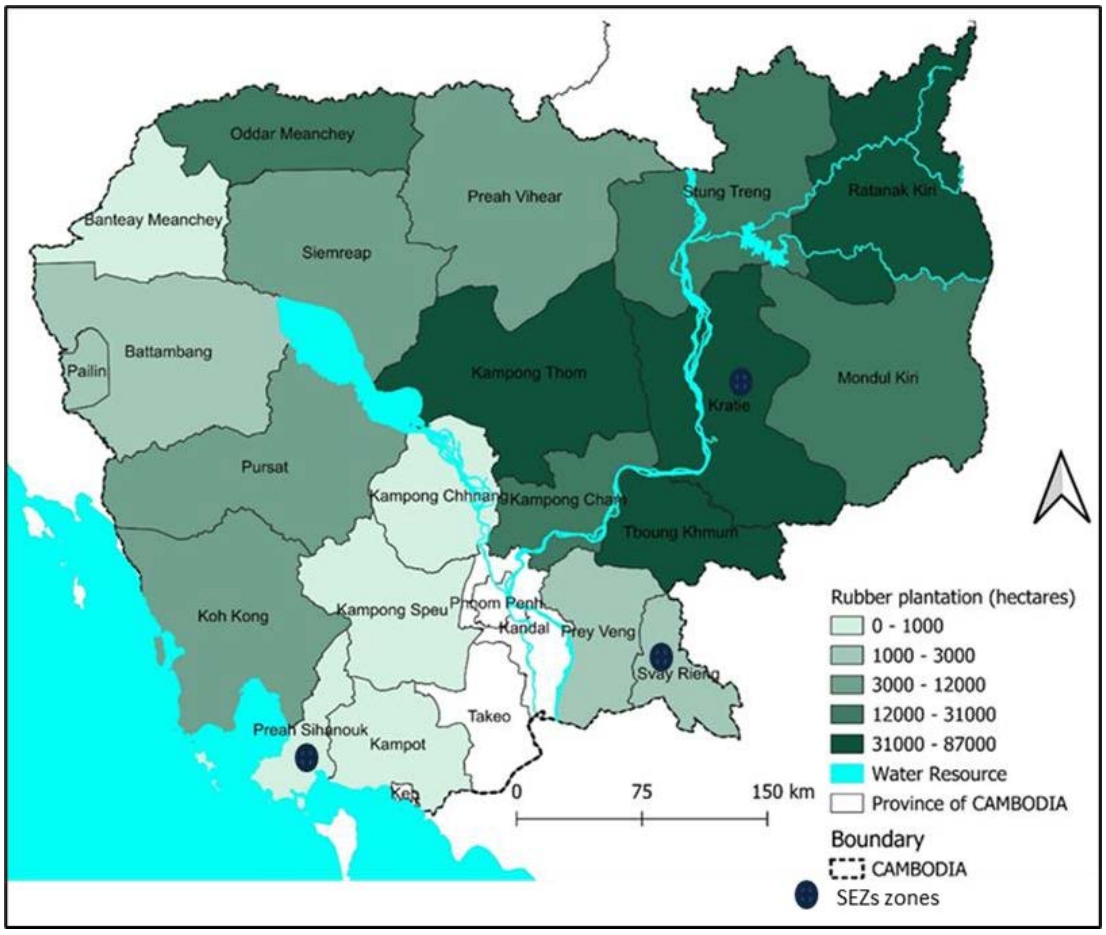


Figure 3-29 Allocation volume of natural rubber export in 2050 by provinces

(4) Rubber transport route

(a) Current rubber transport routes

Transport routes from each province to SEZ zones are via national roads by truck. Around 60% of exports go to Vietnam through provinces such as Ratanakiri, Mondulkiri, Stung Treng, Kratie, or others. The route goes to the Tropeng Tlong border (Tboung Khmum) along the Cambodia-Vietnam border by truck. Moreover, rubber that is processed to be products such as car tires or others will be load into containers for export to abroad.

(b) Future rubber transport routes

20% of raw rubber will be exported by truck or barge to Vietnam and other neighboring countries. The remaining 80% will be processed locally in Cambodia, where there are more car tire companies, especially in SEZs like Svay Rieng, Kratie, and Sihanoukville. The rubber plantations are located in Mondul Kiri, Ratanak Kiri, and Stung Treng, upper Mekong River, will be

transported from these areas to Kratie and then to the SEZs for processing. After processing, the final products will be shipped to foreign countries in containers.

Of the total rubber production of 660,840 tons, 528,672 tons or 80% of the total is consumed domestically. Total export volume of raw rubber is 32,168 tons or 20% of total production. Raw rubber is normally exported to neighboring countries by truck or barge. However, processed rubber is converted locally into products such as car tires or others, and then exported abroad by container.

Table 3-17 The volume of nature rubber export by barge/truck and container in 2050

Province/city	Total Rubber Production 2050 (ton)	Total export Rubber 2050 (ton)	Export of processing Rubber in 2050 (Ton)	Export of processing Rubber in 2050 (TEU)
	(a)	(b)=(a)*0.2	(c)= (a)*0.8	(d)=(c)/14
Banteay Meanchey	264	53	211	15
Battambang	3,932	786	3,145	225
Kampong Cham	45,309	9,062	36,247	2,589
Kampong Chhnang	777	155	621	44
Kampong Speu	833	167	666	48
Kampong Thom	121,300	24,260	97,040	6,931
Kampot	685	137	548	39
Kandal	-	-	-	-
Kep	-	-	-	-
Koh Kong	11,746	2,349	9,397	671
Kratie	114,301	22,860	91,441	6,531
Mondul Kiri	47,526	9,505	38,021	2,716
Oddar Meanchey	22,649	4,530	18,119	1,294
Pailin	3,236	647	2,588	185
Phnom Penh	-	-	-	-
Preah Sihanouk	1,277	255	1,021	73
Preah Vihear	18,734	3,747	14,987	1,071
Prey Veng	2,447	489	1,957	140
Pursat	6,066	1,213	4,853	347
Ratanak Kiri	95,095	19,019	76,076	5,434
Siem Reap	5,027	1,005	4,022	287
Stung Treng	20,384	4,077	16,308	1,165
Svay Rieng	4,305	861	3,444	246
Takeo	-	-	-	-
Tboung Khmum	134,948	26,990	107,958	7,711
Total	**660,840**	**132,168**	**528,672**	**37,762**
Percentage share		**20%**		**80%**

(5) Issues to be addressed

a) Demand from major export partners (e.g., Vietnam, China) can vary unpredictably.
b) Fluctuating fuel prices, coupled with inefficient transport routes, contribute to high transportation costs for rubber producers, impacting profitability.

c) The rubber sector faces challenges such as lack of communication and coordination between suppliers and processors, particularly regarding quality standards.
d) The government and industry leaders emphasize the need for stronger partnerships and cooperation among stakeholders to improve the value chain and support sustainable growth.

3.1.5 Dry Bulk (Cavendish Banana-Agriculture goods)

(1) Present Cavendish Banana production and distribution

In 2023, Cambodia's banana exports dropped by over 21% compared to the previous year. This decline was not due to reduced consumer demand, which remained strong, but rather to lower crop yields caused by adverse weather conditions linked to climate change. Events such as El Niño led to water deficits and soil moisture depletion.

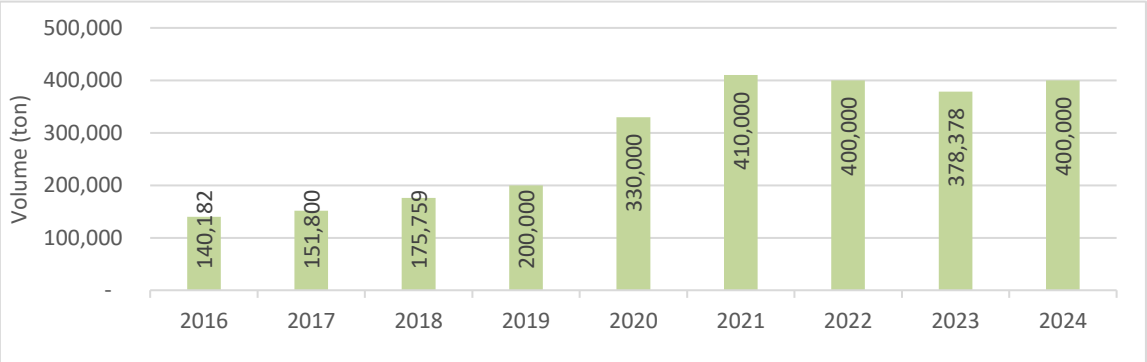


Figure 3-30 Cavendish banana production from 2016 to 2024 (Source: FAOSTAT)

In 2024, a Chinese-invested banana farm in Stung Trang district, Kampong Cham province, plans to expand its plantation to meet rising overseas demand. Cambodia primarily exports cavendish bananas to the following countries: China, Japan and Vietnam, although 98% of the total is exported to China. [36]

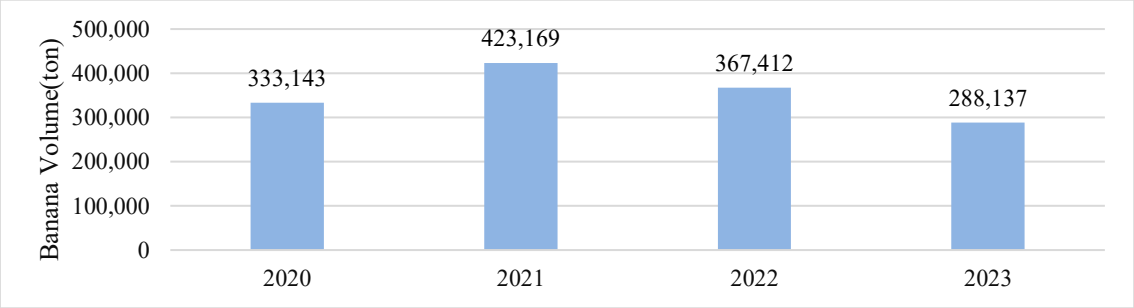


Figure 3-31 Export of Cavendish Banana from 2020 to 2023[37]

[37] Source: General Directorate of Agriculture (GDA) of MAFF

(Banana value chain and transport)

From harvest to market sale, fresh bananas typically have a shelf life ranging from about 7 days under normal cold storage to up to 45 days under controlled atmosphere conditions combined with careful packaging and transport. Without these technologies, bananas ripen and deteriorate faster, leading to significant post-harvest losses if not handled properly.

After harvesting, bananas are quickly transported to nearby packing facilities. Refrigerated transport is used to slow ripening and prevent damage. At the packing facility, bananas undergo quality inspection to remove damaged or diseased fruit. They are washed to remove dirt and latex, which prevents staining and crown rot. Sorting by size, uniformity, and peel color is done to ensure only premium fruit is packed. Banana hands are separated from the main stalk, treatments such as application of antioxidants or fungicides may be applied to prevent crown browning and rot. Bananas are weighed (usually 13 kg net per carton). Each carton is labeled with product name, origin, orchard, packinghouse registration, and traceability codes in English and Chinese. Bananas are packed into vacuum-sealed bags and placed in corrugated cartons with padding. Packed bananas are pre-cooled quickly to about 13.7°C to slow respiration and ripening. They are stored in cold rooms awaiting shipment, usually for 1 day or less to maintain freshness. Bananas are loaded into refrigerated containers (reefers) maintained at optimal temperatures (~13.7°C). Containers are sealed and monitored with data loggers. Before export, fresh bananas must pass phytosanitary inspections by Cambodia's MAFF. Inspection and certification take between 10 to 120 hours (approximately 0.5 to 5 days). Only consignments free of quarantine pests and meeting Chinese import requirements receive export clearance. For export via land, trucks travel from Cambodia border checkpoints to Vietnam and then to China (it takes about 2-3 days). For sea freight, ships transport the bananas from Sihanoukville port to Chinese ports like Shanghai or Dalian (about 5-7 days). Barges are used to transport the bananas by inland waterway Via Phnom Penh to Ho Chi Minh City, and then onward. Upon arrival, bananas are unloaded at distribution centers or ripening warehouses. Further ripening may occur before bananas reach retail markets.

Exporting Cambodian bananas to China involves several key stages. First, banana producers and packing centers must register with Cambodia's GDA, which shares this information with China's GACC for potential inspection and approval. Orchards must adhere to MAFF's agricultural practices. Prior to export, MAFF inspects shipments, and if they meet China's standards, a Phytosanitary Certificate is issued. This process takes between 10 and 120 hours.

Next, exporters need to register with Cambodia's GDCE and obtain an export permit, providing necessary documentation. Upon arrival in China, temperature records are required. A Certificate of Origin from Cambodia's MoC is also mandatory. Shipping requires careful planning, including production scheduling, proper labeling in both English and Chinese, and ensuring the bananas are free of pests and debris. Choosing between sea and air freight depends on factors like cost and time sensitivity. Establishing relationships with logistics companies and understanding payment

methods, such as Letters of Credit, are also important considerations. While agents or distributors in China can aid market entry, selecting reliable partners is crucial.[38]

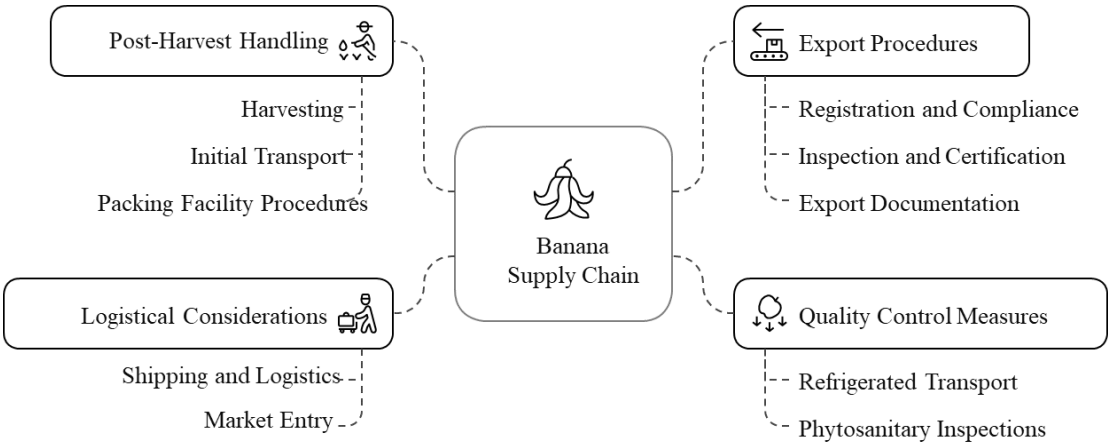


Figure 3-32 Banana Supply Chain from Cambodia to final destinations



Figure 3-33 Cavendish bananas being prepared for export[39]

(2) Future projection of cavendish banana production

In Cambodia, Cavendish bananas are primarily exported to China. Production is expanding through foreign investment and government support; however, the sector faces challenges from climate change, pests and disease risks, and market price fluctuations. The value chain includes cavendish production, input supply, harvesting, packaging, and export logistics, with ongoing efforts to enhance productivity and sustainability to boost export volumes and value.

Cavendish banana production from 2016 to 2024 and export volumes from 2020 to 2023 are shown below. As there are no available forecasts for future cavendish bananas, we assume that from 2024 to 2050, banana production and export will remain unchanged.

[38] Source: Guidelines for exporting bananas from Cambodia to banana
[39] Source: bananas - Khmer Times

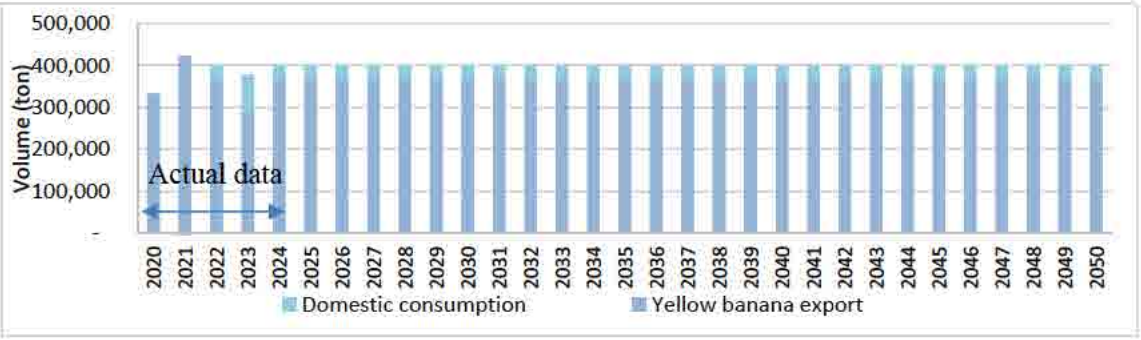


Figure 3-34 Forecast of cavenshish bannana production and exports

(3) Allocating Cavendish banana production and exports

When allocating the volume of export cavendish banana in each province, we assume that the share of export fresh cavendish banana in 2050 will mirror the share of banana production in 2023. In 2050, the volume of export banana is forecast at 367,412 tons. The province of Ratanakiri has the laregest share at 48%.

Table 3-18 Allocation of cavendish banana production and export

Province/City	Cavendish banana Production share by province in 2023 (ton)	Total export of Cavendish banana in 2050	Cavendish banana Production share by province
	(a)	(b)=(a)*(c)	(c)
Battambang	237	259	0.07%
Kampot	56,760	62,109	16.90%
Koh Kong	5,687	6,223	1.69%
Kratie	49,120	53,749	14.63%
Pailin	6,000	6,565	1.79%
Preah Vihear	600	657	0.18%
Prey Veng	1,064	1,164	0.32%
Ratanakiri	161,754	176,997	48.17%
Siem Reap	549	601	0.16%
Stung Treng	48,000	52,523	14.30%
Tboung Khmum	6,000	6,565	1.79%
Total	**335,771**	**367,412**	**100.00%**

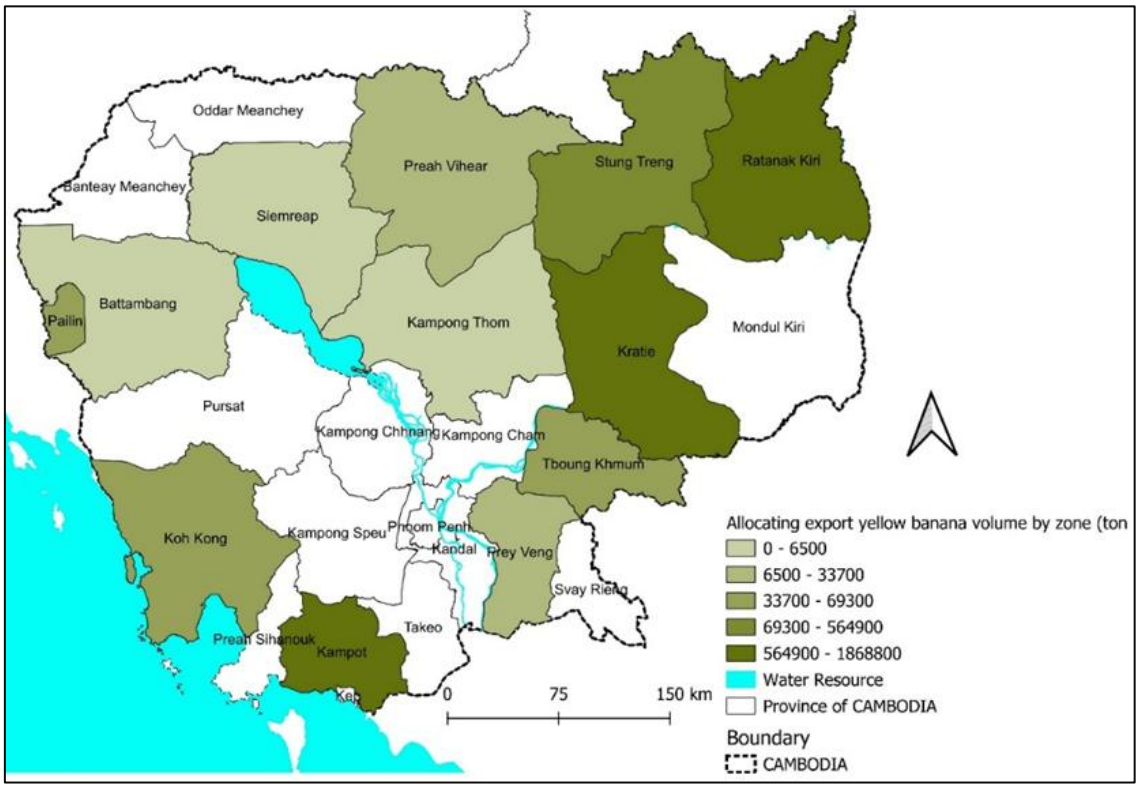


Figure 3-35 Allocation of cavendish banana exports in 2050 by province

(4) Cavendish banana transport route

(a) Current cavendish banana transport routes

Bananas are transported from plantations to packing centers using trucks. For exports to Vietnam and Thailand, road transport is also employed. Proper packaging and labeling are crucial for maintaining quality. For long-distance exports, especially to China, cavendish bananas are shipped in refrigerated containers via sea freight to ensure freshness. Exporting bananas via river transport presents challenges, such as high electricity costs, limited plug and terminal availability, and expensive reefer container fees. The time involved in each step complicates the process, making it difficult for cargo owners to guarantee freshness upon arrival. Although river transport can accommodate large volumes, operational difficulties and the product's nature render bulk exports impractical.

(b) Future Cavendish banana transport routes

It is also important to establish cleaning, labeling and packing factories near plantation areas to preserve the freshness and quality of the bananas. Transportation and shipping from Cambodia to other countries, especially China, need to be well organized. Developing regional logistics hubs with cold storage facilities near production areas can streamline the initial stages of transport and help maintain quality.

Table 3-19 Volume of cavendish banana export by container in 2050

Province/City	Cavendish banana production in 2050	Total export of cavendish banana in 2050 (Ton)	Total export of cavendish banana in 2050 (TEU)
	(a)	(b)	(c)=(b)/14
Battambang	282	259	19
Kampot	67,618	62,109	4,436
Koh Kong	6,775	6,223	444
Kratie	58,516	53,749	3,839
Pailin	7,148	6,565	469
Preah Vihear	715	657	47
Prey Veng	1,268	1,164	83
Ratanak Kiri	192,696	176,997	12,643
Siem Reap	654	601	43
Stung Treng	57,182	52,523	3,752
Tboung Khmum	7,148	6,565	469
Total	**400,000**	**367,412**	**26,244**
Percentage		**92%**	

(5) Issues to be considered

a) Banana production is unpredictable because weather patterns have led to water deficits and soil moisture depletion, affecting banana yields. Adverse weather, including droughts, has led to reduced yields and increased pest issues. Climate change is expected to exacerbate these challenges, negatively affecting production.

b) Cambodia competes with Vietnam, Thailand, and the Philippines, which have more established banana export industries.

c) Most bananas are exported raw, with limited local processing into banana chips, puree, or other value-added products. Accordingly, expanding processing facilities could create new revenue streams and reduce reliance on raw exports. Limited cold storage facilities and inefficient transport routes can lead to banana spoilage before reaching export markets. Cambodia relies on Sihanoukville Port for sea freight, but improvements in port capacity and efficiency are needed.

d) Banana exports have declined due to a global economic downturn and heavy reliance on China, which accounts for over 90% of exports. Fluctuating prices and demand pose significant risks.

e) Increased competition with neighboring countries.

3.1.6 Dry Bulk (Mango-Agriculture goods)

(1) Present mango production and distribution

Mango has been cultivated in Cambodia for thousands of years, thriving in the hot, humid climate of the Mekong plain. There are over 18 types of mangos grown in Cambodia, with the Keo Romeat being the most famous, accounting for 80% of on-season production and nearly 100% of off-season production.

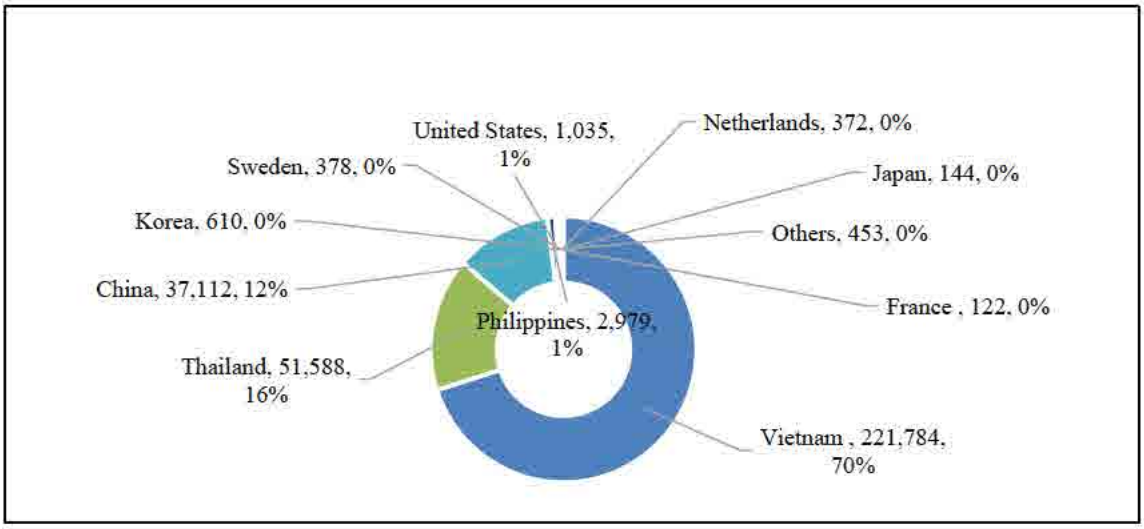


Figure 3-36. Kao Romeat mango export countries in 2024[40]

In 2024, around 70% of mangoes were exported to Vietnam. The main production hubs are Kampong Speu, Battambang, and Oddor Meanchey provinces. Kampong Speu is particularly famous for its sandy, fertile soil along the Mekong River, favorable for Keo Romeat cultivation.

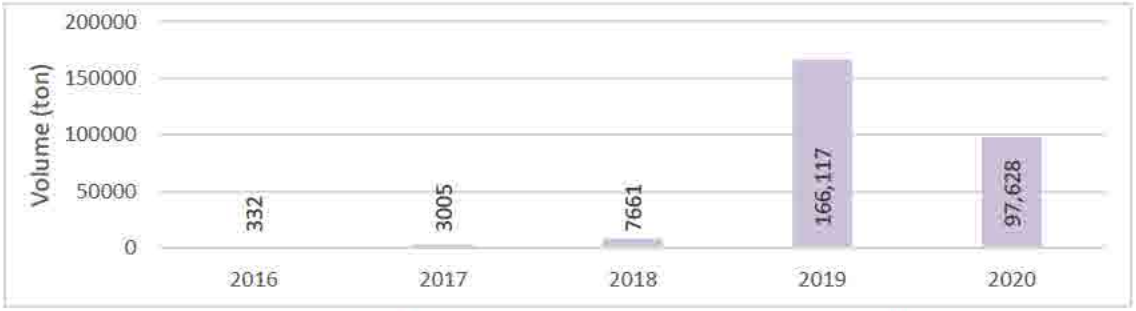
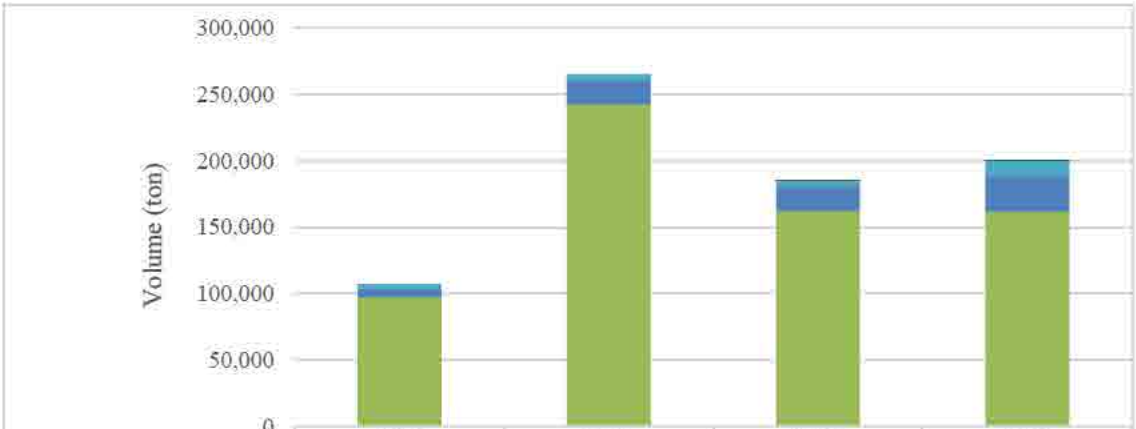


Figure 3-37 Mango production from 2016 to 2023[41]

Statistics on mango production from 2016 to 2023 are available from FAOSTAT. Export data from 2016 to 2023 is also available (from FAOSTAT from 2016 to 2019 and from GDA from 2020 to

[40] General Directorate of Agriculture (GDA) of MAFF
[41] Source: FAOSTAT

2023). The growth rate of mango production and exports has fluctuated, making it difficult to forecast demand accurately.



	2020	2021	2022	2023
dried mango	0	0	31	0
Pickled mango	0	0	0	24
Chocolate mango seeds	0	0	0	3
Mango syrup	3,651	4,866	4,424	10,640
Mango jam	6,402	17,880	18,492	27,388
Fresh mango	97,628	242,484	162,430	161,925

Figure 3-38 Export of mango[42]

Approximately 89% of Cambodia's mango production is consumed domestically, either as fresh fruit or through local processing, while the remaining 11% is exported fresh or as processed products such dried, pickled, chocolate mango seeds, mango syrup and mango jam. This shows that the vast majority of mango production in Cambodia is for domestic consumption and local market supply, with export markets growing but still only represent a small share of total production.

Table 3-20 Domestic consumption and exports of mangoes in 2023

	Mango Fresh weight (ton) in 2023
Processing export (ton)	83,008
Fresh mango export (ton)	161,925
Consumed domestically (ton)	2,005,212

(Mango value chain and transport)

Fresh mangoes typically ripen within 6-10 days and last about 15 days at room temperature. Cold storage at 10-13°C can extend shelf life to 2-3 weeks, while advanced treatments and packaging can prolong it up to 35-40 days. Proper postharvest handling is crucial to minimize losses and

[42] Source: General Directorate of Agriculture (GDA) of MAFF

maintain quality during storage and transport.

First, harvest of mangoes is picked at optimal maturity for sweetness and shelf life. Stems are left long (about 5 cm) to reduce latex staining. Care is taken to avoid bruising. Mangoes are then placed upside down to drain latex for 12-24 hours. After drainage, stems are trimmed to minimize latex exudation. Next, mangoes are quickly transported to packinghouses, ideally within the same day. Vehicles are covered to protect mangoes from sunlight and heat. Additionally, mangoes are sorted by size, color, and quality, damaged fruits are removed, and remaining stems are trimmed if needed. Mangoes also require postharvest treatments in which mangoes are dipped in hot water (46-50°C) for 5-10 minutes to prevent diseases. They are cooled in clean water for about 10 minutes. And mangoes are washed and dried to reduce contamination and then packed in crates with padding to prevent bruising. Each crate is labeled with origin, grade, and traceability info. Mangoes are pre-cooled to 12-13°C to slow ripening. Storage usually lasts less than 24 hours.

For exports, mango crates are loaded into refrigerated containers at 12-13°C. In the case of land transport, trucks transport mangoes via Cambodian-Vietnamese border checkpoints to China, Thailand, or Vietnam (2-3 days). In the case of river transport, barges transport mangoes via Phnom Penh to Ho Chi Minh City, then onward. Sea freight is carried by ships from Sihanoukville to ports in China or other destinations (5-7 days). However, mangoes must first undergo a Phytosanitary Inspection and Export Clearance to meet food safety requirements. Certification typically takes 1 to 5 days. Upon arrival, mangoes are unloaded at distribution centers. Further ripening may occur before retail sale.

Cambodia has signed a Free Trade Agreement (FTA) with China, facilitating mango exports by eliminating tariffs and increasing market access. A protocol was established in June 2020, outlining the phytosanitary requirements for exporting fresh mangoes to China, ensuring they meet specific safety and quality standards. The Cambodian government promotes mango exports as part of its strategy to increase agricultural production and economic growth, with a goal of becoming a major exporter of quality fresh mangoes by 2030. Cambodia relies on Ho Chi Minh City as a key hub for shipping mangoes to China. Mangoes are transported by trucks via border checkpoints to Vietnam or from Phnom Penh to Sihanoukville and then to Chinese ports like Shanghai[43].

[43] Source: Guidelines for Exporting Mangoes form Cambodia to China

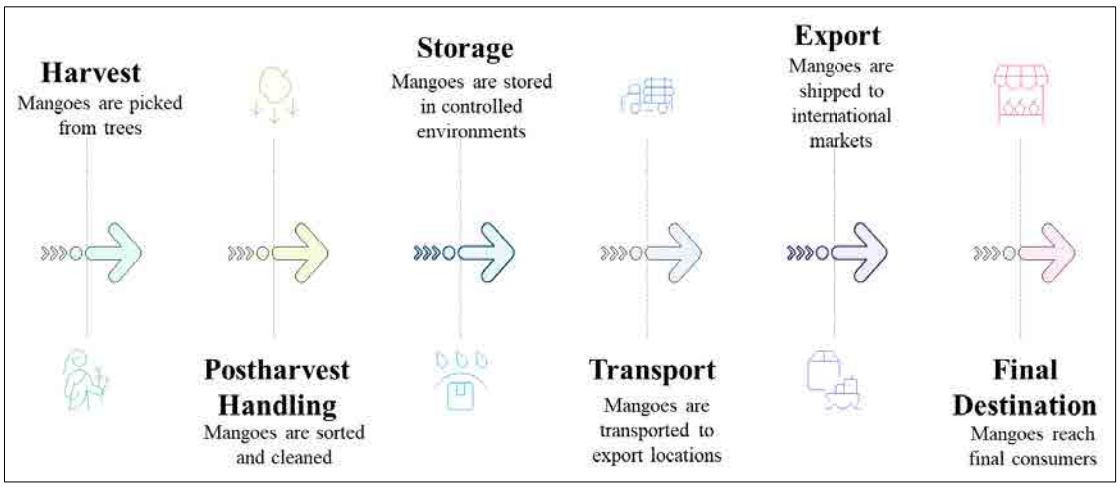


Figure 3-39 Mango Value Chain and Export process



Figure 3-40 Fresh mangoes being prepared for export[44]

(2) Future projection of mango production

The average growth rate of mango production from 2016 to 2020[45] registered 24.3%, which is too high to be applied to demand forecasting. Additionally, there is no policy outlining future projections of mango production. As the mango production volume has fluctuated over the years, we set the base year volume in 2020 as 22,953 tons by averaging the data from 2016 to 2020 and assume an annual growth rate of 3% from 2020 to 2050. We also assume that the volume of fresh mango exports will increase by 60% by 2050 based on historical export data. This also aligns with the government's vision to increase fresh mango exports.

[44] Source: https://www.khmertimeskh.com/tag/mango/
[45] Source: Value Chain Analysis of Keo Romeat Mangoes in Cambodia, 2021

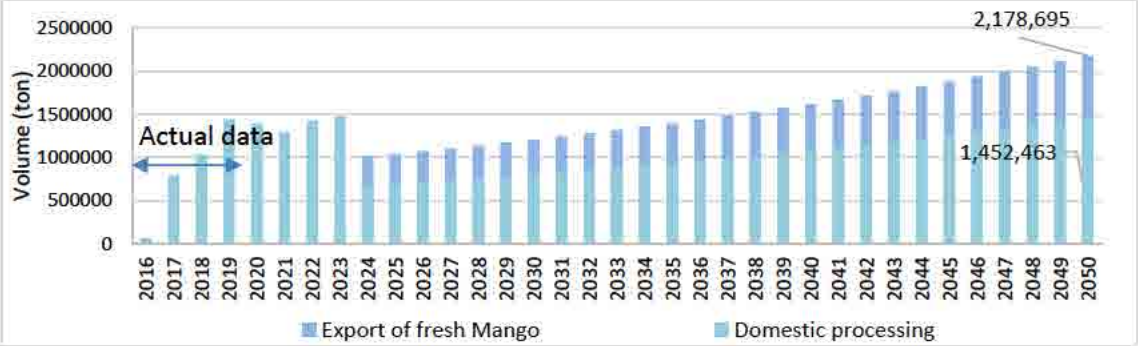


Figure 3-41 Forecast of Kao Romeat Mango export

In the period from 2020 to 2050, global mango production is projected to grow significantly. In 2020, the production was approximately 1.4 million tons, and this is expected to rise to about 3.6 million tons by 2050, reflecting a steady annual growth rate of 3%. This represents an overall increase of 2.4 times from the initial production levels. In Cambodia, the focus is particularly on exporting fresh Keo Romeat mangoes. The export volume for these mangoes was 97,628 tons in 2020, and it is anticipated to soar to 2,178,695 tons by 2050, indicating a remarkable increase of 22.5 times. Additionally, local processing of mangoes in Cambodia is projected to double by 2050, meaning the current processing capacity will increase by one time. This growth highlights a promising future for mango production and export, especially for Cambodia's Keo Romeat variety.

Table 3-21 Forecast of Keo Romeat production and export

	Current volume in 2020 (ton)	Forecast in 2050 (ton)	Increase rate (2050/2020)
(a)Total Mango	1,495,989	3,631,158	2.43
(b)Fresh Mango export	97,628	2,178,695	22.32
(c)Local Processing Mango, (c)=(a)-(b)	1,398,361	1,452,463	1.04

(3) Allocating Mango production and export

When allocating the volume of export mango in each zone, we assume that the share of export mango in 2050 will mirror the share of mango production in 2023. In 2050, mango exports are projected to reach 2.1 million tons, with Kampong Spue accounting for 20.1% and Battambang for 13.9%.

Table 3-22 Allocation of Keo mangoes production and export

Province/City	Mango Production share by province in 2023 (ton)	Total export of Mangoes in 2050 (ton)	Mango Production share by province
	(a)	(b)=(a)*(c)	(c)
Banteay Meanchey	26,257	25,423	1.17%
Battambang	312,126	302,215	13.87%
Kampong Cham	77,547	75,085	3.45%
Kampong Chhnang	104,000	100,698	4.62%
Kampong Speu	452,765	438,388	20.12%
Kampong Thom	146,384	141,736	6.51%
Kampot	115,110	111,455	5.12%
Kandal	109,849	106,361	4.88%
Kep	17,785	17,220	0.79%
Koh Kong	1,808	1,751	0.08%
Kratie	14,745	14,277	0.66%
Mondul Kiri	11,103	10,750	0.49%
Oddar Meanchey	278,735	269,884	12.39%
Pailin	128,964	124,869	5.73%
Phnom Penh	120	116	0.01%
Preah Sihanouk	14,145	13,696	0.63%
Preah Vihear	86,070	83,337	3.83%
Prey Veng	14,000	13,555	0.62%
Pursat	37,800	36,600	1.68%
Ratanak Kiri	53,699	51,994	2.39%
Siem Reap	45,450	44,007	2.02%
Stung Treng	55,800	54,028	2.48%
Svay Rieng	12,093	11,709	0.54%
Takeo	96,000	92,952	4.27%
Tboung Khmum	37,790	36,590	1.68%
Total	**2,250,145**	**2,178,695**	**100.00%**

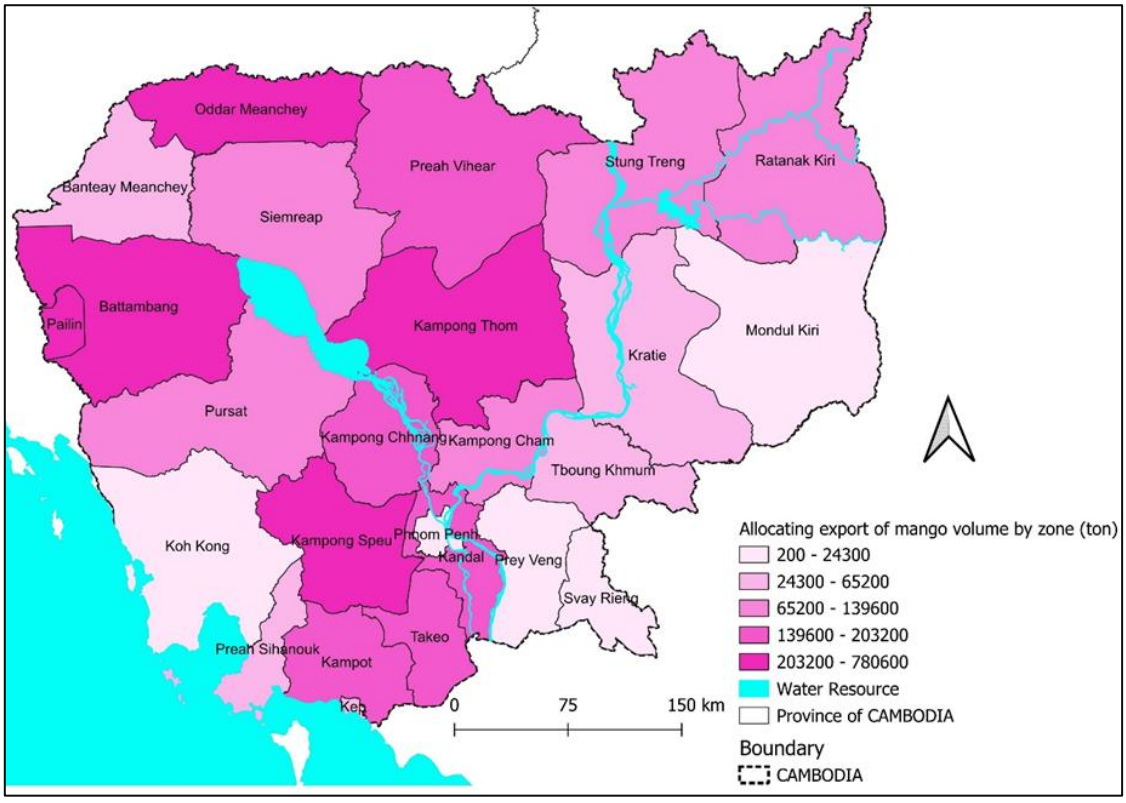


Figure 3-42 Allocation of the volume of mango exports in 2050 by province

(4) Mango transport route

(a) Current mango transport routes

The main export transport routes for Cambodian mangoes primarily involve transit through Vietnam to reach China, the largest market for these mangoes. Cambodian mangoes are transported overland from Cambodia to Vietnam through several border checkpoints such as Bavet (Cambodia) to Moc Bai (Vietnam), Trapeang Phlong (Cambodia) to Xa Mat (Vietnam), Trapeang Sre (Cambodia) to Hoa Lu (Vietnam). From Vietnam, the mangoes proceed to Chinese border points such as Pingxiang and then to major markets in China. For river route, mangoes can be shipped by river from Phnom Penh to Ho Chi Minh City in Vietnam, from where they are forwarded to Chinese ports like Shanghai and Dalian. [46]

(b) Future mango transport routes

Cambodia has recently begun direct mango exports to China after Chinese Customs approved mango plantations and packaging factories in Cambodia. It is necessary to facilitate smoother and faster transport from farms to collection points and processing facilities of mango and to introduce a system for coordinating the collection, handling, and transport of mangoes to reduce delays and

[46] Source: Guidelines for exporting mangoes from Cambodia to China

inefficiencies. It is also necessary to improve post-harvest handling practices, including careful manual fruit selection, washing, and drying, packing facilities at farm or near the farm to maintain fruit quality during transport.

Table 3-23 Volume of Keo mangoes export by container in 2050

Province/City	Fresh mango production in 2050 (ton)	Total export of fresh mango in 2050 (Ton)	Total export of fresh mango in 2050 (TEU)
	(a)	(b)	(c)=(b)/14
Banteay Meanchey	42,372	25,423	1,816
Battambang	503,691	302,215	21,587
Kampong Cham	125,141	75,085	5,363
Kampong Chhnang	167,829	100,698	7,193
Kampong Speu	730,647	438,388	31,313
Kampong Thom	236,226	141,736	10,124
Kampot	185,758	111,455	7,961
Kandal	177,268	106,361	7,597
Kep	28,700	17,220	1,230
Koh Kong	2,918	1,751	125
Kratie	23,795	14,277	1,020
Mondul Kiri	17,917	10,750	768
Oddar Meanchey	449,807	269,884	19,277
Pailin	208,115	124,869	8,919
Phnom Penh	194	116	8
Preah Sihanouk	22,826	13,696	978
Preah Vihear	138,895	83,337	5,953
Prey Veng	22,592	13,555	968
Pursat	61,000	36,600	2,614
Ratanak Kiri	86,656	51,994	3,714
Siem Reap	73,345	44,007	3,143
Stung Treng	90,047	54,028	3,859
Svay Rieng	19,515	11,709	836
Takeo	154,919	92,952	6,639
Tboung Khmum	60,983	36,590	2,614
Total	**3,631,158**	**2,178,695**	**155,621**
Percentage			**60%**

(5) Issues to be addressed

a) Many farmers lack technical knowledge, especially in off-season flowering techniques and proper nutrient management. Off-season production often relies on hormone use learned informally from traders, risking tree stress and lower yields.

b) Cambodia's agrifood processing capacity is limited, especially for mango products beyond fresh and dried fruit, such as mango puree. This lack of in-country processing reduces value addition and export diversification potential.

c) While China is a major export destination driving growth, heavy dependence on a single

market poses risks. Expanding to other markets like Russia, Japan, South Korea, and Europe requires improved quality control, certification, and diversified export channels.

d) Poor storage, transportation, and irrigation infrastructure limit mango quality and shelf life. Environmental compliance, such as wastewater management in processing, is a challenge. Additionally, regulatory burdens and inconsistent enforcement can hinder efficient value chain operations.

3.1.7 Dry Bulk (Cashew Nut-Agriculture goods)

(1) Present cashew nut production and distribution

Cambodia's cashew nut production is primarily concentrated in its central regions. The top-producing provinces are Kampong Cham, Kampong Thom, Ratanak Kiri, Tboung Khmum, and Kratie. Several locally developed cashew nut varieties are cultivated in Cambodia, each exhibiting unique characteristics[47]. The most widely grown variety is M23, representing approximately 70% of cashew cultivation. It flowers two to three times per year (from mid-November to February) and boasts high yields ranging from 1.5 to 2.6 tons per hectare. H09 accounts for about 10% of cultivation. This variety flowers once a year, between late November and early January, and yields between 1.3 and 2.4 tons per hectare. M1 offers yields that are approximately 10-20% lower than M23. It flowers once a year and is considered easier to maintain. This variety produces larger nuts with a brighter shell. IM4 flowers twice a year, from mid-December to February, and has yields ranging from 1.2 to 2.3 tons per hectare. Finally, M10 flowers once a year, starting in early November, and produces yields of 1.4 to 2.3 tons per hectare.



Figure 3-43 Varieties of cashew nut types[48]

In 2023, cashew nut production amounted to 656,000 tons, a 7.6 % decline in volume compared to the previous year. Approximately 618,000 tons or 95% of the total was exported to Vietnam, leaving a mere 5% for local small and medium processors. The total farmland for cashew nut production is around 450,000 hectares.

[47] Source: Cambodia CASHEW NUT Product & Supplier Brochure
[48] Source: Cambodia CASHEW NUT Product & Supplier Brochure

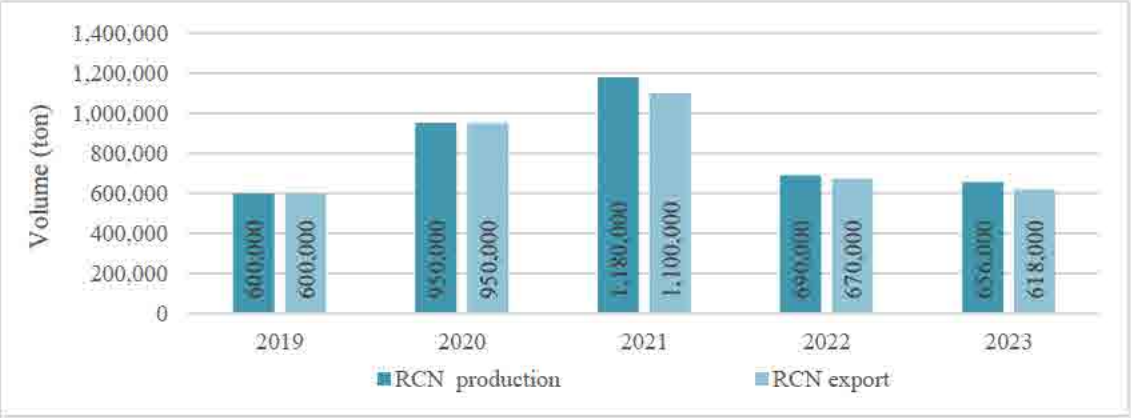


Figure 3-44 Cashew nut production and export[49]

(Cashew nut value chain and transport)

Cashew nuts are harvested during the dry season (April to June); RCN have high moisture content and require sun drying to ~8% moisture for storage and sale. Smallholder farmers sell dried RCN to local collectors or cooperatives who aggregate volumes. Larger traders consolidate RCN from collectors, often purchasing RCN informally, and prepare shipments for export or local processing. Some RCN is sold to Cambodian processors who shell, dry, peel, and pack kernels. Processing capacity is limited but growing, mainly in Kampong Thom, Preah Vihear, Kampong Speu, and Kandal (transport of RCN to processing plants is via road; processed kernels packed for export). Majority of RCN is exported by road to Vietnam for processing. Exporters deliver RCN to Vietnamese border warehouses and drying yards. Processed cashew kernels are exported mainly to China, South Korea, Arabian countries, and Israel (Road transport is used from processing plants to Phnom Penh or ports, then shipped overseas). Cashew kernels and sometimes processed products are shipped overseas by sea or air freight. Sea freight is transported from Phnom Penh or Sihanoukville ports to international markets. [50]

[49] Source: Report of Cashew nut Association of Cambodia (CAC), 2024
[50] Source: Cambodia Cashew nut value chain assessment report, 2019

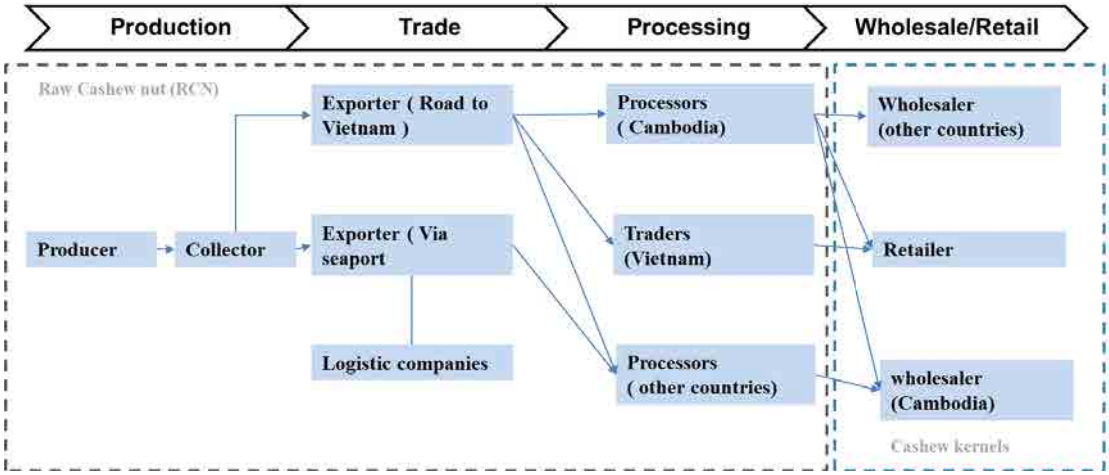


Figure 3-45 Cashew nut value chain and transport

(2) Future projection of cashew nut production

The Cambodia government National Cashew Policy for 2022 to 2027 [51] is designed to significantly enhance the country's cashew production. The policy sets an ambitious goal to increase production volumes by 50% by 2027 compared to the levels in 2022. This increase is not just about growing more cashews; it also focuses on diversifying export markets. By doing this, the government aims to raise the value of cashew exports from $1 billion in 2021 to $1.5 billion by 2027, making it a crucial element of the country's economic growth strategy.

After the initial policy period, from 2033 to 2050, the expected annual growth rate in cashew production is projected to decline to 1%. This slowdown is attributed to various uncertainties in the agricultural sector, such as climate change, market fluctuations, and potential supply chain disruptions. In 2022, 97% of Cambodia's cashew production was exported, and this share is expected to remain the same until 2050. According to the policy and projections, production volume is anticipated to reach 1,344,395 tons by 2050, with export volume expected to be 1,305,427 tons. The cashew nuts will be packed in bags and loaded into containers for export.

[51] Book National cashew polity KH_Final.indd

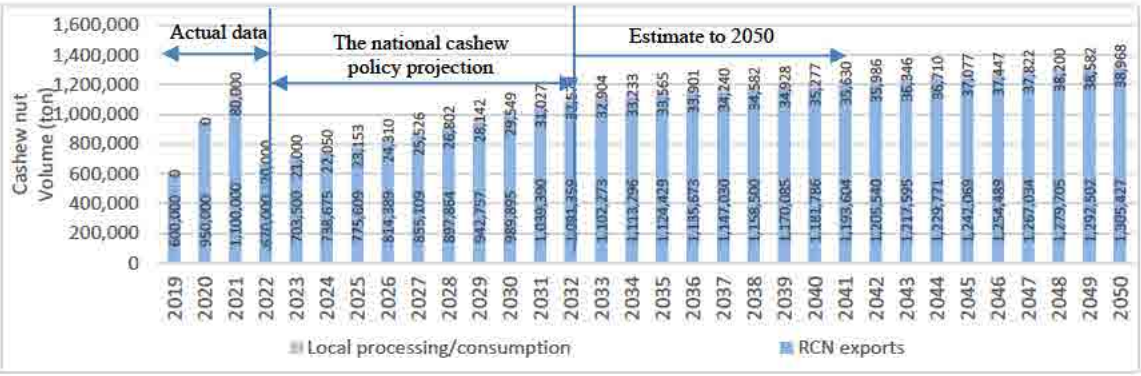


Figure 3-46 Forecast of cashew nut production and export

To facilitate exports, cashew nuts will be carefully packed into bags and loaded into containers. Most Raw Cashew Nuts (RCN) will be transported through five main land border gates, which serve as crucial points for exporting these products. Overall, the policy aims to strengthen the cashew industry, boost economic growth, and ensure that Cambodia remains a significant player in the global cashew market.

The Cambodian government's National Cashew Policy focuses on improving the quality of cashew nuts to meet international standards while also promoting domestic consumption. The policy aims to develop the entire cashew sector, including production, processing, and marketing, to enhance competitiveness and ensure sustainability. This approach is intended to support economic diversification and strengthen the industry for future growth.

Table 3-24 Summary of cashew nut demand forecast

	Actual volume 2022(ton)	Projection in 2027 (ton)	Projection in 2032 (ton)
(a)Cashew nut production	690,000	880,634	1,123,937
(b)Cashew nut export	670,000	855,109	1,091,359
(c)Cashew nut processing, (c)=(a)-(b)	20,000	25,526	32,578
	Actual volume 2033(ton)	Forecast in 2050	Increase rate 2050/2022
(a)Cashew nut production	1,135,177	1,344,395	0.51
(b)Cashew nut export	363,476	1,305,427	0.51
(c)Cashew nut processing, (c)=(a)-(b)	771,701	38,968	0.51

(3) Allocating cashew nut production and export

When allocating the volume of cashew nuts to each zone in Cambodia, we assume that cashew nut exports in 2050 will be the same share as the cashew nut production in 2023. Total cashew nut exports in 2050 are forecast to reach 1.3 million tons. Among the provinces in Cambodia, Kratie produced the largest share at 19.2%, closely followed by stung Treng, Ratanakiri and kampong cham.

Table 3-25Allocation of cashew nut production and export

Province/City	Cashew nut Production (ton) share by province in 2023	Total export of cashew nut (ton) in 2050	Cashew nut Production share by province
	(a)	(b)=(a)*(c)	(c)
Banteay Meanchey	5,360	14,137	1.08%
Battambang	3,478	9,173	0.70%
Kampong Cham	44,452	117,241	8.98%
Kampong Chhnang	8,141	21,472	1.64%
Kampong Speu	397	1,047	0.08%
Kampong Thom	153,602	405,121	0.00%
Kampot	3,405	8,981	0.69%
Kandal	-	-	0.00%
Kep	12	32	0.00%
Koh Kong	347	915	0.07%
Kratie	95,274	251,282	19.25%
Mondul Kiri	9,623	25,380	1.94%
Oddar Meanchey	14,955	39,443	3.02%
Pailin	1,500	3,956	0.30%
Phnom Penh	-	-	0.00%
Preah Sihanouk	861	2,271	0.17%
Preah Vihear	21,750	57,365	4.39%
Prey Veng	533	1,406	0.11%
Pursat	2,136	5,634	0.43%
Ratanak Kiri	35,181	92,789	7.11%
Siem Reap	32,211	84,956	6.51%
Stung Treng	49,238	129,864	9.95%
Svay Rieng	904	2,384	0.18%
Takeo	305	804	0.06%
Tboung Khmum	11,289	29,774	2.28%
Total	**494,954**	**1,305,427**	**100.00%**

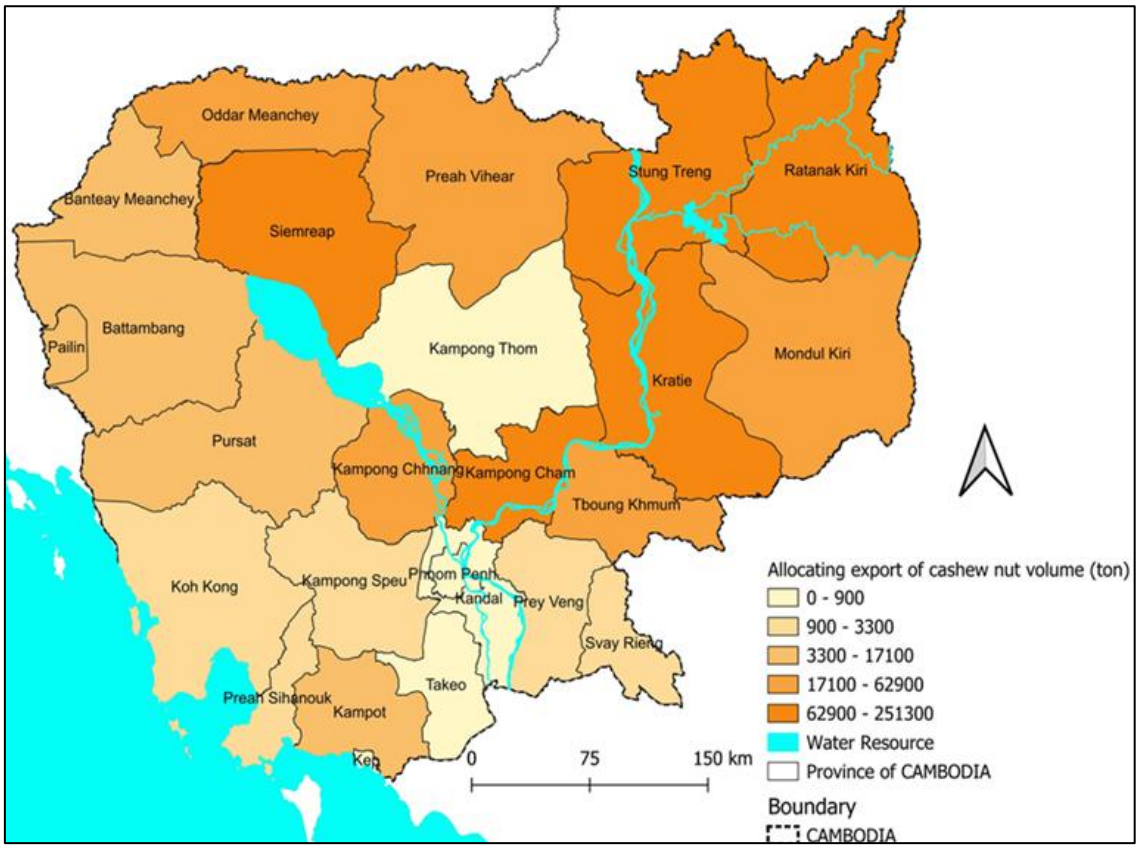


Figure 3-47 Map allocating of the volume of export of cashew nut by province

(4) Cashew nut transport route

(a) Current cashew nut transport routes

Cambodia's cashew nut transport routes rely primarily on road transport from farms in Kampong Thom and other provinces to local drying yards, processing factories, and export border gates to Vietnam. Processed kernels are then transported to ports for overseas shipment. Ongoing infrastructure improvements and industrial park development aim to enhance transport efficiency and value addition.

In 2021, Cambodia exported cashew nuts to various countries. The primary export destination was Vietnam, but cashews were also exported to China and other countries. The majority (94%) of the cashew nut trade in Cambodia is directed to Vietnam by trucks or motorbikes. Only a small fraction, about 5.7%, of cashew nuts are traded through seaports. Cashew nuts are mainly collected by small collectors directly from farmers at the farm gate. Most cashew nuts leave Cambodia by road through the borders of Kratie and Tbong Khmum provinces. The main concern in handling cashew nuts is damaging them during the transportation process[52].

[52] Source: Cambodia cashew nut value chain assessment report, 2019

(b) Future cashew nut transport routes

The Cambodian government's National Cashew Policy for 2022 to 2027[53] aims to develop cashew production, processing and markets in inclusive competitiveness to ensure sustainability and economic diversification. The development of efficient routes (roads, railways, waterways, and airways) is required to connect processing areas/factories to ports or export points, aiming to reduce transportation distance and improve logistics. Cashew nuts can be packaged within the country and transported as break bulk cargo via the river to nearby countries.

The total cashew nut production is 1,344,395 tons, with domestic consumption at 38,968 tons, or 2% of total production. The remaining 1,305,427 tons, or 98% of the total production, is exported. Exports are divided into two types: raw cashew nuts, which account for around 49% and are transported by truck to neighboring countries or by barges; and processed cashew nuts, which make up the other 49%, and are loaded into containers and transported overseas.

[53] Book National cashew polity KH_Final.indd

Table 3-26 Volume of cashew nut production and export by container in 2050

Province/city	Total cashew nut Production 2050 (ton)	Total export raw cashew nut 2050 (ton)	Total export raw cashew nut 2050 (TEU)	Total export after processing cashew nut 2050 (ton), loss 73% weight	Total export after processing cashew nut 2050 (TEU)
	(a)	(b)=(a)*0.49	(c)=(b)/14	(d)=((a)*0.49) *0.27	(e)=(d)/14
Banteay Meanchey	14,559	7,068	505	1,908	136
Battambang	9,447	4,587	328	1,238	88
Kampong Cham	120,741	58,620	4,187	15,828	1,131
Kampong Chhnang	22,113	10,736	767	2,899	207
Kampong Speu	1,078	524	37	141	10
Kampong Thom	417,214	202,560	14,469	54,691	3,907
Kampot	9,249	4,490	321	1,212	87
Kandal	-	-	-	-	-
Kep	33	16	1	4	0
Koh Kong	943	458	33	124	9
Kratie	258,783	125,641	8,974	33,923	2,423
Mondul Kiri	26,138	12,690	906	3,426	245
Oddar Meanchey	40,621	19,722	1,409	5,325	380
Pailin	4,074	1,978	141	534	38
Phnom Penh	-	-	-	-	-
Preah Sihanouk	2,339	1,135	81	307	22
Preah Vihear	59,077	28,682	2,049	7,744	553
Prey Veng	1,448	703	50	190	14
Pursat	5,802	2,817	201	761	54
Ratanak Kiri	95,559	46,394	3,314	12,526	895
Siem Reap	87,492	42,478	3,034	11,469	819
Stung Treng	133,740	64,932	4,638	17,532	1,252
Svay Rieng	2,455	1,192	85	322	23
Takeo	828	402	29	109	8
Tboung Khmum	30,663	14,887	1,063	4,020	287
Total	**1,344,395**	**652,713**	**46,622**	**176,233**	**12,588**
Percentage share			**49%**		**49%**

(5) Issues to be addressed

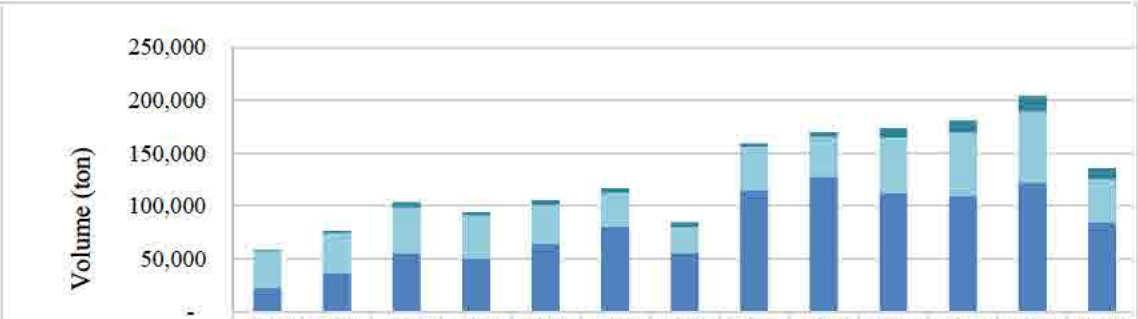
a) Enhancing irrigation, electricity, and drainage systems at the farm level.
b) Improving infrastructure for moving cashews from farms to warehouses and processing areas. This includes roads, waterways, and storage facilities.
c) Developing efficient routes (roads, railways, waterways, and airways) to connect processing areas/factories to ports or export points, aiming to reduce transportation distance and improve logistics.
d) Implementing laws and systems to recycle cashew waste into useful products, promoting better environmental impact management.

3.1.8 Dry Bulk (Fertilizer-Agriculture goods)

(1) Present fertilizer production and distribution

Cambodia imports several types of fertilizers such as nitrogen-only fertilizers which contain ammonium nitrate and urea, mixed nutrition fertilizers including NP (Nitrogen-Phosphorus) types like DAP (Diammonium Phosphate) and NPK fertilizers that contain Nitrogen, Phosphorus, and also Potassium-only fertilizers, mainly Muriate of Potash. However, in the forecasting we select import of fertilizer commodities such as N, P and K. [54]

Cambodia primarily imports fertilizers from neighboring countries, with Vietnam being the largest supplier, accounting for a significant share of total imports. Thailand is another major source of fertilizers. Other importing countries include China, Japan, and South Korea. Cambodia imports most of its chemical fertilizers from these countries.[55]

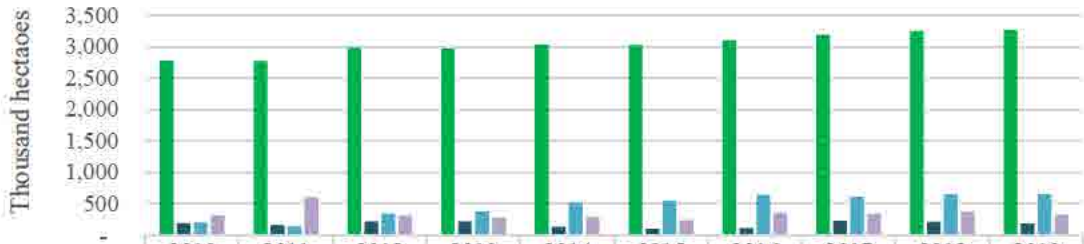


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Fertilizer Type K	1,017	1,727	4,719	2,787	4,128	4,041	4,327	2,780	4,203	8,463	10,94	14,66	9,868
Fertilizer Type P	34,89	38,02	44,01	40,83	37,15	32,03	24,59	41,37	38,06	53,06	59,86	67,91	41,20
FertilizerType N	22,65	36,49	54,83	50,44	64,09	80,85	55,65	114,9	127,8	112,1	110,1	121,7	84,70

Figure 3-48 Imported fertilizer in Cambodia[56]

As the final fertilizer consumption provinces are not available, we assume that paddy production share by province could represent the final fertilizer consumption share by province. We consider only paddy rice because paddy fields cover almost 75% of the total cultivated area. Therefore, it is appropriate to focus solely on paddy production.

[54] Source: Development of the fertilizer Industry in Cambodia: Structure of the Market, challenges in the demand and supply sides, and the way forward, CDRI, 2014
[55] Source: Based on World Integrated Trade Solution (WITS)
[56] Source: FAOSTAT (2010 to 2022)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Paddy Rice	2,777	2,767	2,980	2,969	3,029	3,026	3,100	3,190	3,248	3,264
Corn	190	160	215	217	136	104	113	227	208	186
Cassava	203	140	338	377	515	546	643	613	651	653
Other crops	316	600	307	276	286	240	366	339	373	324

Figure 3-49 Harvested area of Major crops, Statistical Yearbook of Cambodia 2021[57]

(Fertilizer imports value chain in Cambodia)

The import of fertilizer to Cambodia involves a structured supply chain, primarily sourcing from countries like Vietnam, Thailand, China or another country. These fertilizers are essential for various agricultural applications and must be certified and packaged before shipment. Transportation of fertilizers to Cambodia can occur via overland trucking through various border crossings for Thailand and Vietnam or through maritime shipping to key ports such as Sihanoukville and Koh Kong. Vietnamese trucks are allowed to travel up to 20 kilometers inside Cambodia without a special license, which facilitates smoother logistics. Upon arrival, fertilizer imports must be registered with MAFF. This process includes obtaining import permits, conducting quality testing, and ensuring that all products are labeled in Khmer to meet local regulations. Once cleared, the fertilizers are transported to warehouses and wholesalers across different provinces. Distribution is carried out using trucks and, where applicable, railways, ensuring that agricultural producers can access the necessary supplies efficiently. This organized process supports agricultural productivity and contributes to the overall economic development of Cambodia.[58]

[57] Source: Statistical Yearbook of Cambodia 2021 of Ministry of planning
[58]Source: The Fertilizer Industry in Cambodia, MARKET, CHALLENGES AND THE WAY FORWARD, 2014

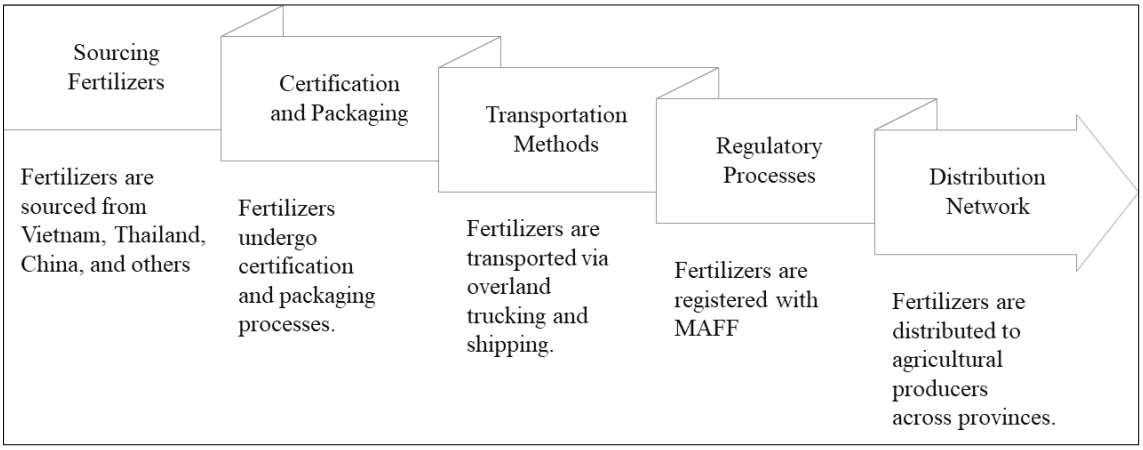


Figure 3-50 Fertilizer Import Process in Cambodia

(2) The future projection of fertilizer import

In order to estimate the future fertilizer, import volume, we assume the growth rate of paddy rice and that of fertilizer import volume may have a close relationship because fertilizer is essential for paddy production. Based on a growth rate comparison analysis, the expert team applies the average growth rate of total paddy production, which is 1.7%, when forecasting the future demand of three types of imported fertilizers.

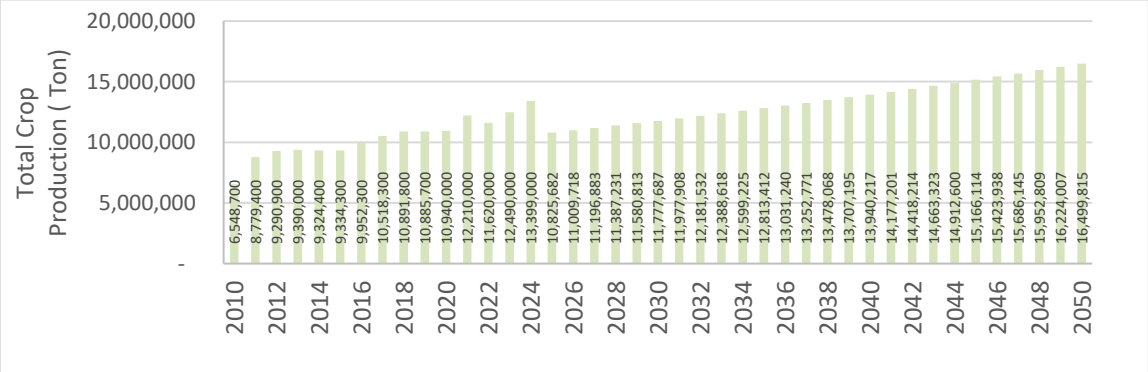


Figure 3-51 Forecast of paddy rice production by JICA team

The average annual growth rate for total paddy rice production is 1.7% from 2025 to 2050, and this rate is also applied to forecast fertilizer imports. The import volume of fertilizer type N will increase from 84,706 ton in 2022 to 142,512 ton in 2050. Type P will increase from 41,201 tons in 2022 to 76,035 tons in 2050. Type K will increase from 9,868 tons in 2022 to 10,129 tons in 2050; total fertilizer imports in 2050 will reach 228,677 tons. This means we expect each type of fertilizer to also increase by 1.7% from 2025 to 2050. Overall, this represents a total increase of 1.7 times in fertilizer imports from 2022 to 2050.

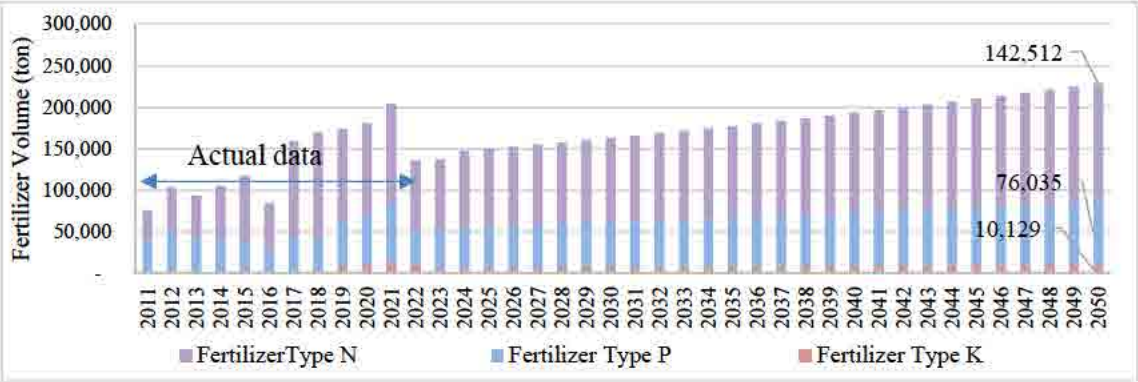


Figure 3-52 Forecast of fertilizer import to 2050

Fertilizers are imported in bulk and then bagged for distribution. Most imports come through border points via road or river. Fertilizers are stored in warehouses near borders and in Phnom Penh before being distributed to provincial retailers. Larger distributors can store significant quantities during peak seasons. Village retailers typically purchase fertilizers from provincial distributors and sell them to farmers. Many sales are made on credit, especially during planting seasons.

Table 3-27 Summary of fertilizer imports in Cambodia

	Average Volume (2010-2022) (i)	Current volume in 2022(ton) (ii)	Forecast in 2050 (ton) (iii)	Increase rate (2050/2022) (iv)=(iii)/(ii)
(a)Paddy rice		11,620,000	16,499,815	1.42
(b)Fertilizer types N	79,734	84,706	142,512	1.68
(c)Fertilizer types P	42,541	41,201	76,035	1.85
(d)Fertilizer type K	5,667	9,868	10,129	1.03
(e)Total import of fertilizer, (e)=(b)+(c)+(d)	**127,942**	**135,775**	**228,676**	1.68

(3) Allocating imports fertilizer volume by zone

When allocating the volume of imported fertilizer to each province, we assume that the fertilizer imports in 2050 will be the same share as the paddy production in 2023. Therefore, in 2050, the total import volume of fertilizer will reach 37 thousand tons. The three provinces with the largest fertilizer imports are Battambang at 11.6%, Prey Veng at 10.7%, and Banteay Meanchey at 9.5%.

Table 3-28 Allocation of the volume of import of fertilizer in 2050 into provinces

Province/City	Total Export fertilizer in 2050 (ton) (a)=Total volume * (b)	Paddy Production share by province (b)
Banteay Meanchey	21,724	9.50%
Battambang	26,526	11.60%
Kampong Cham	9,604	4.20%
Kampong Chhnang	11,891	5.20%
Kampong Speu	229	0.10%
Kampong Thom	8,690	3.80%
Kampot	10,748	4.70%
Kandal	18,980	8.30%
Kep	6,860	3.00%
Koh Kong	686	0.30%
Kratie	6,403	2.80%
Mondul Kiri	4,116	1.80%
Oddar Meanchey	1,829	0.80%
Pailin	7,318	3.20%
Phnom Penh	457	0.20%
Preah Sihanouk	457	0.20%
Preah Vihear	7,546	3.30%
Prey Veng	24,468	10.70%
Pursat	10,062	4.40%
Ratanak Kiri	1,829	0.80%
Siem Reap	16,007	7.00%
Stung Treng	915	0.40%
Svay Rieng	2,058	0.90%
Takeo	14,178	6.20%
Tboung Khmum	15,093	6.60%
Total	**228,677**	**100.00%**

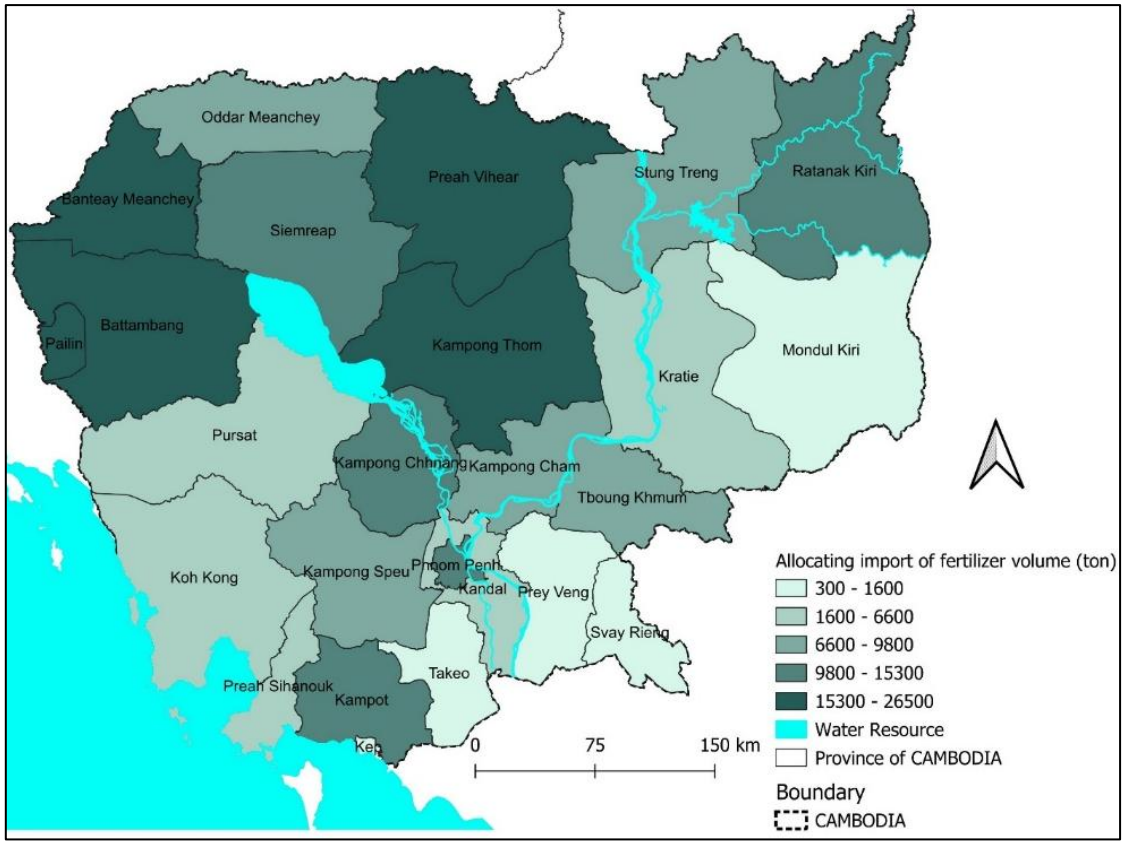


Figure 3-53 Allocation of the volume of import of fertilizer in 2050 by province

(4) Fertilizer transport route

(a) Current fertilizer transport routes

Fertilizers from Vietnam and Thailand typically enter Cambodia via overland routes through border checkpoints, leveraging Cambodia's road networks. From China, a newly launched direct shipping route between Fang Chenggang Port (China) and Koh Kong Port (Cambodia) has enhanced trade efficiency, reducing shipping time by over 50% and logistical costs by more than 20%. This route supports the agricultural sector by preserving product quality and lowering transport costs. Cambodia also uses its deep-sea port at Sihanoukville for maritime imports, with inland container yards and railway connections facilitating movement from ports to Phnom Penh and other areas

Fertilizers are imported from neighboring countries, Thailand and Vietnam, across the borders. Fertilizers from other countries are also imported via Phnom Penh port and Sihanoukville port. Licensed Cambodian importers store fertilizer in warehouses near the border (Thailand and Vietnam) and/or in Phnom Penh. From the point of import, fertilizers are distributed to farmers.

(b) Future fertilizer transport routes

For fertilizer imported through the port, bulk cargo is loaded into jumbo bags and transported by truck to a central warehouse for distribution to customers. Constructing terminals equipped to handle barges and offload products is essential for improving this logistics process.



Figure 3-54 Distribution of fertilizer imports[59]

(5) Issues to be addressed

a) Cambodia's agriculture is largely rainfed and diverse, with significant variability in soil nutrient status and crop types across regions. This makes it difficult to accurately predict optimum fertilizer application rates and total demand.
b) Research shows that nutrient deficiencies (N, P, K) vary widely, and farmers' fertilization practices are influenced by local conditions and perceptions, complicating demand estimation.
c) Farmers' expectations of average or poor seasons also reduce fertilizer use, making demand volatile and hard to forecast reliably. The prevalence of poor-quality and adulterated fertilizers undermines farmers' confidence, which can suppress demand or cause unpredictable shifts in purchasing behavior.
d) Cambodia's fertilizer market is largely free and competitive but suffers from weak enforcement of regulations and unclear roles among government agencies.
e) Fertilizer prices are subject to fluctuations due to global market changes, fuel costs, and supply chain disruptions.
f) Demand forecasting often relies on historical accurate import data, crop area estimates, and broad assumptions rather than detailed, localized data.

[59] Source: Fertilizer transportation in full swing for spring farming in Heilongjiang - Global Times

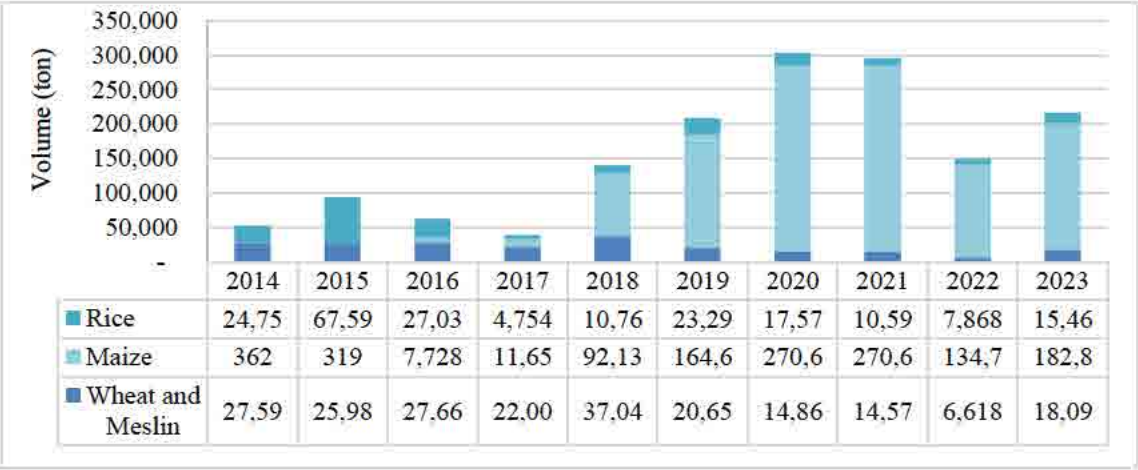
3.1.9 Dry Bulk (Cereal-Agriculture goods)

(1) Present cereal import and distribution

Limited agricultural technology, inadequate irrigation systems, and the impact of climate change have hindered Cambodia's ability to produce large quantities of cereals like rice and wheat. Accordingly, the country heavily relies on imports. As more people move to urban areas, the demand for processed and convenient food products, which often include cereals, increases. Importing cereals can sometimes be more cost-effective than producing them domestically, especially when considering the costs associated with agricultural inputs and labor.

Cambodia imports cereals in bulk through land and river routes before distributing them across the country. Most cereals enter Cambodia via border crossings with Thailand and Vietnam, transported by trucks and river barges, while some arrive through Sihanoukville Port from international markets. After import, cereals are stored in warehouses near border areas and in Phnom Penh, where major distributors manage inventory. Provincial distributors play a crucial role in supplying cereals to local retailers and wholesalers, ensuring availability in rural areas. Village retailers purchase cereals from provincial suppliers and sell them to farmers and consumers, making cereals accessible across different regions.

Importers of cereal must comply with Cambodian laws and regulations regarding import licensing, quality standards, packaging, and labeling, similar to those for fertilizers and pesticides.[60] In 2023, the share of cereal imports is 85% for maize, 8% for wheat and meslin, and 7% for rice.[61]



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Rice	24,75	67,59	27,03	4,754	10,76	23,29	17,57	10,59	7,868	15,46
Maize	362	319	7,728	11,65	92,13	164,6	270,6	270,6	134,7	182,8
Wheat and Meslin	27,59	25,98	27,66	22,00	37,04	20,65	14,86	14,57	6,618	18,09

Figure 3-55 Cereals import data from 2014 to 2023[62]

[60] Source: https://faolex.fao.org/docs/pdf/cam211050.pdf
[61] Source: General Department of Customs and Excise of Cambodia (GDCE) 2023
[62] Source: UN Comtrade Database




Figure 3-56 Major import of cereal in Cambodia[63]

Cambodia imports cereals due to the demand for processed and convenient food products, which often include cereals. In forecasting the import of cereals in 2050, we assume there is a correlation with population growth. The population is projected to increase from about 17.3 million in 2024 to 21.7 million in 2050.



Figure 3-57 Total population projection to 2050[64]

(2) Future projection of cereal import

In order to estimate the future cereal, import volume, we assume the growth rate of population and that of cereal import volume may have a close relationship because cereal is essential for people consume. Based on a growth rate comparison analysis, the expert team applies the average growth rate of total population, which is forecasting the future demand of imported cereals.

[63] Source: 85,636 Cereal Grains Stock Photos - Free & Royalty-Free Stock Photos from Dreamtime - Page 2
[64] Source: National Institute of Statistics, Ministry of Planning

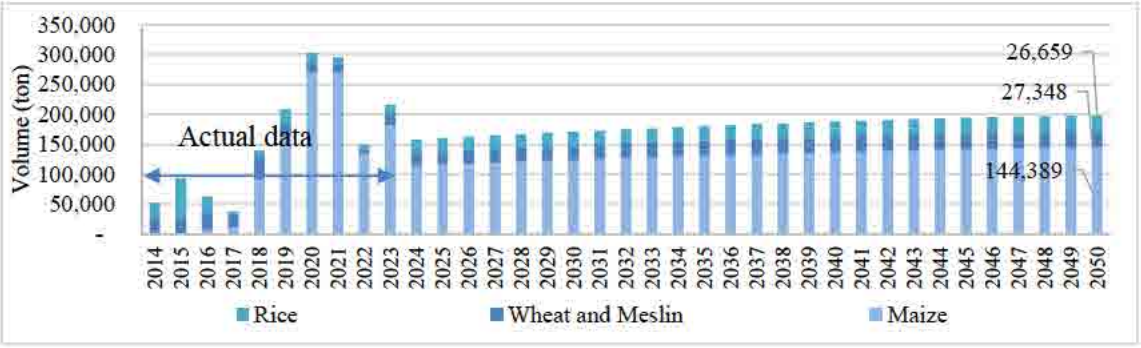


Figure 3-58 Forecast of import cereal in 2050

Table 3-29 Summary of cereal Import demand forecast

	Average volume (2014 to 2023) (i)	Current volume in 2023(ton) (ii)	Forecast in 2050 (ton) (iii)	Increase rate (2050/2023) (iv)=(iii)/(ii)
(a)Population		17,091,464	21,728,446	1.27
(b)Total import of cereal, (b)=(c)+(d)+(e)	**156,057**	**216,457**	**198,395**	0.92
(c)Import of wheat and meslin	21,511	18,099	27,348	1.51
(d)Import of Mazie	113,575	182,893	144,389	0.79
(e)Import of Rice	20,970	15,465	26,659	1.72

(3) Allocating imports cereal volume by zone

When allocating the volume of import cereals in each zone, we assume that the percentage share of population in 2050 each province in Cambodia will the same as share as import cereal by province 2050. In 2050, cereal imports are projected to total around 19 thousand tons, with Phnom Penh accounting for a large share. In contrast, rural areas consume less, resulting in lower cereal imports.

Table 3-30 Volume of import of cereals in 2050 by provinces

Province/City	Population shares in 2050 (a)	Import of Cereals in 2050 (ton) (b)=Total cereal export*(c)	Import of Cereals by Province share (c)
Banteay Meanchey	1,128,708	10,994	5.54%
Battambang	1,305,875	12,720	6.41%
Kampong Cham	1,178,351	11,478	5.79%
Kampong Chhnang	690,185	6,723	3.39%
Kampong Speu	1,149,189	11,194	5.64%
Kampong Thom	892,545	8,694	4.38%
Kampot	777,864	7,577	3.82%
Kandal	1,573,570	15,327	7.73%
Kep	55,873	544	0.27%
Koh Kong	164,879	1,606	0.81%
Kratie	490,773	4,780	2.41%
Mondul Kiri	120,760	1,176	0.59%
Oddar Meanchey	361,494	3,521	1.77%
Pailin	98,366	958	0.48%
Phnom Penh	2,988,404	29,108	14.67%
Preah Sihanouk	407,152	3,966	2.00%
Preah Vihear	333,717	3,251	1.64%
Prey Veng	1,385,172	13,492	6.80%
Pursat	549,962	5,357	2.70%
Ratanak Kiri	284,773	2,774	1.40%
Siem Reap	1,328,223	12,937	6.52%
Stung Treng	217,015	2,114	1.07%
Svay Rieng	688,182	6,703	3.38%
Takeo	1,179,821	-	0.00%
Tboung Khmum	1,017,338	9,909	4.99%
Total	**20,368,191**	**198,395**	**100.00%**

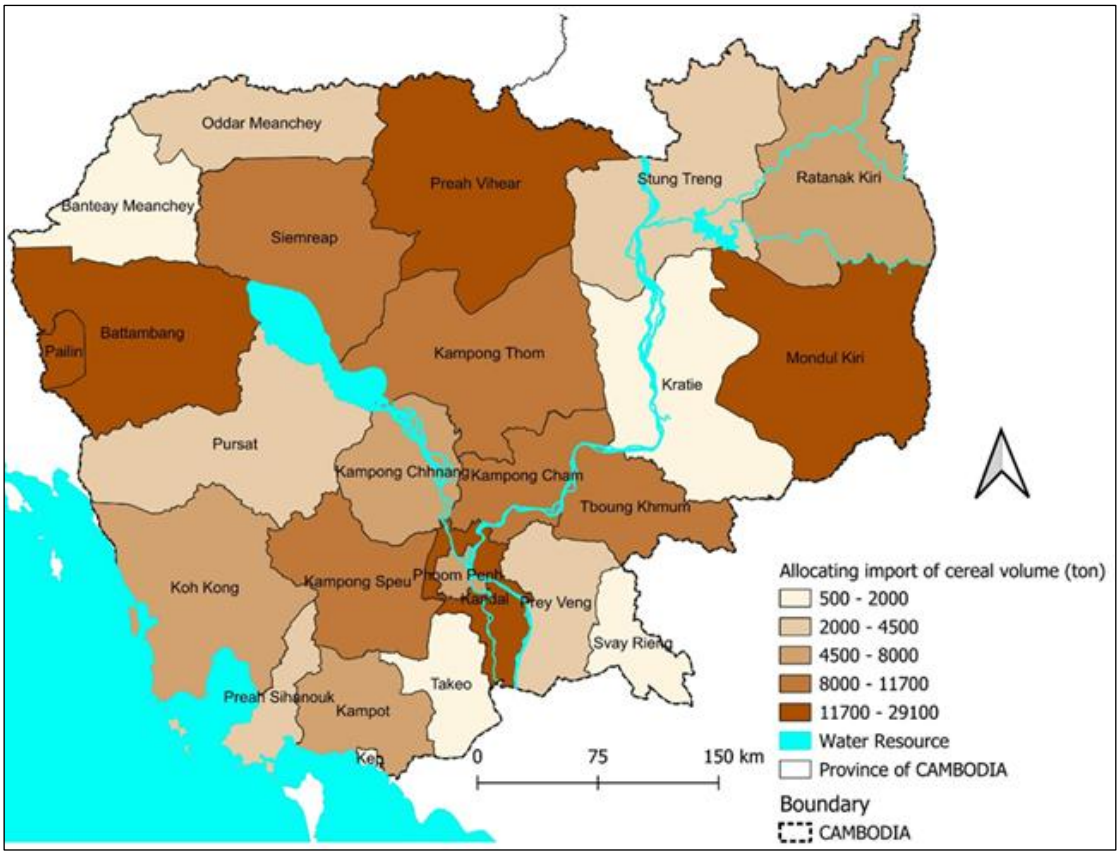


Figure 3-59 Allocation of the volume of cereal import in 2050 by zone

(4) Cereal import transport route

(a) Current cereal transport routes

Importers of cereals need to register their business with the Ministry of Commerce. Phnom Penh is a central distribution hub. Large importers or wholesalers may have warehouses in or around the capital and then redistribute goods to other provinces. They purchase cereals in bulk and then use their own fleets of trucks or contract with transporters to deliver to retailers and markets in various provinces. Most roads transported are National Roads (such as NR1, NR4, NR5, NR6).

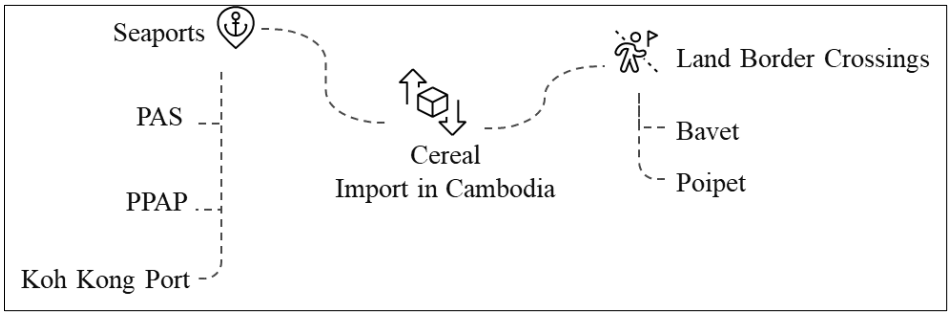


Figure 3-60 Cereal Import Routes and Modes in Cambodia[65]

(b) Future cereal transport routes

The transport process for cereals is similar to that of fertilizer. Bulk cargo is loaded into jumbo bags and transported by truck to a central warehouse for distribution to customers. To enhance this logistics process, constructing terminals equipped to handle barges and offload products is essential.





Figure 3-61 Cereal import[66]

(5) Issues to be considered

a) Imported rice, wheat, and maize are vulnerable to global price fluctuations and trade restrictions, affecting affordability and availability. Infrastructure issues, including limited cold storage and inefficient transport routes, may lead to spoilage and increased costs, highlighting the need for improvements in port capacity and road networks.

b) Navigating trade agreements and regulatory requirements is crucial to maintaining stable trade relationships, as compliance with import regulations and quality standards will directly influence Cambodia's ability to secure steady cereal imports.

c) Investment in domestic cereal production could strengthen food security while encouraging local processing which could open up new economic opportunities.

[65] Source: Cambodia Transport sector assessment, strategy, and road map, 2019
[66] Source: 189 Cereal Port Import Stock Photos - Free & Royalty-Free Stock Photos from Dreamstime

3.1.10 Dry Bulk (Timber-Agriculture goods)

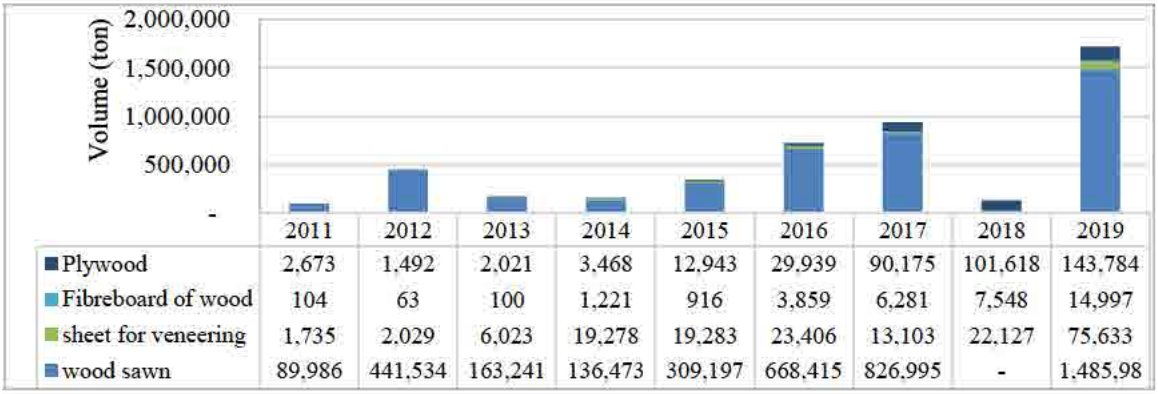
(1) Present timber import and distribution

While Cambodia has its own forestry resources, regulations and efforts to curb illegal logging have impacted domestic timber availability. Therefore, importing timber helps for domestic production and consumption. Cambodia's construction and furniture industries are expanding, creating a significant demand for wood products.

Cambodia's timber imports are vital for its economy, focusing on plywood, sawn wood, and veneer sourced mainly from neighboring countries. Plywood, used extensively in construction and design, is primarily imported from China, Vietnam, and Thailand. Sawn wood, essential for furniture manufacturing, allows Cambodia to supplement its domestic supply, while veneer, consisting of thin wood sheets, caters to high-end furniture demands. However, challenges such as ensuring sustainable sourcing and compliance with regulations are crucial for environmental conservation. Overall, these imports support Cambodia's growth, highlighting the importance of regional collaboration for a steady supply of quality timber products.



Figure 3-62 Types of main timer imports in Cambodia[67]



	2011	2012	2013	2014	2015	2016	2017	2018	2019
Plywood	2,673	1,492	2,021	3,468	12,943	29,939	90,175	101,618	143,784
Fibreboard of wood	104	63	100	1,221	916	3,859	6,281	7,548	14,997
sheet for veneering	1,735	2,029	6,023	19,278	19,283	23,406	13,103	22,127	75,633
wood sawn	89,986	441,534	163,241	136,473	309,197	668,415	826,995	-	1,485,98

Figure 3-63 Timber imports from 2011 to 2019[68]

[67] Source: Greenply Eucalyptus Laminate Plywood Sheets, For Furniture at ₹ 95/square feet in Chirakkal

[68] Source: UN Comtrade

We forecast demand for timber based on the GDP growth rate from 2020 to 2050. The government's strategy is for Cambodia to obtain economic diversification and competitiveness by adding high-value industries. Therefore, while water transportation will contribute to GDP growth, new businesses that will not rely on the water transportation sector will increase. Then, real value base GDP growth rate which applies a 2.5 % inflation rate (average between 2015 and 2024). The nominal values of GDP in 2050 are US$ 282.0 billion (Pentagonal strategy), and US$ 231.5 billion (JICA expert's assumption).



Figure 3-64 Forecast of GDP to 2050 by JICA team

(2) Future projection of timber imports

For timber imports we gather historical data from GDCE in 2023, timber imported was 21% of total import commodities, which the timber has four types such as sheet for veneering, fiberboard of wood, ply wood and wood sawn. However, actual data from demand forecast of timber import from 2011 to 2019[69], average volume is 525,294 ton. We use an average volume rather than a single base year for demand forecasting provides a more reliable estimate because it reduces the impact of fluctuations, reflects long-term trends, and improves forecast accuracy. Import timber production and consumption can vary significantly due to factors such as economic shifts, and policy changes, making an average value a more stable reference point that accounts for these variations. Additionally, considering multiple years helps identify growth patterns rather than relying on an isolated data point, as a base year may experience abnormally high or low demand, leading to inaccurate forecasts.

[69] Source: Un Comtrade Database

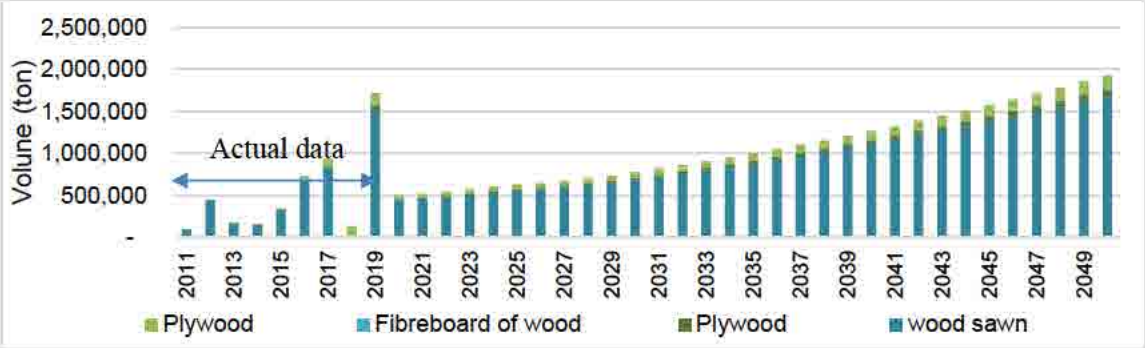


Figure 3-65 Forecast of import timber to 2050

In industries like agriculture, demand often fluctuates seasonally, meaning that a base year might not represent peak or off-season trends effectively, whereas an average value provides a better long-term indicator. By taking historical trends into account, an average volume offers a more balanced perspective that enhances the precision of demand forecasts.

Table 3-31 Summary of timber import demand forecast

	Average volume (2011-2019) (i)	Current volume in 2019(ton) (ii)	Forecast in 2050 (ton) (iii)	Increase rate (2050/2019) (iv)=(iii)/(ii)
(a)Total timber import, (a)=(b)+(c)+(d)+(e)	**525,294**	**1,720,400**	**1,929,636**	**0.93**
(b)Wood sawn	457,981	1,485,986	1,682,365	0.94
(c)Sheet for veneering	20,291	75,633	74,537	0.82
(d)Fiberboards of wood	3,899	14,997	14,322	0.79
(e)Plywood	43,124	143,784	158,412	0.91

(3) Allocating imports cereal volume by zone

When allocating the volume of import timber in each zone, we assume that the share of import of timber in 2050 will the same as share as rGDP by province 2050. In 2050, timber imports are projected to total around 1.5 million tons, with Phnom Penh, Kandal, Siem Reap and Battambang accounting for a large share. By contrast, in the Northern Area, timber imports are forecast to be lower due to the lower share of rGDP.

Table 3-32 Volume of import of timber in 2050 by province

Province/City	Import of timber in 2050 (ton) (a)= total import of timber* (b)	Share of rGDP 2050[70] (b)
Banteay Meanchey	73,326	3.80%
Battambang	88,763	4.60%
Kampong Cham	79,115	4.10%
Kampong Chhnang	55,959	2.90%
Kampong Speu	84,904	4.40%
Kampong Thom	55,959	2.90%
Kampot	63,678	3.30%
Kandal	125,426	6.50%
Kep	3,859	0.20%
Koh Kong	17,367	0.90%
Kratie	32,804	1.70%
Mondul Kiri	11,578	0.60%
Oddar Meanchey	21,226	1.10%
Pailin	9,648	0.50%
Phnom Penh	683,091	35.40%
Preah Sihanouk	75,256	3.90%
Preah Vihear	21,226	1.10%
Prey Veng	69,467	3.60%
Pursat	44,382	2.30%
Ratanak Kiri	23,156	1.20%
Siem Reap	77,185	4.00%
Stung Treng	17,367	0.90%
Svay Rieng	57,889	3.00%
Takeo	77,185	4.00%
Tboung Khmum	61,748	3.20%
Total	**1,929,636**	**100.00%**

[70] From JICA team estimate

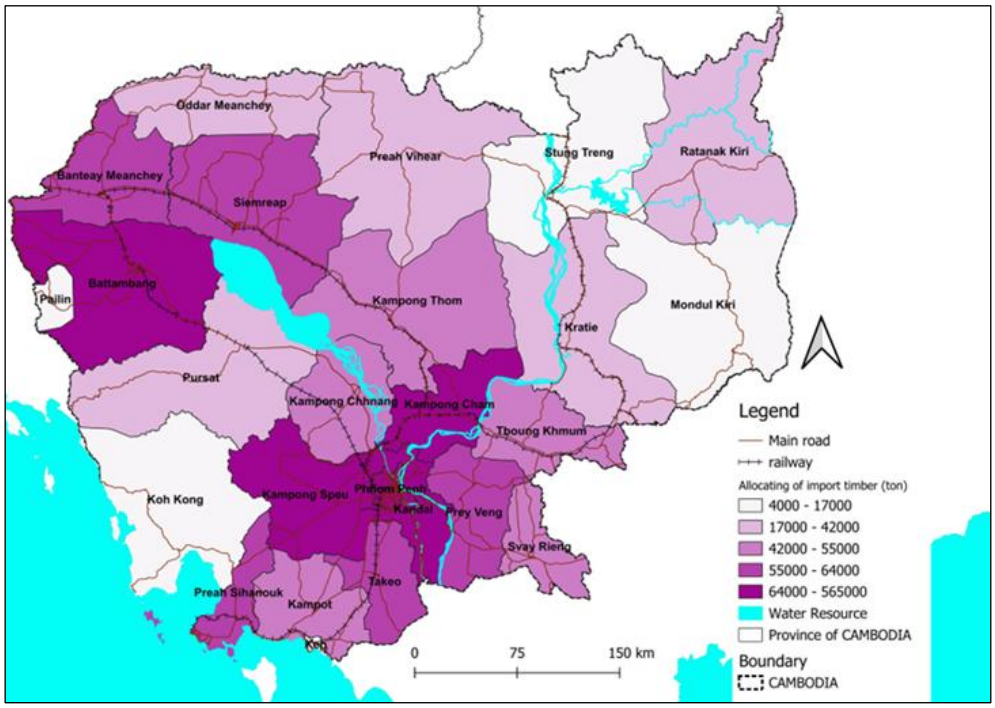


Figure 3-66 Allocation of the volume of timber import in 2050 by zone

(4) Timber import transport route

(a) Current timber transport routes

Sihanoukville Autonomous Port (PAS) handles a high volume of imported timber arriving by sea, imported from China, Chile, Brazil, and other countries. Some types of timber imports from countries like Vietnam and Thailand likely use road transport through cross-border trucking.

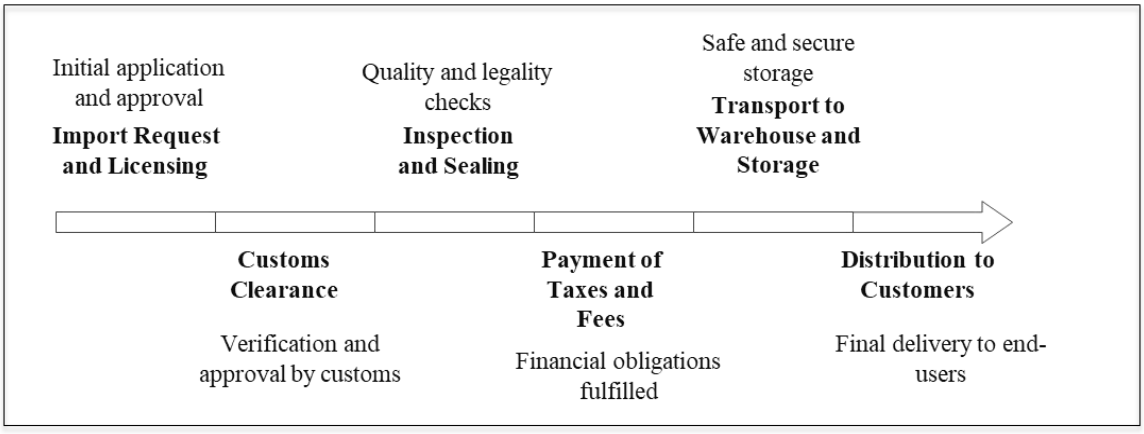


Figure 3-67 Timber Import and Distribution Process in Cambodia [71]

[71] Source: Cambodia National Trade Repository

(b) Future timber transport routes

In 2050, we expect the total volume of imported timber to be 1.59 million tons. We assume that the share of timber imports in each province will match the share of regional GDP as estimated by the JICA team. Much of this imported timber will come from overseas, particularly from Thailand and Vietnam by cross border, however, timber from other countries will arrive at sea port and rver port in large shipments loaded into containers.

Table 3-33 Volume timber import by container in 2050

Province/City	Import of timber in 2050 (ton)	Import of timber in 2050 (TEU)	Share of rGDP 2050
	(a)	(b)=(a)/14	(c)
Banteay Meanchey	60,728	4,338	3.80%
Battambang	73,513	5,251	4.60%
Kampong Cham	65,522	4,680	4.10%
Kampong Chhnang	46,345	3,310	2.90%
Kampong Speu	70,316	5,023	4.40%
Kampong Thom	46,345	3,310	2.90%
Kampot	52,737	3,767	3.30%
Kandal	103,877	7,420	6.50%
Kep	3,196	228	0.20%
Koh Kong	14,383	1,027	0.90%
Kratie	27,168	1,941	1.70%
Mondul Kiri	9,589	685	0.60%
Oddar Meanchey	17,579	1,256	1.10%
Pailin	7,991	571	0.50%
Phnom Penh	565,728	40,409	35.40%
Preah Sihanouk	62,326	4,452	3.90%
Preah Vihear	17,579	1,256	1.10%
Prey Veng	57,532	4,109	3.60%
Pursat	36,756	2,625	2.30%
Ratanak Kiri	19,177	1,370	1.20%
Siem Reap	63,924	4,566	4.00%
Stung Treng	14,383	1,027	0.90%
Svay Rieng	47,943	3,425	3.00%
Takeo	63,924	4,566	4.00%
Tboung Khmum	51,139	3,653	3.20%
Total	**1,598,101**	**114,150**	**100.00%**



Figure 3-68 Import of timber by container[72]

(5) Issues to be considered

To create more accurate projections, it is essential to consider improvements in the logistic cost, as well as the impact of electricity costs.

[72] Source: timber global times images - Google 検索

3.2 Dry Bulk (Mines and Energy)

3.2.1 Methodology and results of estimating dry bulk (Mines and Energy)

(1) Methodology of estimating dry bulk (Mines and Energy)

To forecast demand for mines commodities, we adopt following method. First, we ensure that our forecast assumptions are consistent with national policy. If no relevant national policy exists, we interview stakeholders from relevant ministries and ministry of mines and energy to understand the future trends. Additionally, when we lack sufficient statistics on certain mines commodities, data from open sources such as United National Comtrade Database (UN Comtrade), Electricity Authority of Cambodia (EAC) and other are used to complete forecasts.

The table below shows the required data, main data sources, datasets used, and specific forecasting methods such as time-series analysis and interviews with stakeholders. Key commodities such as: Mines (Gypsum, Sand, Bauxite, Iron ore, Mable, Pebbles, Manganese ore, Stone), Energy (Coal, Liquefied Natural Gas (LNG), Fuel oil, Gasoline, Jet Fuel, Liquefied Petroleum Gas (LPG), Diesel, Lubricant, Black oil.), along with their production data from various years. We also address commodities import and provide supporting data for commodity value chains and socio-economic indicators such as GDP. Our approach combines data with insights from relevant parties to increase the accuracy of the forecasting work and better grasp production trends.

Table 3-34 Required data on mines and energy resources and forecasting methods.

No	Required Data	Main Sources	Dataset Date	Forecasting Method
I	Mines resources			
1	Mines Import			
1.1	Gypsum	UN Comtrade	Gypsum imports from 2000 to 2023	GDP Elasticity
2	Mines Export			
2.1	River Sand	MME, MPWT	River Sand Export from 2020 to 2024 (MME)	Mines exploring company and validate by MPWT
2.2	Bauxite	MPWT	-	
2.3	Iron ore	MME, MPWT	Iron ore export from 2023 to 2024 (MME)	
2.4	Mable	MPWT	-	
2.5	Pebbles	MPWT	-	
2.6	Manganese ore	MME	Manganese ore export 2024 (MME)	Selected the highest of history data
2.7	Stone	MME	Stone export from 2020 to 2024 (MME)	Increasing rate 0.35%

II	Energy resources			
1	Energy Import			
1.1	Coal	MME	Coal Balance from 2008 to 2021 (MME)	Contingency Generation Plan / Installed Power Capacity (2022-2040), MME + Cement demand Forecasting
1.2	LNG	MME	-	Contingency Generation Plan / Installed Power Capacity (2020-2040), MME
1.3	Fuel oil	MME	Oil Supply from 2000 to 2021 (MME)	
1.4	Gasoline	MME		GDP Elasticity
1.5	Jet Fuel	MME		
1.6	LPG	MME		
1.7	Diesel	MME		
1.8	Lubricant	MME		
1.9	Black oil	MME		GDP increasing

The major trade cargo commodities used in the demand forecast were selected based on 2023 statistics from the General Department of Customs and Excise (GDCE)[73]. In 2023, the total volume of imports was 17 million tons. HS code 27, which covers Mineral Fuels, Mineral oils, and products of their distillation (including bituminous substances and mineral waxes), accounted for 43.6% of the total imports. Additionally, HS code 25, which includes salts, sulfur, earths, stones, plastering materials, lime, and cement, represented 4.5% of the imports. Upon further analysis by the JICA Expert Team, it was found that approximately 78.7% of the products within the 4-digit sub-headings of HS code 25 were Gypsum and Cement. The mines export is based on interview with Ministry of Mines and Energy (MME) and Ministry of Public Works and Transport (MPWT), in 2024 based interview with MME, Cambodia has export mineral resources to foreign countries such as River Sand, Iron ore, Manganese ore, Mables, and Stone. Regrading to MPWT in the future Cambodia will export more type of mineral resources such as Bauxite, and Pepples.

(2) Results of demand forecasting Mines and Energy

The table below provide an overview of demand forecasting method for certain Cambodia mines and energy resources with transportation mode are expected for 2050.

[73] General Department of Customs and Excise (GDCE) and analysis by JICA Team Survey.

Table 3-35 Assumption used in the demand forecast of mines and energy.

Cargo Items	Forecasting assumptions	Transportation mode in 2050
Mines Import		
Gypsum	Gypsum is using in cement factory to produce the cement, and also using to be construction material. Construction will increase following the GDP growth when construction increased cement also increasing therefore gypsum also increased.	Barge
Mines Export		
River Sand	The quantity that can be exported in the future depends on the information of the exploration company and validation by the MPWT.	Barge
Bauxite		Barge
Iron ore		Barge
Mable		Barge
Pebbles		Barge
Manganes ore	Because manganese ore exports only began in 2024, there is a lack of comprehensive data and information. Therefore, experts assume that the quantity that can be exported in the future will be similar to the amount exported in 2024.	Barge
Stone	Based on data provided by the Ministry of Mines and Energy (MME) from 2020 to 2024, the MME has predicted a 0.35% increase in stone exports for 2025. Therefore, the expert team is forecasting an annual increase of 0.35% per year.	Barge
Energy resources import		
Coal	The main import coal is for Coal-fire power plant and second is for cement factories. The forecasting is following Contingency Generation Plan / Installed Power Capacity (2022-2040) of MME with Cement demand forecasting.	Barge
LNG	Cambodia currently does not import LNG. However, according to the Ministry of Mines and Energy (MME), the country will import LNG in the near future for its LNG Power Plant. Therefore, forecasting LNG imports will follow the MME's Contingency Generation Plan / Installed Power Capacity (2022-2040) with forecasting of electricity consumption.	Barge
Fuel oil	Fuel oil is imported for power plants, and its use generates greenhouse gas emissions. In line with its commitment to the Paris Agreement, Cambodia is working to reduce these emissions and environmental pollution. Therefore, future fuel oil consumption is being forecasted as remaining the same as the current level.	Barge
Gasoline	Gasoline, jet fuel, LPG, diesel and Lubricant are imported to support human activities. The expert team assumes their consumption is closely linked to GDP. Therefore, future consumption is being forecasted based on the GDP elasticity of demand.	Barge
Jet Fuel		Barge
LPG		Barge
Diesel		Barge
Lubricant		Barge
Black oil	Cambodia is working to reduce its reliance on black oil due to its greenhouse gas emissions. However, once the Funan Techo Canal is complete, black oil demand will still be significant for waterway transportation. As a result, the forecast for its consumption is an increase that aligns with GDP growth.	Barge

The table below summarizes the export and imports quantity of various Mines and Energy. Beasd on the result from Table 3-36, in 2050 Cambodia will import mines around 2.2 million tons, export mines 79.7 million tons and import energy resources 28.4 million tons for scenario 1, 30,8 million tons for scenario 2, and 28.9 million tons for scenario 3.

Table 3-36 Summary of mines and energy demand forecasting

Mines import					
Sub items	Base year volume	Base year	Forecast volume in 2050	Unit	Forecast method
Gypsum	348,869	2023	2,182,080	Tons	GDP Elasticity
Mines export					
River Sand	28,000,000	2023	45,000,000	Ton	Mines exploring company and validate by MPWT
Bauxite	-	-	10,000,000	Ton	
Iron ore	5,000,000	2024	9,000,000	Ton	
Mable	-	-	3,000,000	Ton	
Pebbles	-	-	1,000,000	Ton	
Manganese ore	40,012	2024	40,012	Ton	Selected the highest of history data
Stone	10,651,924	2024	11,664,644	Ton	Increasing rate 0.35%
Energy import					
Coal	4,617,147	2023	7,952,041	Ton	Contingency Generation Plan / Installed Power Capacity (2022-2040) of MME with Cement demand forecasting
LNG	-	-	Sc.1: 4,324,548 Sc.2: 6,792,813 Sc.3: 4,894,524	Ton	Contingency Generation Plan / Installed Power Capacity (2022-2040) of MME
Fuel oil	117,000	2023	117,000	Ton	Contingency Generation Plan / Installed Power Capacity (2022-2040) of MME
Gasoline	636,400	2021	2,705,322	Ton	GDP Elasticity
Jet Fuel	67,100	2021	2,946,988	Ton	
LPG	325,600	2021	4,470,776	Ton	
Diesel	1,789,100	2021	5,737,951	Ton	
Lubricant	13,400	2021	22,286	Ton	
Black oil	33,500	2021	124,884	Ton	GDP Increasing

3.2.2 Mines import (Gypsum)

(1) Present gypsum and distribution

Gypsum is a crucial ingredient in cement factories, gypsum is added to prevent flash setting, control setting time, enhance workability, and ensure durability and strength. It reacts with C_3A to stabilize the hydration process and allows for a gradual gain in strength, leading to more robust structures. The percentage of gypsum in cement typically ranges from 3% to 5% by weight of the Portland cement[74]. Gypsum not only for cement factories, is also for construction material such as Plasterboard, Building Plaster, Plaster Blocks and Tiles, Gypsum Fiberboard, Decorative Plaster, Self-Leveling Screed, etc.

Gypsum is the mineral that Cambodia imports from the foreign countries to produce the cement and construction material, the biggest supply from Thailand around 80% based on General Department of Customs and Excise (GDCE) data 2023. By the limited of data got from GDCE, JICA Team Expert Team check data of UN Comtrade. UN Comtrade stands for the United Nations Commodity Trade Statistics Database; it is a comprehensive repository of official international trade statistics collected and maintained by United Nations Statistics Division (UNSD). According to UN Comtrade data, Cambodia Import gypsum with small amount is compare with currently, the import gypsum starts increasing with Cambodia start cement production in 2008 by Kampot Cement Co.,Ltd at Kampot province and continues increasing by Cambodia continues provide license to private to conduct cement factory to supply domestic demand. As of early 2025, Cambodia has 5 cement factories with total capacity around 8 million tons per year. To produce more cement, the demand for gypsum must also increase, because in cement has 3% to 5% is gypsum[75]. Gypsum also used in construction material. The graph below is Gypsum import to Cambodia since 2000 to 2023[76].

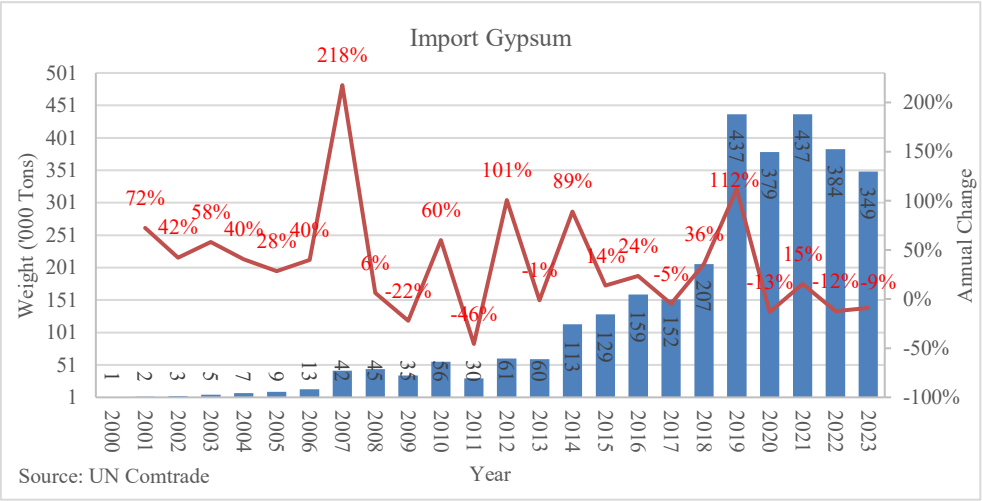


Figure 3-69 Gypsum Import to Cambodia (Data UN Comtrade)

[74] UNITY Cement: Gypsum in Cement; Role; Importance; and why it's added, January 7,2025.
[75] Minerals Education Coalition; Infrastructure and Construction Material Guide-Gypsum
[76] UN Comtrade Database and analysis by JICA Team Survey.

Cambodia starts to produce cement in 2008, Cambodia joint venture with Thailand 'Siam Cement to start the first cement factory is Kampot Cement Co.,Ltd[77] with capacity 950 thousand tons at Kampot province and extended capacity to 2 million tons since 2015[78]. The second factory is Cambodia Cement Chakreey Ting Factory Co.,Ltd[79], start to produce cement in 2015 with capacity 1 million tons at Kampot province. In 2018 has 2 more cement factories start to produce cement, one is Chip Mong Insee Cement Corporation has location at Kampot province with capacity 2 million tons[80], and another one is Battambang Conch Cement Company Limited at Battambang province with capacity 2 million tons[81]. Thai Boon Roong Cement Co.,Ltd start to produce cement since 2019 with capacity 1 million at Kampot province[82]. The new one factory starts to produce cement in 2025 is Conch KT Cement with capacity 2 million tons at Kampong Speu province[83]. In the short future will be have a new factory at Battambang province with capacity 1 million tons but it is not yet specific the date to start produce the cement[84].

Table 3-37 Cement factories in Cambodia

Factory Name	Start produce	Annual capacity (Million Tons)	Location
Kampot Cement Co.,Ltd	2008	2	Kampot
Cambodia Cement Chakrey Ting Factory Co.,Ltd	2015	1	Kampot
Chip Mong Insee Cement Corporation	2018	2	Kampot
Thai Boon Roong Cement Co Ltd	2019	1	Kampot
Battambang Conch Cement Company Limited	2018	2	Battambang
Conch KT Cement	2025	2	Kampong Speu
Dong-fang Junma Cement Co., Ltd	N/A	1	Battambang

In the cement processing also requires coal, during this process raw material (Limestone and Clay) are heated to high temperature around 1450°C in kilns, leading to chemical reactions that form clinker. Generally, cement factories require approximately 0.2 to 0.3 tons of standard coal per ton of cement produced, according to the World Bank Group[85].

[77] Ruter: Cambodia open first big cement plant, January 14,2008.
[78] May Kunmakara/Khmer Times: Siam Cement Moving the Expand in Cambodia, November 5, 2015.
[79] Ministry of Mines and Energy Cambodia; Post the information of Cambodia Cement Chakrey Ting Factory on Facebook page, August 4,2023.
[80] Khmer Times: Chip Mong Insee Cement Corporation to launch new product CAMEL Strong Build it strong, Build with pride, July 1, 2019.
[81] Ministry of Mines and Energy: Post the information about Battambang Conch Cement Company Limited on Facebook page, May 31,2018.
[82] The Phnom Penh Post: New Kampot cement plant set to open, October 15,2019.
[83] The Phnom Penh Post: Kampong Speu could get cement plant, March 18,2021.
[84] The Phnom Penh Post: Cement factory worth nearly 100 million US$ to be built in Battambang province, June 21,2023.
[85] Environmental, Health, and Safety Guidelines Cement and Lime Manufacturing, June 24,2022

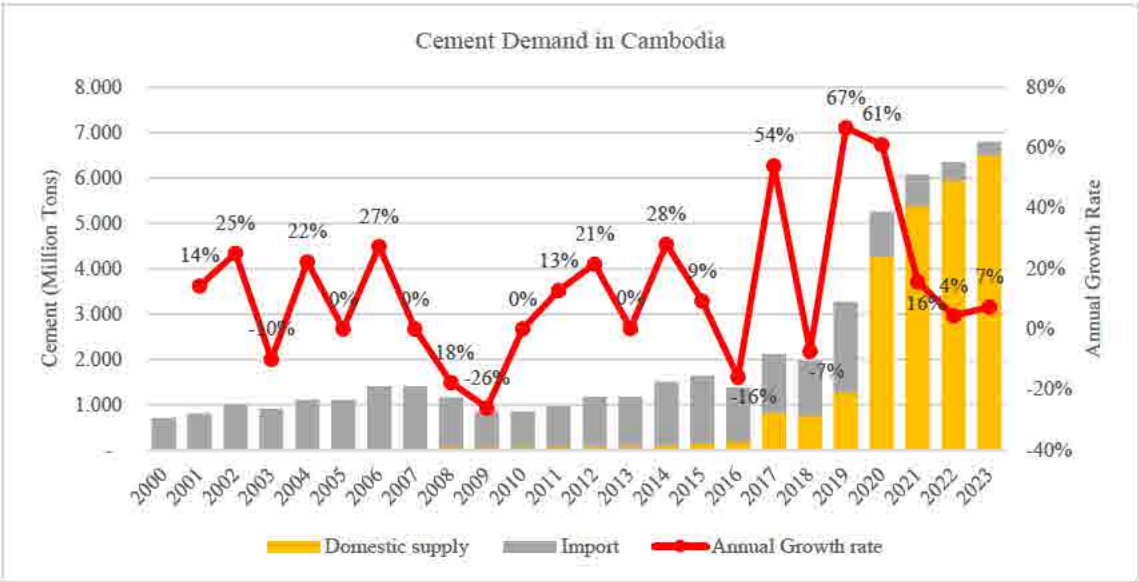


Figure 3-70 Cement demand in Cambodia

The graph above illustrates Cambodia's historical cement demand from 2000 to 2023. This data was compiled by the expert team by combining information from two sources: UN Comtrade's database on cement imports to Cambodia and the ministry of mines and energy's (MME) reports on industrial coal consumption. The data was converted to cement production figures following a methodology from the World Bank Group[85] above.

From 2000 to 2007, all cement for the construction sector was imported. From 2008 to 2016, domestic production remained limited, with the country still relying heavily on foreign imports. A significant increase in domestic cement production began in 2017 and continued through 2023, with almost all of Cambodia's cement now supplied by local companies. In 2023, Cambodia's cement supply was met by approximately 6.5 million tons of domestic production and 0.3 million tons of imports.

(2) Future projection of gypsum import

Gypsum is imported into Cambodia for two purposes: cement produces and construction materials. Therefore, the forecast for gypsum demand is generated by combining the cement demand forecast with the gypsum forecast for construction materials.

(a) Demand forecast of cement

Demand of cement are supply in Cambodia by two sources one is domestic supply and another is import. The expert team assumed there is close correlation between growth rate of demand of cement and GDP. In order to estimation the growth between the demand of cement and GDP, the expert team sampled data from 2011 to 2019 that can eliminate the COVID 19 economic disruption period.

The historical data on cement demand and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

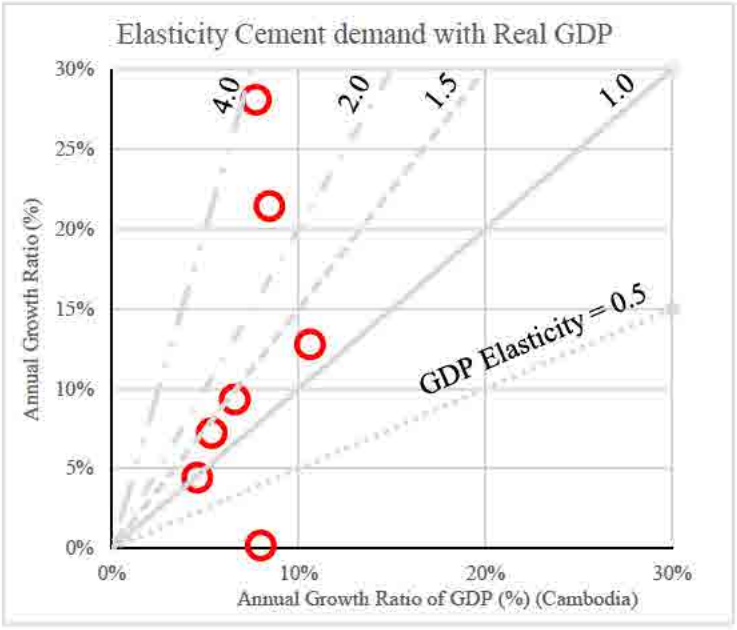


Figure 3-71 Elasticity between cement demand with real GDP

The Cement-GDP elasticity is defined as the annual growth rate of cement with the annual growth rate of GDP. Although the distribution varied widely, the expert team assumes a Cement-GDP elasticity of 1.0. The expert team used the Cement-GDP elasticity to predict future cement demand. The graph below presents the results of this demand forecast for cement from 2024 to 2050, based on actual data from 2010 to 2023. The forecast indicates that cement demand will rise from 6.7 million tons in 2023 to 16.0 million tons in 2050.

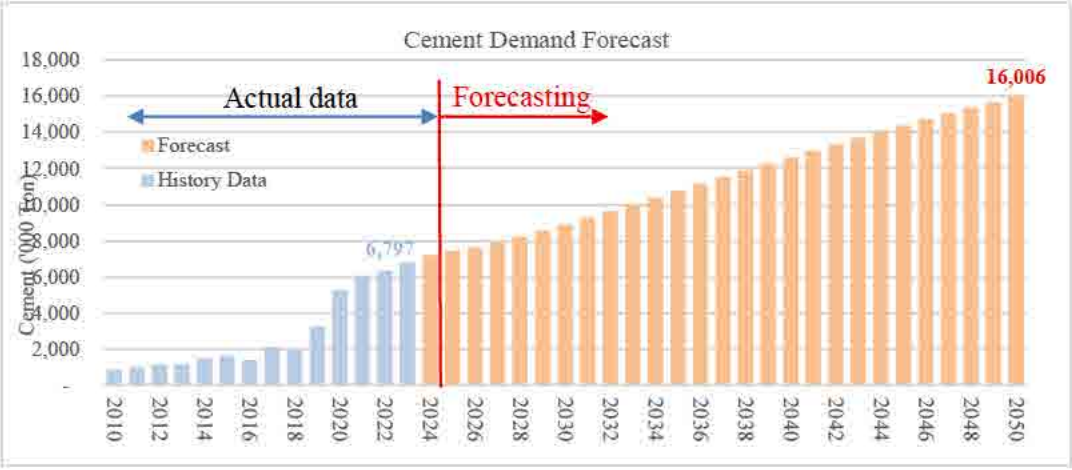


Figure 3-72 Cement demand forecast

In 2023, Cambodia's cement production capacity was 8 million tons. This capacity is projected to increase to 10 million tons by 2025. The expert team assumes that cement factories will operate at 80% capacity, meaning actual production will reach 8 million tons in 2025. To meet future demand, Cambodia will need to build more cement factories. The expert team predicts that Cambodia's cement production capacity will reach 21 million tons by 2050, with actual production reaching 16.0 million tons.

(b) Demand forecasting of Gypsum for construction material

Gypsum imports serve two main purposes: as a component for cement production and as a construction material. In cement, gypsum typically makes up 3% to 5% of the content[75], though our expert team assumes a 3% ratio for our analysis. The historical data for gypsum consumption, presented below, is based on two methods: one derived from domestic cement supply and another that estimates the amount used for construction. The graph illustrates that in 2019, the demand for gypsum as a construction material reached a historical peak of 340 thousand tons, before decreasing to 145 thousand tons in 2023. The expert team collected data on gypsum for construction to use for forecasting.

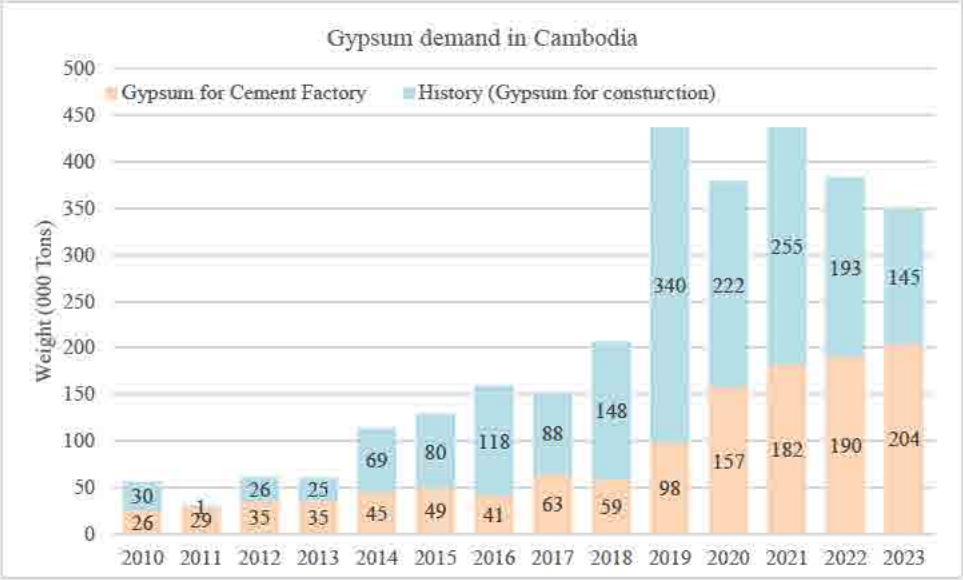


Figure 3-73 Gypsum demand in Cambodia

The expert team assumed there is close correlation between growth rate of demand of gypsum for construction and GDP. In order to estimation the growth between the demand of gypsum for construction and GDP, the expert team sampled data from 2011 to 2019 that can eliminate the COVID 19 economic disruption period. The historical data on gypsum for construction and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

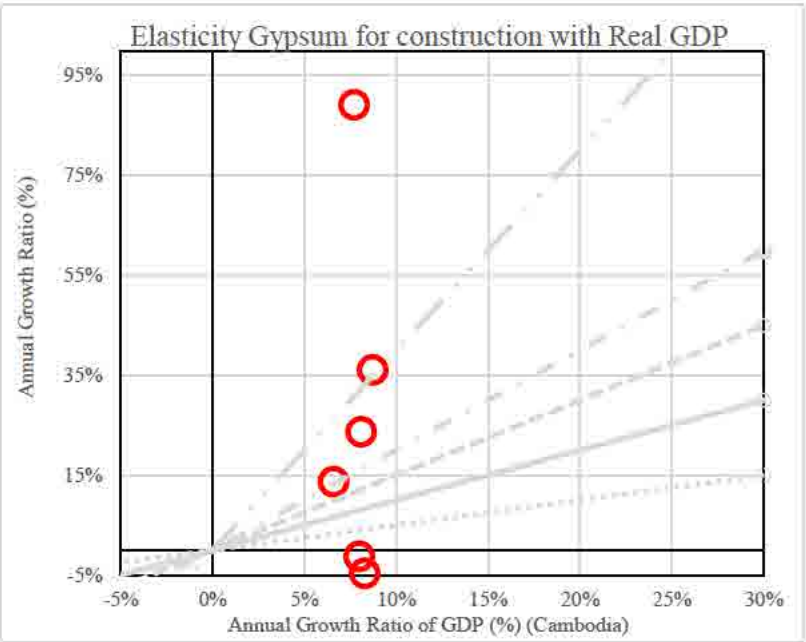


Figure 3-74 Elasticity between gypsum for construction with real GDP

The gypsum for construction-GDP elasticity is defined as the annual growth rate of gypsum for construction with the annual growth rate of GDP. Although the distribution varied widely, the expert team assumes a gypsum for construction-GDP elasticity of 2.0. The expert team used the gypsum for construction-GDP elasticity to predict future cement demand. The graph below presents the results of this demand forecast for gypsum for construction from 2024 to 2050, based on actual data from 2010 to 2023. The forecast indicates that gypsum for construction demand will rise from 145 thousand tons in 2023 to 1.7 million tons in 2050.

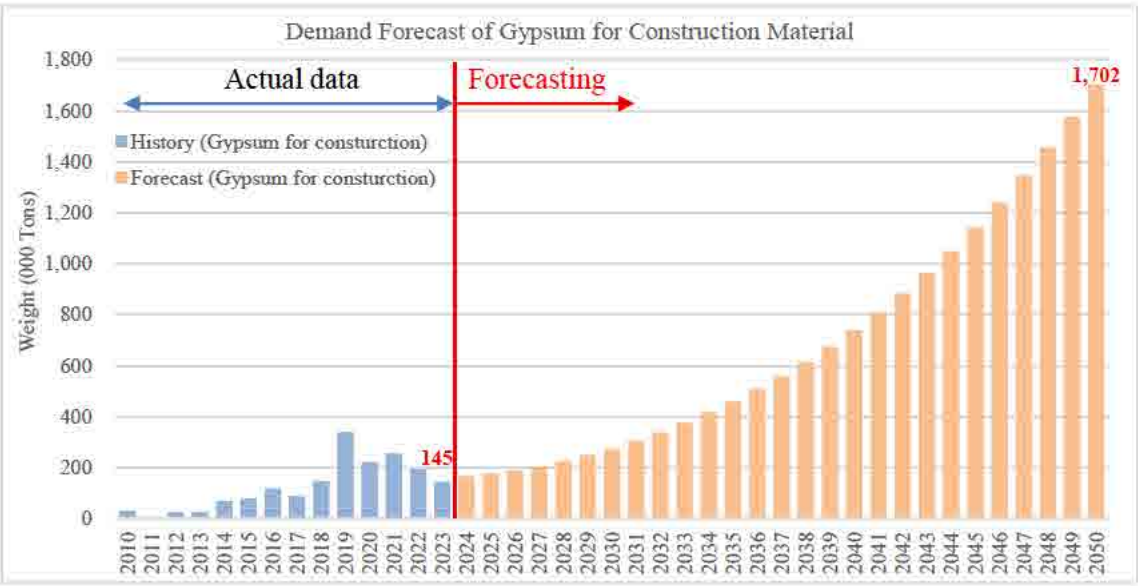


Figure 3-75 Gypsum for construction material demand forecast

(c) Demand forecast total of Gypsum import

Total gypsum imports in the future are defined by the demand forecasts for both cement and gypsum for construction materials. The graph below presents the results of this demand forecast for total gypsum import demand from 2024 to 2050, using actual data from 2010 to 2023. The forecast indicates that total gypsum import demand will rise from 340 thousand tons in 2023 to 2.1 million tons in 2050. This increase is divided between 480 thousand tons for cement production and 1.7 million tons for construction materials.

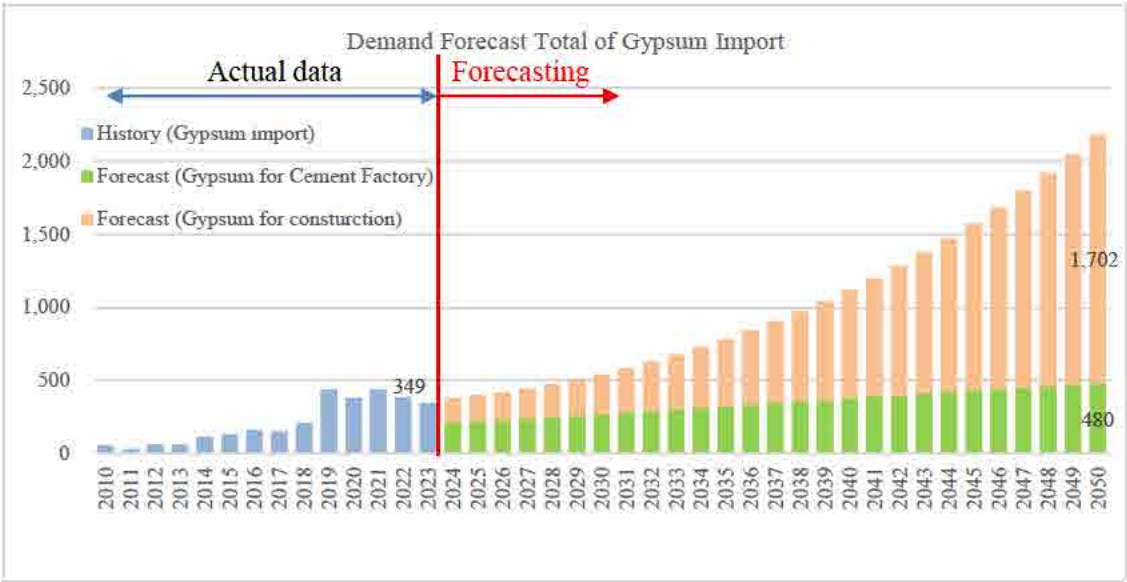


Figure 3-76 Demand forecast total of gypsum import

The table below shows the actual volume in 2023 compared with the demand forecast for 2050. According to the comparison, the volume of gypsum for cement production is projected to increase 2.4 times, while gypsum for construction material is expected to increase 11.7 times. Overall, total gypsum demand is forecast to increase 6.3 times.

Table 3-38 Summary demand forecast of Gypsum

	Actual volume in 2023	Demand forecast in 2050	increase rate
Cement demand	6,796,602	16,006,019	2.4
Gypsum for Cement produces	203,898	480,181	2.4
Gypsum for Construction Material	144,972	1,701,900	11.7
Total Gypsum demand	348,870	2,182,080	6.3

(3) Allocation gypsum import volume by zone

The gypsum demand forecast's allocation method is divided into two parts. The first is an allocation based on the current location and capacity of cement factories. The second is an allocation that follows each province's share of the regional GDP.

Based on Table 3-37 Cement factories in Cambodia, which details cement factories in Cambodia, Kampot province has a cement capacity of 6 million tons, Battambang has 3 million tons, and Kampong Speu has 2 million tons. Using this information, the allocation of gypsum for cement factories follows the current capacity share of each province: Kampot province (54.5%), Battambang province (27.3%), and Kampong Speu province (18.2%).

Province	Cement produces share	Gypsum for cement produces	Regional GDP	Gypsum for construction material	Gypsum demand of each province
Koh Kong			0.9%	15,535	15,535
Preah Sihanouk			3.9%	67,100	67,100
Kampot	54.5%	261,917	3.3%	56,442	318,358
Kep			0.2%	3,860	3,860
Stung Treng			0.9%	15,972	15,972
Kratie			1.7%	29,399	29,399
Ratanak Kiri			1.2%	20,198	20,198
Mondul Kiri			0.6%	10,778	10,778
Kampong Thom			2.9%	49,124	49,124
Preah Vihear			1.1%	19,185	19,185
Pursat			2.3%	38,673	38,673
Battambang	27.3%	130,958	4.6%	77,937	208,895
Siem Reap			4.0%	67,794	67,794
Pailin			0.5%	8,239	8,239
Banteay Meanchey			3.8%	64,681	64,681
Oddar Meanchey			1.1%	18,487	18,487
Kampong Speu	18.2%	87,306	4.4%	74,213	161,518
Takeo			4.0%	67,437	67,437
Kampong Chhnang			2.9%	48,781	48,781
Kampong Cham			4.1%	68,996	68,996
Tboung Khmum			3.2%	54,857	54,857
Prey Veng			3.6%	61,367	61,367
Svay Rieng			3.0%	50,588	50,588
Phnom Penh			35.4%	601,705	601,705
Kandal			6.5%	110,551	110,551

Province	Cement produces share	Gypsum for cement produces	Regional GDP	Gypsum for construction material	Gypsum demand of each province
Total	100%	480,181	100%	1,701,900	2,182,080

According to Map below representation the gypsum demand of each province, the highest demand in Phnom Penh City, the second demand in Kampot province, the third demand in Battambang province.

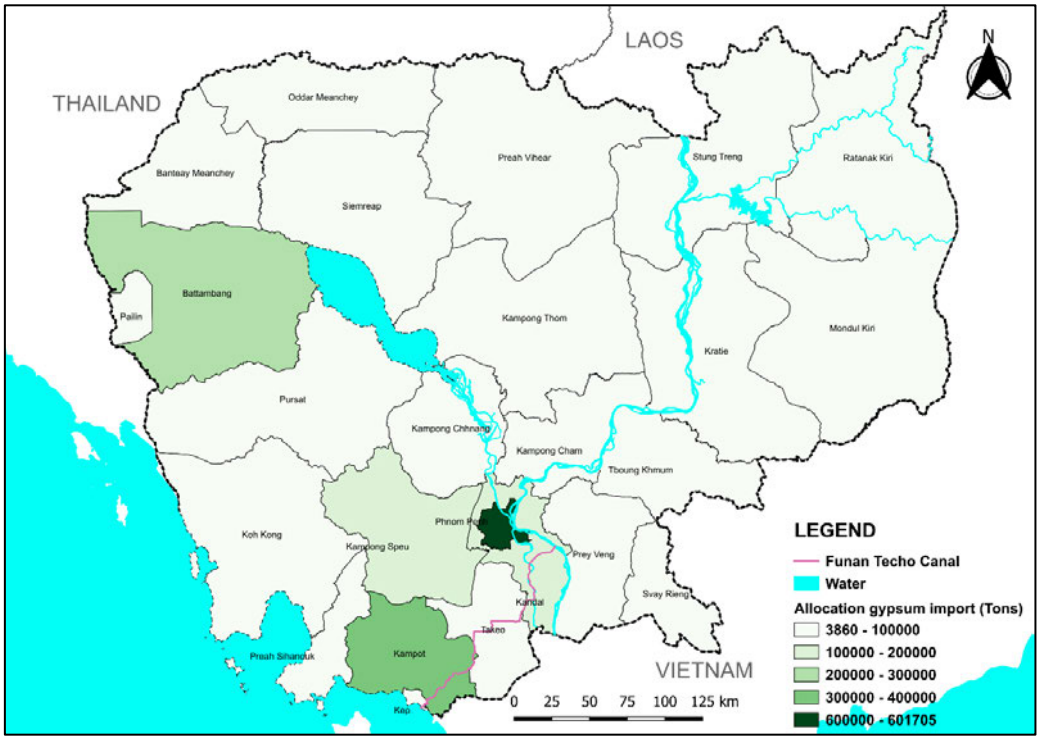


Figure 3-77 Allocation of gypsum import volume in 2050 by province

The table below presents the results of the gypsum demand forecast, allocated by zone. The forecast indicates that in the future, gypsum imports will be distributed as follows: zone 1 is 405 thousand tons, zone 2 is 145 thousand tons, zone 3 is 407 thousand tons, zone 4 is 278 thousand tons, zone 5 is 236 thousand tons, and zone 6 is 712 thousand tons.

Table 3-39 Allocate volume of gypsum import of each zone

Zone	Import ('000 Tons)
	Gypsum
Zone 1	405
Zone 2	145
Zone 3	407
Zone 4	278
Zone 5	236
Zone 6	712
Total	2,182

(4) Gypsum transport route

(a) Current gypsum transport routes

Gypsum is a mineral that Cambodia imports from foreign countries to produce cement and construction materials. Based on 2023 data from the General Department of Customs and Excise (GDCE), Thailand is the largest supplier, accounting for approximately 80% of imports. Gypsum is primarily imported from Thailand by seaport; after it is unloaded at a Cambodian seaport, it is transported by truck to its final destination.

(b) Future gypsum transport routes

Due to the border conflict between Cambodia and Thailand, the main supply source is expected to shift from Thailand to other countries. In the future, once the Funan Techo Canal is completed, gypsum will be transported from foreign countries to a Cambodian seaport. It will then be transferred to barges for transport from the seaport to destinations within Cambodia via the canal, which is expected to reduce transportation costs.

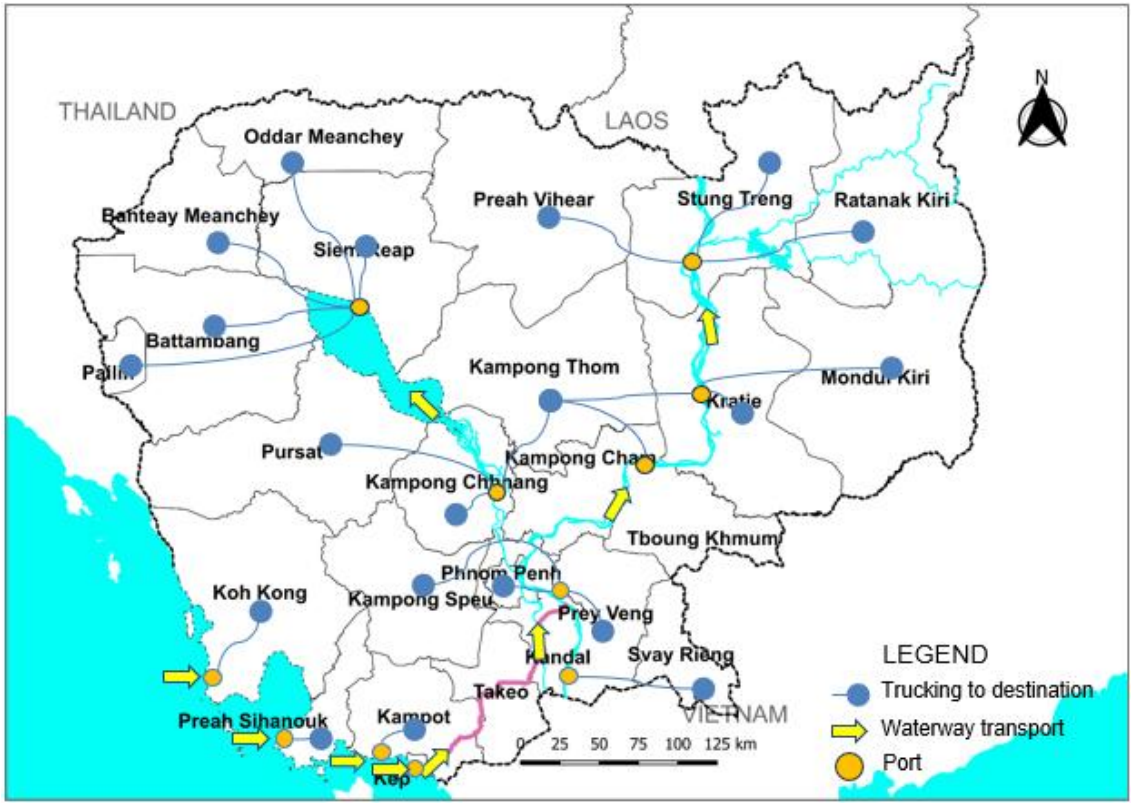


Figure 3-78 The flow represents future waterway transport routes.

3.2.3 Mines Export

(1) Present mines export and distribution

Cambodia export mines such as: River Sand, Bauxite, Iron Ore, Mable, Pebbles, Manganese Ore, and Stone.

Based on information from Mines exploring Company and validate by MPWT, River sand 28 million tons were exported to the global market in 2023. Bauxite exports from Cambodia are projected to reach 2 million tons by 2028. Iron Ore 5 million tons was export to global market in 2024. Mable will export 1 million tons to global market in 2026. And Pebbles exports to the global market will rise to 0.5 million tons by 2026. According to Ministry of Mines and Energy (MME), Manganese Ore export 40 thousand tons in 2024, and Stone export in 2024 in 3 figures: Dimension stone 5.2 million square meters, Stone Blocks 322 thousand cubic meters, and Stone Slabs 135 thousand cubic meters, the totally of stone export is 10.6 million tons.

According to Ministry of Mines and Energy, currently River sand is dredged from Cambodia rivers and transported by barge for export to the global market via the Vietnam border. Cambodia sand barges transship sand to larger vessels in Vietnam for transport to final destination. Iron Ore was exported from Preah Vihear and Strung Treng province transport by truck to Kampot port and loading to large barge and transport to final destination. Stone mainly conducted through inland transportation to border Vietnam from Kratie province.

(2) Future projection of mines export

In the future Cambodia will export 79.7 million tons of mining to foreign countries including River Sand, Bauxite, Iron Ore, Mable, Pebbles, Manganese, and Stone. The method to forecasting River Sand, Bauxite, Iron Ore, Mable, Pebbles, are get it from Mines exploring company and validate by Ministry of Public Works and Transport (MPWT). Manganese Ore using selection method by selected the highest of history data. And Stone using assumption method by assumed increasing rate 0.35%.

Table 3-40 Summary of demand forecast of mines export

Mines	Base year volume	Based year	Estimation volume in 2050	Unit	Estimation method
River Sand	28,000,000	2023	45,000,000	Ton	Mines exploring Company and validate by MPWT.
Bauxite mining	-	-	10,000,000	Ton	
Iron ore	5,000,000	2024	9,000,000	Ton	
Mable mining	-	-	3,000,000	Ton	
Pebbles	-	-	1,000,000	Ton	
Manganese ore	40,012	2023	40,012	Ton	Selected the highest of history data
Stone	10,651,924	2024	11,664,644	Ton	Increasing rate 0.35%

(a) Demand forecasting of River Sand

River sand in Cambodia primarily originates from the Mekong River and its tributaries, with much of the sediment flowing downstream from the Tibetan Plateau through China and neighboring countries. Based on information from mining exploration companies and validated by the Ministry of Public works and Transport (MWPT), 28 million tons of this river sand were exported to the global market in 2023, increasing to 45 million tons by 2024, with projections indicating that this level of export will remain steady through 2050.

Moreover, if river sand is not dredged regularly, sediment accumulation can cause the river to become excessively shallow, which would negatively affect the navigation of barges and other vessels, disrupting transport and trade along Cambodia's waterways.

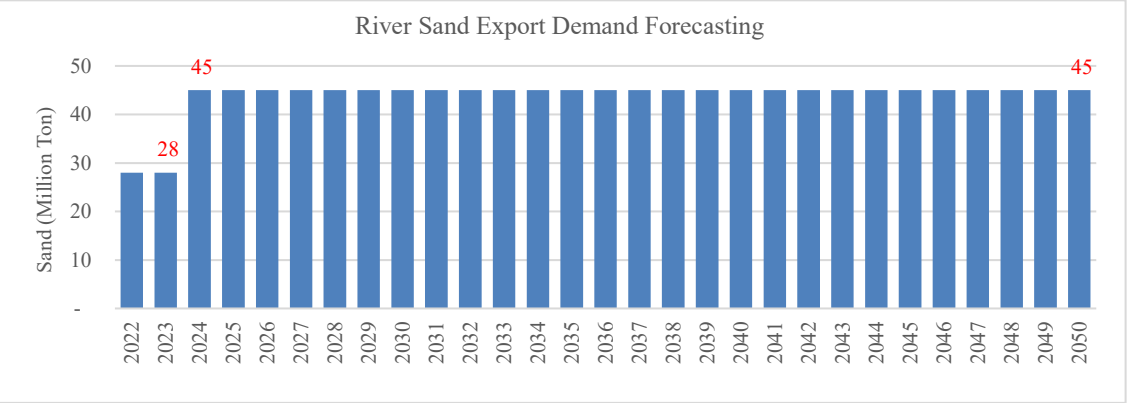


Figure 3-79 Demand forecasting of river sand export

(b) Demand forecasting of Bauxite

According to information from Mines exploring Company and validate by MPWT, Bauxite mining has the potential for large-scale operations in Cambodia. Bauxite exports from Cambodia are projected to reach 2 million tons by 2028 and increase to 10 million tons by 2050. Based on information from Phnom Penh Autonomous Port (PPAP), Bauxite are located in Mondul Kiri province.

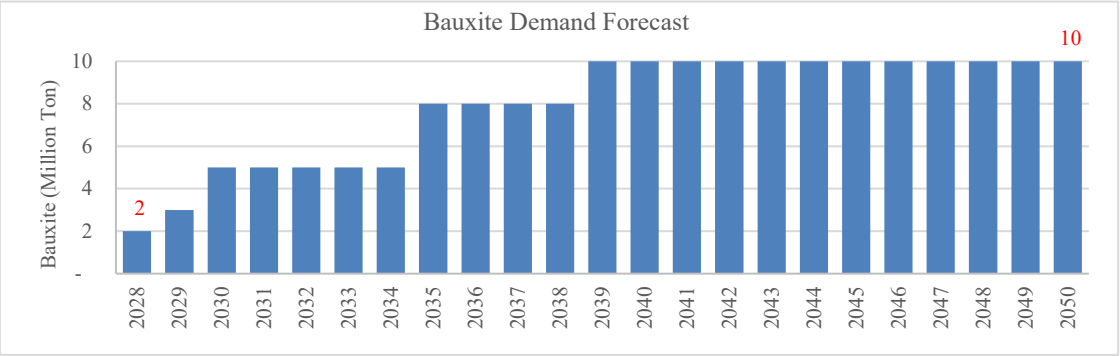


Figure 3-80 Demand forecasting of bauxite export

(c) Demand forecasting of iron ore

Based on information from Mines exploring Company and validate by MPWT, Iron Ore 5 million ton was export to the global market in 2024 and increasing to 9 million ton in 2041 and remaining at that level through 2050. According to Ministry of Mines and Energy the quality of Iron Ore in Cambodia is quite good, Currently Iron Ore was located at Preah Vihear and Strung Treng Province.

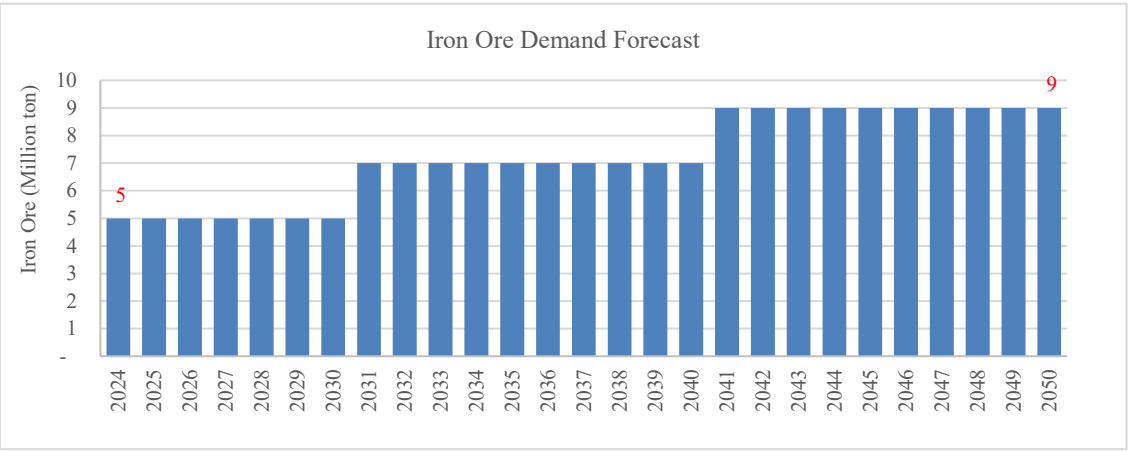


Figure 3-81 Demand forecasting of iron ore export

(d) Demand forecasting of marble

Based on information from Mines exploring Company and validate by MPWT, prospection Cambodia's marble exports to the global market will rise to 1 million tons by 2026, increase to 3 million tons by 2031, and remaining at that level through 2050. Marble was location in Kratie province. Marble are transport from Kratie to Tboung Khmum Port (UM2) by truck and input it into container and loading into Container barge at UM2 and transport to LM 17 to loading more container and export via Vietnam port.

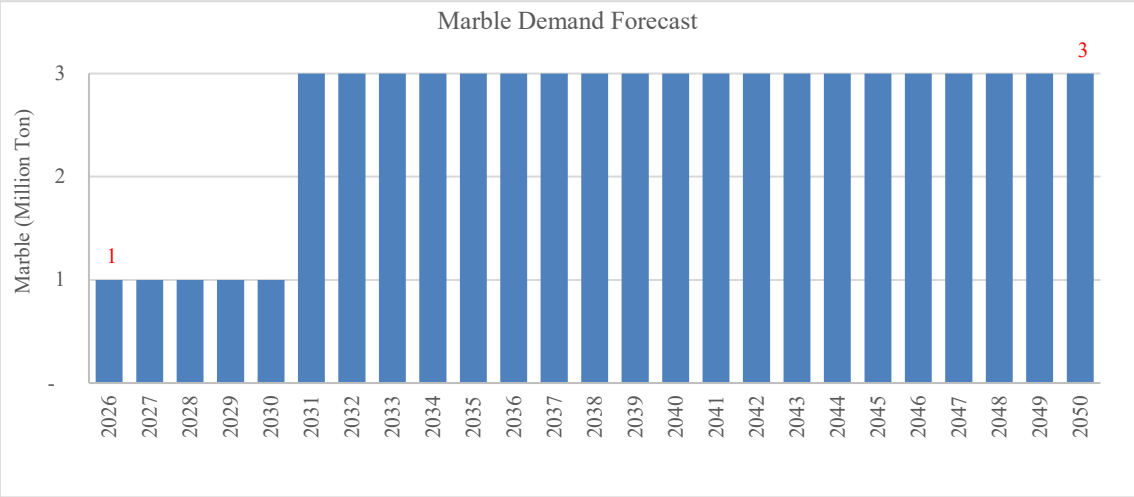


Figure 3-82 Demand forecasting of marble export

(e) Demand forecasting of Pebbles

Based on information from Mines exploring Company and validate by MPWT, Projections Cambodia's Pebbles exports to the global market will rise to 0.5 million tons by 2026, increase to 1 million tons by 2036, and continue at that level until 2050. Pebbles are commonly in riverbeds.

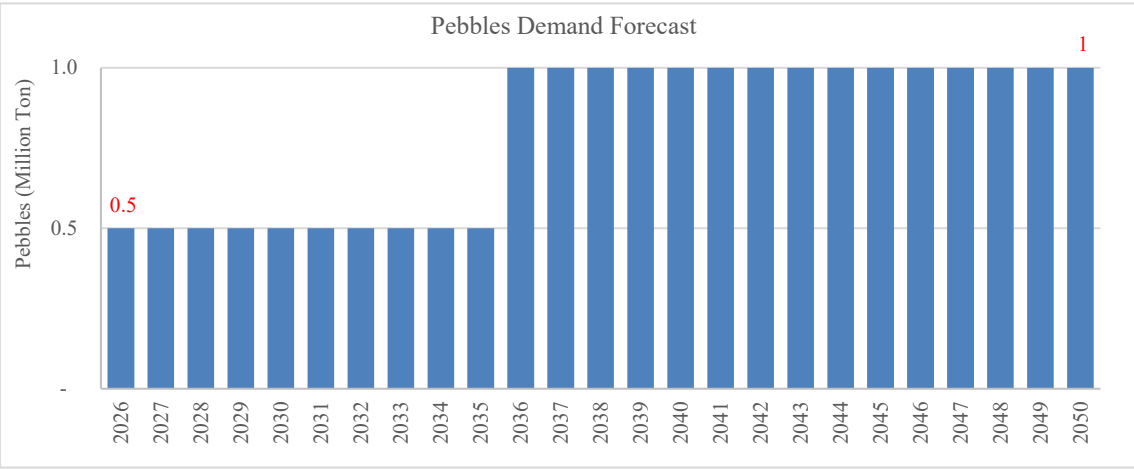


Figure 3-83 Demand forecasting of pebbles export

(f) Demand forecasting of manganese ore

According to the Ministry of Mines and Energy (MME), Manganese Ore has located in Preah Vihear and Stung Treng province and transportation to Kampong Chhnang province and transship to the barge and export to the world via Vietnam border. MME recorded an export volume of 40 thousand tons in 2024, while UN Comtrade has no data on Manganese exports. Due to the limited historical data and the absence of specific policies on Manganese Ore, the expert team assumes that future export volumes will remain at 40 thousand tons of Manganese Ore.

(g) Demand forecasting of stone

According from the Ministry of Mines and Energy, the mainly conducted through inland transportation to border Vietnam from Kratie. And Stone was export in three shapes:

- Dimension Stone exports were 420 thousand square meters in 2020 and are expected to increase to 5 million square meters by 2024.
- Stone Blocks exports were 26 thousand cubic meters in 2020 and are projected to rise to 320 thousand cubic meters by 2024.
- Stone Slabs exports were 8 thousand cubic meters in 2020 and are expected to grow to 134 thousand cubic meters by 2024.

The stone exports are converted from cubic meters to tons (with the conversion rate of 1 cubic meter = 2.1 tons). For Dimension Stone, it is assumed that the thickness is 0.1 meter to convert the area into cubic meters.

Table 3-41 Stone exports last five years and converted into tons

Year	Export Stone			Convert to Ton			
	Dimension stone (m2)	Stone Blocks (m3)	Stone Slabs (m3)	Dimension Stone	Stone Blocks	Stone Slabs	Total
2020	420,104	26,394	8,402	88,222	554,274	176,442	818,938
2021	331,359	48,030	6,627	69,585	1,008,630	139,167	1,217,382
2022	351,724	70,623	7,034	73,862	1,483,083	147,714	1,704,659
2023	1,571,755	142,502	31,435	330,069	2,992,542	660,135	3,982,746
2024	5,156,250	320,877	134,795	1,082,813	6,738,417	2,830,695	10,651,925
Estimated 2025	5,200,000	322,000	135,000	1,092,000	6,762,000	2,835,000	10,689,000

By converting the stone export volume from cubic meters to tons, it is clear that the export of stone has increased significantly year by year from 2020 to 2024, growing by around 12 times. The Ministry of Mines and Energy predicts that stone exports will continue to increase by 0.35% in 2025. The expert team assumes that the growth rate will remain at 0.35% per year from 2025 to 2050. As of 30 September 2023, the Cambodian government has reduced the export tax on stone between 0% to 30%. As a result, stone exports are expected to increase from 10.6 million tons in 2024 to 11.6 million tons by 2050.

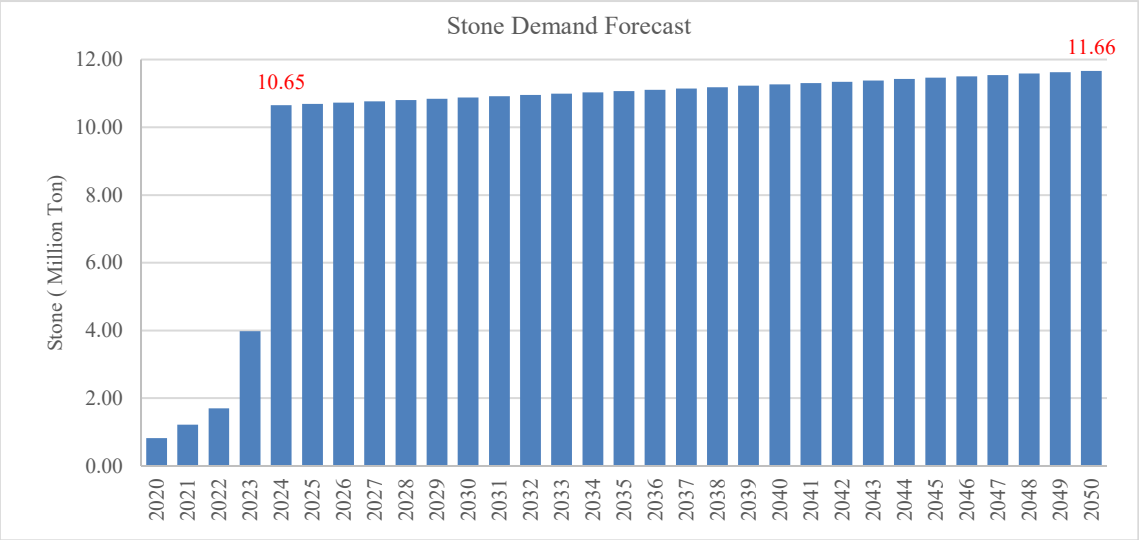


Figure 3-84 Demand forecasting of stone export

(3) Allocating mines export by zone

The allocation method is crucial for distributing volume across Cambodia's zones. The expert team uses: (1) GDCE data information, and (2) Mines Resource Location. The bottom table is the table of allocation method for each item.

Table 3-42 Allocating method for each mines resources export

Mines Export Items	Allocation Method
River Sand	GDCE Export Data 2024
Iron Ore	Location of Iron Ore resource
Manganese Ore	Location of Manganese Ore resource
Bauxite	Location of Bauxite resource
Purple Mines	Location of Purple Mines resource
Marble	Location of Marble resource
Stone	Location of Stone resource

River sand, dredged from Cambodian rivers. According to 2024 GDCE data, sand is exported from Phnom Penh City and Kandal province to foreign countries. Sand is loaded onto barges and transported through Phnom Penh and Kandal provinces for export to the global market via the Vietnamese border. Therefore, the expert team assumes all sand exports originate from Phnom Penh. Bauxite, located in Mondul Kiri. Iron Ore and manganese Ore, located in Preah Vihear and Stung Treng. Marble and Stone, located in Kratie. Pebbles, located in Kratie.

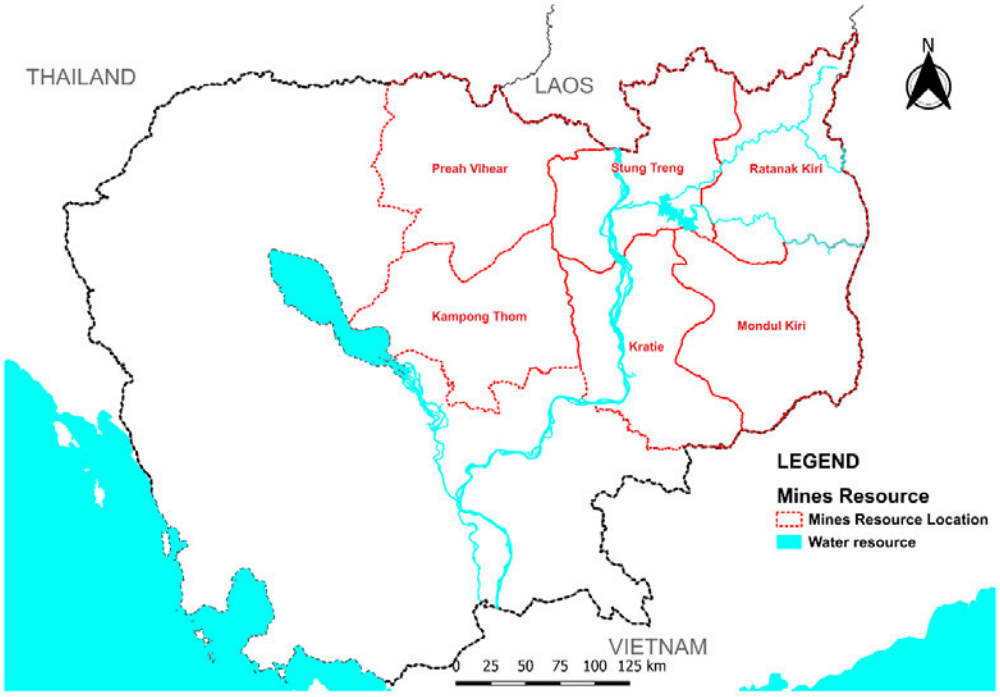


Figure 3-85 Mines location in Cambodia

The table shows the future provincial allocation of Cambodia's 79.7 million tons of mineral exports: Sand, Iron Ore, Manganese Ore, Bauxite, Purple Mines, Marble, and Stone. The minerals such as Iron Ore are found at two provinces, and their capacity is assumed to be equal due to missing specific location details.

Table 3-43 Allocate volume of mines export of each province

Province	Sand	Iron Ore	Manganese Ore	Bauxite	Purple Mines	Marble	Stone	Total
Koh Kong								
Preah Sihanouk								
Kampot								
Kep								
Stung Treng		4,500,000	20,006					4,520,006
Kratie						3,000,000	11,664,644	14,664,644
Ratanak Kiri					500,000			500,000
Mondul Kiri				10,000,000				10,000,000
Kampong Thom					500,000			500,000
Preah Vihear		4,500,000	20,006					4,520,006
Pursat								
Battambang								
Siem Reap								
Pailin								
Banteay Meanchey								
Oddar Meanchey								
Kampong Speu								
Takeo								
Kampong Chhnang								
Kampong Cham								
Tboung Khmum								
Prey Veng								
Svay Rieng								
Phnom Penh	45,000,000							45,000,000
Kandal								
Total	45,000,000	9,000,000	40,012	10,000,000	1,000,000	3,000,000	11,664,644	79,704,656

Total mines export in the future 2050 is 79.7 million tons from 2 Zone: Zone 6 will export 45 million tons and Zone 2 will export 34 million tons. Zone 6 export only River sand and Zone 2 export many types of mines to foreign countries.

Table 3-44 Allocate volume of mines export of each zone

Zone	Export ('000 Tons)							Total ('000 Tons)
	Iron Ore	Manganese Ore	Sand	Stone	Bauxite	Pebbles	Marble	
Zone 1	-	-	-	-	-	-	-	-
Zone 2	9,000	0.04	-	11,665	10,000	1,000	3,000	34,705
Zone 3	-	-	-	-	-	-	-	-
Zone 4	-	-	-	-	-	-	-	-
Zone 5	-	-	-	-	-	-	-	-
Zone 6	-	-	45,000	-	-	-	-	45,000
Total	9,000	0.04	45,000	11,665	10,000	1,000	3,000	79,705

(4) Mines transport route

(a) Currently mines transport route

Mineral resources are extracted from mining sites and transported to a river port, where they are then transshipped onto barges and carried to a Vietnamese seaport. At the seaport, they undergo a second transshipment onto sea vessels for export to foreign countries. This current export route, which passes through Vietnam, requires the processing of specific documents and the payment of fees for the mineral resources that are being shipped. But Vietnam has banned the export of some mineral resources from passing through its territory, these resources must be transported by truck to a Cambodian seaport. This route is costly, making it too expensive for Cambodia to export certain types of minerals.

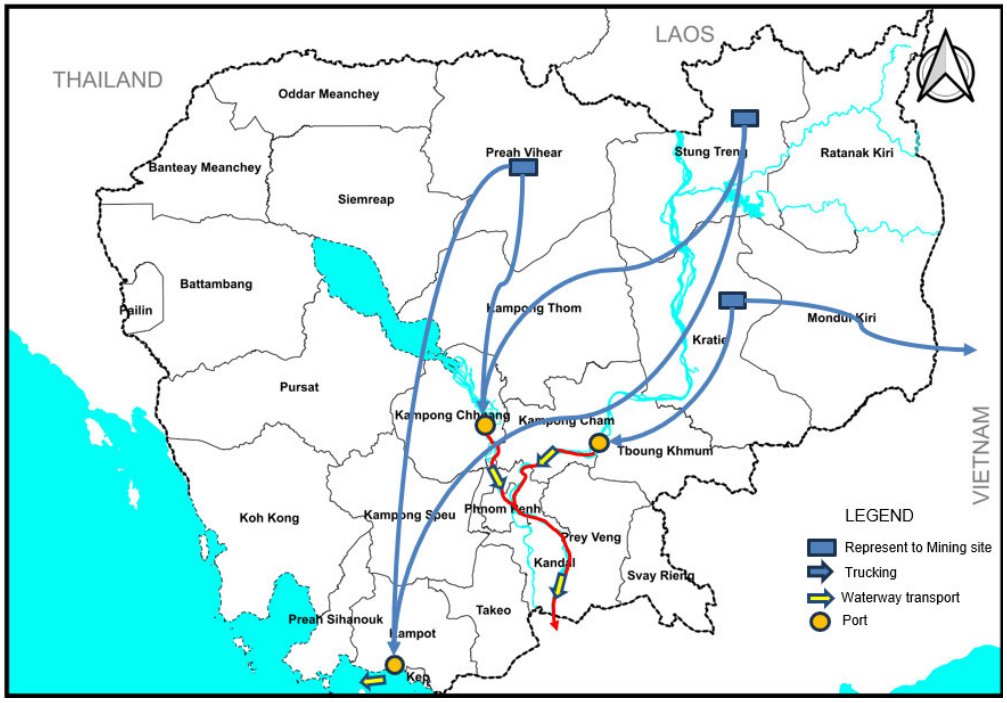


Figure 3-86 Currently mines export route

(b) Future mines export route

Upon the completion of Cambodia's mega-project, the Funan Techo Canal, the export of mineral resources will have two available routes. The first is the current transportation route via the Mekong River, which passes through Vietnamese territory. The second is the Funan Techo Canal, which will provide a direct waterway from inland Cambodia to a Cambodian seaport. This new canal will allow Cambodia to export mineral resources that have been banned by Vietnam, and it is expected to reduce the overall cost of transportation. The map below illustrates these two potential future routes for Cambodia's mineral exports.

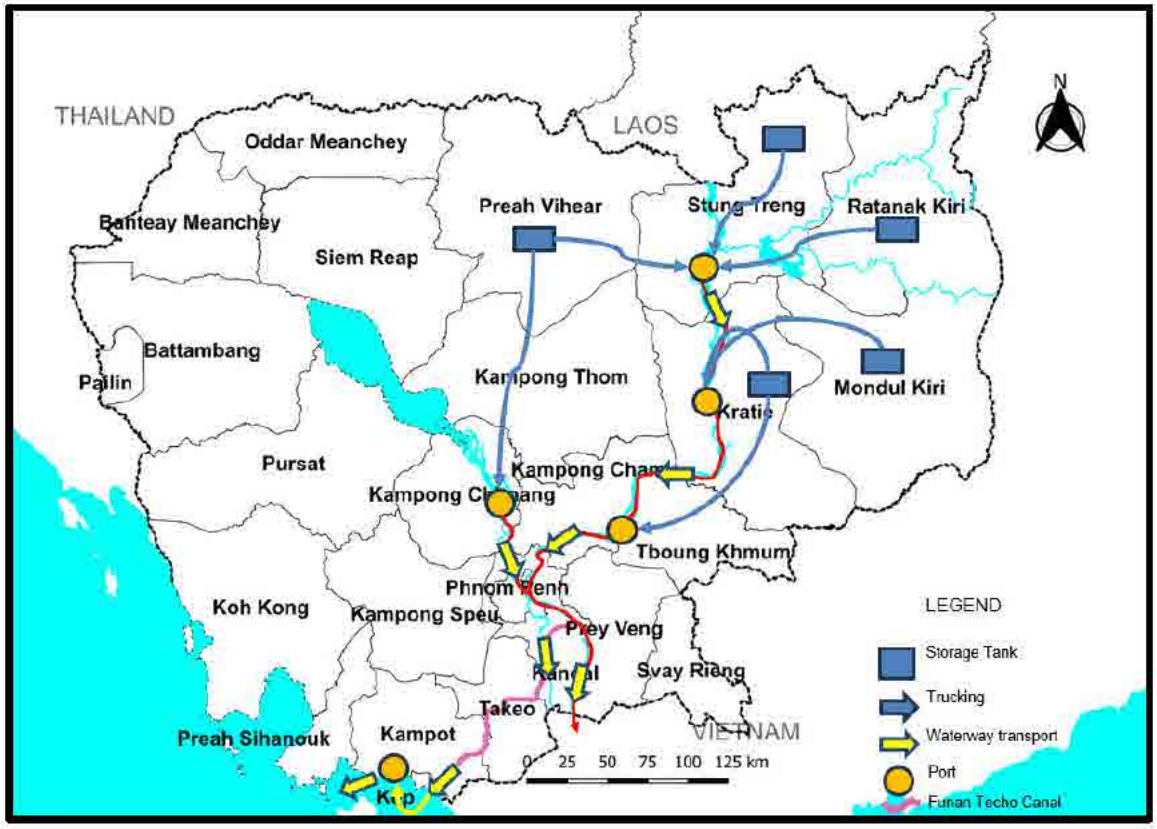


Figure 3-87 The future mines export routes of Cambodia

3.2.4 Energy resource import

(1) Present energy resource import and distribution

Cambodia always imports energy resource from foreign countries according to database of ministry of mines and energy (MEE) that collected from two reports one is Cambodia energy statistic 2019-2020 and another is energy balance table statistic 2020-2021. Energy resource import to Cambodia such as: Coal, Gasoline, Jet Fuel, LPG, Diesel, Lubricant, and Black oil. Below graph is history of energy import to Cambodia from 2000 to 2021. The total energy import is 0.667 million tons by 2000 and increased to 6.706 million tons by 2020 and 6.245 million tons by 2021.

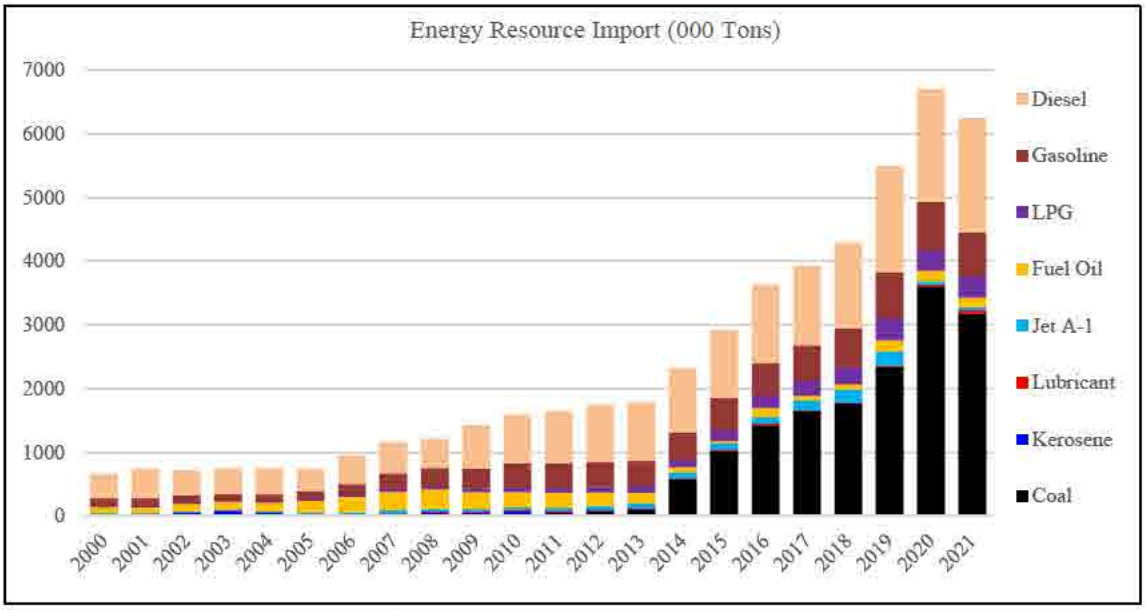


Figure 3-88 History of energy resources import[86,87]

(a) Coal consumption in Cambodia

According to reports from the Ministry of Mines and Energy, Cambodia has been importing coal since 2008. These imports serve two primary purposes: electricity generation at coal-fired power plants and various industrial applications. Within the industrial sector, the main use for coal is in cement factories. Based graph below is showing coal more than 60% import for coal-fired power plant and lower than 40% import for industry sector.

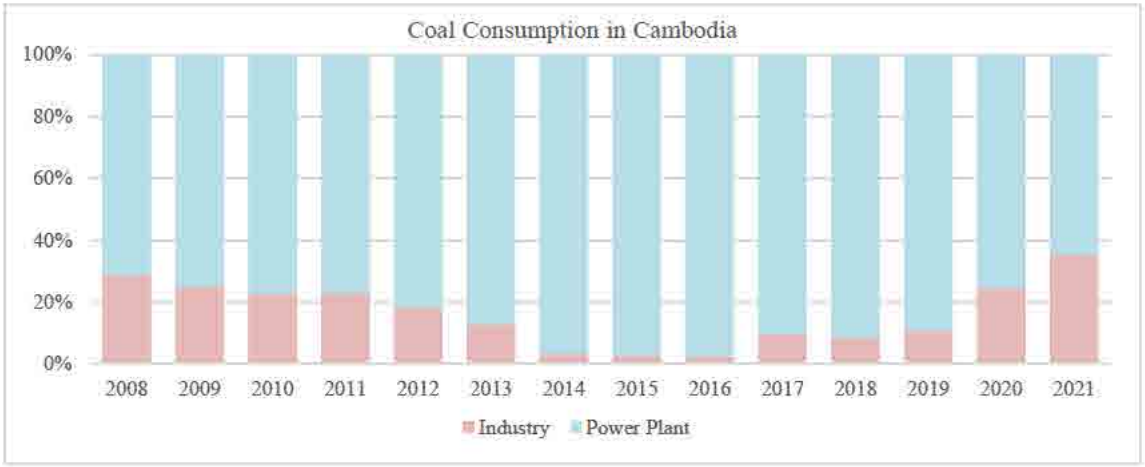


Figure 3-89 Share of coal consumption in Cambodia[86,87]

[86] Cambodia energy statistics 2000-2019
[87] Energy balance table statistic 2020-2021

(b) Petroleum consumption in Cambodia

According to reports from the Ministry of Mines and Energy, petroleum supply in Cambodia such as Gasoline, Jet Fuel, Diesel, Black oil, Lubricant, LPG, and Kerosene, to support transportation sector, Power sector, agriculture sector, industrial sector, commercial, residential, and other sector. As the history data of petroleum supply in Cambodia, Kerosene is not required since 2014. The total supply of petroleum in Cambodia is increasing every from 2000 to 2019 and decreasing in 2020 and 2021 that is the duration of covid 19.

Table 3-45 Petroleum supply in Cambodia[86,87]

Petroleum Supply (000 Tons)								
Year	Jet Fuel	Gasoline	Diesel	Black Oil	Lubricant	LPG	Kerosene	Total
2000	17.37	119.76	387.83	95.51	3.64	13.43	29.55	667.09
2001	16.78	120.86	465.65	92.12	3.14	16.66	28.27	743.48
2002	16.83	116.93	389.2	122.46	5.13	18.13	50.41	719.09
2003	16.83	103.8	400.58	118.53	5.65	22.28	83.69	751.36
2004	19.67	96.75	409.62	142.35	6.52	27.54	47.82	750.27
2005	20.03	129.3	346.58	180.03	7.46	28.24	30.34	741.98
2006	27.06	158.98	449.81	248.8	6.94	38.26	24.41	954.26
2007	48.73	238.4	492.53	293.95	11.41	47.34	32.62	1164.98
2008	44.31	293.22	456.1	310.09	12.83	43.29	30.78	1190.62
2009	35.19	313.61	677.06	269.94	17.54	56.95	28.95	1399.24
2010	46.35	384.09	762.08	244.07	16.74	65.11	30.59	1549.03
2011	54.6	398.52	814.54	228.78	17.64	71.94	12.07	1598.09
2012	68.99	387.73	897.64	213.74	18.02	84.68	6.26	1677.06
2013	79.21	392.01	918.44	165.93	18.84	98.69	3.03	1676.15
2014	91.66	426.83	1,005.48	89.28	11.69	112.12	-	1737.06
2015	96.95	507.26	1,073.25	35.59	20.39	162.33	-	1895.77
2016	105.74	513.76	1,240.18	138.53	25.13	193.6	-	2216.94
2017	152.81	562.04	1,247.63	77.69	12.1	224.37	-	2276.64
2018	201.52	606.09	1,343.34	84.07	11.83	270.32	-	2517.17
2019	224.71	725.65	1,661.33	179.92	13.83	340.96	-	3146.4
2020	59.7	695.8	1767.4	169.8	14.5	322	-	3029.2
2021	67.1	636.4	1789.1	150.5	13.4	325.6	-	2982.1

* Lubricants include base oil; gasoline includes naphtha and methyl tert-butyl ether (MTBE)
Sources: Cambodia energy statistics 2000-2019 and energy balance table statistic 2020-2021

Cambodia's reliance on imported petroleum fuels a wide range of activities, from powering flights to lighting homes. Each type of fuel serves a distinct purpose, a fact made clear when we examine the flow of imports:

- Gasoline: This fuel has a singular, crucial purpose: it powers the nation's road transportation sector, keeping cars, motorbikes, and other vehicles moving.

- Jet Fuel: This specialized fuel is imported to keep the skies busy, supplying airplanes for both international and domestic flights, connecting Cambodia to the world.
- Diesel: A workhorse of the economy, diesel is imported for a variety of critical sectors. It fuels everything from the power and industrial sectors to road transportation and agriculture, making it an essential part of the country's economic engine.
- Black Oil: Imported to fuel heavy-duty operations, black oil is a key energy source for the power and industrial sectors.
- Lubricant: Like gasoline, lubricants are imported for a single purpose: to keep the machinery of the road transportation sector running smoothly and efficiently.
- LPG (Liquefied Petroleum Gas): This versatile gas serves multiple needs, providing energy for the commercial and residential sectors as well as for some road transportation.
- Kerosene: Primarily used for a single purpose, kerosene is imported to meet the energy needs of the residential sector.

(c) Electricity consumption in Cambodia

Electricity in Cambodia is supplied by both imports from neighboring countries (Thailand, Vietnam, and Laos) and domestic generation. The graph below illustrates the history of electricity consumption in Cambodia from 2003 to 2024, combining data from the annual reports of the Electricity Authority of Cambodia (EAC) from 2003 to 2023 and the 'Salient Features of Power Development in the Kingdom of Cambodia' report for 2019 to 2024.

The demand for electrical energy in Cambodia has shown annual increase since 2003. The annual growth rate of electricity consumption tells a story of economic dynamism punctuated by significant external shocks. Cambodia experienced periods of exceptionally high growth, hitting a peak of 27% in 2007 and registering strong surges of 24% in 2012 and again in 2015, and 21% in 2018 and 2019. During the period from 2010 to 2013, the domestic supply of electricity was limited, necessitating that more than 50% of the country's demand be met by imports from neighboring countries. The subsequent increase in domestic generation from 2014 to 2024 has been significant, rising to approximately 18 thousand GWh.

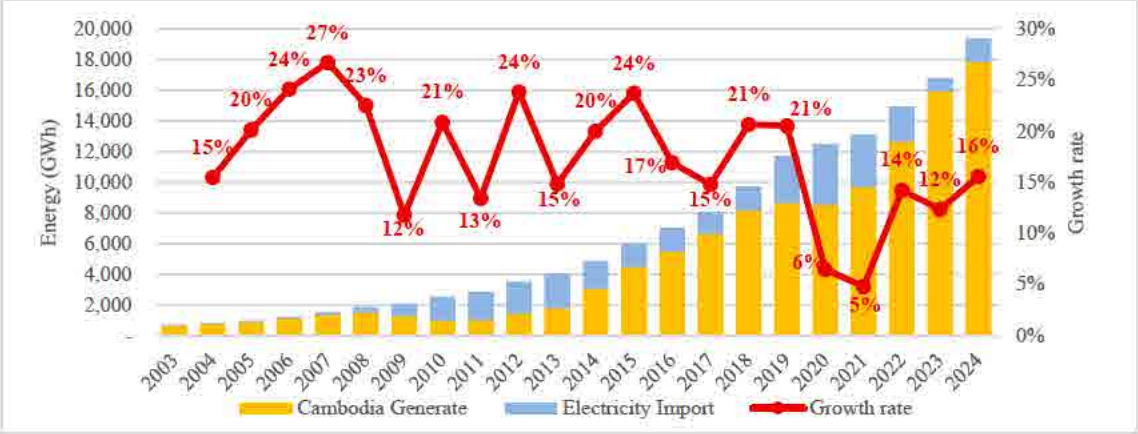


Figure 3-90 Electricity energy consumption in Cambodia

According to Annual report of Electricity Authority of Cambodia (EAC), Cambodia generates electricity from various sources, including coal, hydropower, solar power, diesel/Black-oil, biomass, and steam (by burning HFO).

In 2003, Cambodia primarily had three electricity generation sources: hydro-power, steam (burning HFO), and diesel/black-oil. In 2006, Cambodia phased out electricity generation from steam (burning HFO), focusing instead on biomass, diesel/black-oil, and hydro-power. In 2008, Cambodia began generating electricity from coal. By 2017, solar power generation was started. Currently, Cambodia generates electricity from five main types of sources: hydropower, diesel/heavy fuel oil, biomass, coal, and solar power. In 2023, the total installed electricity capacity reached 3,873 MW, with the following breakdown by generated electricity: Coal: 8,895 GWh, Hydro-power: 7,912 GWh, Solar Power: 1,072 GWh, Diesel/Black-oil: 495 GWh, Biomass: 77 GWh.

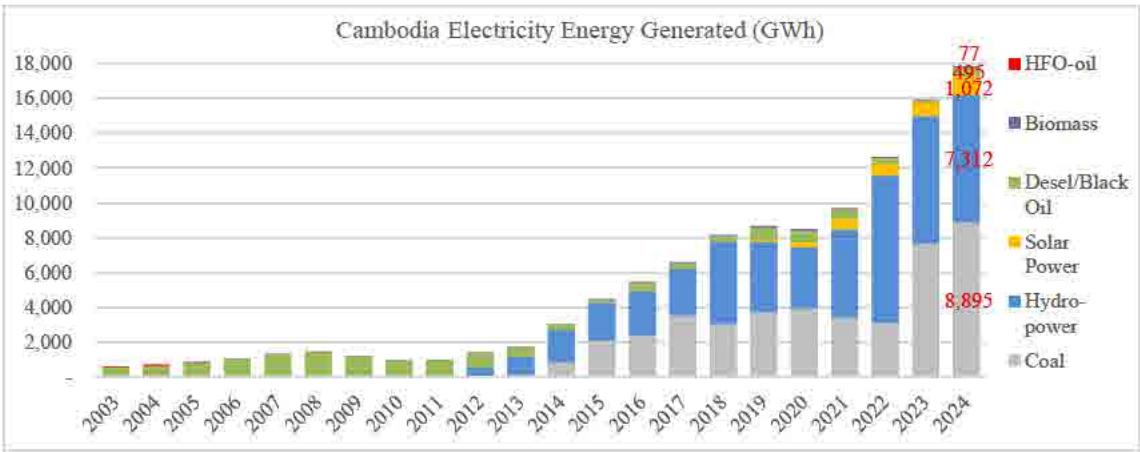


Figure 3-91 Cambodia electricity energy generated

(2) Future projection of energy resources imports

The energy resource demand forecasting is related to electricity energy so before the forecasting for energy resource is needed to forecast for electricity energy first. Especial coal is needed to combine of two demand forecasting: one is forecasting cement produces in Cambodia and convert the volume of cement to define coal required for cement factory, and the other is forecasting coal using electricity energy generate from coal-fired power plants.

(a) Demand forecasting of electricity energy

Ministry of mine and energy has public a document "Power Development Masterplan 2022 to 2040" inside of this document already forecasted the electricity energy up to 2040. But the expert team is targeting forecasting to 2050, so expert team is continues forecasting from 2040 to 2050. The expert team assumed there is close correlation between growth rate of demand of electricity energy consumption and GDP. To estimation the growth between the demand of electricity energy consumption and GDP, the expert team sampled data from 2011 to 2019 that can eliminate the COVID 19 economic disruption period. The historical data on electricity energy consumption and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

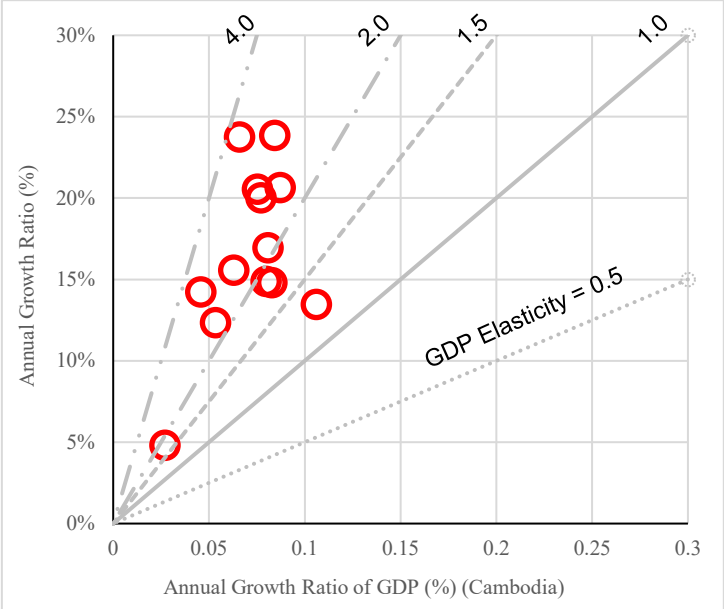


Figure 3-92 Elasticity between electricity energy consumption with real GDP

The electricity consumption-GDP elasticity is defined as the ratio of the annual growth rate of electricity consumption to the annual growth rate of GDP. Despite wide variations in the distribution, the expert team has assumed an electricity consumption-GDP elasticity of 2.0 to predict future electricity demand. The graph below illustrates the results of this demand forecast for electricity consumption from 2011 to 2050. With electricity consumption at 19,419 GWh in

2024, the Ministry of Mines and Energy has already forecasted consumption to reach 60,274 GWh for the Base Case and 67,473 GWh for the High Case by 2040. The expert team's forecast extends from 2040 to 2050, with projected results of 97,262 GWh for the Base Case and 114,920 GWh for the High Case.

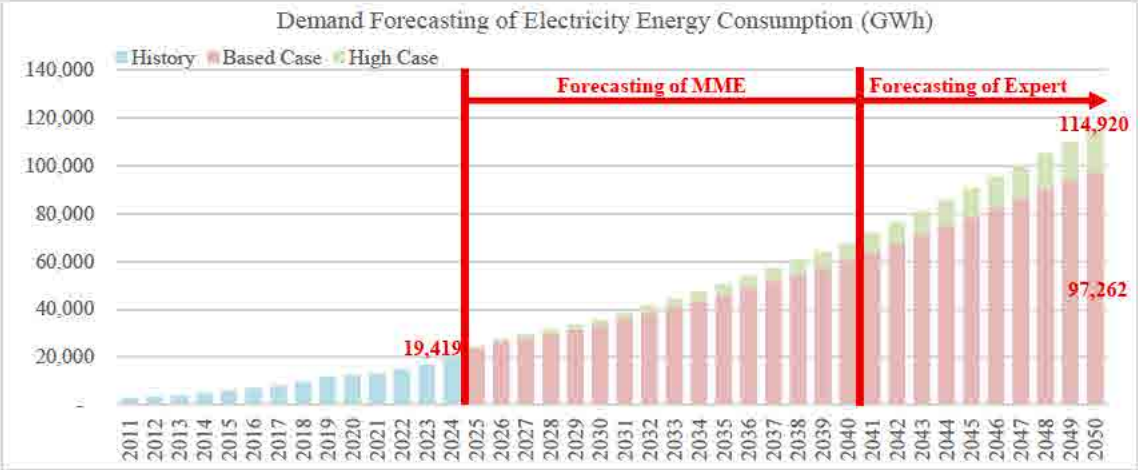


Figure 3-93 Demand forecast of electricity energy consumption

The Ministry of Mines and Energy also forecasted the installed capacity for 2040 under various scenarios:

Scenario 1: The moderate-growth scenario, with the development of coal-fired power plants in the Lao PDR being postponed.

Scenario 2: The moderate-growth scenario, with the development of coal-fired power plants in the Lao PDR fail.

Scenario 3: The high-growth scenario, with the development of coal-fired power plants in Lao PDR being postponed.

The projected installed capacity in 2040 is 30,345 MW for Scenario 1, 31,645 MW for Scenario 2, and 32,145 MW for Scenario 3.

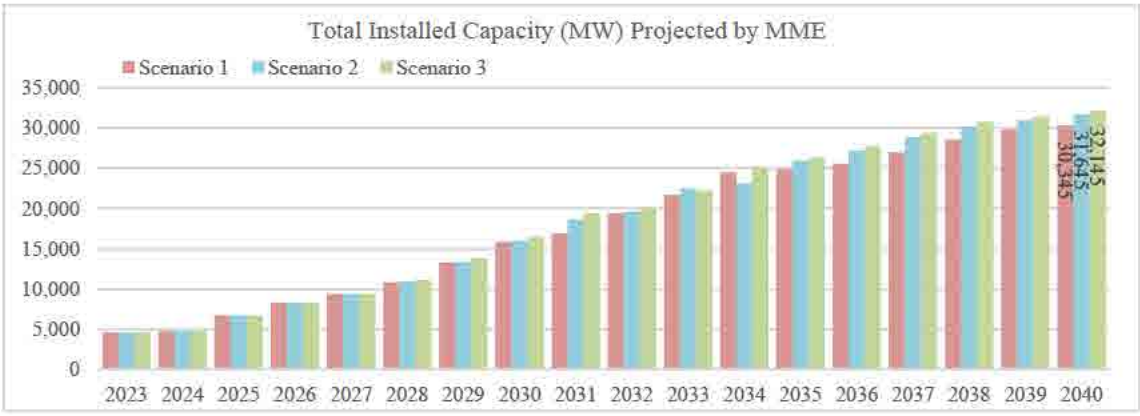


Figure 3-94 Total installed capacity projection by MME

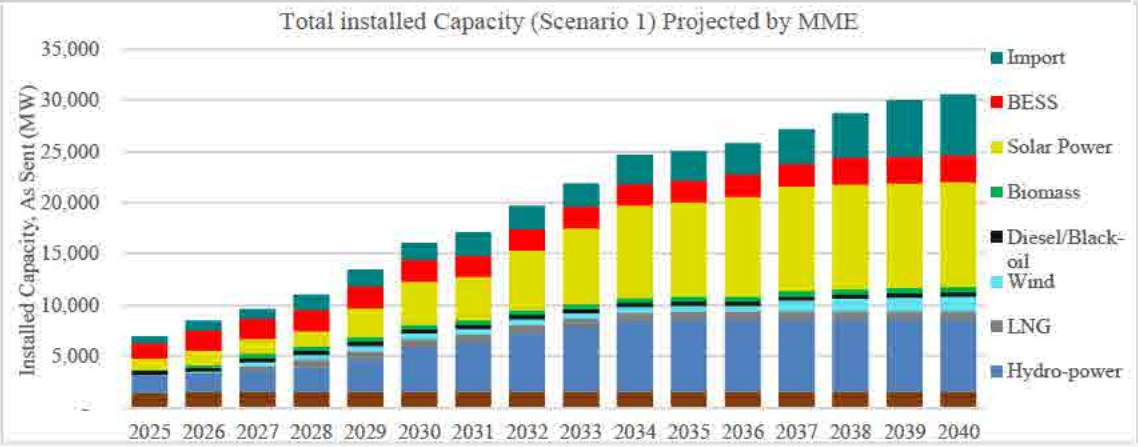


Figure 3-95 Total installed capacity (Scenario 1) projected by MME

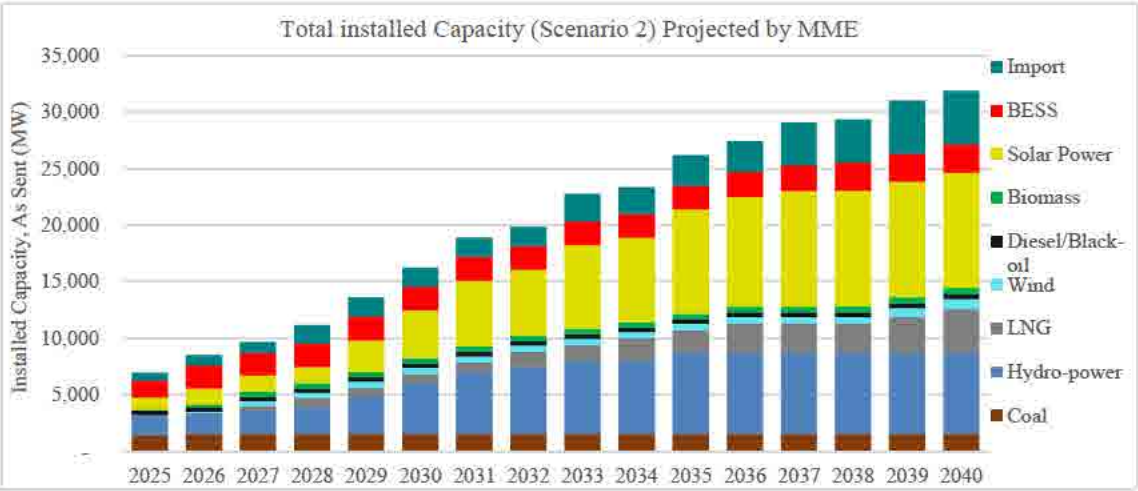


Figure 3-96 Total installed capacity (Scenario 2) projected by MME

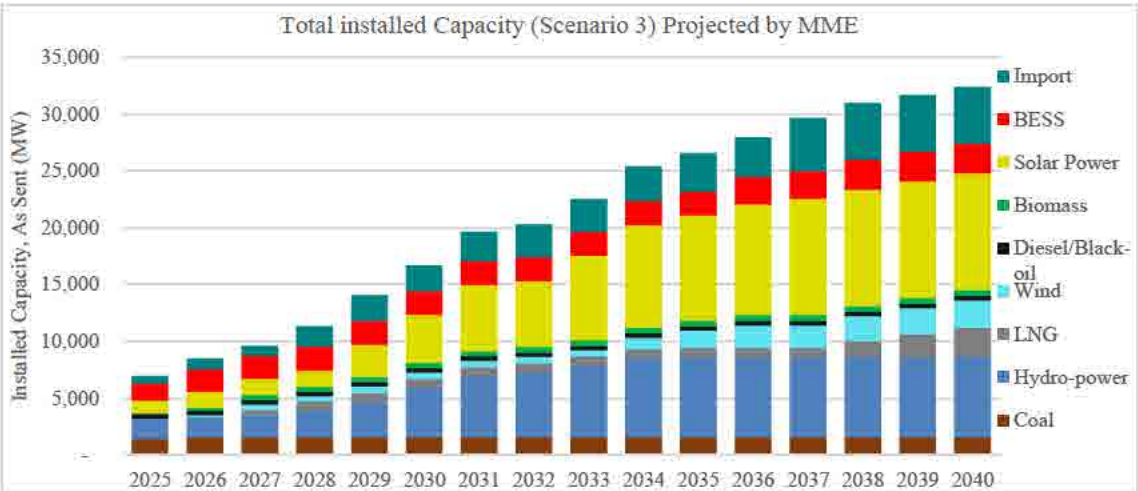


Figure 3-97 Total installed capacity (Scenario 3) projected by MME

The graph below displays the total energy generation (GWh) for Scenarios 1, 2, and 3 in 2040.
Scenario 1: 85,338 GWh
Scenario 2: 88,506 GWh
Scenario 3: 94,799 GWh
When comparing these 2040 energy generation figures with the projected electricity consumption in 2050 (for both Base and High Cases), the following differences are observed (where 2050 consumption exceeds 2040 generation):
For Scenario 1 (2040 Generation: 85,338 GWh):

- Compared to the Base Case in 2050, electricity consumption is 11,924 GWh higher.
- Compared to the High Case in 2050, electricity consumption is 29,582 GWh higher.

For Scenario 2 (2040 Generation: 88,506 GWh):

- Compared to the Base Case in 2050, electricity consumption is 8,756 GWh higher.
- Compared to the High Case in 2050, electricity consumption is 26,414 GWh higher.

For Scenario 3 (2040 Generation: 94,799 GWh):

- Compared to the Base Case in 2050, electricity consumption is 2,463 GWh higher.
- Compared to the High Case in 2050, electricity consumption is 20,121 GWh higher.

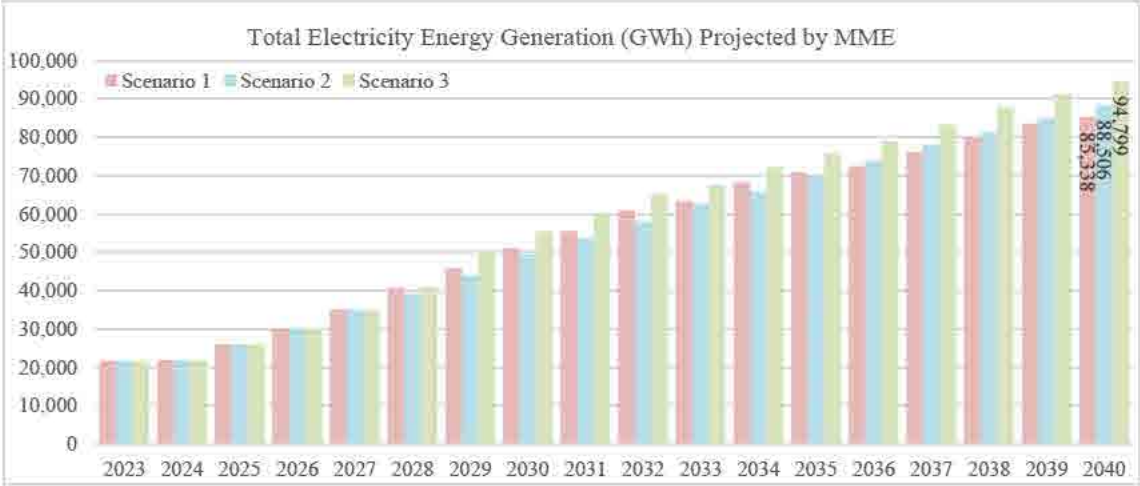


Figure 3-98 Total electricity energy generation projected by MME

According to the Ministry of Mines and Energy (MME), no new coal-fired power plants are planned for development in Cambodia. Existing coal-fired power plants are in Sihanoukville and Oddar Meanchey provinces. Based on the Power Development Masterplan 2022-2040, Cambodia generated 1,300 MW of electricity from coal in 2023. To generate this amount, Cambodia imported 3.3 million tons of coal. The MME projects that coal-fired power generation will increase to 1,565 MW in the near future and stop allow to process more Coal-fired power plant. To achieve this, Cambodia is expected to import approximately 4.7 million tons of coal.

Cambodia began generating electricity using Fuel Oil in 2019. Currently, Fuel Oil power plants

generate 490 MW of electricity by the statistics data of MME in 2021 is used only Black Oil 117 thousand ton to generated to electricity by this the expert team assume Black Oil 117 thousand ton for generated 490 MW. Based on existing policies, the figures will likely remain at the same level in 2050.

Table 3-46 Coal and Fuel oil consumption in 2050

Energy Product	Unit	2023	Future 2040	Future 2050
Coal	Generate Electricity (MW)	1,300	1,565	1,565
	Resource ('000 Tons)	3,320	4,750	4,750
Fuel Oil (Diesel/Black oil)	Generate Electricity (MW)	490	490	490
	Resource ('000 Tons)	117	117	117

(b) Demand forecasting of coal resource

The graph below illustrates the future consumption of coal. Coal is not used solely by power plants; it is also required for the industrial sector. Coal for industry is converted from forecasting of cement produces and Coal for power plant is converted from electricity capacity.
Based on demand forecast of expert team, coal for power plants is projected to require 4.7 million tons annually from 2026 to 2050. For the industrial sector, coal demand is forecasted at 1.5 million tons in 2026, increasing to 3.2 million tons by 2050.

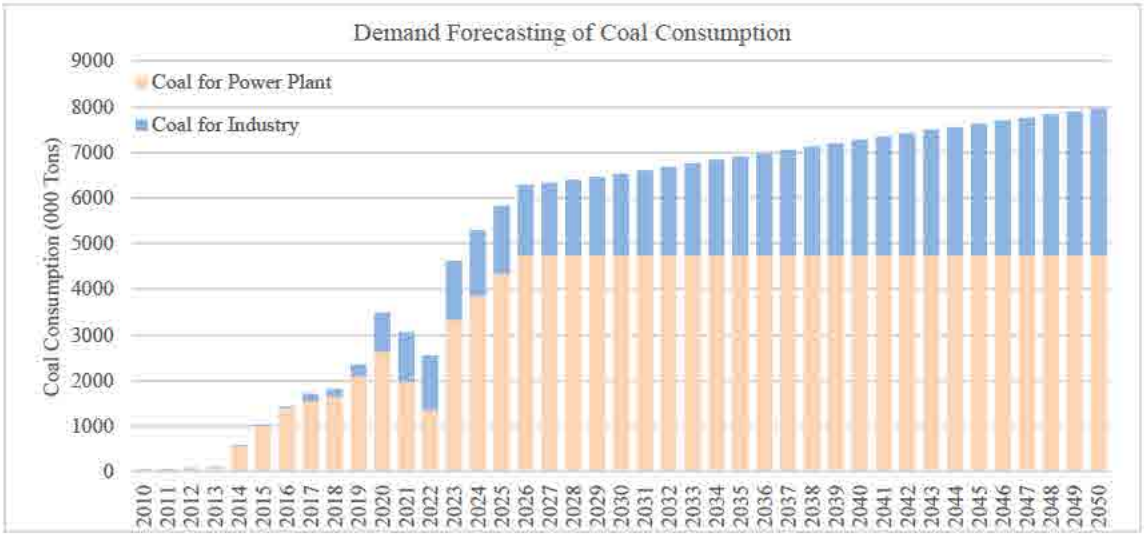


Figure 3-99 Demand forecasting of coal consumption

(c) Demand forecasting of gasoline

Gasoline is imported from foreign countries to serve the transportation sector in Cambodia. Gasoline demand remained relatively stable between 2011 and 2013 at approximately 390 thousand tons before increasing annually. Demand peaked at 725 thousand tons in 2019 but

subsequently decreased in 2020 and 2021, which may be attributed to the impact of the COVID-19 pandemic.

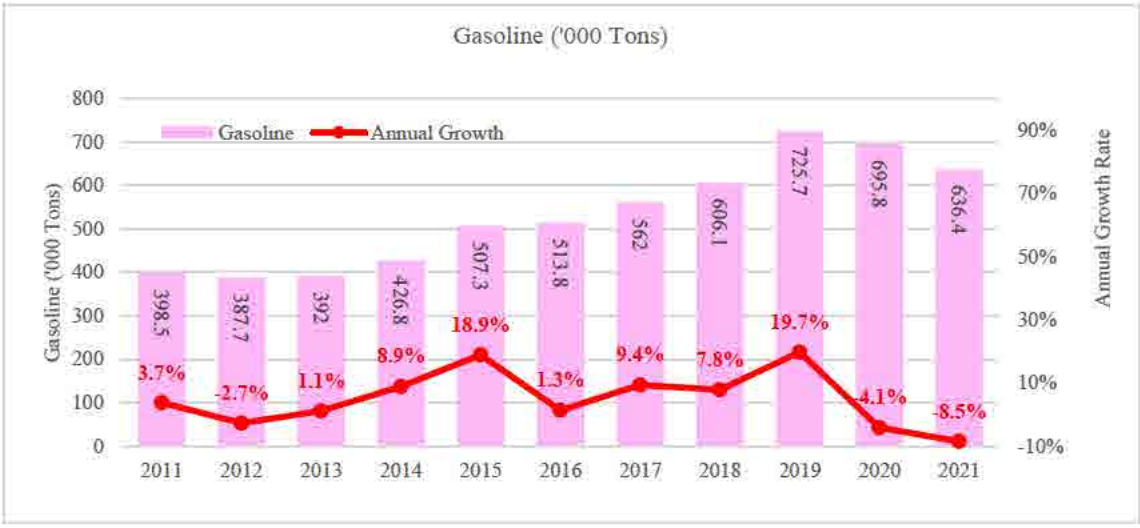


Figure 3-100 History of gasoline consumption in Cambodia

The expert team utilized historical data from 2011 to 2021 to conduct a demand forecast extending to 2050. In this analysis, the experts assumed a strong correlation between gasoline demand and the real GDP growth rate. To mitigate the impact of the economic disruption from COVID-19, the team used a data sample from the period of 2011 to 2019. The historical data on Gasoline consumption and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

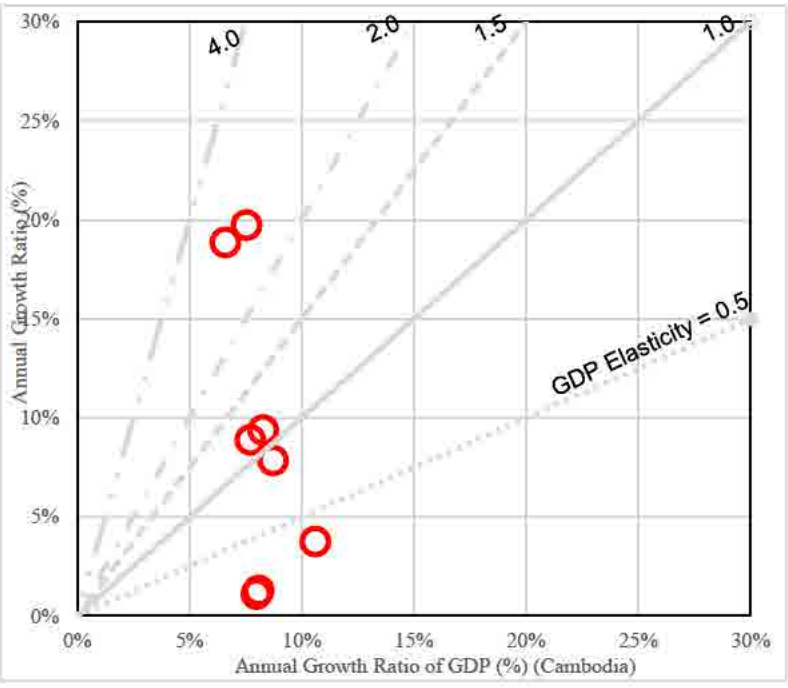


Figure 3-101 Elasticity between gasoline consumption with real GDP

The gasoline consumption-GDP elasticity is defined as the ratio of the annual growth rate of gasoline consumption to the annual growth rate of GDP. Despite wide variations in the distribution, the expert team has assumed an electricity consumption-GDP elasticity of 1.0 to predict future electricity demand. The graph below illustrates the results of this demand forecast for gasoline consumption from 2011 to 2050. The import volume of gasoline has steadily increased. The expert team apply the Gasoline-GDP elasticity to the future demand forecast of gasoline import. The import gasoline will increase from 636 thousand ton in 2021 to 2.7 million ton in 2050. Gasoline is transported by tankers.

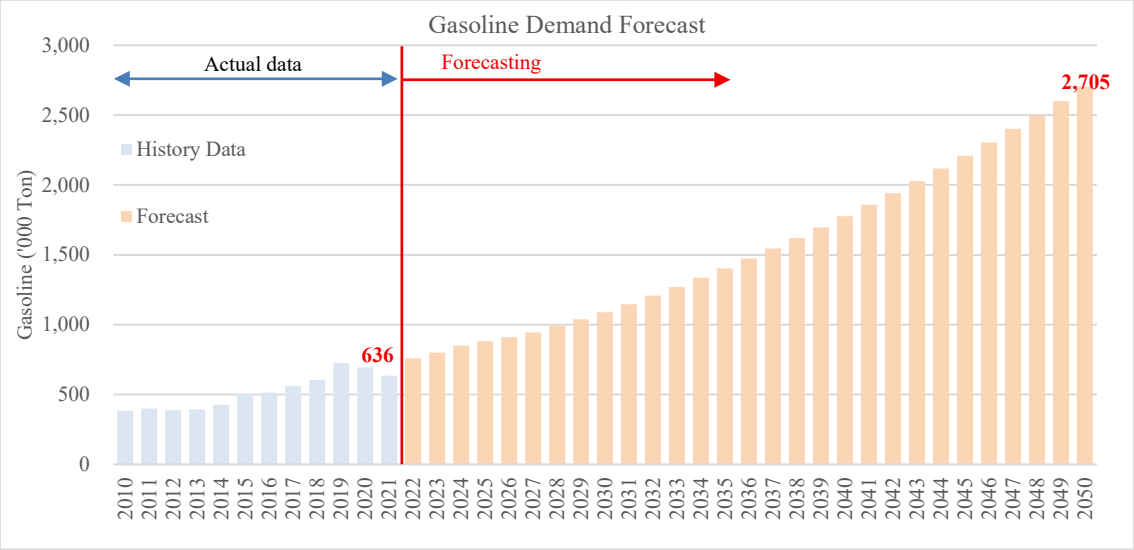


Figure 3-102 Demand forecasting of gasoline

(d) Demand forecasting of liquefied natural gas (LNG)

While LNG is not currently a requirement in Cambodia, its consumption is projected to begin in the future for electricity generation at Combined Cycle Gas Turbine (CCGT) Power Plants. The first CCGT plant is slated to begin generating electricity in the near term and will be located on the southwestern coast in Koh Kong Province. The Power Development Master Plan 2022-2040 report indicates that LNG-based electricity generation will commence in 2027 with an initial installed capacity of 300 MW, which will expand to 1,200 MW by 2037. Furthermore, a report from the Agency for Natural Resources and Energy on the cost of nuclear power notes that a natural gas power plant with a 1,000 MW capacity requires an annual supply of 950,000 tons of LNG to operate[88].

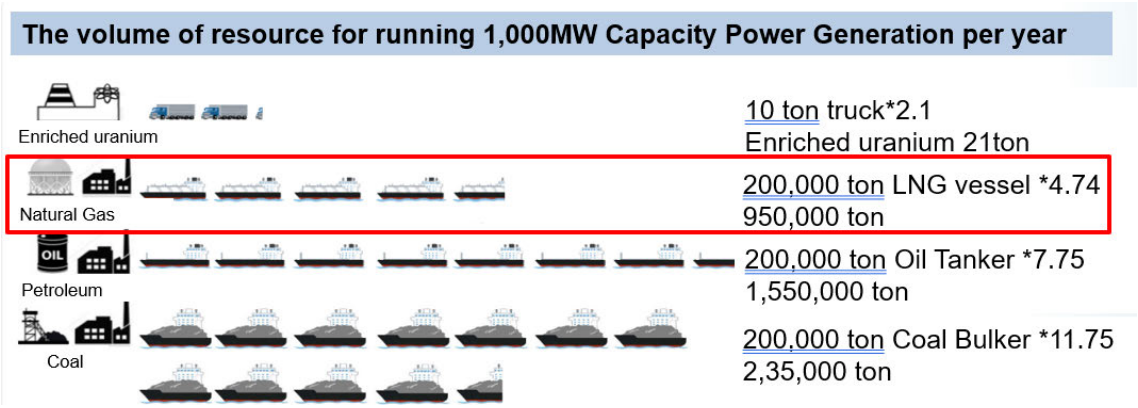


Figure 3-103 The volume of resource for running 1,000 MW capacity power generation[88]

LNG power plants are designed for high utilization and can theoretically run at a very high percentage, around 90%, of their installed capacity. Based on the Ministry of Mines and Energy's (MME) installed capacity planning for 2040, Scenario 1 projects 800 MW, Scenario 2 projects 3,800 MW, and Scenario 3 projects 2,600 MW. However, this installed capacity planning for 2040 will result in a deficit for 2050. If this entire deficit were to be met by LNG power plants, the total installed capacity would need to increase to:

Scenario 1: 4,552 MW

Scenario 2: 7,150 MW

Scenario 3: 5,152 MW

Consequently, the projected LNG consumption for power plants in 2050 would be:

Scenario 1: 4.3 million tons

Scenario 2: 6.7 million tons

Scenario 3: 4.8 million tons

Table 3-47 The installed capacity of CCGT power plant and LNG consumption

CCGT power plant	Installed capacity (MW)			LNG consumption (Tons)		
Year	2027	2040	2050	2027	2040	2050
Scenario 1	400	800	4,552	380,000	760,000	4,324,548
Scenario 2	400	3,800	7,150	380,000	3,610,000	6,792,813
Scenario 3	400	2,600	5,152	380,000	2,470,000	4,894,524

(e) Demand forecasting jet fuel

Jet fuel is imported to supply both international and domestic flights, which connect Cambodia to the world. The graph below illustrates the history of jet fuel consumption in Cambodia from 2011 to 2021. With an initial demand of 54.6 thousand tons in 2011, jet fuel consumption experienced a steady increase, peaking at 224 thousand tons in 2019. The subsequent sharp decline in 2020 and 2021 is likely attributable to the impact of the COVID-19 pandemic.

[88] Agency for natural resource and energy in topic Considering the cost of nuclear power

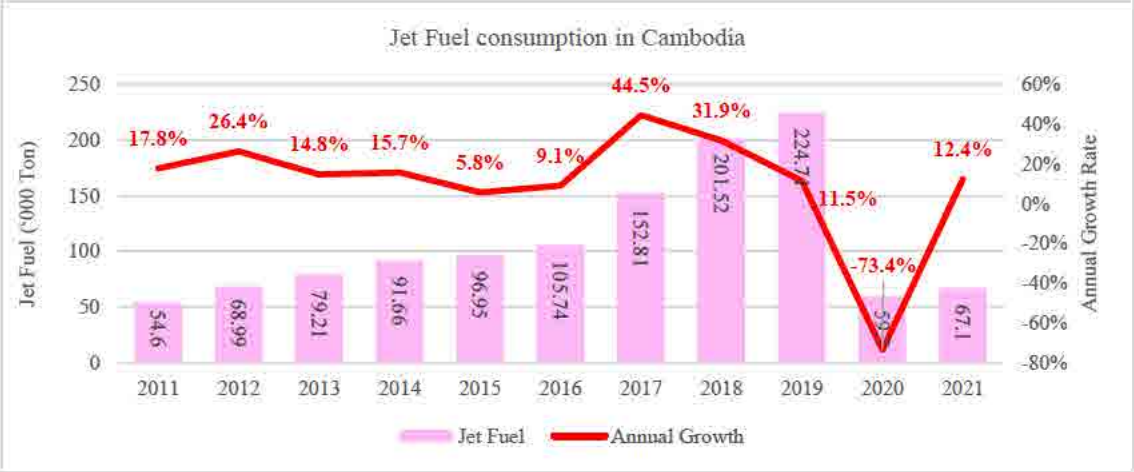


Figure 3-104 History of jet fuel consumption in Cambodia

The expert team utilized historical data from 2011 to 2021 to conduct a demand forecast extending to 2050. In this analysis, the experts assumed a strong correlation between jet fuel demand and the real GDP growth rate. To mitigate the impact of the economic disruption from COVID-19, the team used a data sample from the period of 2011 to 2019. The historical data on jet fuel consumption and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

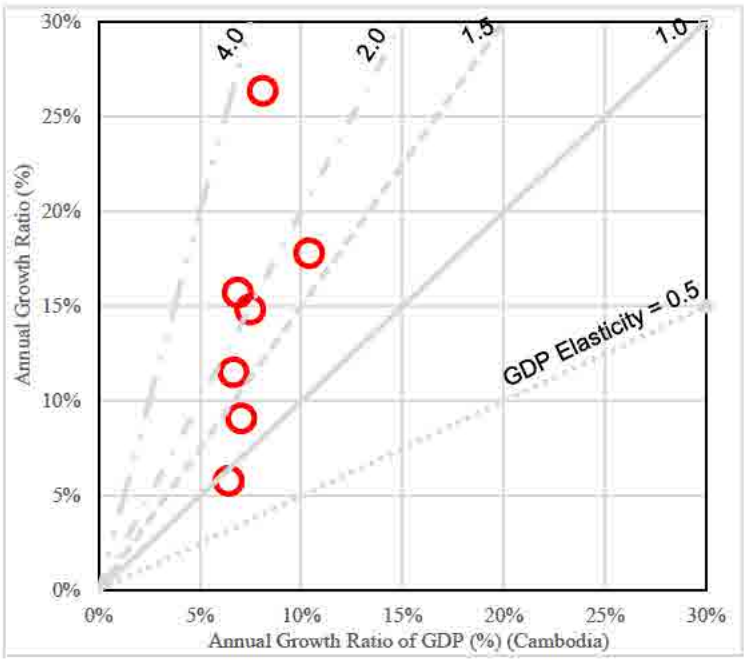


Figure 3-105 Elasticity between jet fuel consumption with real GDP

The jet fuel consumption-GDP elasticity is defined as the ratio of the annual growth rate of jet fuel consumption to the annual growth rate of GDP. Despite wide variations in the distribution, the expert team has assumed an jet fuel consumption-GDP elasticity of 2.0 to predict future

electricity demand. The graph below illustrates the results of this demand forecast for jet fuel consumption from 2011 to 2050. The import volume of jet fuel has steadily increased. The expert team apply the jet fuel-GDP elasticity to the future demand forecast of jet fuel import. The import jet fuel will increase from 67 thousand ton in 2021 to 2.9 million ton in 2050. Jet fuel is transported by tankers.

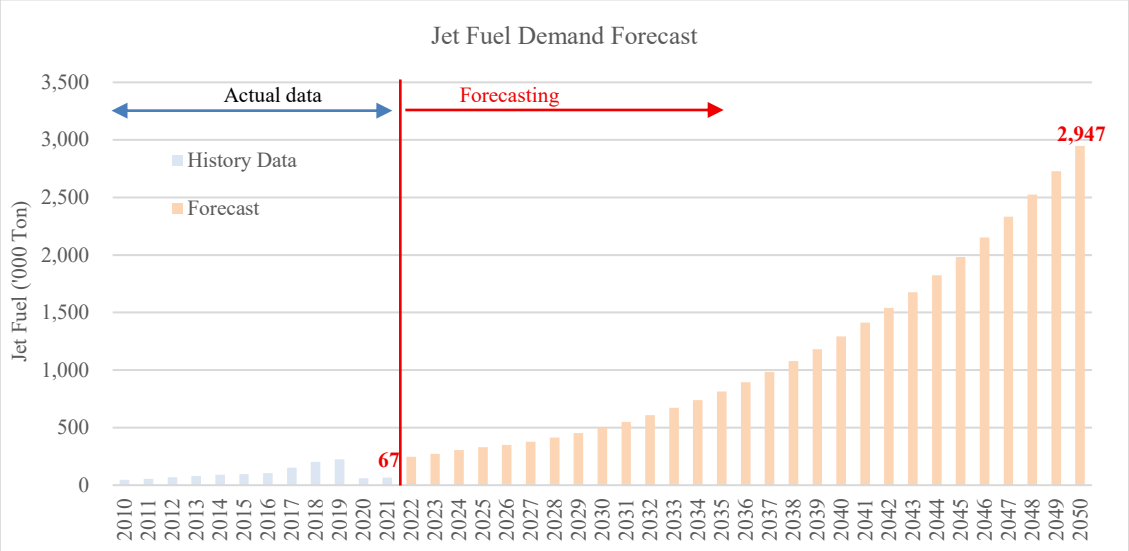


Figure 3-106 Demand forecasting of jet fuel

(f) Demand forecasting of liquefied petroleum gas (LPG)

Liquefied petroleum gas (LPG) is imported into Cambodia to provide energy for the commercial, residential, and transportation sectors. The graph below illustrates the history of LPG consumption in Cambodia from 2011 to 2021. Beginning with an initial demand of 71.9 thousand tons in 2011, LPG consumption experienced a steady increase, peaking at 340 thousand tons in 2019. The slight decline in LPG consumption during 2020 and 2021 was likely caused by the COVID-19 pandemic. During the pandemic, the commercial and transportation sectors were significantly impacted, while the demand from the residential sector increased. As people stayed and worked from their homes during lockdowns, their energy consumption patterns shifted, slightly reducing overall LPG demand.

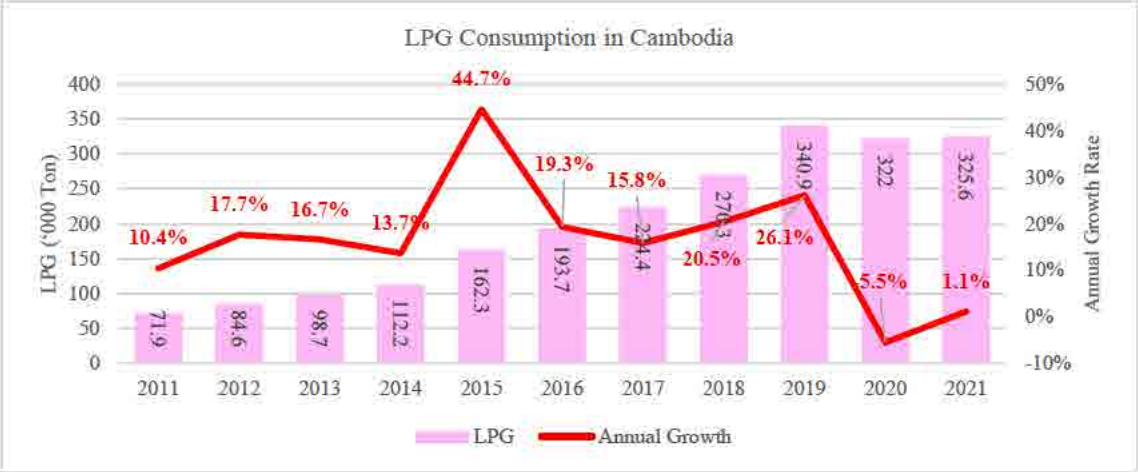


Figure 3-107 history of LPG consumption in Cambodia

The expert team utilized historical data from 2011 to 2021 to conduct a demand forecast extending to 2050. In this analysis, the experts assumed a strong correlation between LPG demand and the real GDP growth rate. To mitigate the impact of the economic disruption from COVID-19, the team used a data sample from the period of 2011 to 2019. The historical data on LPG consumption and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

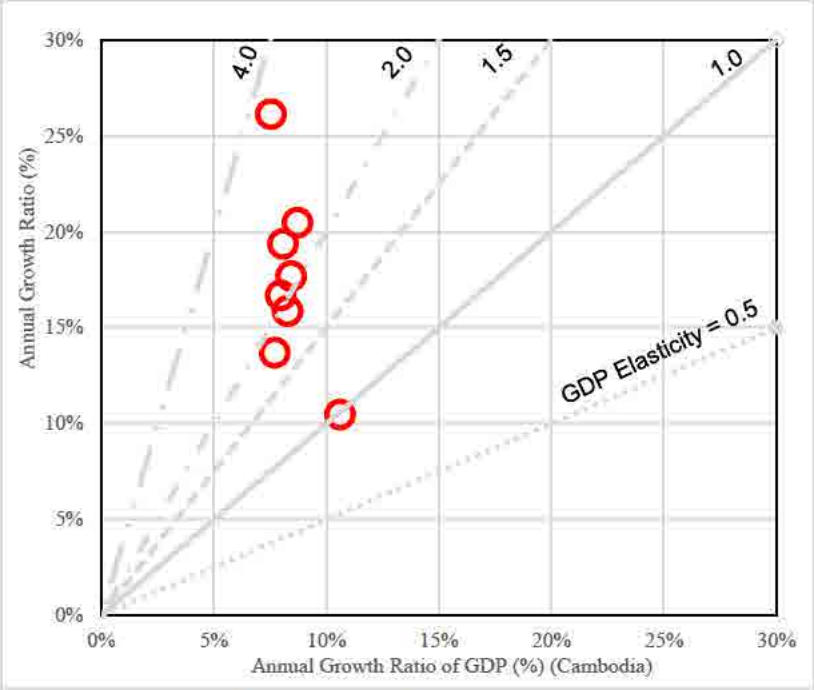


Figure 3-108 Elasticity between LPG consumption with real GDP

The LPG consumption-GDP elasticity is defined as the ratio of the annual growth rate of LPG consumption to the annual growth rate of GDP. Despite wide variations in the distribution, the

expert team has assumed an LPG consumption-GDP elasticity of 2.0 to predict future electricity demand.

The graph below illustrates the results of this demand forecast for LPG consumption from 2011 to 2050. The import volume of LPG has steadily increased. The expert team apply the LPG-GDP elasticity to the future demand forecast of LPG import. The import LPG will increase from 326 thousand ton in 2021 to 4.4 million ton in 2050. LPG is transported by tankers.

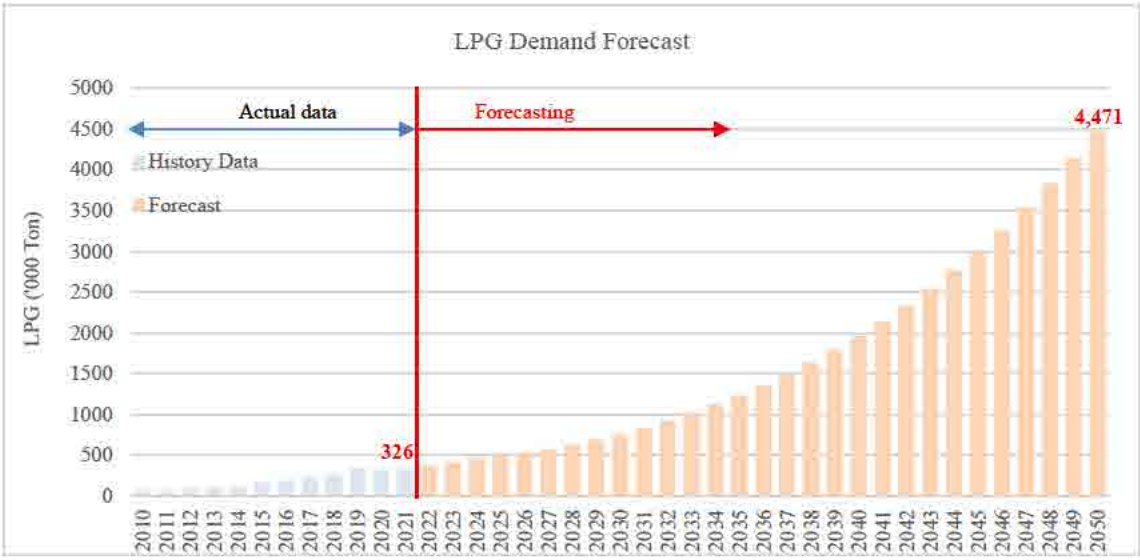


Figure 3-109 Demand forecasting of LPG

(g) Demand forecasting of Diesel

Diesel is a critical component in supporting Cambodia's economy, imported to fuel a variety of vital sectors. It powers everything from the industrial and energy sectors to road transportation and agriculture, making it an essential part of the country's economic engine. Following a period of steady growth, diesel consumption in Cambodia rose from 663 thousand tons in 2011 to 1.5 million tons by 2019.

Surprisingly, even during the COVID-19 pandemic in 2020 and 2021, demand for diesel continued to increase, reaching nearly 1.8 million tons. This sustained growth can be attributed to a significant shift in consumer behavior. With people working and staying at home during lockdowns, new business models—particularly food delivery services—became widely popular. This new habit of ordering food via mobile applications created a high and sustained demand for diesel to power the logistics and transportation required to deliver goods to customers, offsetting potential declines from other sectors.

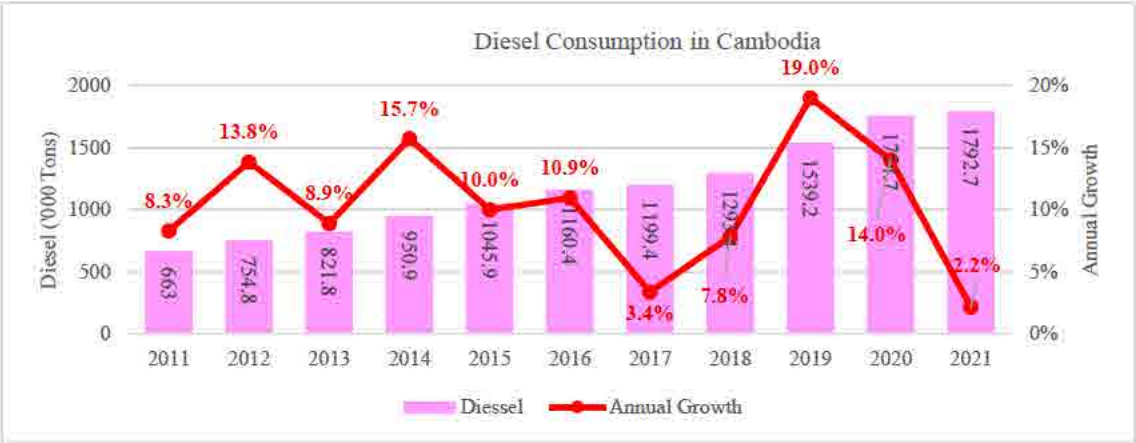


Figure 3-110 History of diesel consumption in Cambodia

The expert team utilized historical data from 2011 to 2021 to conduct a demand forecast extending to 2050. In this analysis, the experts assumed a strong correlation between diesel demand and the real GDP growth rate. To mitigate the impact of the economic disruption from COVID-19, the team used a data sample from the period of 2011 to 2019. The historical data on diesel consumption and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

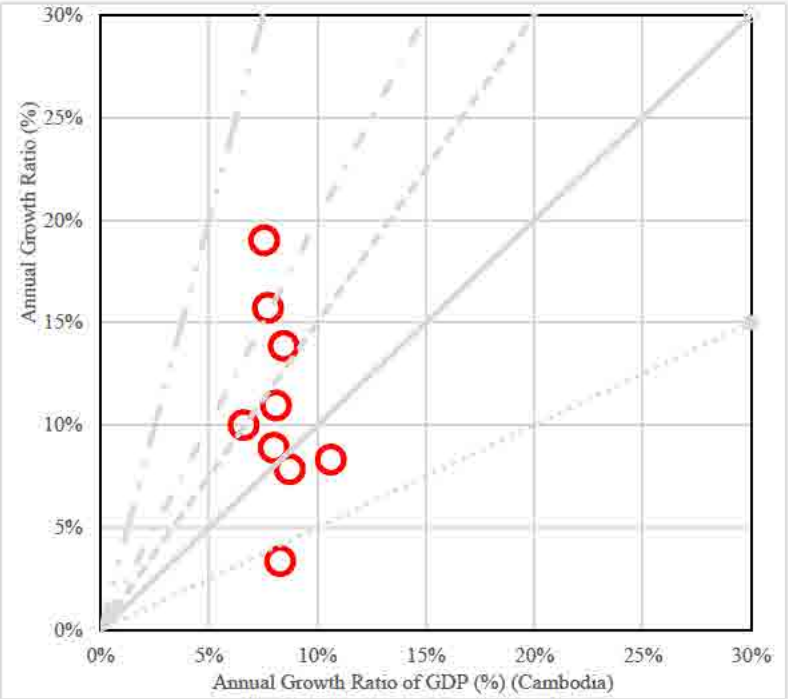


Figure 3-111 Elasticity between diesel consumption with real GDP

The diesel consumption-GDP elasticity is a key metric defined as the ratio of the annual growth

rate of diesel consumption to the annual growth rate of GDP. This elasticity helps forecast future energy demand as a country's economy grows.

To predict future diesel demand, an expert team has assumed a diesel consumption-GDP elasticity of 1.0. This assumption is based on the expectation that Cambodia's efforts to promote electric vehicles (EVs) will mitigate the direct link between economic expansion and diesel use. While historical data might suggest a higher elasticity (e.g., 1.5 or 2.0), the government's policy to encourage electric transportation is expected to keep this ratio at a more moderate level.

Based on this forecast, diesel imports are projected to increase from 1.8 million tons in 2021 to 5.7 million tons in 2050. This significant growth indicates that despite the push for EVs, the overall demand for diesel—driven by sectors like industry, agriculture, and transportation—will continue to rise as the Cambodian economy expands. The majority of this imported diesel is transported by tankers.

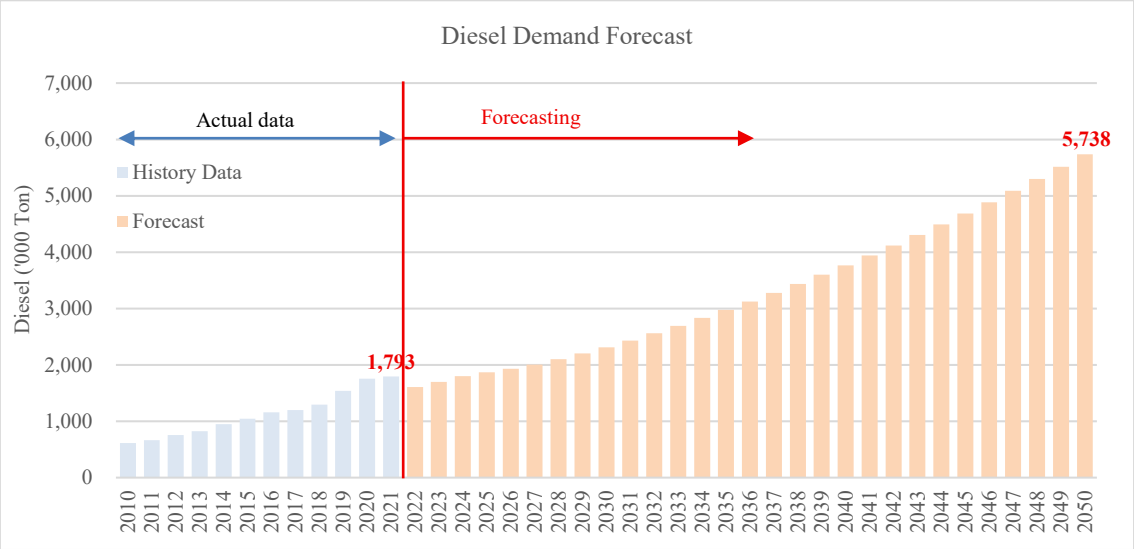


Figure 3-112 Demand forecasting of diesel

(h) Demand forecasting of Lubricant

Lubricant imports to Cambodia serve the primary purpose of keeping machinery, particularly within the road transportation sector, operating smoothly. The history of lubricant consumption in Cambodia shows significant year-to-year fluctuations.

In 2011, demand was 17.6 thousand tons, increasing to 18 thousand tons in 2012 and 18.8 thousand tons in 2013. However, in 2014, lubricant demand saw a sharp decline of 37.8% before rebounding in 2015 and 2016. Demand peaked in 2016 at 25.1 thousand tons and then dropped by 51.8% in 2017. From 2018 to 2021, consumption fluctuated within a narrower range, staying

between 11 and 14 thousand tons.

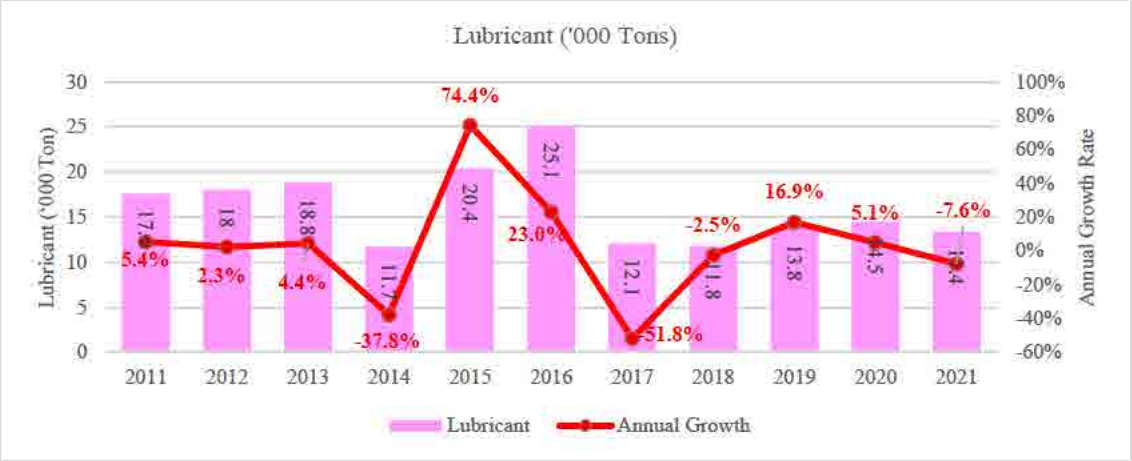


Figure 3-113 History of lubricant consumption in Cambodia

The expert team utilized historical data from 2011 to 2021 to conduct a demand forecast extending to 2050. In this analysis, the experts assumed a strong correlation between lubricant demand and the real GDP growth rate. To mitigate the impact of the economic disruption from COVID-19, the team used a data sample from the period of 2011 to 2019. The historical data on lubricant consumption and real GDP in Cambodia are crucial for forecasting methods. Based on the annual growth rates of both, an elasticity graph was created to illustrate relationship.

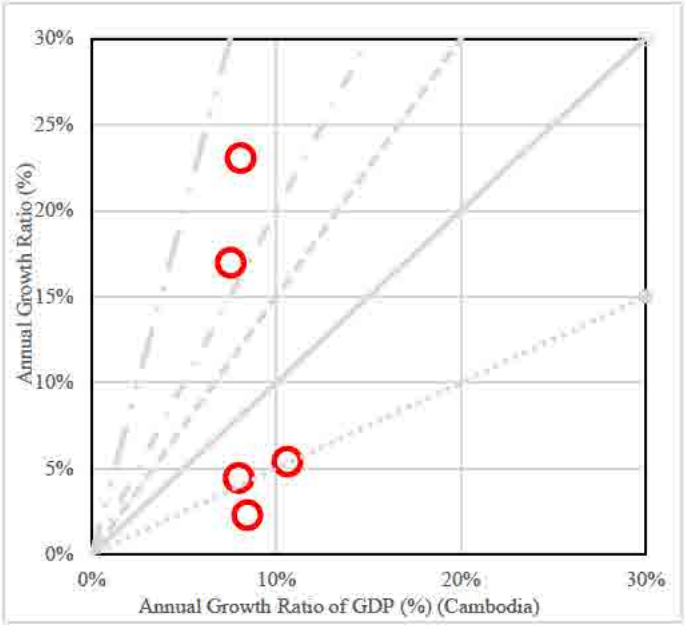


Figure 3-114 Elasticity between lubricant consumption with real GDP

The lubricant consumption-GDP elasticity is defined as the ratio of the annual growth rate of

lubricant consumption to the annual growth rate of GDP. Despite wide variations in the distribution, the expert team has assumed lubricant consumption-GDP elasticity of 0.5 to predict future electricity demand.

The graph below illustrates the results of this demand forecast for lubricant consumption from 2011 to 2050. The expert team apply the lubricant-GDP elasticity to the future demand forecast of lubricant import. The import lubricant will increase from 13 thousand tons in 2021 to 22 thousand tons in 2050.

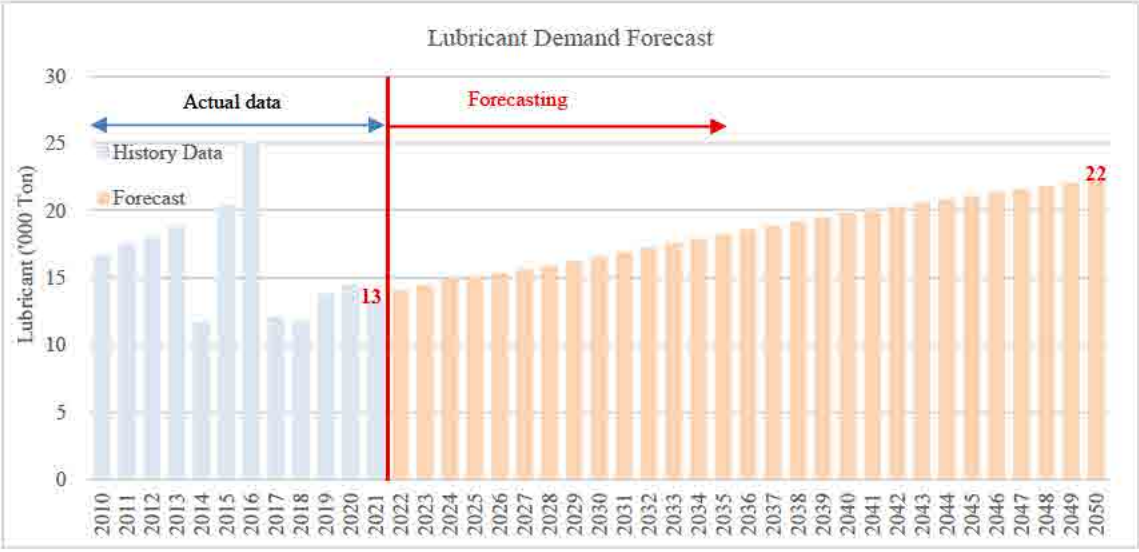


Figure 3-115 Demand forecasting of lubricant in Cambodia

(i) Demand forecasting of Black oil

Black oil is imported into Cambodia primarily to fuel heavy-duty operations in the power and industrial sectors. The historical demand for black oil has shown significant fluctuation, making it difficult to interpret without deeper analysis. According to Cambodia's National Energy Efficiency Policy (NEEP) 2022–2030, the government aims to reduce energy consumption to lower fossil fuel use and greenhouse gas emissions. This policy is a key part of Cambodia's commitment to the Paris Agreement and its efforts to combat environmental pollution.

Despite this policy, black oil will remain a crucial resource for international trade, particularly for ship operations. The upcoming Funan Techo Canal, a new inland waterway connecting Cambodia's capital with a seaport, is expected to increase demand for black oil to supply the ships that will use this new route.

Given the historical volatility of black oil consumption, an expert team has based its future projections on the country's real GDP growth. This approach assumes that black oil demand will

increase in tandem with overall economic expansion, projecting continued growth in its import volume of black oil.

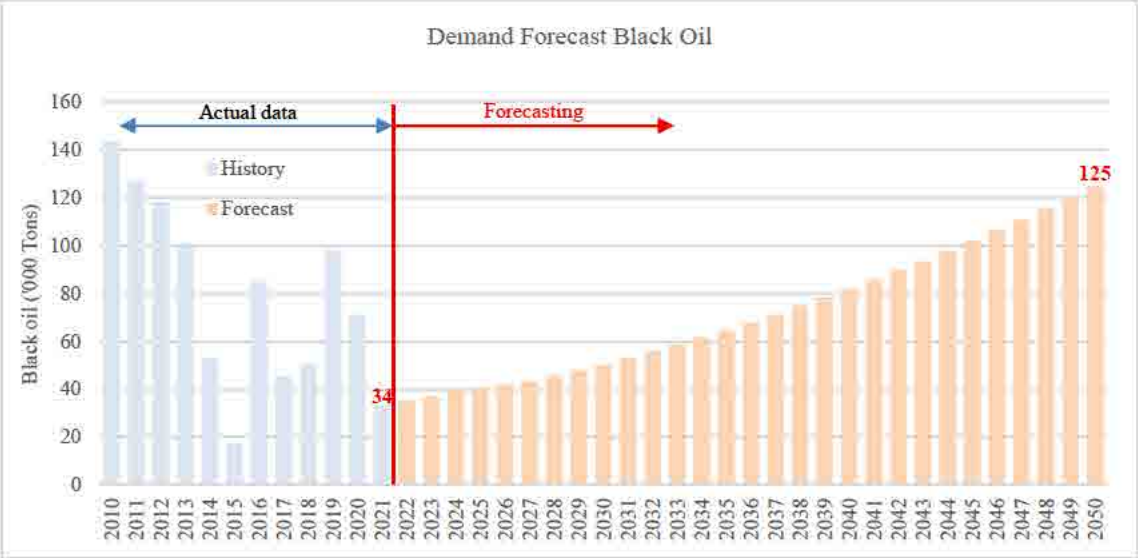


Figure 3-116 Demand forecasting of Black oil in Cambodia

(3) Allocating energy import by zone

The allocation method is crucial for distributing volume across Cambodia's zones. The expert team uses: (1) power plant locations, (2) regional GDP, (3) international airport locations, and (4) international vessel entry points. These are applied based on the consumption patterns of each item. The bottom table is the table of allocation method for each item.

Table 3-48 Allocation method of each energy resources

Energy Item	Allocation Method
Coal	Coal Power Plant location + cement Factory location
Fuel Oil	Fuel Oil Power Plant location
LNG	LNG Power Plant location (Future)
Gasoline	Regional GDP
LPG	Regional GDP
Diesel	Regional GDP
Lubricant	Regional GDP
Jet Fuel	International Airport location
Black Oil	International Vessel entry

Coal imports are essential for supplying cement production and coal-fired power plants in Cambodia. The volume of coal required is directly linked to the operational locations and capacities of these facilities.

Based on current capacity data, the expert team assumes that coal allocation for cement factories will be distributed according to the production share of each province: Kampot province (54.5%), Battambang province (27.3%), Kampong Speu province (18.2%). For power generation, coal is imported to support the existing coal-fired power plants, which, according to the Ministry of Mines and Energy, will not see new facilities constructed. Given that these plants are primarily located in Sihanoukville, the expert team assumes all coal for power plants will be imported through this port.

Similarly, the expert team assumes that fuel oil will be imported to Phnom Penh, as most of the city's fuel oil-burning power plants are located there. The first Combined Cycle Gas Turbine (CCGT) power plant, with a planned capacity of 900MW, is currently under construction in Koh Kong province. The expert team anticipates that future CCGT plants will also be built in this province. Confirm CCGT will processing will LNG resources.

Table 3-49 Allocation energy resources supply for power plant.

Province	Energy resource supply to Power Plant in future				
	Coal	Fuel Oil	LNG		
			Scenario 1	Scenario 2	Scenario 3
Preah Sihanouk	4,751				
Phnom Penh		117			
Koh Kong			4,325	6,793	4,895
Kampot	1,601				
Battambang	800				
Kampong Speu	800				

Jet fuel is imported to support air travel at Cambodia's three international airports and ten domestic airports. The international airports primarily cater to foreign tourists, while the domestic airports, which are not yet fully operational for commercial inter-provincial travel, are primarily used for airborne troop transport. Historically, domestic airports have consumed approximately 44% of the total jet fuel, with the remaining portion used by international airports. The expert team assumes that all jet fuel is stored at the international airports.

The allocation of jet fuel is determined by the locations of the international airports: Phnom Penh, Sihanoukville, and Siem Reap. It is important to note that the Phnom Penh international airport is being relocated to Kandal province and is scheduled to begin operations in September 2025. The volume of jet fuel allocated to each international airport will be based on the percentage of inbound tourism. According to statistics from the Ministry of Tourism, the distribution of inbound tourists is as follows: Phnom Penh (67%), Siem Reap (31%), and Preah Sihanouk (2%).

Table 3-50 Allocation of jet fuel consumption

Province	International Airport	Jet Fuel ('000 Tons)
Preah Sihanouk	1 (2%)	59
Siem Reap	1 (31%)	914
Kandal	1(67%)	1,974
Total	3 (100%)	2,947

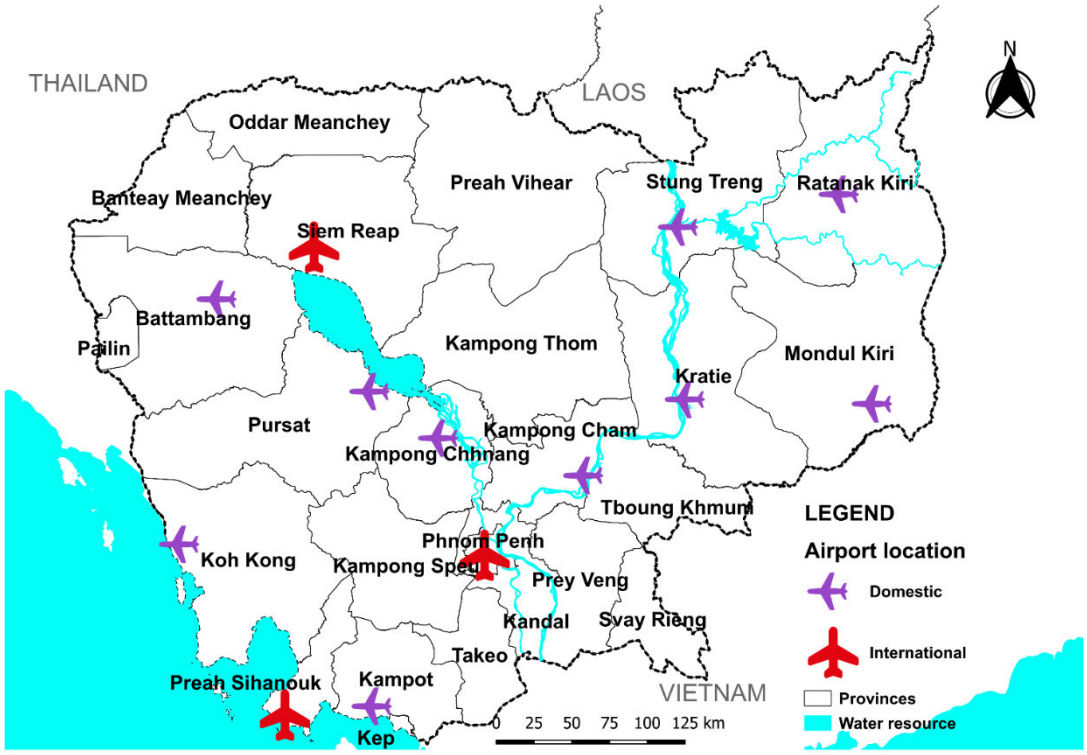


Figure 3-117 Airport location in Cambodia

Black oil without the power plant consumption it was consume a lot with internation vessel. That why expert team assume the black oil are import for using at ocean area in Preah Sihanouk that is the point province Cambodia export and import directly to the world market.

Table 3-51 Allocation energy resources of each province

Province	Energy resource ('000 Ton)									
	Coal	Fuel Oil	LNG	Gasoline	LPG	Diesel	Lubricant	Jet Fuel	Black oil	Total
Kampot	1,601	-	-	90	148	190	1	-	-	2,030
Kep	-	-	-	6	10	13	0	-	-	29
Koh Kong	-	-	1,140	25	41	52	0	-	-	1,258
Preah Sihanouk	4,751	-	-	107	176	226	1	59	125	5,445
Kampong Thom	-	-	-	78	129	166	1	-	-	373
Kratie	-	-	-	47	77	99	0	-	-	223
Mondul Kiri	-	-	-	17	28	36	0	-	-	82
Preah Vihear	-	-	-	30	50	65	0	-	-	146
Ratanak Kiri	-	-	-	32	53	68	0	-	-	154
Stung Treng	-	-	-	25	42	54	0	-	-	121
Banteay Meanchey	-	-	-	103	170	218	1	-	-	492
Battambang	800	-	-	124	205	263	1	-	-	1,393
Oddar Meanchey	-	-	-	29	49	62	0	-	-	141
Pailin	-	-	-	13	22	28	0	-	-	63
Pursat	-	-	-	61	102	130	1	-	-	294
Siem Reap	-	-	-	108	178	229	1	914	-	1,429
Kampong Chhnang	-	-	-	78	128	164	1	-	-	371
Kampong Speu	800	-	-	118	195	250	1	-	-	1,364
Takeo	-	-	-	107	177	227	1	-	-	513
Kampong Cham	-	-	-	110	181	233	1	-	-	524
Prey Veng	-	-	-	98	161	207	1	-	-	466
Svay Rieng	-	-	-	80	133	171	1	-	-	385
Tboung Khmum	-	-	-	87	144	185	1	-	-	417
Kandal	-	-	-	176	290	373	1	1,974	-	2,815
Phnom Penh	-	117	-	956	1,581	2,029	8	-	-	4,691
Total	7,952	117	1,140	2,705	4,471	5,738	22	2,947	125	25,217

Table 3-52 Allocation of energy resources import of each zone

Zone	Energy resource ('000 Ton)									
	Coal	Fuel Oil	LNG	Gasoline	LPG	Diesel	Lubricant	Jet Fuel	Black oil	Total
Zone 1	6,351	-	1,140	227	375	482	2	59	125	8,762
Zone 2	-	-	-	230	380	488	2	-	-	1,100
Zone 3	800	-	-	438	725	930	4	914	-	3,810
Zone 4	800	-	-	303	500	642	2	-	-	2,248
Zone 5	-	-	-	375	619	795	3	-	-	1,792
Zone 6	-	117	-	1,132	1,871	2,401	9	1,974	-	7,505
Total	7,952	117	1,140	2,705	4,471	5,738	22	2,947	125	25,217

(4) Energy resource import route

(a) Current transport route

The below figure illustrates the distribution flow of Gasoline. The blue rectangle is capacity of storage of each province, and that of Phnom Penh and Kandal province is combined. Red arrows indicate imports from foreign countries to coastal areas and Phnom Penh/Kandal province. Blue arrows indicate distribution flow, Gasoline are transported by train from Preah Sihanouk to northwestern provinces along National Road 5, while tanker trucks handle transport along National Road 6.

Preah Sihanouk also supplies Gasoline to Phnom Penh by both railway and tanker truck, despite Phnom Penh receiving supplies via waterways from Vietnam. Distribution corridors reaching southeastern and northeastern provinces are served by tanker trucks originating from Preah Sihanouk and Phnom Penh, except for Tboung Khmum, which has a Gasoline storage location along the upper Mekong River.

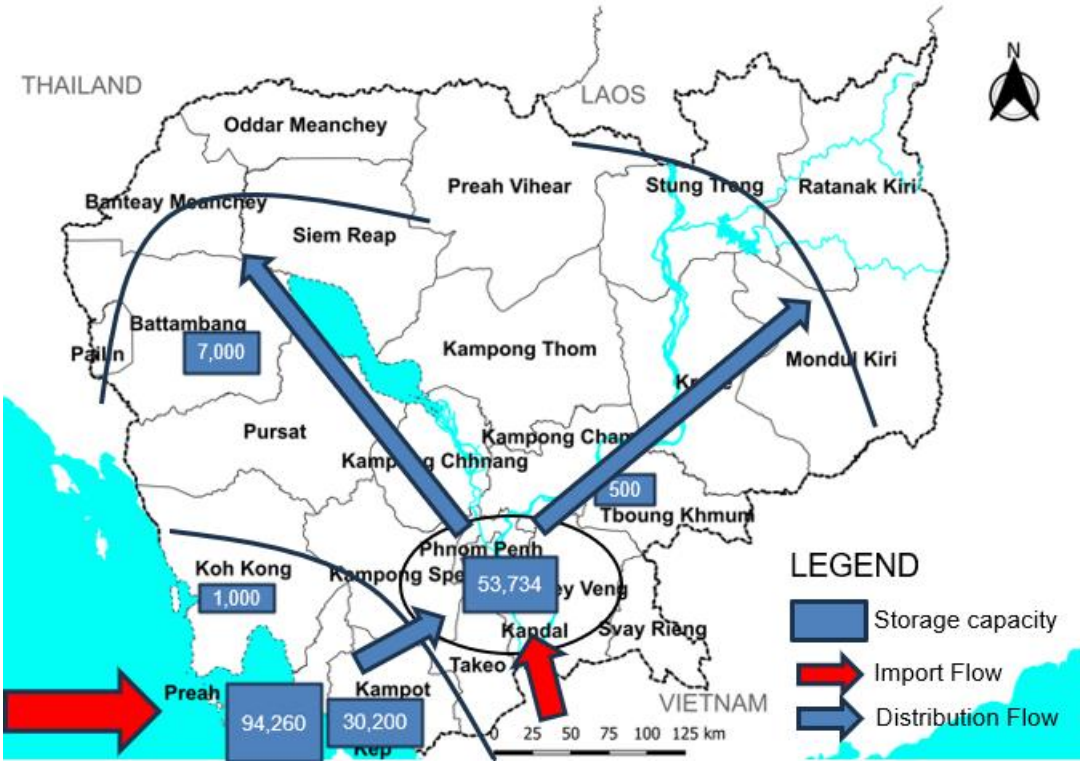


Figure 3-118 Current gasoline transport route

The below Figure 3-119 & Figure 3-120 illustrates the distribution flow of Diesel and LPG. The blue rectangle is capacity of storage of each province, and that of Phnom Penh and Kandal province is combined. Red arrows indicate imports from foreign countries to coastal areas and Phnom Penh/Kandal province. Bule arrows indicate distribution flow; Diesel and LPG are

distributing the same flow of Gasoline.

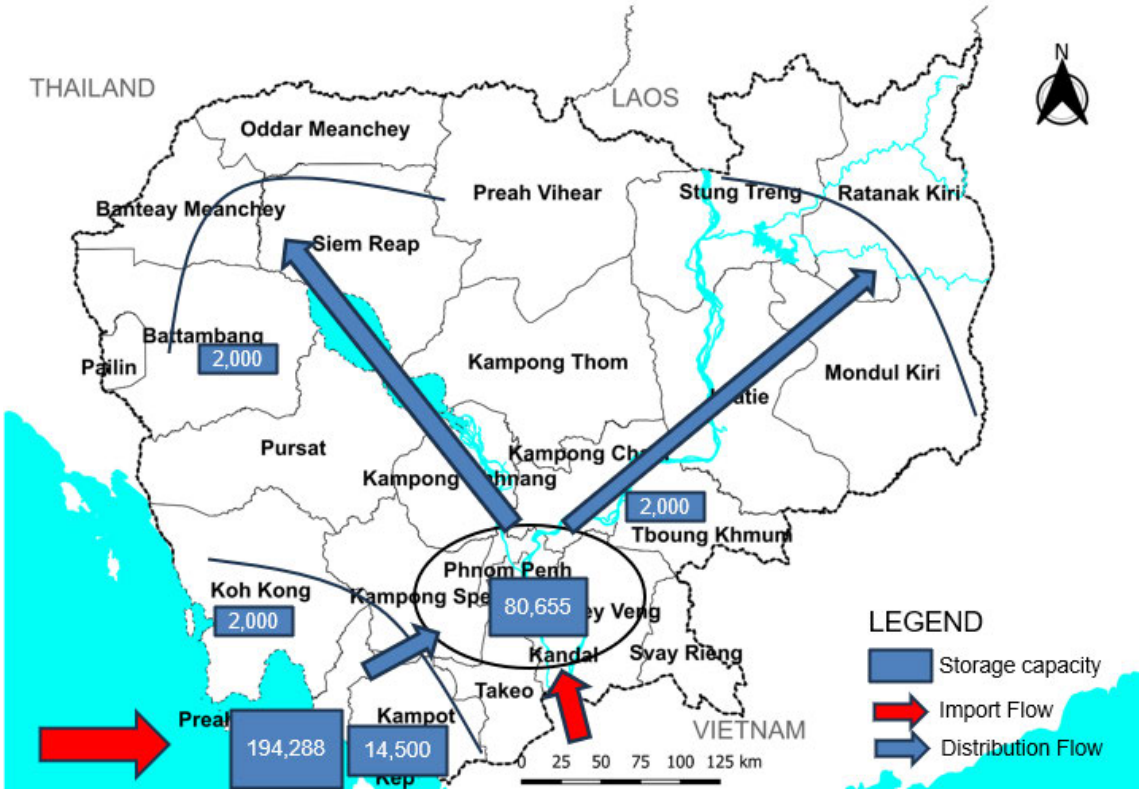


Figure 3-119 Current diesel transport route

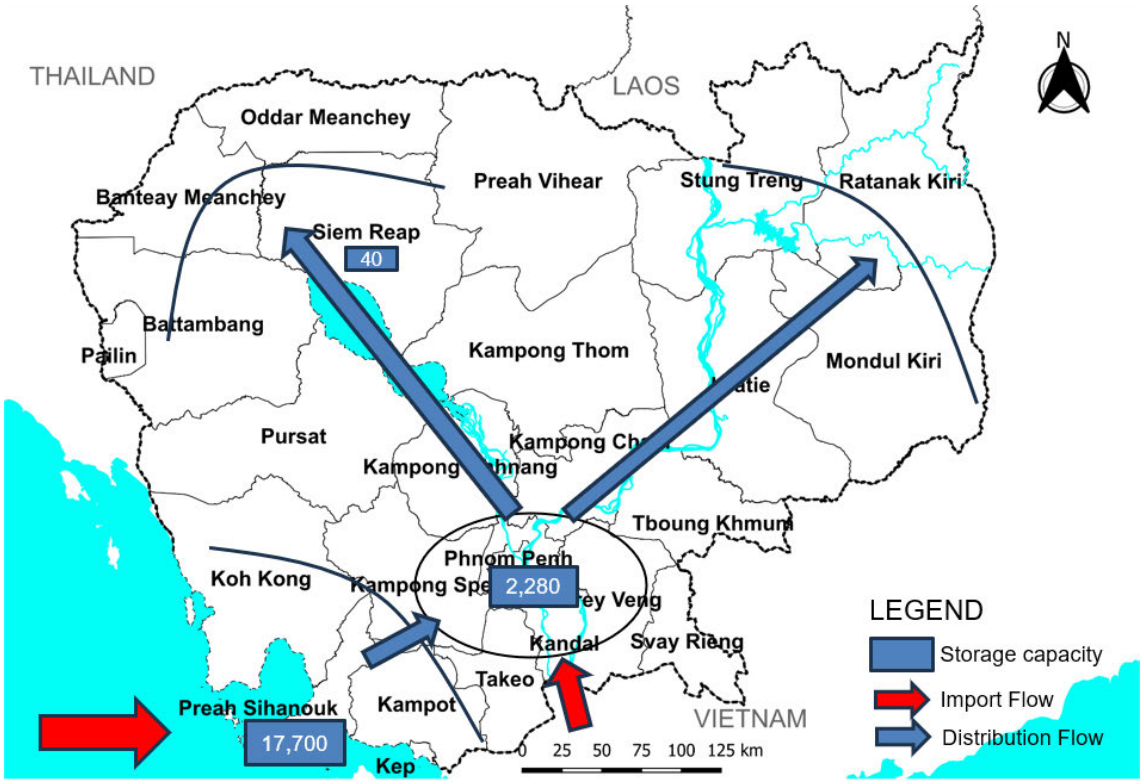


Figure 3-120 Current LPG transport route

The below Figure 3-121 illustrates the distribution flow of Fuel Oil. The blue rectangle is capacity of storage; Fuel Oil storage has location at Preah Sihanouk and Phnom Penh. Red arrows indicate imports from foreign countries to coastal areas and Phnom Penh. Bule arrows indicate distribution flow, by Fuel Oil are using for fire Power Plant and location of Fuel Oil Power Plant almost in Phnom Penh and one at Preah Sihanouk. So, Fuel Oil are import to Preah Sihanouk storage distributed from Preah Sihanouk to Phnom Penh storage by Tanker truck or Train.

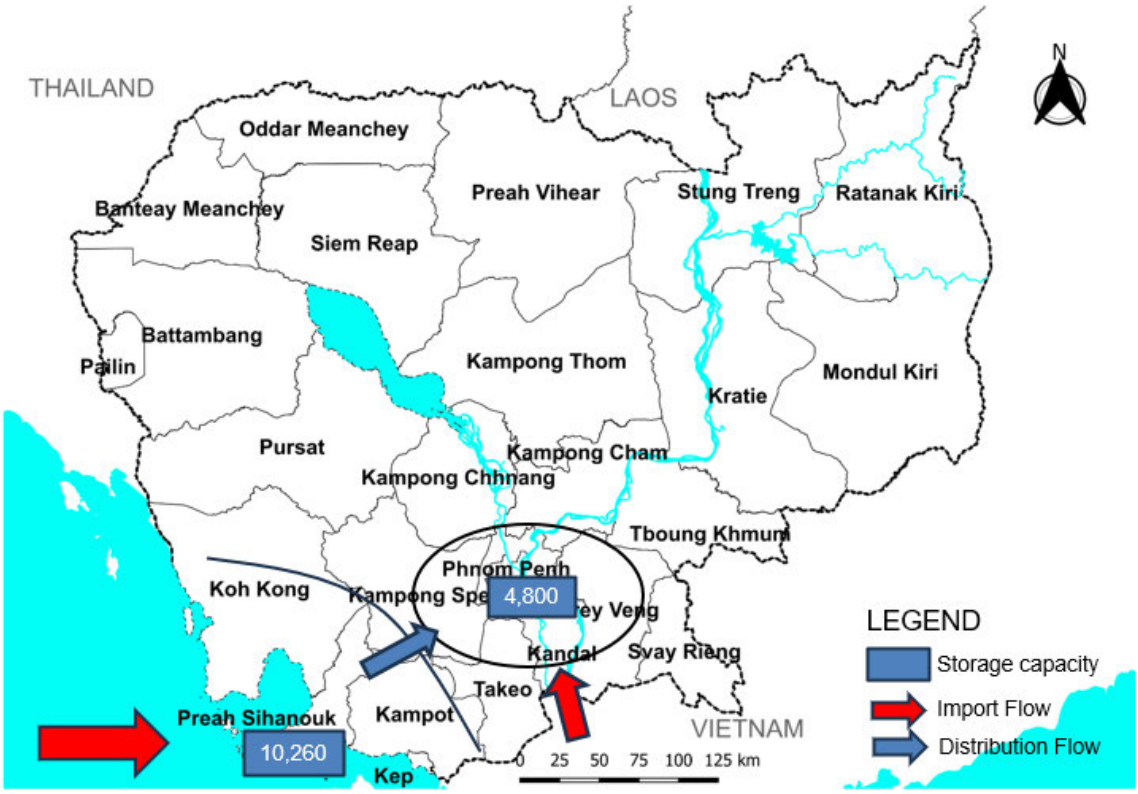


Figure 3-121 Current Fuel oil transport route

The below Figure 3-122 illustrates the distribution flow of Jet Fuel. The blue rectangle is capacity of storage, Jet Fuel storage has location at Sihanoukville Siem Reap, Phnom Penh and Kandal province. By Phnom Penh and Kandal province is so close, therefore, the storage capacity is combined. Red arrows indicate imports from foreign countries to coastal areas and Phnom Penh/Kandal province. Blue arrows show the distribution flow, as Jet Fuel is used for airplanes and international airports are in Preah Sihanouk, Siem Reap, and Phnom Penh. Therefore, Jet Fuel is distributed from Preah Sihanouk to Phnom Penh by tanker truck or train. Although Preah Sihanouk's storage capacity is smaller than Phnom Penh's, Ministry of Tourism data indicates that international air passenger traffic at Preah Sihanouk is only 1%. To supply airplanes at Siem Reap, Jet Fuel is distributed from Phnom Penh by tanker truck via National Road 6.

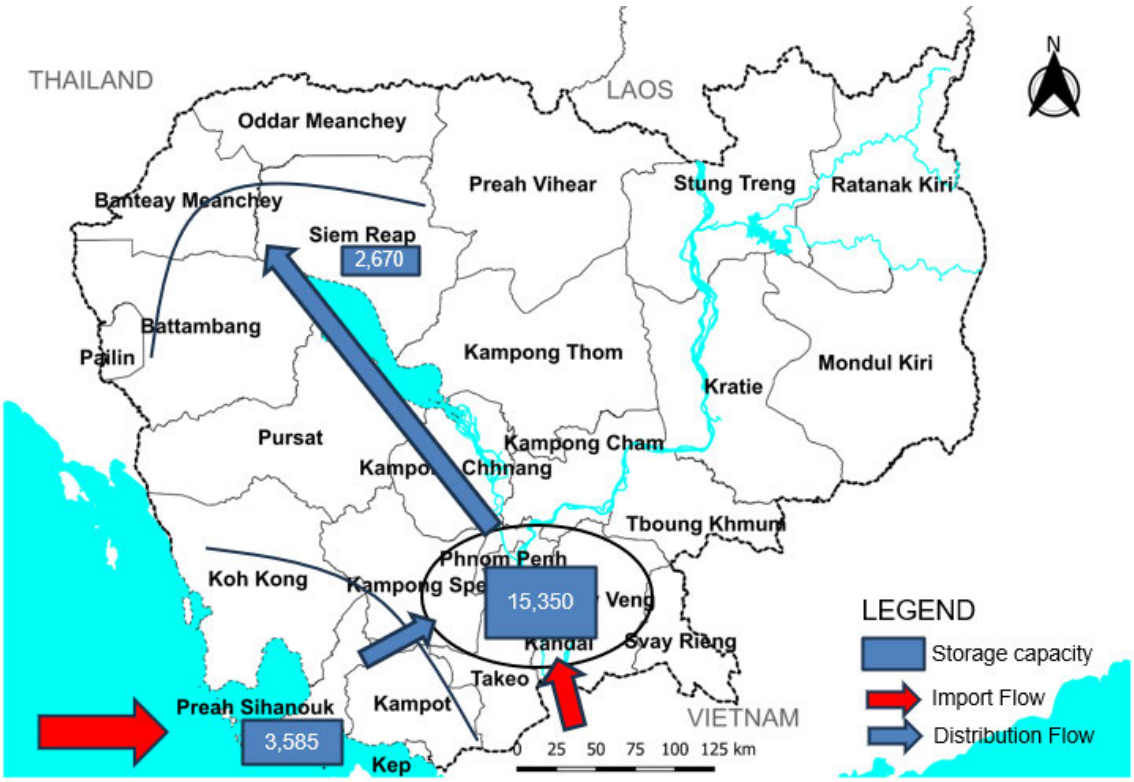


Figure 3-122 Current jet fuel transport route

(b) Future petroleum transport route

Currently, petroleum in Cambodia is distributed from coastal storage tanks to Phnom Penh by truck and railway. However, with the completion of the Funan Techo Canal, a new waterway route will become available for transporting some of this petroleum. The canal is designed to accommodate barges up to 3,000 DWT (deadweight tonnage). To put this into perspective, a single barge can carry a volume equivalent to approximately 150 tanker trucks, each with a capacity of 20 tons. This shift to a more efficient, high-volume transportation method is expected to significantly reduce the cost of transporting petroleum from the coast to the capital.

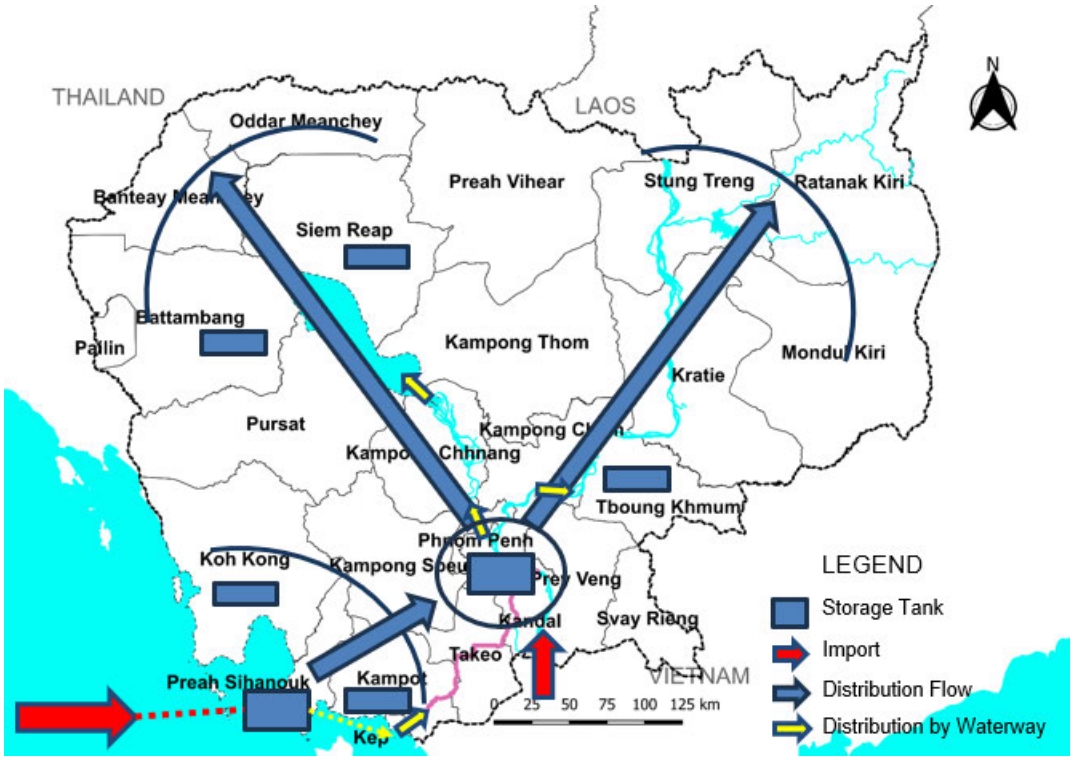


Figure 3-123 Future petroleum transport route

Chapter-4 Cruise, Commuter and Fishery ports

4.1 Cruise and Commuters

4.1.1 International tourists

The total number of international passengers inbound to Cambodia from 2007 to 2024 is shown in the figure below. In 2024, the number of international tourists reached 6.7 million air, land, and waterway.

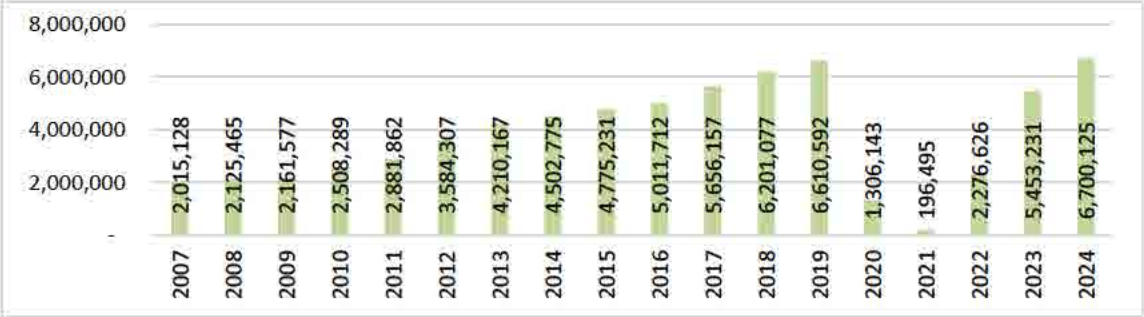


Figure 4-1 Total international tourists inbound to Cambodia[89]

In 2023, the most popular mode of transport for international tourists was land transportation (65% of the total), followed by air (34%) and waterway (1%).

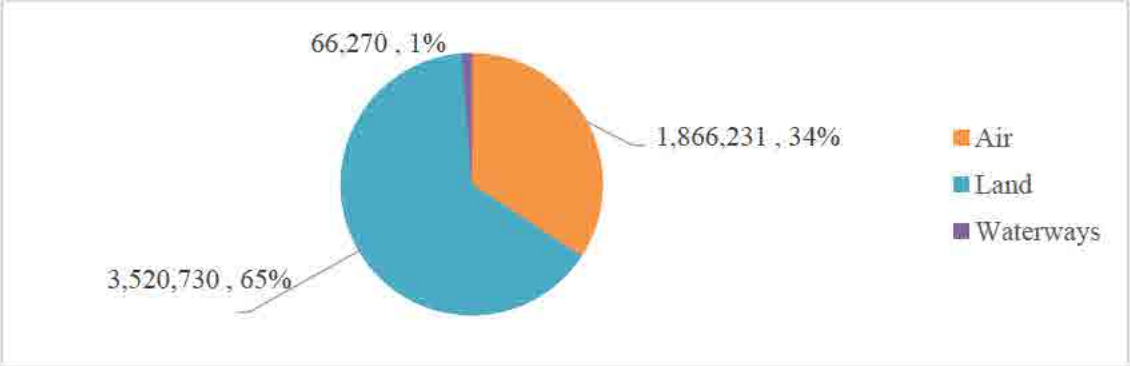


Figure 4-2 International passenger travel shares in 2023 [90]

International tourists who travel to Cambodia by waterway via river and seashore can enjoy unique routes. For river journeys, particularly Mekong River cruises from Phnom Penh to Siem Reap, travelers are able to explore cultural sites and authentic floating villages. Day trips from Siem Reap to Tonle Sap Lake offer traditional lifestyles and scenic boat rides to villages such as Kampong Phluk. Along the coast, Sihanoukville serves as an important hub for large cruise ships,

[89] Source: Ministry of Tourist (MOT)
[90] Source: Tourism statistics Report 2024

providing access to beautiful beaches and nearby islands.

(1) Methodology and results of estimating of cruise ship and international passengers

The expert team forecasts the number of cruise ships traveling on inland waterways and coastlines based on data from PPAP and PAS, but they only provide projections up to 2030. For the years 2031 to 2050, our expert team will use estimates from 'The Master Plan, which covers projections from 2026 to 2035'. These estimates account for expected growth to 2050 due to improved tourism facilities and planned projects. Furthermore, The Master Plan provides projections for international tourists based on 8% growth rate.

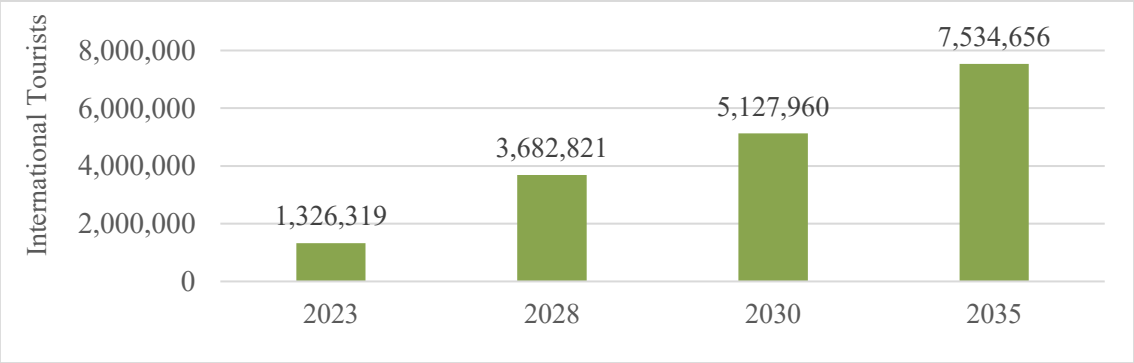


Figure 4-3 Forecast number of international tourists to Siem Reap province to 2035[91]

To forecast the demand for cruise ship calls on inland waterways and coastlines through 2050, we will first utilize the projections provided by PPAP and PAS for the period up to 2030. For the subsequent years, 2031 to 2050, we will adopt a more optimistic, rapid growth trajectory by applying an 8% annual growth rate. This higher rate is informed by the "Tourism Development Master Plan for Siem Reap" and is contingent on the successful execution of regional tourism master plans and the introduction of new attractions, ultimately linking existing short-term data with a long-term, accelerated growth forecast.

[91]Source: Tourism Development Master Plan Siem Reap 2021-2035

To forecast commuter demand for 2050, we can use factors A and B, which represent the proportions of the total population expected to use ferries and bridges. These factors can be estimated based on surveys or historical data. By applying these proportions to the projected population, we can calculate the expected number of commuters in the future.

To estimate fish demand, we can calculate the average fish consumption per person and multiply it by the projected population. By applying the average consumption of 52.4 kg per person per year, the forecast shows a substantial need for fish.

Table 4-1 Summary of demand forecast results (Cruise ships, Commuters and fish)

Field	Inland Waterway (PPAP)	Cruise (Seashore - PAS)	Cruise (Seashore - Kampot)	Commuter	Fishery (ton)	Population
Base year (Ship Calls)	746	23	-	-	-	-
Base year	2024	2024	-	2022	2019	2019
Base year (Passenger /Population)	36,312	19,448	-	16,062	601,200	16,078,660
Estimation in 2050 (Number of ship Calls)	2,797	233	3,333	-	-	-
Estimation volume in 2050 (Number of passenger)	531,430	246,196	1,000,000	19,330	753,366	21,728,446
Estimation method	Assumed increasing rate 8%		China-aided Project of the Intermodal Transport Master Plan for Cambodia	Population growth	Consumption-Population growth	National policy
Mode	Cruise ship	Cruise ship	Cruise ship	Ferry	Fishing boat	-

4.1.2 Port Infrastructure for Cruise Ship Tourism

(1) Multipurpose Terminal TS1

TS1 terminal is in the heart of Phnom Penh's Daun Penh District. This terminal serves as a gateway to the city's riverine landscape and is a popular for cruises along the Tonle Sap River for both domestic and international tourists. This terminal boasts robust infrastructure, including 20m x 300m pontoons, two berths, and a river depth of 4.5m, further supported by two floating piers (42m x 12m). Beyond local excursions, TS1 facilitates international travel, with navigation from TS3 to Ho Chi Minh City, Vietnam, taking approximately 31 hours over 470 km, highlighting its significance in regional waterway connectivity.[92]



Figure 4-4 Cruise ship terminal TS1 of PPAP along Tonle Sap River [93]

(a) Multipurpose Terminal TS3

TS3, located in Phnom Penh City, functions as both a focal point for inland container operations and a tourist terminal. This terminal is equipped with 20m x 300m jetties, six berths, and a river depth of 4.5m, complemented by two floating piers (42m x 12m) to accommodate various vessels. TS3 also features a dedicated Passenger and Tourist Station Hall spanning 52m x 17m, all within a substantial land size of 2 hectares. Demonstrating its importance in regional connectivity, the terminal facilitates international journeys, with a navigation time of approximately 31 hours to Ho Chi Minh City. The accompanying visuals depict large cruise ships docked against the backdrop of a bridge and the city skyline, underscoring TS3's significant role in both commerce and tourism along the Tonle Sap River.[94]

[92] Source: PPAP (TS1 information)
[93] Source: PPAP
[94] Source: PPAP (TS3 information)



Figure 4-5 Cruise ship terminal TS3 of PPAP along the Tonle Sap River[95]

(b) Chong Khneas (Siem Reap Port)

Chong Khneas Port is the principal gateway to the iconic Chong Khneas Floating Village on Tonle Sap Lake, located just south of Siem Reap (about 12-16 km). It serves as the main departure point for boat tours on the lake, giving tourists access to the floating village and Tonle Sap ecosystem. The port is very close to Siem Reap and operates year-round. Besides tourism, it connects Siem Reap with other regions by river routes. Passenger speed boats operate between Phnom Penh and Chong Khneas, and cargo boats facilitate the transport of goods. It also has direct cargo routes from Phnom Penh to locations such as Krakor and Chhnok at the southern end of the lake[96]



Figure 4-6 Chong Khneas (Siem Reap Port) along the Tonle Sap River[97]

Siem Reap is a key stop for multi-day river cruises along the Mekong River, connecting Cambodia with Vietnam (between Siem Reap and Saigon/Ho Chi Minh City). These cruises typically use Tonle Sap Lake to access Siem Reap. [98]

(c) Kampong Chhnang

Kampong Chhnang, located 100km upstream from Phnom Penh, was developed in 2021 to accommodate up to six ferries within a 6,523m² area. The port area also supports tourism and

[95] Source: PPAP
[96] Source: Siemreap wonder.com
[97] Source: Chong Khneas. Cambo tour
[98] Source: HelloAngkor.com

provides boat tours on the Tonle Sap River.[99]



Figure 4-7 Images of Kompong Chhnang Port along the Tonle Sap River[100]

(d) Pursat Port

Pursat Port is located in the southeastern region of Tonle Sap Lake, and serves as a significant hub for both passenger and cargo transport. The port is crucial for linking Siem Reap and Phnom Penh, facilitating waterway transport for goods and passengers. While specific infrastructure details may vary, the port is equipped to handle local and international traffic, accommodating both passenger ferries and cargo vessels. Moreover, Pusat Port serves as a gateway for travelers visiting Siem Reap, allowing visitors to experience the daily lives of communities that rely on Tonle Sap Lake for their livelihoods.[101]

(e) Kampot Tourism Port

This port has the capacity to accommodate vessels carrying up to 300 passengers or tourists internationally. The channel has a water depth of 3 meters, a length of 6.75 km, and a width of 62 meters (divided into two lanes). Future development aims for a water depth of more than 3 meters, a width of 160 to 340 meters, and a length of up to 15 km.[102]



Figure 4-8 Kamport international tourism port[103]

[99] Source: evendo (Kampong Chhnnang: pottery Port on the Tonle Sap)
[100] Source: Cambodia lifestyle
[101] Source: Pursat River Basin Profile
[102] Source: MPWT
[103] Source: Khmer Times

(f) Sihanoukville Autonomous Port (PAS)

The port features an Old Jetty, and a Multipurpose Terminal dedicated to cruise ships. Frequent callers include SEABOURN ENCORE, COSTA FORTUNA, MS WESTERDAM, and MARELLA DISCOVERY.[104]



Figure 4-9 PAS cruise ship terminal

[104] Source: PAS

4.1.3 Future projection of cruise ship calls in inland waterways

(1) The present number of cruise ship calls and tourists in PPAP

Significant growth in cruise tourism is projected at Phnom Penh Autonomous Port (PPAP). In 2024, a total of 746 cruise ship called, carrying 36,312 passengers, or 190 passengers per ship on average.

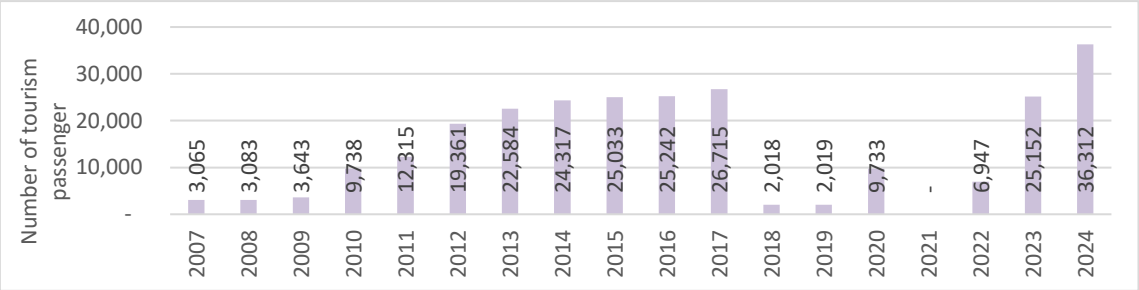


Figure 4-10 The present number of international tourists in PPAP (source: PPAP)

From 2017 to 2024, the annual growth rate for cruise ship calls is only 2% as the number of passengers decreased from 2018 to 2022 due to COVID-19. Looking ahead, there is a sharp increase expected in early 2025, with an estimated 500 cruise calls anticipated that year. Therefore, PPAP forecasts a 5% growth rate in cruise ship calls from 2025 to 2030.

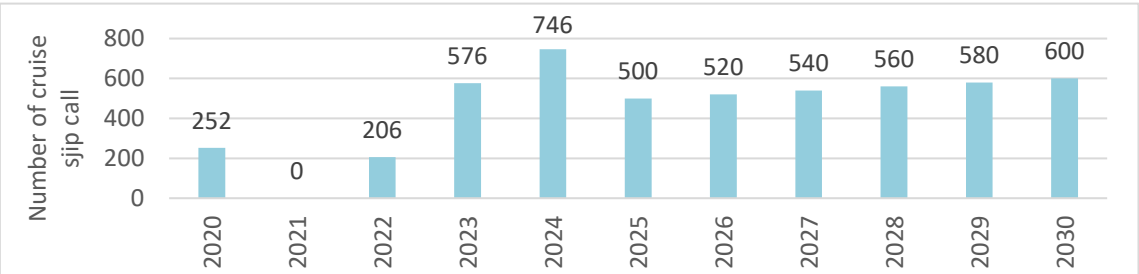


Figure 4-11 Cruise ship calls in PPAP (Source: PPAP)

To forecast the number of cruise ship calls, we consider the number of passengers per cruise ship call. Specifically, we estimate this number use the average number of passengers per cruise ship call based on data from popular international cruise ships, such as the Aqua Mekong, Scenic Spirit, and Emerald Harmony. These cruise ships typically carry around 190 passengers per call, which will serve as our assumed average for the estimation.

Table 4-2 Popular cruise ship calls in 2024

Cruise Line	Total Passengers (in/out of PPAP), 2024	Total Cruises (in PPAP), 2024	Passengers per Cruise (Calculated)
Aqua Mekong	7,738	28	276
Scenic Spirit	3,059	21	146
Emerald Harmony	2,981	20	149
Overall average of passenger per cruise ship call			**190**

(2) Future projection of cruise ship calls and international passengers in PPAP

From 2017 to 2024, cruise ships call grew at a rate of 2% each year. In early 2025, 500 cruise ship calls are forecast and calls will continue to grow at a rate of 5% each year until 2030. After 2030, the JICA team estimates cruise ship calls by the average number of passengers per cruise ship call using popular international cruises like Aqua Mekong, Scenic Spirit, and Emerald Harmony which carry 190 passengers per call on average.



Figure 4-12 The forecast number of tourists arriving via cruise ship in PPAP

By 2050, the estimate rises to 532,350 passengers is 2,797 cruise ship call in 2050. These projections highlight significant growth potential for cruise tourism in Cambodia, particularly in relation to Siem Reap.

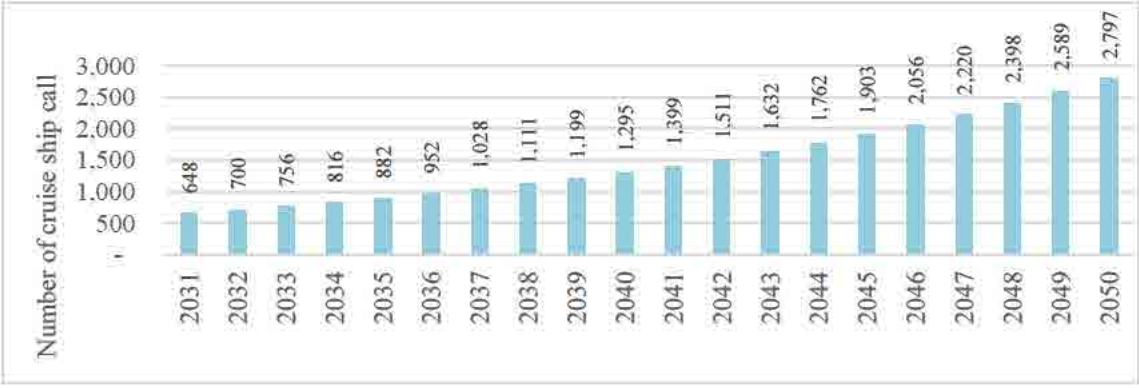


Figure 4-13 The forecast number of cruise ship calls in PPAP

Table 4-3 Summary of forecast international tourists and cruise ship calls in 2050

Passenger	The number of Cruise ship Calls 2024	The number of Passengers in 2024	The average number of Passengers per call	2050 (Scenario 2)	
				Cruise ship calls	Passengers
PPAP	746	36,312	190	2,797	532,350

(3) Travel route

(Phnom Penh to Siem Reap, Cambodia)

Traveling from Phnom Penh to Siem Reap by cruise ship takes 3 nights and includes stops at Phnom Penh, Oudong, Kampong Trollach, and Kampong Chhnang. In contrast, the speedboat option is much quicker, taking only 6 to 6.5 hours to cover 248 km.

This forecast focuses on inland waterway transport for international tourists in Cambodia, particularly those traveling from Vietnam to Phnom Penh (PPAP) and then to Siem Reap Port. We assume that 40% of international travelers arriving at PPAP will use the waterway to continue their journey to Siem Reap by cruise ship, which this amounts is 107,431 travelers. This information will help us plan for the transport needs of these tourists effectively.

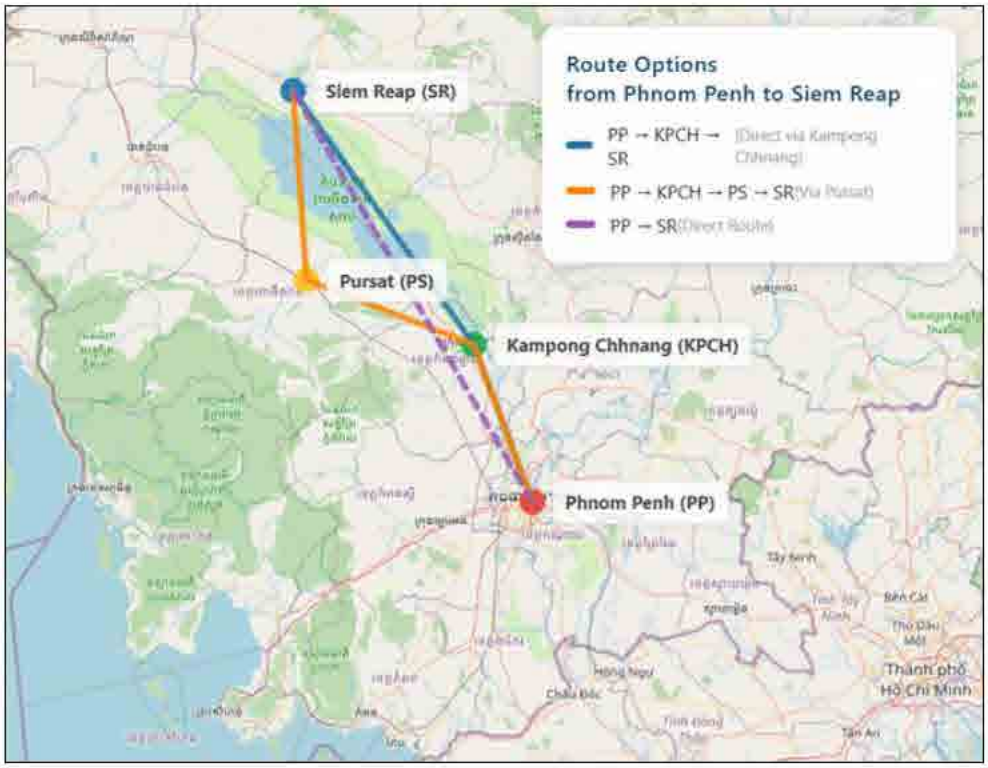


Figure 4-14 International tourists travel route from Phnom Penh to Siem Reap

(Expected International Tourist Distribution to Siem Reap by Waterway (2050))

a) Phnom Penh to Siem Reap (PPAP to SR): This direct route is expected to be the most popular among waterway tourists, accounting for about 60% of total waterway travelers. The forecast predicts 127,764 passengers.
b) Phnom Penh to Kampong Chhnang to Siem Reap (PPAP to KPCH to SR): This route, which includes a stop at Kampong Chhnang, is projected to attract 25% of waterway tourists. The expected number of passengers is 53,235.
c) Phnom Penh to Kampong Chhnang to Pursat to Siem Reap (PPAP to KPCH to PS to SR): This route, which has stops at both Kampong Chhnang and Pursat, represents 10% of waterway tourists. The forecast indicates 21,294 passengers.
d) Alternative Route: This route involves traveling by cruise ship from Phnom Penh with additional stops before reaching Siem Reap. It accounts for the remaining 5% of waterway tourists, with 10,647 passengers.

Table 4-4 The number of international passengers travel ingfrom Phnom Penh to Siem Reap by route

Travel Route	
Direct Waterway (PPAP to SR)	127,764
Via Kampong Chhnang (PPAP to KPCH to SR)	53,235
Via Pursat (PPAP to KPCH to PS to SR)	21,294
Alternative route	10,647
Total	**212,940**

The forecast for cruise calls at PPAP is based on demand forecast results in 2050. And we assume that 40% of these calls will continue to Siem Reap. Cruise ships traveling from Phnom Penh to Siem Reap will make stops at Kampong Chhnang and Pursat. We assume that 25% of the cruise ship calls heading to Siem Reap will stop at Kampong Chhnang, while 10% will stop at Pursat.

Table 4-5 Cruise ships call from Phnom Penh to Siem Reap

Port for tourism	Cruise ship calls in 2050
PPAP	2,797
Kompong Chhnang	280
Pursat	112
Siem Reap	1,119

(4) Estimating the required volume of port facilities (Inland water)

We estimate the required volume of port facilities using the annual cruise ship calls per berth set under the estimate conditions shown in the table below, in which cruise ships are accommodated 365 days per year. A cruise ship berths in the morning, and all passengers disembark and go sightseeing somewhere in town. The boat will depart the port in the afternoon. Therefore, one cruise boat occupies the berth all day long. Typical river cruise ships calling at PPAP are 50 to

68m long and 10 to 13m in width with passenger capacity from 48 to 60 passengers for typical Mekong River cruise vessels. Larger vessels designed for about 200 passengers could be about 80 to 100m in length and 12 to 15m in width.[105]

Table 4-6 Required berths for cruise ship (Inland waterway)

Port	Operation (day/year)	Cruise ship calls in 2050	Calculation Berth	The round number of berths
PPAP	365	2,797	7.66	8
Kampong Chhnang		280	0.77	1
Pursat		112	0.31	1
Siem Reap		1,119	3.06	4
Total				**14**

The table shows the expected number of cruise ship visits (calls) for each port in 2050 and the number of berths needed at each port.

For the port of PPAP, we forecast 2,797 cruise ship calls in 2050. Of these, we estimate that 40% will continue to Siem Reap, resulting in 1,119 cruise ship calls to Siem Reap. The cruise ships heading to Siem Reap will also make stops at Kampong Chhnang and Pursat. We assume that 25% of the calls going to Siem Reap, which is about 280 calls, will stop at Kampong Chhnang. Additionally, we expect 10% of the calls, around 112 cruise ship calls, will stop at Pursat. This approach helps us understand the potential traffic at each port for effective planning.

[105] Source: Top Mekong Cruise

4.1.4 Future projection of cruise ship calls at the seashore

(1) The present number of international cruise passengers in PAS

Cruise tourism at PAS is poised for growth in 2025, with an increasing number of foreign liners docking regularly, contributing to Cambodia's coastal tourism development and economic benefits. PAS is Cambodia's only deep-sea port capable of accommodating medium-sized cruise ships with drafts up to about 10.5 meters.[106]

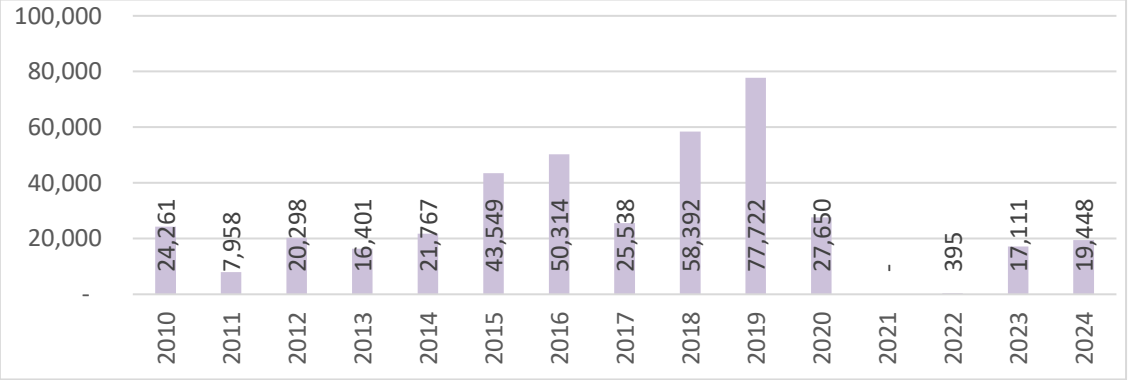


Figure 4-15 The present number of international tourists in PAS (Source: PAS)

PAS serves as Cambodia's only deep-water international port, located on the Gulf of Thailand in Preah Sihanouk province. Major cruise itineraries include routes connecting:

- Preah Sihanouk to Vietnam's Phu Quoc Island and other regional ports
- Preah Sihanouk to Thailand's coastal ports such as Trat.
- Cruises often start or end in larger regional hubs like Singapore or Ho Chi Minh City, with Preah Sihanouk as a key stopover.
- The port is connected to Phnom Penh and the rest of Cambodia via the Phnom Penh-Preah Sihanouk transport corridor, Cambodia's main trade and passenger route.[107]

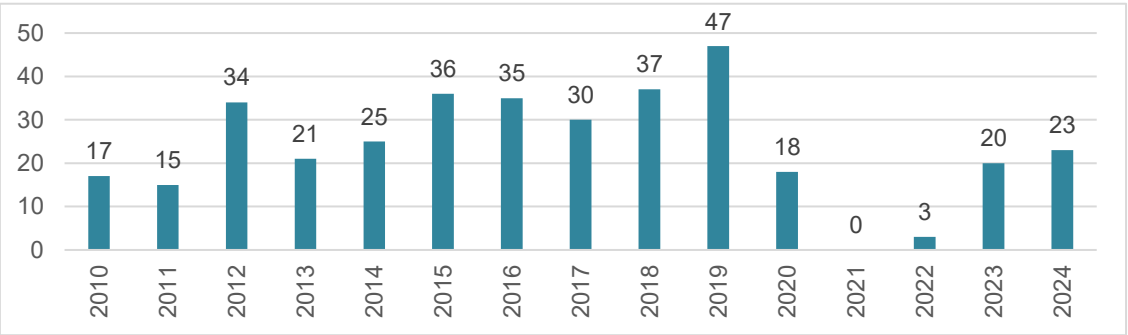


Figure 4-16 The present number of cruise ship calls in PAS (Source: PAS)

[106] Source: PAS
[107] Source: CrewCenter

Cruise ships which frequently call Sihanoukville port are as follows:

1. SEABOURN ENCORE 15 calls
2. COSTA FORTUNA 14 calls
3. MS WESTERDAM 12 calls
4. MARELLA DISCOVERY 10 calls[108]

(2) Future projection of cruise ship calls in PAS

The forecast for cruise ship calls from 2025 to 2030 includes the following three scenarios: Low Growth at 10%, indicating a gradual recovery; Base Case at 14%, reflecting normal market conditions; and High Growth at 16%, suggesting a rapid increase driven by strong demand.

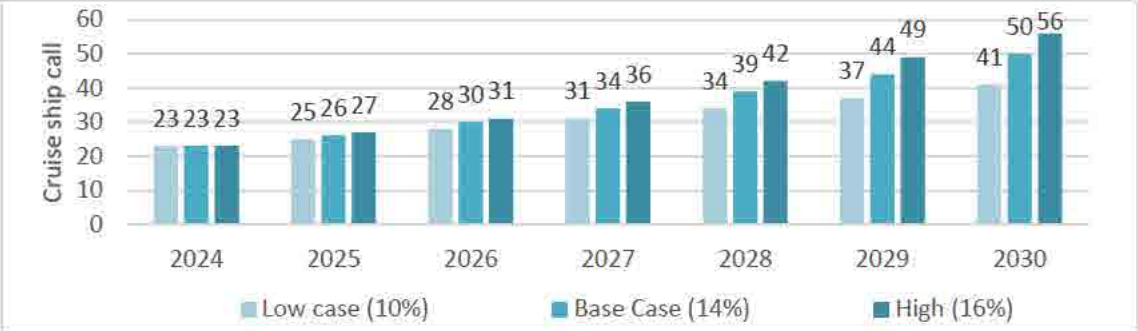


Figure 4-17 The forecast number of cruise ship calls (Estimate by PAS)

To forecast the number of cruise ship calls to 2050, the JICA team, we assume 8% annual growth, the number of cruise ship calls will reach 233.



Figure 4-18 The forecast number of cruise ship calls in PAS to 2050

The future projection of cruise ship calls from 2010 to 2024 shows significant fluctuations, mainly due to the impact of COVID-19 in 2021, 2022, and 2023, which we will exclude from the analysis. To project future international passengers, we use the average number of passengers per cruise

[108] Source: PAS

ship call, which is 1,056 based on historical data from 2010 to 2024.

Forecasting for 8% growth rate, with 233 cruise calls, the projection increases to about 246,196 passengers by 2050.

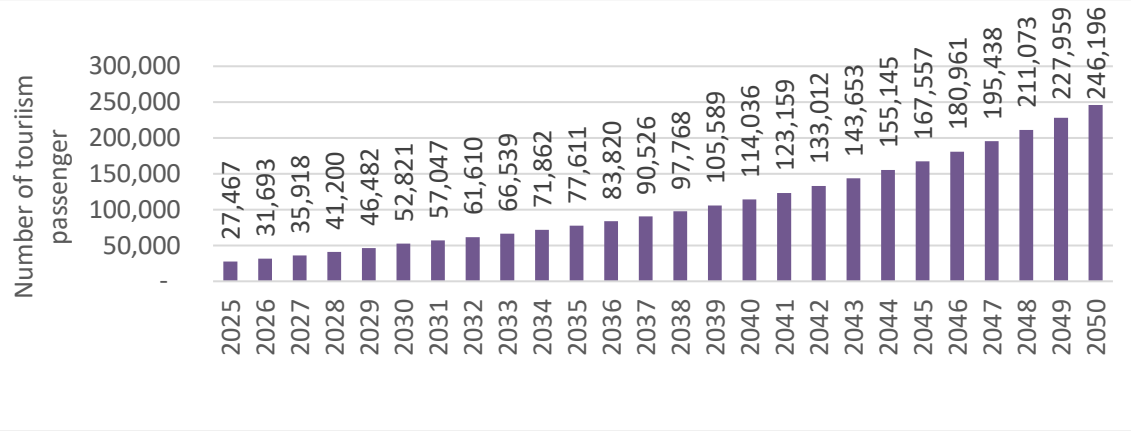


Figure 4-19 The forecast number of international passengers in PAS to 2050

(3) Future projection of Kampot port

According to the Comprehensive Master Plan on Cambodia Intermodal Transport and Logistics System 2023-2033, one million international passengers are projected to pass through Kampot Tourism Port in 2030[109] . Therefore, JICA experts also assume there will be 1 million cruise passengers per year from 2030 to 2050. In 2050, the international passenger port at Kampot is projected to have 3,333 cruise ship calls, operating 365 days a year.

The port serves as a gateway for tourists traveling between Cambodia, Vietnam (Phu Quoc Island), Thailand (Trat), and nearby coastal/island destinations like Koh Rong thanks to its strategic location near the Vietnam border and coastal tourism hubs.

(4) Estimating the required volume of port facilities (Seashore Zone)

The table below shows the annual cruise ship calls per berth for various international passenger ports projected for 2050, with operation days set at 365 days per year. For PAS, the projection is 233 cruise ship calls in 2050, also operating every day of the year. Accordingly, 1 berth will be required (rounded up from 0.6). In the case of Kampot, where the projected number of cruise ship calls in 2050 is 3,333, the required number of berths is calculated at approximately 9.1, which is rounded to 10 for practical purposes.

[109] Source: Comprehensive Master Plan on Cambodia Intermodal Transport and Logistics System 2023-2033

Cruise ships generally stay at Preah Sihanouk for less than one day, typically around 7 to 12 hours for their port call. Mid-size ships usually carry around 800 to 1,000 passengers, while larger ships range from approximately 2,300 to 3,600 passengers. The cruise ships calling at Preah Sihanouk tend to have lengths primarily between 150 to 320 meters and widths averaging about 20 to 36 meters. Suitable berth lengths range from 290 to 330 meters, with drafts of up to 8.5 meters.[110]

Table 4-7 The required number of berths for cruise ships (Seashore)

International passenger port	Cruise ship calls in 2050	Operation (day/year)	Required Berths	The round number of berths
Pas	233	365	0.6	1
Kampot	3333	365	9.1	10
			Total	11

(5) Issues to be considered

a) Forecasting demand for international passengers and cruise calls based on Siem Reap's tourism policy comes with several challenges. We don't have specific data on cruise ships and international passengers using waterways in the future.

b) For passengers from the PPAP, we assume that 40% will travel to Siem Reap by waterway, stopping at Kampong Chhnang and Pursat, while the remaining 60% will travel by land or other transportation mode.

[110] Source: Preparatory survey for Sihanoukville port now container terminal development project

4.1.5 Forecast of commuter volume (Phnom Penh)

(1) Present commuter traffic (by ferry)

A commuter across the river is a person who regularly travels between their place and their workplace or school by crossing a river as part of their daily or routine journey. This typically applies in cities or regions where a river divides residential areas from other zones, requiring commuters to use bridges, ferries and boats. In Phnom Penh city, many people living on one side of the Tonle Sap or the Mekong River may commute daily to work or school on the opposite bank, making them commuters across the river.

In this forecast, the area considered for commuter traffic is within Phnom Penh city along the Mekong River, focusing on commuter traffic across bridges and ferries. The forecast aims to understand the share of commuters who will use waterways, such as ferries and bridges, in the future.

The previous study by the JICA team[111] shows bridge commuter traffic along the Mekong River in Phnom Penh City. The Trea Mak Bridge on NR8 is a significant crossing. Another important structure is the Bridge over the Tycoon Island, the Cambodia-Korea Friendship Bridge and a bridge near the Mekong River play crucial roles in connecting different areas, although specific traffic volumes for these are not detailed. By 2035, the projected number of commuter passengers using the bridges within Phnom Penh is anticipated to reach 408,400.

Table 4-8 Commuter traffic in Phnom Penh city along the Mekong River by 2035[112]

Bridge Name	2035
	Traffic Volume (PCU/day)
1. Prek Ta Meak Bridge on NR8 (Existing)	29,100
2. RR3 Bridge north	66,800
3. Bridge over the Tycoon Island	---
4. RR2 bridge north	83,400
5. Cambodia-Korea Friendship Bridge	40,200
6. Requested Mekong River tunnel	31,100
7. Bridge leadting to Koh Norea Island	---
8. Requested Mekong River bridge on RR2	100,400
9. RR3 bridge south	57,400
Total	**408,400**

From the previous study by the JICA team[113], which focused on ferries on the Mekong River, this

[111] Source: Data Collection Survey on the Road and Bridge Sector in the Southern Economic Corridor
[112] Source: Data Collection Survey on the Road and Bridge Sector in the Southern Economic Corridor
[113] Source: Data collection Survey on Urban Transport in Phnom Penh, JICA 2023

study selects three ferry locations: Svay Chrum Ferry, Avey Kasat Ferry, and Kohdach Ferry. Together, these ferries accounted for a total of 16,062 passengers in 2022, providing vital connections across the Mekong River.

Table 4-9 The number of ferry commuters crossing the Mekong River[114]

Location	Traffic Volume (PCU/day) (2022)
Svay Chrum Ferry	5,871
Arey Kasat Ferry	7,505
Kohdach Ferry	2,686
Total	16,062

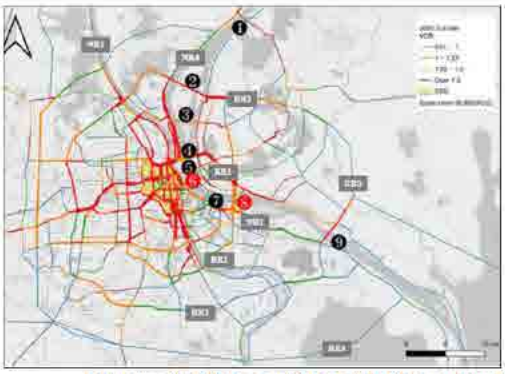


Figure 4-20 Location of bridge traffic demand along Mekong river in 2035[115]

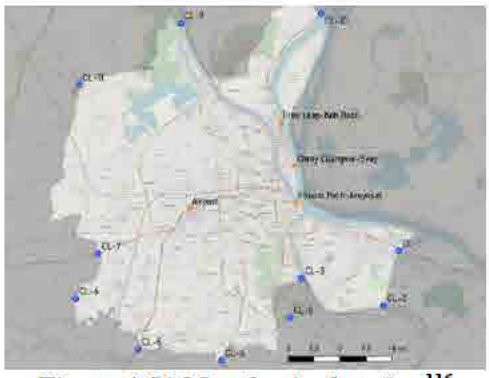


Figure 4-21 Map ferries location[116]

(2) Future projection of commuter traffic (by Ferry)

To forecast the number of ferry commuters, we can use the following formula:
Ferry Commuters = (Right Riverbank Population + Left Riverbank Population) × A

Where:

- A is the proportion of the total population that uses boats.
- Right Riverbank Population is the total number of people living on the right side of the river.
- Left Riverbank Population is the total number of people living on the left side of the river, obtained in the same way as the right bank population.
  (This information can be gathered from census data of the National Institute of Statistics (NIS) of MoP)

[114] Source: Data collection Survey on Urban Transport in Phnom Penh, JICA 2023
[115] Source: Data Collection Survey on the Road and Bridge Sector in the Southern Economic Corridor
[116] Source: Data collection Survey on Urban Transport in Phnom Penh, JICA 2023

For estimating the number of bridge commuters, we use this formula:
Bridge Commuters = (Right Riverbank Population + Left Riverbank Population) × B

Where:

- B is the proportion of the total population that uses bridges.
- Right Riverbank Population is the total number of people living on the right side of the river.
- Left Riverbank Population is the total number of people living on the left side of the river, obtained in the same way as the right bank population. (This information can be gathered from census data of the National Institute of Statistics (NIS) of MoP)

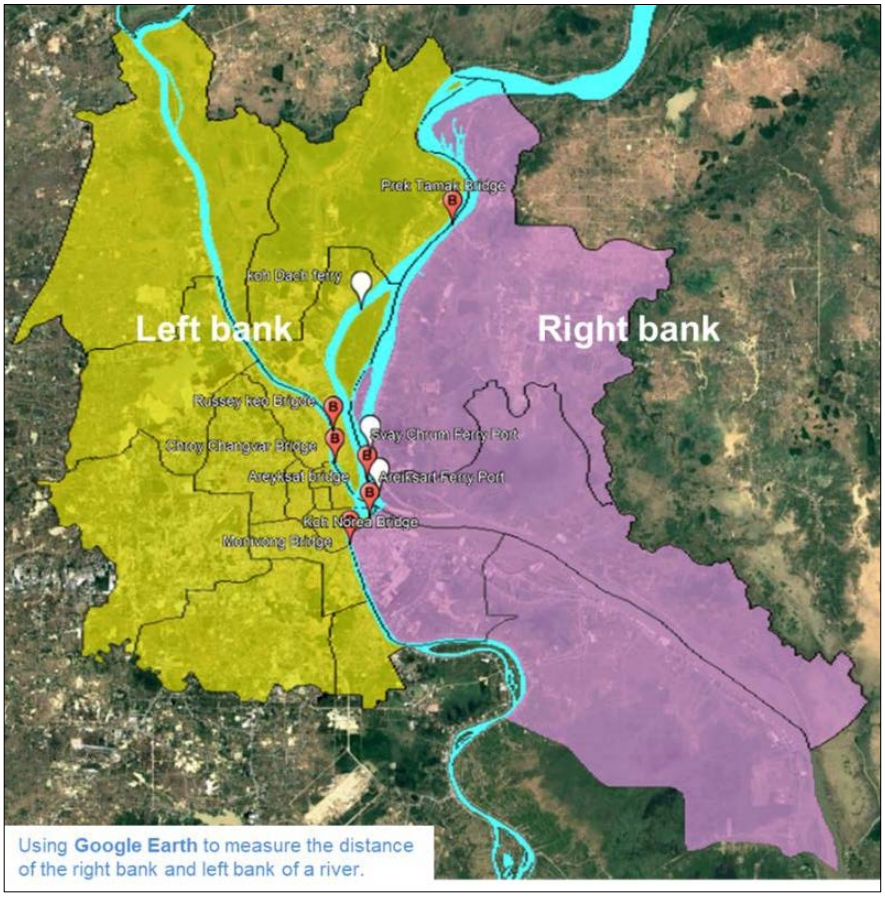


Figure 4-22 Map of divided of left and right bank of Mekong River (source: google earth)

Phnom Penh City had a population of 2.4 million in 2022, which is expected to grow to 2.9 million by 2035 and nearly 3 million by 2050.

(Left Riverbank)

On the left bank, which includes the Pohnea Lue and Krong Ta Khmao districts in Kandal, the population was 2,715,877 in 2022. This number is projected to increase to 3,171,547 by 2035 and

3,268,710 by 2050.

(Right Riverbank)

On the right bank, which includes the Kien Svay, Leva Aem, and Khsaach Kandal districts in Kandal, the population is expected to grow from 304,984 in 2022 to 355,815 by 2035, reaching 366,716 by 2050.

Table 4-10 Future Projection of left and right river bank populations[117]

Province	City/District	Population		
		2022	2035	2050
Left river bank population	Phnom Penh city	2,482,758	2,899,573	2,988,404
	Popnhea Lueu district in Kandal	96,165	112,192	115,629
	Mukh Kampul district in Kandal	66,895	78,045	80,436
	Krong Ta Khmau district in Kandal	70,060	81,737	84,241
	Total left river bank population	**2,715,877**	**3,171,547**	**3,268,710**
Right river bank population	Kien Svay district in Kandal	107,587	125,518	129,363
	Lvea Aem district in Kandal	66,893	78,043	80,433
	Khsach Kandal district in Kandal	130,504	152,255	156,919
	Total right river bank population	**304,984**	**355,815**	**366,716**

For ferries and bridges, we can estimate factors A and B using currently available data, such as the 'ferries commuter traffic 2022'. We can define factor A and apply it to estimate commuters in 2050 based on the population in 2050. Additionally, for 'bridge commuters' traffic', we already have data for 2035, and based on population, we can estimate a factor to project bridge commuters' traffic in 2050 according to population growth by 2050.

For ferry commuters, we calculate Factor A using the formula: A = Ferry Commuters / Total Population. This gives us A = 16,062 / 3,020,861, which is about 0.005.

For bridge commuters, we find Factor B with the formula B = Bridge Commuters / Total Population. This results in B = 408,400 / 3,527,362, or about 0.116.

[117] Source: General Population Census of Cambodia 2019, Series Thematic Report on Population Projection, NIS of MoP

Table 4-11 Projected commuter traffic in 2050

Year	Right bank river population	Left bank river population	Right+ Left	Commuter	Factor		Ferry	Bridge
					A	B		
2022	304,984	2,715,877	3,020,861	**365,819**	0.005	0.116	16,062	349,757
2035	355,815	3,171,547	3,527,362	**427,155**			18,755	408,400
2050	366,716	3,268,710	3,635,426	**440,241**			19,330	420,912
Share of commuter							**4%**	**96%**

Once we have defined Factors A and B, we can estimate future commuter numbers for both ferries and bridges. The total number of commuters forecasted for 2050 is expected to reach 440,241 for both modes of transport. This means that around 4% of commuters will rely on ferries, while 96% will use the bridge.

Table 4-12 Projected ferry commuter traffic in 2050

Year	Total Ferry commuters	Factor A
2022	16,062	0.005
2035	18,755	
2050	**19,330**	

In 2022, the percentage shares of ferry commuters for each service projected for 2050 are as follows: 37% by Svay Chrum Ferry, 47% by Arey Kasat Ferry, and 17% by Kohdach Ferry. Overall, the total number of ferry commuters is projected to reach 19,330 in 2050.

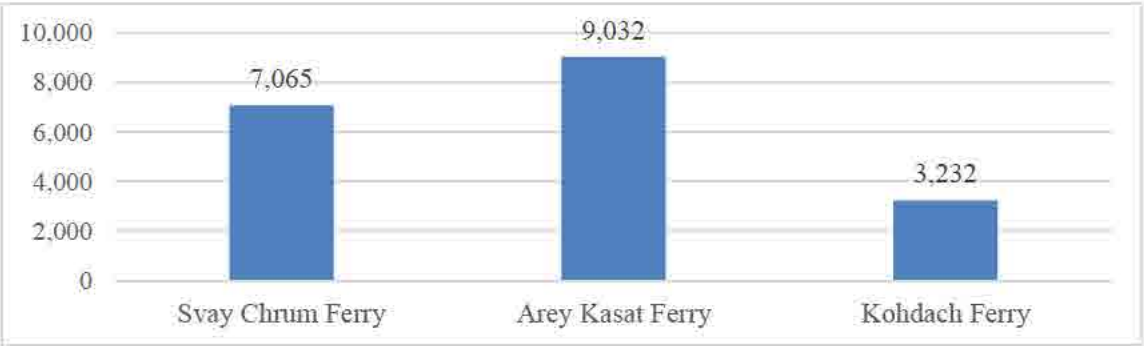


Figure 4-23 The number of ferrry commuters by route in 2050

(3) Estimating the required volume of port facilities (Ferry)

The ferry services at Svay Chrum Ferry, Arey Kasat Ferry, and Kohdach Ferry within Phnom Penh city on the Mekong River are generally operated daily, starting early in the morning and running until the evening, covering about 6 hours per day (3 hours in the morning and 3 hours in the evening). A ferry usually accommodates around 40 to 60 passengers plus several vehicles

(motorcycles, cars, and small trucks) simultaneously.[118]

Table 4-13 Annual ferry capacity per berth

Estimation	
(a) The average number of passengers per trip	50
(b) Daily working hours (hour/day)	6
(c) Turnaround time (hour)	1
(d) The number of passengers in one hour, (passenger/hour), (a)*(c)	50
(e) Daily (passenger/day/berth), (b)*(d)	300
(f) The number of working days per year (day/year)	365
(g) Annual ferry boat capacity per berth (passenger/year/berth), (e)*(f)	**109,500**

To estimate the number of berths needed for ferry services, we first determine the ferry's capacity for passenger and vehicle capacity per trip. Next, calculate daily operations by identifying the number of trips made each day and estimate the annual demand based on operational days. Finally, calculate the number of berths per ferry location by dividing the total annual passenger demand by the ferry's annual capacity.

Table 4-14 Required berths for commuters by ferry (Phnom Penh)

Ferry location	Passenger (Round trip)	Required berths	The round number of berths
Svay Chrum Ferry	7,065	0.06	1
Arey Kasat Ferry	9,032	0.08	1
Kohdach Ferry	3,232	0.03	1
Total			**3**

The ferries are 20 to 25 meters in length and 6 to 8 meters in width. They feature a flat vehicle deck with ramp access on both sides, facilitating easy loading and unloading of passengers and vehicles. This design is common in ferries, ensuring efficient operations and providing a smooth transition between the ferry and the docks.



Figure 4-24 Images of ferry crossing the Mekong river[119]

[118] Source: Mekong Space
[119] Source: Khmer Times

(4) Issues to be considered

a) When forecasting demand for ferries in Phnom Penh, we concentrate on three specific locations. This focus is necessary due to the limited data available for other ferry locations in Cambodia.

b) There are several challenges in forecasting commuter demand in Cambodia. Cities are constantly changing, which affects how people travel. Additionally, there isn't enough information available to make accurate predictions. People's travel habits are evolving, making it tough to keep up. Furthermore, the construction of new roads and bridges may lead to less interest in using ferries in the future.

4.2 Fishery port

4.2.1 Present level of fisheries production

According to MAFF, annual fish consumption in Cambodia is 52.4 kg per capita which includes consumption of all edible parts of the fish, not just the meat. This is consistent with traditional Cambodian habits where people consume fish heads, fins, and internal organs as well, especially in rural areas. [120]

Based on the real situation in Cambodia's fisheries sector, the total fisheries volume is divided into several main categories, reflecting Cambodia's diverse sources of fish production and utilization:

- Inland Fisheries Production: This includes large- and medium-scale commercial fishing, as well as family fisheries and rice field fisheries. In Tonle Sap Great Lake, inland fisheries are critical to Cambodia.
- Marine Fisheries Production: Fishing activities in coastal and marine waters form another important source of fish, although overall marine production is smaller compared to inland fisheries.
- Aquaculture: Aquaculture has rapidly expanded in recent years and now accounts for about 40.7% of Cambodia's total fisheries production.

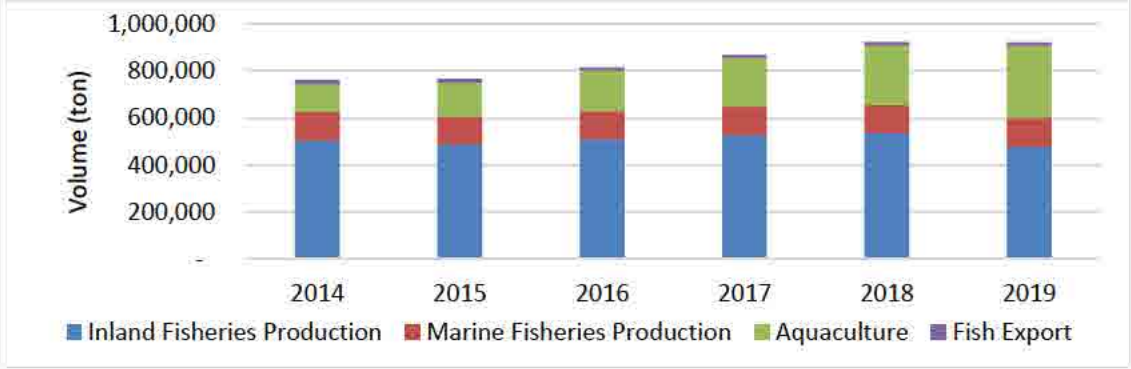


Figure 4-25 Present production levels of Cambodia's fisheries [121]

Fish consumption in Cambodia is based on a strong tradition of artisanal and small-scale fishing combined with community conservation efforts, making fish a vital, culturally embedded food with significant reliance on sustainable local practices.

[120] Source: Southeast Asian Fisheries Development Center
[121] Source: Statistical year book of Cambodia 2021, National Institute of Statistic of Ministry of Planning

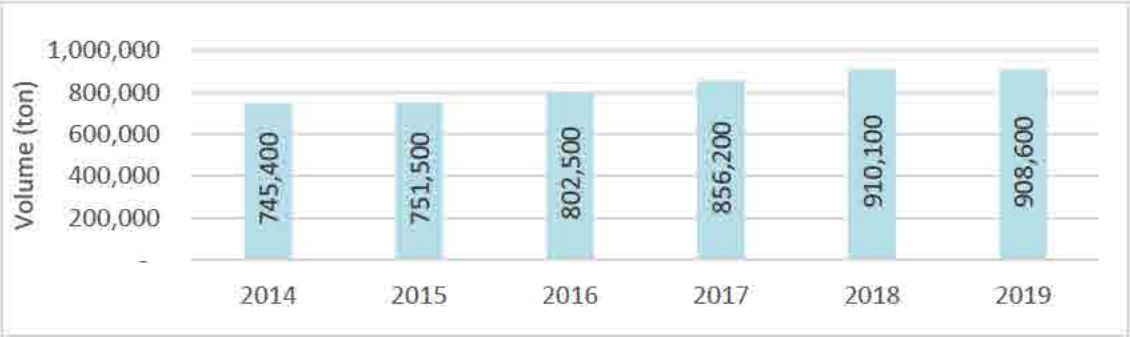


Figure 4-26 Fish consumption in Cambodia[122]

4.2.2 Future projection of fishery consumption

In Cambodia, people consume an average of 52.4 kg of fish per person each year. With the population growing from 16 million in 2019 to 21 million by 2050, total fish consumption is projected to increase from 908,600 tons in 2019 to 1,138,571 tons in 2050. Fish consumption comes from different sources: 20% is imported from inland fisheries, 34% from marine fisheries along the coast, and the rest from domestic fisheries, which includes about 45% from aquaculture (fish farming).

For domestic fisheries, we can estimate the number of ports needed by considering the remaining fish after accounting for aquaculture. Fishermen usually take their farmed fish directly to the market, so they don't need port facilities. This direct transport helps keep the fish fresh and reduces handling time. However, for inland and marine fisheries, fishermen do use ports to unload their catch. At the ports, the fish are sorted, processed, and stored before being distributed. This process is important for maintaining quality and meeting regulatory standards before the fish reach consumers.

Table 4-15 Summary of fish consumption demand in 2050

	Actual volume in 2019(ton)	Estimation in 2050 (ton)	Increase rate (2050/2019)
Population	16,078,666	21,728,446	1.35
(a) Total Fishing consumption	908,600	1,138,571	1.25
(b) Fishery imported (inland), 20%	181,720	227,714	1.25
(c) Fishery imported (marine), 34%	308,924	387,114	1.25
(d) Domestic (Aquaculture + inland) fish, (d)=(a)-(b)-(c)	417,956	523,742	1.25
(e) Aquaculture, (e)= 45%* (d)	188,080	235,684	1.25
(f) Domestic fisheries minus aqaculture, (f)=(d)-(e)	229,876	288,058.35	1.25

[122] Source: Statistical year book of Cambodia 2021, National Institute of Statistic of Ministry of Planning

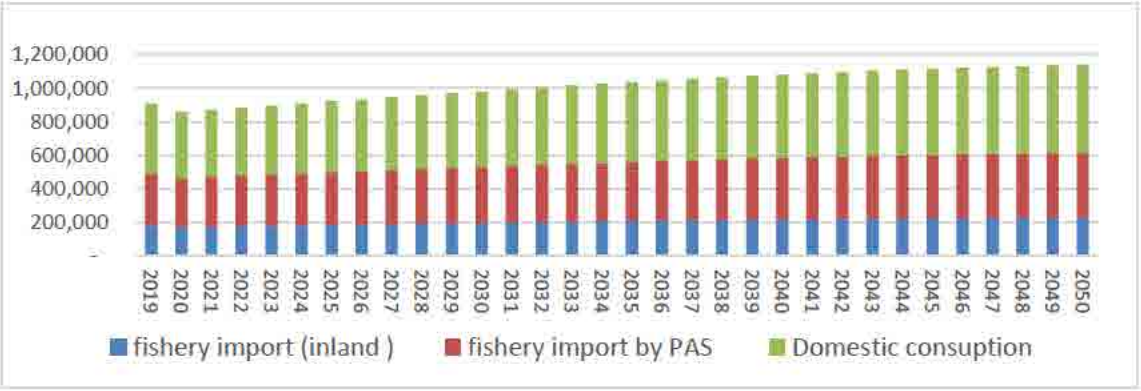


Figure 4-27 Forecast fish consumption to 2050

4.2.3 Allocation of fishery port

To allocate the fisheries demand for each province, we consider the percentage share based on the population of each province and its fish consumption. For 2050, the fisheries demand will be divided among provinces. Additionally, we will categorize the domestic fisheries demand into zones such as coastal, lower Mekong, upper Mekong, Tonle Sap, and a special zone. The total demand will then be split based on supply, with imports set at 20% for inland fisheries and 34% for marine fisheries, meaning domestic fisheries must cover the remaining 46%. Importantly, this domestic supply will be further divided, with 45% of the domestic requirement expected to come from aquaculture (fish farming).

Table 4-16 Fishery demand volume share by provinces in 2050

Zone	Province	Share of Population in 2050 (%)	Total demand fish in 2050 (ton)	Import (inland fisheries) in 2050 (ton)	Import (Marine fisheries) in 2050 (ton)	Domestic fisheries in 2050 (ton)	Fisheries Aquaculture in 2050 (ton)	Domestic fisheries minus aquaculture in 2050 (ton)
		i	a=total fishery demand*i	b= 20%*a	c=34%*a	d=a-b-c	e=45%*d	f=d-f
1	Kampot	3.82%	43,482	8,696	14,784	20,002	9,001	11,001
	Kep	0.27%	3,123	625	1,062	1,437	647	790
	Koh Kong	0.81%	9,217	1,843	3,134	4,240	1,908	2,332
	Preah Sihanouk	2.00%	22,760	4,552	7,738	10,469	4,711	5,758
2	Kampong Thom	4.38%	49,893	9,979	16,964	22,951	10,328	12,623
	Kratie	2.41%	27,434	5,487	9,328	12,620	5,679	6,941
	Mondul Kiri	0.59%	6,750	1,350	2,295	3,105	1,397	1,708
	Preah Vihear	1.64%	18,655	3,731	6,343	8,581	3,862	4,720
	Ratanak Kiri	1.40%	15,919	3,184	5,412	7,323	3,295	4,027
	Stung Treng	1.07%	12,131	2,426	4,125	5,580	2,511	3,069
3	Banteay Meanchey	5.54%	63,094	12,619	21,452	29,023	13,060	15,963
	Battambang	6.41%	72,998	14,600	24,819	33,579	15,111	18,468
	Oddar Meanchey	1.77%	20,207	4,041	6,870	9,295	4,183	5,112
	Pailin	0.48%	5,499	1,100	1,870	2,529	1,138	1,391
	Pursat	2.70%	30,743	6,149	10,452	14,142	6,364	7,778
	Siem Reap	6.52%	74,247	14,849	25,244	34,154	15,369	18,784
4	Kampong Chhnang	3.39%	38,581	7,716	13,118	17,747	7,986	9,761
	Kampong Speu	5.64%	64,239	12,848	21,841	29,550	13,297	16,252
	Takeo	5.79%	65,951	13,190	22,423	30,338	13,652	16,686
5	Kampong Cham	5.79%	65,869	13,174	22,396	30,300	13,635	16,665
	Prey Veng	6.80%	77,430	15,486	26,326	35,618	16,028	19,590
	Svay Rieng	3.38%	38,469	7,694	13,079	17,696	7,963	9,733
	Tboung Khmum	4.99%	56,869	11,374	19,335	26,160	11,772	14,388
6	Kandal	7.73%	87,962	17,592	29,907	40,462	18,208	22,254
	Phnom Penh	14.67%	167,050	33,410	56,797	76,843	34,579	42,264
Total of fishery port			1,138,571	227,714	387,114	523,742	235,684	**288,058**

4.2.4 Estimating the required volume of port facilities (Fishery port)

Fishermen fish at night and return in the morning. Our estimates indicate that a fishery port can accommodate approximately 30 boats each day. Each boat can carry about 1.5 tons of fish. The overall capacity of a fishery port is estimated at 45 tons per day, which is calculated by multiplying the fishing boat capacity by the number of boats. Ports operate year-round, 270 days a year. Fisheries are generally not allowed to operate from July to September in many northern provinces and water areas to protect and replenish fish populations.

Table 4-17 Annual capacity of a fishing port

Estimation	
(a) Fishing boat capacity (ton/boat)	1.5
(b) Fishery port per day (boat/day)	30
(c) Fishery port capacity per day (ton/day), (a)*(b)	45
(d) Operation of fishery port (day/ year)	270
(f) Fishing boat capacity (ton/year/port), (c)*(d)	**12,150**

It's important to note that we do not consider fish demand from aquaculture, as fishermen transport their catch directly to the market. This direct transport often eliminates the need for port facilities, helping to maintain freshness and reduce handling time. In contrast, for inland and marine fisheries, fishermen dock at ports to unload their catch. At the port, the fish are sorted, processed, and stored before distribution.

Table 4-18 The required number of fishing ports

Zone	Province	Share of Population in 2050 (%)	Total domestic fishery demand	Demand fish of aquaculture in 2050 (ton)	Demand domestic fish of Inland and Marine in 2050 (ton)	Fish demand each port zone (ton)	The number of fishery port Calculated	The round number of fishery port
		(i)	(ii)=46%* total fishery) *(i)	(iii)=45%*(ii)	(iv)=(ii)-(iii)	(v)	(vi)=(v)/(f)	
1	Kampot	3.82%	20,002	9,001	11,001	19,881	1.64	2
	Kep	0.27%	1,437	647	790			
	Koh Kong	0.81%	4,240	1,908	2,332			
	Preah Sihanouk	2.00%	10,469	4,711	5,758			
2	Kampong Thom	4.38%	22,951	10,328	12,623	33,088	2.72	3
	Kratie	2.41%	12,620	5,679	6,941			
	Mondul Kiri	0.59%	3,105	1,397	1,708			
	Preah Vihear	1.64%	8,581	3,862	4,720			
	Ratanak Kiri	1.40%	7,323	3,295	4,027			
	Stung Treng	1.07%	5,580	2,511	3,069			
3	Banteay Meanchey	5.54%	29,023	13,060	15,963	67,497	5.56	6
	Battambang	6.41%	33,579	15,111	18,468			
	Oddar Meanchey	1.77%	9,295	4,183	5,112			
	Pailin	0.48%	2,529	1,138	1,391			
	Pursat	2.70%	14,142	6,364	7,778			
	Siem Reap	6.52%	34,154	15,369	18,784			
4	Kampong Chhnang	3.39%	17,747	7,986	9,761	42,699	3.51	4
	Kampong Speu	5.64%	29,550	13,297	16,252			
	Takeo	5.79%	30,338	13,652	16,686			
5	Kampong Cham	5.79%	30,300	13,635	16,665	60,375	4.97	5
	Prey Veng	6.80%	35,618	16,028	19,590			
	Svay Rieng	3.38%	17,696	7,963	9,733			
	Tboung Khmum	4.99%	26,160	11,772	14,388			
6	Kandal	7.73%	40,462	18,208	22,254	64,518	5.31	6
	Phnom Penh	14.67 %	76,843	34,579	42,264			
Total		**100.00 %**	**523,742**	**235,684**	**288,058**	**288,058**		**26**
Total of fishery port								**26**

This step is crucial for maintaining quality and complying with regulatory standards before the fish reach consumers. Then, we divide the total demand among the fishery port zones using the annual fishing boat capacity per fishery port set under the estimate conditions. Fishery ports include facilities such as cold storage, auction halls, slipways (for maintaining boats), etc. One fishery port, we assume, has ten fishing boats, with a cold storage, an auction hall, and so on.

A fishery port has several important features to ensure that fish are handled properly and kept fresh. Here are the key components:

- Cold Storage: This is a facility where fish are stored at low temperatures. Keeping fish cold is crucial for maintaining their freshness and quality. It helps preserve the catch until it can be processed or sold.
- Auction Hall: This is a special area where fishermen can sell their catch. In the auction hall, fish are sold to buyers through bidding. This process helps ensure fair prices for both sellers and buyers.
- Processing Facility: This area is for cleaning, processing, and packaging fish. It ensures that fish are prepared properly before they reach the market.
- Slipway: A slipway is a structure that helps with launching and maintaining fishing boats. It makes it easier to take boats in and out of the water.

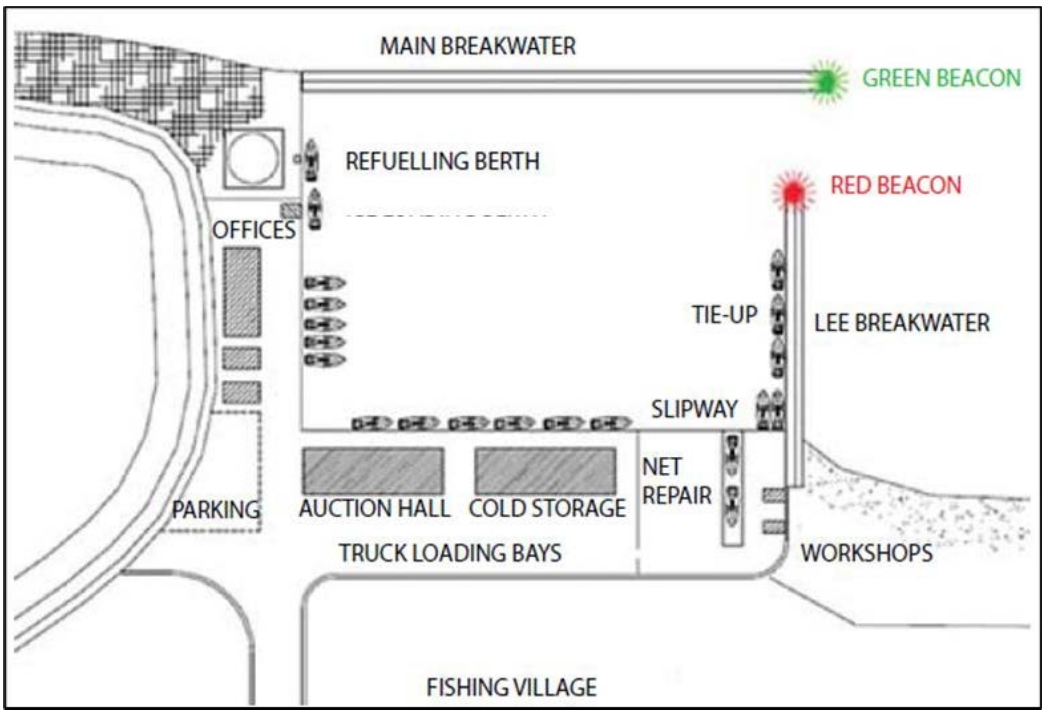


Figure 4-28 Coastal fisheries harbour[123]

[123] Source: Fishing harbour planning construction and management

A fishery port can accommodate up to 30 boats, each with a capacity of 1.5 tons. Operating every day of the year, the port can handle a total of 12,150 tons of fish annually. The berths are designed with a length of 20 meters, while each fishing boat is 3.5 meters wide and has an overall length of 16 meters[124].

4.2.5 Issues to be considered

a) Our main concern is meeting the demand for fish consumption in Cambodia. We have not considered any limits on natural resources.
b) Changes in weather, such as floods, rising water temperatures, and low water levels during dry seasons, affect how fish move, breed, and grow. These climate changes make it hard to predict future fish supplies.
c) Loss of wetlands, pollution, and damage to fish habitats also reduce fish productivity. We need to consider these factors when making predictions to avoid overestimating fish supplies.
d) In Cambodia, there is a lack of reliable data on fish stocks, catch rates, and the health of ecosystems. This makes it difficult to forecast fish demand accurately.

[124] Interview with fisherman

Chapter-5 Estimation of Modal choice for Demand Forecast

In this chapter, we will discuss how to allocate the cargo in each province and how to select transportation mode (river or road) from/to each zone.

5.1 Modal choice method from/to each zone

The total volume of cargo generation/consumption by province in 2050 was obtained in the previous chapter. The project volume includes container, bulk cargo (Agriculture, Energy, Mineral resources), cruise ship, passenger ship and fish catch. Table 5-1 shows the demand forecast results by cargo items. In this chapter, we will estimate the modal choice of the estimated cargo volume from/to each zone.

Table 5-1 Demand forecast results by cargo item from/to Cambodia

Cargo items	Sub items	Base year volume	Base year	Estimation volume in 2050	Import/ Export	Unit	Estimation method	Mode
Container (General)		1,063,148	2024	4,764,731	Total	TEU	Laden only	barge/trailer
		540,766	2024	1,992,806	Export	TEU	World's GDP elasticity, laden only	ditto
		522,382	2024	2,771,925	Import	TEU	Cambodia's GDP elasticity, laden only	ditto
Container (Agriculture)		0		863,755	Total	TEU	Laden only	ditto
		0		749,605	Export	TEU	Trend analysis and national policy, laden only	ditto
		0		114,150	Import	TEU	Ditto	ditto
Container (Fishery)		0		23,060	Import	TEU	Fish consumption based on population growth, laden only	ditto
Container (Total)		1,063,148		5,651,546	Total	TEU	Laden only	ditto
		540,766		2,742,411	Export	TEU	ditto	ditto
		522,382		2,909,135	Import	TEU	ditto	ditto
Agriculture	Paddy	5,180,155	2024	4,191,401	Export	Ton	trend analysis	barge/truck
	Milled Rice	675,642	2024	1,350,667	Export	Ton	trend analysis	Ditto
	Fresh Cassava	13,051,754	2024	2,488,945	Export	Ton	Cassava association interview	Ditto
	Starch Cassava	60,525	2024	1,333,364	Export	Ton	Cassava association interview	Ditto
	Cassava slice	964,682	2024	3,111,182	Export	Ton	Cassava association interview	Ditto
	Cassava residue	33,153	2024	177,782	Export	Ton	Cassava association interview	Ditto
	Mango	97,628	2020	2,178,695	Export	Ton	trend analysis	Ditto
	Cashew nut	363,476	2022	1,305,427	Export	Ton	National policy	Ditto
	Rubber	338,000	2024	132,168	Export	Ton	Policy of rubber	Ditto
	Banana	367,412	2022	367,412	Export	Ton	Select peak year data	Ditto
	Fertilizer	135,775	2022	228,677	Import	Ton	Fertilizer-Paddy Rice Production	Ditto
	Cereal	216,457	2023	198,395	Import	Ton	Cereal- Population growth	Ditto
	Timber	1,720,400	2019	1,598,101	Import	Ton	Timber- follow the GDP growth rate	Ditto
	Sub total	23,205,059		18,662,216		Ton		
Energy	Coal	4,620,431	2023	7,952,041	Import	Ton	Contingency Generation Plan / Installed Power Capacity, MME+ Cement Demand Forecast	tanker/truck
	LNG	0	2021	4,324,548	Import	Ton	Contingency Generation Plan / Installed Power Capacity, MME	Ditto
	Fuel oil	117,000	2023	117,000	Import	Ton	Contingency Generation Plan / Installed Power Capacity, MME	Ditto
	Diesel	1,792,700	2021	5,737,951	Import	Ton	Diesel-GDP elasticity	Ditto
	LPG	325,600	2021	4,470,776	Import	Ton	LPG-GDP elasticity	Ditto
	Gasoline	636,400	2021	2,705,322	Import	Ton	Gasoline-GDP elasticity	Ditto
	Jet fuel	67,100	2021	2,946,988	Import	Ton	Jet Fuel-GDP elasticity	Ditto
	Lubricant	13,400	2021	22,286	Import	Ton	Lubricant-GDP elasticity	Ditto
	Black oil	33,500	2021	124,884	Import	Ton	GDP increasing	Ditto
	Sub total	2,985,700		28,401,796		Ton		
Mineral resources	Gypsum	348,869	2023	2,182,080	Import	Ton	Gypsum-GDP elasticity	barge/truck
	Sand	28,000,000	2023	45,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	barge
	Bauxite mining	-	-	10,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	barge/truck
	Iron ore	5,000,000	2024	9,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	Barge
	Mable mining	-	-	3,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	Barge
	Pebbles	-	-	1,000,000	Export	Ton	Mines exploring Company and validate by MPWT.	barge/truck
	Manganese ore	40,012	2023	40,012	Export	Ton	Selected the highest of history data	Barge
	Stone	10,651,924	2024	11,664,644	Export	Ton	Assumed increasing rate 0.35%	Barge
	Sub total	44,040,805		81,886,736		Ton		
Cruise	Inland waterway	746	2024	2,797		# of call	Assumed increasing rate 8%	Cruise ship
		36,312	2024	531,430		# of passenger		Ditto
	Seashore (PAS)	23	2024	233		# of call	Assumed increasing rate 8%	Ditto
		19,448	2024	246,196		# of passenger		Ditto
	Seashore (Kampot)	-	-	3,333		# of call	China-aided Project of the Intermodal Transport Master Plan for Cambodia	Ditto
		-	-	1,000,000		# of passenger		Ditto
	sub total (#of calls)	769		6,363		# of call		
	sub total (#of passengers)	55,760		1,777,626		# of passenger		
Commuter		16,062	2022	19,330	Domestic	Passengers	Population growth	Ferry
Fishery		601,200	2019	753,366	Domestic	Ton	Fish consumption based on population growth	Fishing boat
GDP		47.6	2030	118.2		B. US$	Modified GDP growth rate based on Pentagonal strategy	
Population		16,078,660	2019	21,728,446			National policy	

5.1.1 Types of modal choice models

When determining modal choice, a logit model is commonly used for container cargo, while an individual port selection model is developed for bulk cargo. In Cambodia, container cargo is already a well-established commercial practice. Reliable import and export statistics are available, which enable us to develop a logit model that can be accurately calibrated. On the other hand, statistical data for bulk cargo is extremely limited and does not cover whole Cambodian provinces. The available data is not sufficient to develop a logit model. Therefore, we estimated the volume of bulk cargo based on survey results from cargo owners, forwarders, and by setting transportation methods, routes, and inland waterway share by province. Figure 5-1 shows a conceptual diagram of the two estimation methods.

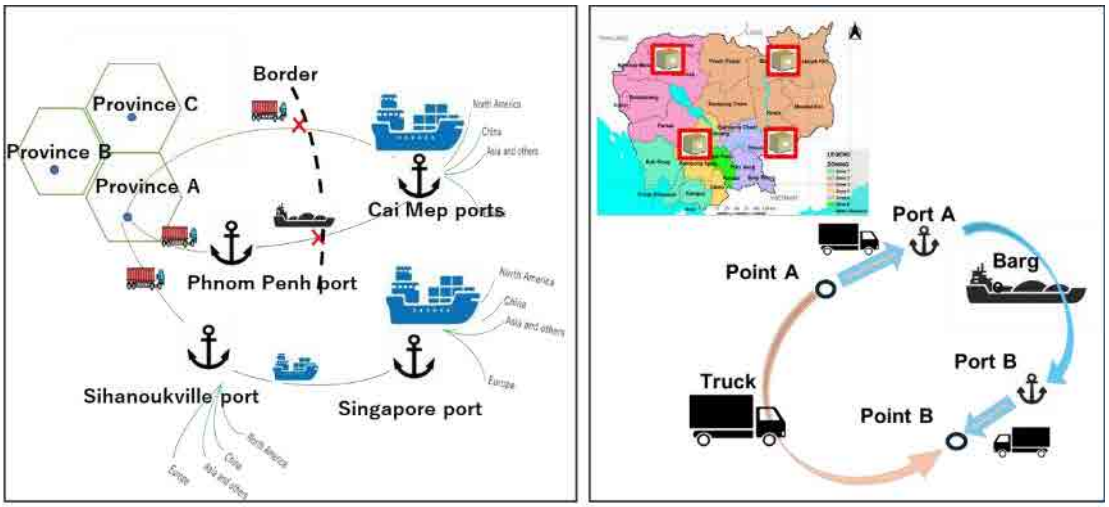


Figure 5-1 Conceptual diagram of estimation methods (left: Logit model, right: Individual port selection model)

5.1.2 Selection of bulk transport cargo

When applying the modal choice to the cargo, we separate the cargo items into two packing types: container cargo and bulk cargo. Based on interviews with a producer and forwarders, we separate the cargo by cargo packing type as shown in Table 5-2.

Table 5-2 Packing type of container and bulk

Packaging Type	Export/Import	Cargo item
Container	Export	Agriculture goods: Milled rice, Starch cassava, Cassava slice, Cassava residue, Mango, Cashew nut, Banana, Rubber products Mineral resources: Marble
	Import	Agriculture goods: Timber
Bulk	Export	Agriculture goods: Paddy, Raw rubber Mineral resources: Bauxite, Iron ore, Manganese ore, Pebbles, Sand, Stone
	Import	Agriculture goods: Cereal, Fertilizer Energy: Diesel, Gasoline, liquefied petroleum gas (LPG), Lubricant

It should be noted that the following cargoes are directly consumed in the seaport area or transported by truck or pipelines. Therefore, these cargoes are excluded from the modal choice study.

a. Fresh cassava: this fruit must be processed within 24 hours after harvesting. Cargo is transported by trucks to a processing factory in Vietnam or Thailand.
b. Coal, LNG, Fuel oil: these cargoes are stored in a tank or burned as fuel in power plants just behind the seaports.
c. Jet fuel: this cargo is delivered to airports by tank trailers.
d. Black oil: this cargo is mainly used for vessel fuel. A fuel tank is generally located near the seaports.
e. Sand: this cargo is dredged in the Mekong River and directly transported to Vietnam by barges.
f. Gypsum: this cargo is used in cement plants by truck, primarily in seashore provinces like Kampot.

5.2 Overview of inland waterways in Cambodia

5.2.1 Navigation conditions in the Mekong River System

Before discussing model choice in the Mekong River System, we will briefly review the navigation conditions of the Mekong River System. The total length of navigable inland waterways, including the Mekong River, the Tonle Sap River, and the Tonle Sap Lake, is approximately 1,750 km. The breakdown is as follows: Mekong River 30%, Tonle Sap River 15%, Bassac River 5%, and other tributaries 50%[125]. Figure 5-2 shows the status of rivers and lakes in Cambodia, with major ports and port facilities indicated by anchor marks, and the starting and ending points of major river and lake sections marked by black circles.



Figure 5-2 Rivers, lakes, and major ports/port facilities in Cambodia

The navigable vessel sizes for each river and lake section are shown in Table 5-3. On the Mekong River, vessels over 2,000 DWT can navigate year-round up to UM2, and on the Tonle Sap River up to Kampong Chhnang. However, upstream of these points, only small vessels of less than 100 DWT can navigate. Similarly, on the Bassac River from Takeo to Phnom Penh, only small vessels of less than 50 DWT can navigate. It should be noted that among the major ports and port facilities, Kampong Chhnang is currently in the planning stage.

[125] Source: ESCAP HP, International conference on Sustainable Inland Waterway Transport (IWT) Development (8 June 2024), https://www.unescap.org/sites/default/d8files/event-documents/14-Cambodia.pdf

Table 5-3 Current navigable vessel sizes for each section

Stretch	Navigable vessel size	
	Rainy season	Dry season
Stung Treng～Kratie	50DWT	20DWT
Kratie～UM2	400DWT	80DWT
UM2～Phnom Penh～LM26	4,000DWT	2,000DWT
Chong Khneas～Kampong Chhnang	150DWT	20DWT
Kampong Chhnang～Phnom Penh～LM26	4,000DWT	2,000DWT
Takeo～Phnom Penh	50DWT	20DWT

5.2.2 Cargo movement in the river

At Phnom Penh port, the volume of container cargo transported by barges between Cambodia and Vietnam through the Mekong River has steadily increased in recent years. In addition, at LM26, developed on the lower Mekong River near the Vietnamese border, paddy is exported to Vietnam using small barges (200-300 DWT class). Table 5-4 shows the annual handling volume of paddy and the number of vessels calling at LM26 from 2022 to 2024, in which a steady annual increase is observed. Figure 5-3 depicts the loading of paddy onto barges observed during a site visit in January 2025.

Table 5-4 The annual paddy handling volume and the number of vessel calls at LM26

Year	2022	2023	2024
Cargo volume (tons)	28,928	61,840	90,197
The number of vessels calling (vessels)	169	363	527
Deadweight Tonnage (DWT)	200-300	200-300	200-300

Source: Obtained from Phnom Penh Autonomous Port (PPAP)



Source: Obtained from stakeholders involved in paddy exports

Figure 5-3 Loading of paddy at LM26

On the other hand, the use of inland waterway transport upstream of Phnom Penh Port remains limited. In 2024, container transport of marble and bulk transport of cereal between Phnom Penh and UM2 was initiated. Figure 5-4 shows the unloading of cereal from a barge at UM2 in March 2025.



Figure 5-4 Unloading of cereal by bag at UM2

Inland waterway transport enables mass transportation, making it more cost-efficient than trucking while also offering environmental advantages. The Cambodian government recognizes these benefits and envisages that 35% of Cambodia's total trade volume will be via waterway transport in the "Framework of Development and Management River Port Investment in Cambodia[126]".

5.2.3 Inland waterway in Vietnam

By contrast, in neighboring Vietnam, inland waterway transport has developed significantly, particularly in the Mekong River Delta in the south and the Red River (Hong River) Delta in the north, becoming one of the country's important freight transport modes. The total length of Vietnam's inland waterways is 26,500 km. In the southern region centered on Ho Chi Minh City, a network of waterways is developed around the Mekong River. Furthermore, recognizing that inland waterway development lags behind road development in Vietnam, the government has been promoting inland waterway development, strengthening initiatives, and increasing government budget allocations through a Prime Ministerial Decision issued in October 2015.

The volume of cargo handled by each transport mode in Vietnam is available on the National Statistics Office website under the "Statistical Yearbook of 2023[127]." Table 5-5 and Table 5-6 show the data from 2015 to 2023, with IWT modal share added for each year. In recent years,

[126] The Framework of Development and Management River Port Investment in Cambodia (Draft), Royal Government of Cambodia, 2025
[127] Source: National Statistics Office HP, https://www.nso.gov.vn/en/default/2024/07/statistical-yearbook-of-2023/

Vietnam's IWT share in tonnage and in ton-kilometers has plateaued at around 16%. This stagnation at approximately 16%, even in Vietnam where inland water transport is already well developed and the government actively promotes its development, is a factor that must be considered when setting Cambodia's IWT share.

Table 5-5 Cargo volume handled by transport mode (ton base) in Vietnam

(thous.ton)

Year	IWT	Road	Railway	Maritime	Aviation	Total	IWT share
2015	201,530.7	882,628.4	6,707.0	60,800.0	229.6	1,151,895.7	17.5%
2016	215,768.2	969,721.0	5,209.0	64,474.4	285.6	1,255,458.2	17.2%
2017	232,813.8	1,074,450.9	5,611.0	70,019.2	317.9	1,383,212.8	16.8%
2018	251,904.6	1,207,682.8	5,717.7	73,562.2	404.4	1,539,271.7	16.4%
2019	268,026.5	1,319,853.4	5,204.7	77,088.4	446.4	1,670,619.4	16.0%
2020	257,841.5	1,282,119.6	5,216.3	76,086.2	272.4	1,621,536.0	15.9%
2021	242,365.8	1,303,327.9	5,660.0	69,961.3	283.9	1,621,598.9	14.9%
2022	331,918.0	1,594,700.8	5,692.2	97,945.4	281.9	2,030,538.3	16.3%
2023	390,654.0	1,842,204.1	4,639.2	113,415.7	328.8	2,351,241.8	16.6%
						Average=	**16.4%**

Table 5-6 Cargo volume handled by transport mode (ton-kilometers base) in Vietnam

(mill.ton･km)

Year	IWT	Road	Railway	Maritime	Aviation	Total	IWT share
2015	42,064.8	51,514.9	4,035.5	131,835.7	4,041.3	233,492.2	18.0%
2016	44,925.2	57,377.3	3,198.2	135,171.2	4,752.5	245,424.4	18.3%
2017	47,800.4	63,459.3	3,616.7	140,307.7	5,047.8	260,231.9	18.4%
2018	52,580.4	71,010.9	4,039.3	144,629.2	5,643.4	277,903.2	18.9%
2019	55,998.1	76,529.1	3,739.5	154,753.2	6,218.7	297,238.6	18.8%
2020	52,862.2	73,503.2	3,819.0	152,586.7	3,562.0	286,333.1	18.5%
2021	24,768.6	75,272.8	4,099.9	70,130.3	14,051.1	188,322.7	13.2%
2022	33,053.1	94,155.3	4,546.5	95,407.8	6,089.6	233,252.3	14.2%
2023	36,937.4	107,008.4	3,717.0	107,915.1	8,338.7	263,916.6	14.0%
						Average=	**16.9%**

5.3 Container cargo port choice

Projected container volumes have already been provided in Section "Container- Demand forecast and container distribution".

5.3.1 Case setting for a modal choice simulation

In this section, we set the case for modal choice simulation on bulk cargoes as well as containers (Table 5-7).

Case 0: The current transportation condition in 2023. Land and inland water transportation is the same as in 2023.

Case 1: The future infrastructure projects aim to significantly improve Cambodia's logistics network.

a) Road upgrades (Ring Road 3 and NR4 rehabilitation) will reduce domestic travel time, cutting the Phnom Penh-Sihanoukville journey from 6 to 4 hours, and lowering overall transportation costs.
b) International connectivity is expected to improve with a 10% travel time reduction across the Cambodia-Vietnam-Thailand network, while port efficiency will increase by reducing vessel wait and dwell times.
c) Sihanoukville Port will become a deeper seaport by 2029 with the completion of three new container terminals (NCT-1, NCT-2, NCT-3), enabling it to accommodate larger mother vessels.

Case 2: Funan Techo canal will also be realized in addition to the road network and port operation improvement.

Case 3: A 3,000DWT or 5,000 DWT class vessel can navigate up to the upper Mekong River and Tonle Sap Lake in addition to the transport conditions in Case 2.

Note that Case 1 only serves as the reference case in the logit model to distinguish the effects of the "Funan Techo Canal Project" and "improvements to land transportation and port operations." The individual port selection model is not able to differentiate the results between Case 1 and Case 2.

Table 5-7 Case settings for the modal choice model

Logit model	Individual port selection	Remarks
Case 0	Case 0	Current transportation condition in 2023
Case 1	N/A	Port and road improvement without Funan Techo Canal
Case 2	Case 2	Port and road improvement with Funan Techo Canal
Case 3	Case 3	Entire canal and riverports development by MPWT

5.3.2 Export container port choice results

Table 5-8 and Table 5-9 shows which route export containers take from a province. We estimate that 1,992,806 TEUs of containers will be generated in 2050 as a base case. The containers will be distributed to possible ports by the logit model as discussed in Chapter 3. The destination ports and routes include the following five options: containers are transported to Sihanoukville port via Canal, containers are transported to Sihanoukville by truck, containers are transported to the Cai Mep ports via Phnom Penh port, containers are transported to the Cai Mep ports by trucks crossing the border, and containers are transported to Leam Chabang port by trucks crossing the border.

Table 5-8 Export container port choice（1/2）

Province	TEU	Sea port	TEU			
			Case 0	Case 1	Case 2	Case 3
Banteay Meanchey	7,167	SHV via Canal	-	-	3,547	4,447
		SHV direct	2,183	4,533	986	703
		Cai Mep via PPAP	3,214	1,712	2,428	1,788
		Cai Mep direct	918	488	108	37
		Leam Chabang	851	434	97	192
Battambang	4,276	SHV via Canal	-	-	2,101	2,489
		SHV direct	1,334	2,770	618	697
		Cai Mep via PPAP	1,964	985	1,441	975
		Cai Mep direct	606	321	72	44
		Leam Chabang	372	200	45	71
Kampong Cham	2,803	SHV via Canal	-	-	1,417	1,609
		SHV direct	797	1,873	391	525
		Cai Mep via PPAP	1,280	621	931	622
		Cai Mep direct	570	229	48	38
		Leam Chabang	157	80	17	9
Kampong Chhnang	43	SHV via Canal	-	-	21	24
		SHV direct	14	28	7	8
		Cai Mep via PPAP	20	10	14	9
		Cai Mep direct	7	3	1	1
		Leam Chabang	1	1	0	0
Kampong Speu	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Kampong Thom	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Kampot	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Kandal	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Kep	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Koh Kong	12,821	SHV via Canal	-	-	5,655	2,218
		SHV direct	6,181	9,561	2,933	9,620
		Cai Mep via PPAP	4,905	2,442	3,987	868
		Cai Mep direct	1,480	668	201	108
		Leam Chabang	255	150	45	7
Kratie	70,010	SHV via Canal	-	-	35,327	43,856
		SHV direct	18,659	44,245	9,269	6,255
		Cai Mep via PPAP	32,794	15,010	23,151	16,952
		Cai Mep direct	16,448	9,487	1,996	2,914
		Leam Chabang	2,110	1,267	267	33
Mondul Kiri	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-

Table 5-9 Export container port choice（2/2）

Province	TEU	Sea port	TEU			
			Case 0	Case 1	Case 2	Case 3
Oddar Meanchey	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Pailin	2,168	SHV via Canal	-	-	1,062	1,199
		SHV direct	738	1,490	328	435
		Cai Mep via PPAP	877	413	721	470
		Cai Mep direct	321	155	34	18
		Leam Chabang	232	110	24	46
Phnom Penh	1,275,638	SHV via Canal	-	-	597,338	514,339
		SHV direct	414,706	832,778	225,581	521,225
		Cai Mep via PPAP	609,313	322,520	420,128	200,191
		Cai Mep direct	223,498	102,293	27,701	38,807
		Leam Chabang	28,122	18,047	4,890	1,077
Preah Sihanouk	288,876	SHV via Canal	-	-	117,346	-
		SHV direct	166,502	219,075	78,129	265,119
		Cai Mep via PPAP	90,005	54,525	88,067	22,154
		Cai Mep direct	28,532	12,437	4,340	1,503
		Leam Chabang	3,837	2,839	993	99
Preah Vihear	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Prey Veng	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Pursat	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Ratanak Kiri	31,181	SHV via Canal	-	-	15,624	20,800
		SHV direct	8,614	20,246	4,189	1,806
		Cai Mep via PPAP	14,766	6,465	10,443	8,058
		Cai Mep direct	6,381	3,678	760	490
		Leam Chabang	1,420	792	164	27
Siemreap	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Stung Treng	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Svay Rieng	297,823	SHV via Canal	-	-	144,494	120,131
		SHV direct	71,367	175,868	43,820	58,674
		Cai Mep via PPAP	134,322	67,259	95,688	45,703
		Cai Mep direct	86,785	50,891	12,860	73,190
		Leam Chabang	5,349	3,805	961	126
Takeo	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
boung Khmu	-	SHV via Canal	-	-	-	-
		SHV direct	-	-	-	-
		Cai Mep via PPAP	-	-	-	-
		Cai Mep direct	-	-	-	-
		Leam Chabang	-	-	-	-
Total	1,992,806	Total	1,992,806	1,992,806	1,992,806	1,992,806

5.3.3 Import container port choice results

Table 5-10 and Table 5-11 show which route import containers take from seaports to each province. We estimate that 2,771,925 TEUs of containers will be consumed in 2050 as a base case. The containers will be distributed to possible provinces by the logit model as discussed in Chapter 3. The destination routes are comprised of the following five options: containers are transported to Sihanoukville port via Canal, containers are transported to Sihanoukville by truck, containers are transported to the Cai Mep ports via Phnom Penh port, containers are transported to the Cai Mep ports by trucks crossing the border, and containers are transported to Leam Chabang port by trucks crossing the border.

Table 5-10 Import container port choice（1/2）

Province	TEU	Sea port	TEU			
			Case 0	Case 1	Case 2	Case 3
Banteay Meanchey	101,970	SHV via Canal	-	-	58,452	68,355
		SHV direct	50,369	81,578	19,886	2,930
		Cai Mep via PPAP	16,507	14,965	23,380	30,229
		Cai Mep direct	29,720	5,116	163	70
		Leam Chabang	5,374	310	87	386
Battambang	122,868	SHV via Canal	-	-	65,196	79,875
		SHV direct	62,472	98,488	29,588	6,218
		Cai Mep via PPAP	20,543	18,175	27,740	36,299
		Cai Mep direct	38,028	6,091	303	175
		Leam Chabang	1,825	114	41	302
Kampong Cham	113,618	SHV via Canal	-	-	63,403	74,048
		SHV direct	55,940	93,330	24,367	6,285
		Cai Mep via PPAP	15,183	14,979	25,542	33,026
		Cai Mep direct	42,191	5,293	301	205
		Leam Chabang	304	15	4	54
Kampong Chhnang	87,278	SHV via Canal	-	-	41,962	53,377
		SHV direct	45,069	70,026	25,631	7,901
		Cai Mep via PPAP	16,287	13,951	19,350	25,707
		Cai Mep direct	25,889	3,298	333	265
		Leam Chabang	33	4	2	29
Kampong Speu	114,313	SHV via Canal	-	-	28,855	57,111
		SHV direct	62,164	94,125	62,660	24,169
		Cai Mep via PPAP	20,447	17,646	22,264	32,532
		Cai Mep direct	31,694	2,542	534	483
		Leam Chabang	9	1	1	18
Kampong Thom	84,596	SHV via Canal	-	-	40,586	54,348
		SHV direct	42,759	68,380	25,068	5,176
		Cai Mep via PPAP	13,144	11,811	18,559	24,845
		Cai Mep direct	28,623	4,399	380	197
		Leam Chabang	70	6	3	29
Kampot	96,648	SHV via Canal	-	-	16,650	42,461
		SHV direct	77,031	87,355	64,657	30,112
		Cai Mep via PPAP	16,611	8,995	15,079	23,802
		Cai Mep direct	3,001	298	261	261
		Leam Chabang	5	0	0	11
Kandal	171,601	SHV via Canal	-	-	58,408	90,846
		SHV direct	85,710	130,936	73,887	26,045
		Cai Mep via PPAP	34,861	32,975	37,031	52,815
		Cai Mep direct	51,018	7,688	2,273	1,869
		Leam Chabang	12	1	1	26
Kep	6,240	SHV via Canal	-	-	1,398	3,039
		SHV direct	4,285	5,459	3,737	1,557
		Cai Mep via PPAP	720	650	1,086	1,626
		Cai Mep direct	1,234	131	18	17
		Leam Chabang	0	0	0	1
Koh Kong	22,849	SHV via Canal	-	-	3,337	9,363
		SHV direct	15,977	20,762	16,131	7,995
		Cai Mep via PPAP	2,352	1,768	3,345	5,449
		Cai Mep direct	4,518	318	35	39
		Leam Chabang	1	0	0	3
Kratie	49,669	SHV via Canal	-	-	28,658	33,470
		SHV direct	23,291	37,393	9,210	1,303
		Cai Mep via PPAP	4,674	4,175	10,878	14,616
		Cai Mep direct	21,693	8,099	922	277
		Leam Chabang	11	1	0	3
Mondul Kiri	17,701	SHV via Canal	-	-	10,362	11,832
		SHV direct	8,197	13,042	3,094	526
		Cai Mep via PPAP	1,393	1,442	3,912	5,221
		Cai Mep direct	8,109	3,218	333	121
		Leam Chabang	2	0	0	1

Table 5-11 Import container port choice（2/2）

Province	TEU	Sea port	TEU			
			Case 0	Case 1	Case 2	Case 3
Oddar Meanchey	30,683	SHV via Canal	-	-	18,563	20,965
		SHV direct	14,394	24,394	4,964	525
		Cai Mep via PPAP	3,515	3,629	7,073	9,104
		Cai Mep direct	11,457	2,574	62	18
		Leam Chabang	1,317	87	22	71
Pailin	13,467	SHV via Canal	-	-	7,132	8,801
		SHV direct	6,925	11,526	3,321	705
		Cai Mep via PPAP	1,180	1,157	2,987	3,911
		Cai Mep direct	5,027	767	22	13
		Leam Chabang	334	17	5	36
Phnom Penh	964,687	SHV via Canal	-	-	293,879	505,378
		SHV direct	498,755	765,234	463,121	166,323
		Cai Mep via PPAP	186,177	171,932	201,221	287,270
		Cai Mep direct	279,686	27,514	6,460	5,557
		Leam Chabang	69	8	7	159
Preah Sihanouk	112,306	SHV via Canal	-	-	7,318	30,279
		SHV direct	98,487	103,455	92,409	58,463
		Cai Mep via PPAP	4,168	8,186	12,475	23,413
		Cai Mep direct	9,650	665	105	142
		Leam Chabang	1	0	0	10
Preah Vihear	31,716	SHV via Canal	-	-	17,060	21,362
		SHV direct	15,791	25,045	7,375	890
		Cai Mep via PPAP	4,501	4,200	7,136	9,408
		Cai Mep direct	11,335	2,465	142	44
		Leam Chabang	89	6	2	12
Prey Veng	105,566	SHV via Canal	-	-	54,759	66,283
		SHV direct	49,835	80,168	26,032	7,405
		Cai Mep via PPAP	15,614	13,837	22,641	30,590
		Cai Mep direct	40,110	11,559	2,133	1,278
		Leam Chabang	7	1	1	10
Pursat	67,042	SHV via Canal	-	-	35,353	43,051
		SHV direct	34,554	53,715	16,355	3,980
		Cai Mep via PPAP	12,145	10,251	15,133	19,828
		Cai Mep direct	20,202	3,062	196	128
		Leam Chabang	142	14	5	55
Ratanak Kiri	33,287	SHV via Canal	-	-	19,421	22,834
		SHV direct	15,553	25,313	6,073	516
		Cai Mep via PPAP	2,670	2,412	7,466	9,869
		Cai Mep direct	15,034	5,559	326	64
		Leam Chabang	29	2	1	4
Siemreap	106,877	SHV via Canal	-	-	52,747	71,985
		SHV direct	50,936	76,436	30,190	3,069
		Cai Mep via PPAP	3,455	508	23,463	31,583
		Cai Mep direct	28,013	15,783	443	115
		Leam Chabang	24,474	14,151	35	126
Stung Treng	26,437	SHV via Canal	-	-	16,224	18,225
		SHV direct	12,355	19,596	3,902	295
		Cai Mep via PPAP	2,155	2,188	5,971	7,856
		Cai Mep direct	11,898	4,652	340	57
		Leam Chabang	29	2	1	3
Svay Rieng	85,802	SHV via Canal	-	-	39,389	50,960
		SHV direct	38,339	61,868	24,463	6,646
		Cai Mep via PPAP	6,950	7,509	15,306	24,406
		Cai Mep direct	40,509	16,425	6,643	3,783
		Leam Chabang	3	0	0	7
Takeo	109,308	SHV via Canal	-	-	33,616	57,750
		SHV direct	56,733	88,084	52,867	19,526
		Cai Mep via PPAP	21,635	17,742	22,156	31,438
		Cai Mep direct	30,933	3,482	668	578
		Leam Chabang	7	1	1	16
Tboung Khmum	95,397	SHV via Canal	-	-	53,881	62,222
		SHV direct	45,445	72,649	18,941	4,497
		Cai Mep via PPAP	11,110	9,985	20,849	27,802
		Cai Mep direct	38,829	12,761	1,725	868
		Leam Chabang	13	1	1	8
Total	2,771,925	Total	2,771,925	2,771,925	2,771,925	2,771,925

5.4 Bulk cargo port choice

5.4.1 Setting the modal share of IWT for bulk cargo

(1) Seminar on modal choice survey

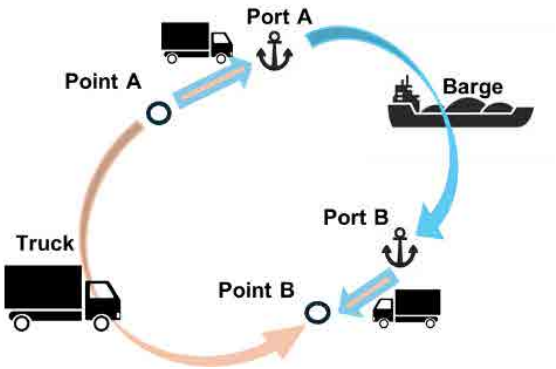
As mentioned in Section 5.2, the IWT use in Cambodia remains limited. Consequently, at present no data is available to statistically estimate modal share figures in the country. Therefore, the JICA expert team held a seminar to grasp the potential needs of IWT in Cambodia.

(2) Stakeholders' IWT preference survey

(a) Basic concept for determining stakeholders' level of interest in IWT

We established the following basic concept to survey stakeholders' level of interest in using IWT.

a. Seven major provinces were selected. We survey the preferred mode of transport between the seven provincial capitals (Stung Treng, Kratie, Kampong Cham, Battambang, Siem Reap, Kampong Chhnang, Takeo) and Phnom Penh. Figure 5-5 illustrates the two transportation methods. In this study, Point A represents the seven major provincial capitals, and Point B represents Phnom Penh.
b. Two transport methods were considered: by barge and truck or by truck only (railways were excluded for simplification).
c. As shown in the figure, truck transport involves direct overland haulage from Point A to Point B. In the case of barge transport, cargo is first moved by truck from Point A to the nearest river port (Port A), then transported by barge to Port B, and finally carried again by truck from Port B to Point B.
d. The figure also contains response fields designed to capture stakeholders' level of interest in the use of IWT. For both truck and barge transport, participants were asked to select their level of interest on a scale from 0 to 100%.
e. The target cargo items were Paddy (bulk cargo), milled rice (container), and others (bulk cargo or container).



Mode	0	10%	20%	30%	40%	50%	60%	70%	80%	90%	100 %
Truck							✓				
Barge					✓						

Figure 5-5 Example of response field on modal preference

(b) Travel time and freight rate settings

Furthermore, to allow participants to easily compare modes, the survey sheet provided examples transport distance, time, and freight rates from the seven major provincial capitals to Phnom Penh for each transport mode as described below.

- Barge

  Distance: Calculated based on materials prepared by the Cambodia National Mekong Committee. For the route from Takeo to Phnom Penh, which was not included in the materials, the distance was measured using Google Earth.

  Time: Calculated by dividing distance by the average barge speed, which was set at 10 km/hour based on published literature.

  Freight rate: Estimated through interviews with an operator currently transporting paddy from LM26 to Vietnam by barge. The calculation was based on the charter fee of a 300 DWT barge used by the operator, port handling charges, and actual transport performance.

- Truck

  Distance: Measured using Google Maps between the provincial capitals and the nearest river ports (including planned ports), as well as Phnom Penh port's LM17. The distance from LM17 to the final destination was assumed to be 10 km.

  Time: Calculated based on survey results commissioned from Nippon Express (Cambodia).

  Freight rate: Calculated based on the average freight rate for a 2.5-ton truck from a survey commissioned to Nippon Express (Cambodia).

(c) Navigation scenario settings for the modal preference survey

MPWT requested that the Funan Techo Canal development, currently in the pipeline, be included in the case settings. The same request was made for the development of river ports including the channel in Kampong Chhnang-Chong Khneas and UM2-Stung Treng sections, which allows 3,000 to 5,000 DWT class vessels to navigate. The Funan Techo Canal is scheduled to be open by 2028. On the other hand, the upper Mekong and Tonle Sap Lake development involves hydraulic difficulty that should be addressed in the future. JICA expert team does not unreservedly endorse this development.

Therefore, the JICA expert team prepared the following two navigation scenarios for the modal preference survey as shown in Table 5-12.
Navigation scenario 1: the vessel navigable condition is the same as the current condition.
Navigation scenario 2: MPWT will develop the Funan Techo Canal and upgrade river ports and channel up to Stung Treng (3,000 DWT class vessel) and Tonle Sap Lake (5,000 DWT class vessel).

Table 5-12 Channel navigation setting for the modal preference survey

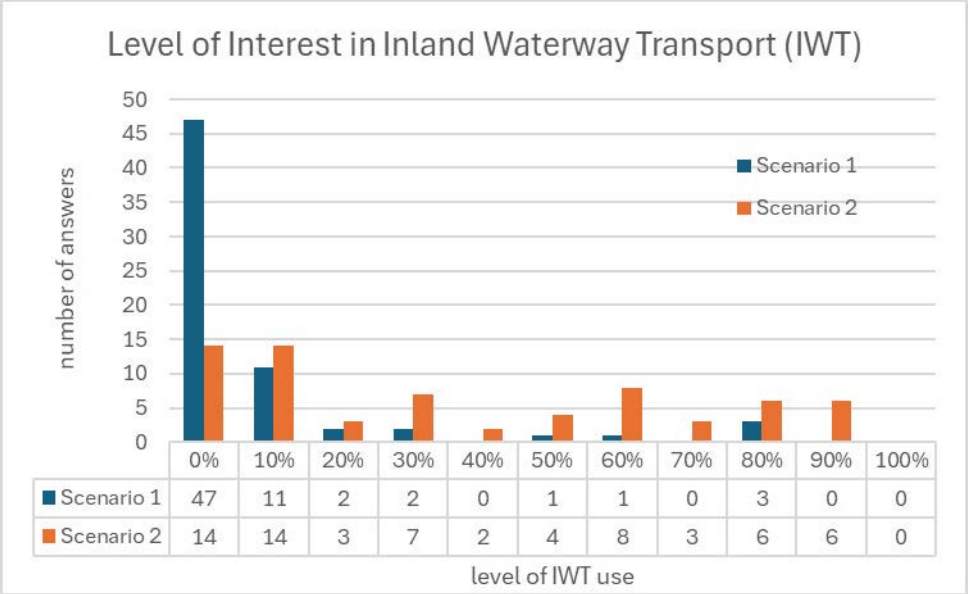
Stretch	Scenario 1		Scenario 2
	Rainy season	Dry season	All season
Stung Treng～Kratie	50DWT	20DWT	3,000DWT
Kratie～UM2	400DWT	80DWT	3,000DWT
UM2～Phnom Penh	4,000DWT	2,000DWT	5,000DWT
Chong Khneas～Kampong Chhnang	150DWT	20DWT	5,000DWT
Kampong Chhnang～Phnom Penh～LM26	4,000DWT	2,000DWT	5,000DWT
Takeo～Phnom Penh	50DWT	20DWT	5,000DWT
Kep～Phnom Penh (Funan Techo Canal)	N/A	N/A	5,000DWT

(3) Survey results and IWT modal share setting

A total of 67 answers were collected in this survey (see in Section Appendix-2). Figure 5-6 shows the distribution of interest levels of using IWT for each Navigation scenario. A steep profile can be observed. Forty-seven respondents answered that they had 0% interest in IWT use while 11 indicated a 10% interest in IWT use. Over 80% (58/67) of respondents indicated a level of interest between 0-10% in Navigation scenario 1.

On the other hand, if MPWT's channel development plan is realized in Navigation scenario 2, the profile becomes flattened. The stakeholders become interested in using IWT. The share of responses in the 0-10% interest range declined to about 40% (28/67), while the share of responses

the 50% or more interest range increased to the same number (27/67).



	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Scenario 1	47	11	2	2	0	1	1	0	3	0	0
Scenario 2	14	14	3	7	2	4	8	3	6	6	0

Figure 5-6 Level of interest in using IWT (67 responses)

In addition, we compared the level of IWT interest and transport distance in transporting paddy crop. Navigation scenario 1 shows that even though the level of IWT interest slightly increases it is still less than 20% in all distances. Average level of IWT interest is 7.0% (see Figure 5-7)

Navigation scenario 2 shows that even though the deviation is large, the level of IWT interest increases dramatically (see Figure 5-8). The line shows the level of IWT interest is 30% within a 100km radius and that is 90% within a 300km radius. Average level of IWT interest is 56.5%. In short, once a 3,000 DWT class vessel becomes navigable on Cambodia's rivers and lakes, the stakeholders show a positive interest to use the IWT.

Based on the above survey results, we set the level of IWT use below. As the volume of data is not sufficient to differentiate by distance, we will set a single number in each case to simplify the simulation. Note that the level of IWT use in Navigation scenario 2 is much higher than that in Vietnam where the river transport network stretches all over the country.

a) Level of IWT use in Navigation scenario 1 is 10%
b) Level of IWT use in Navigation scenario 2 is 60%.

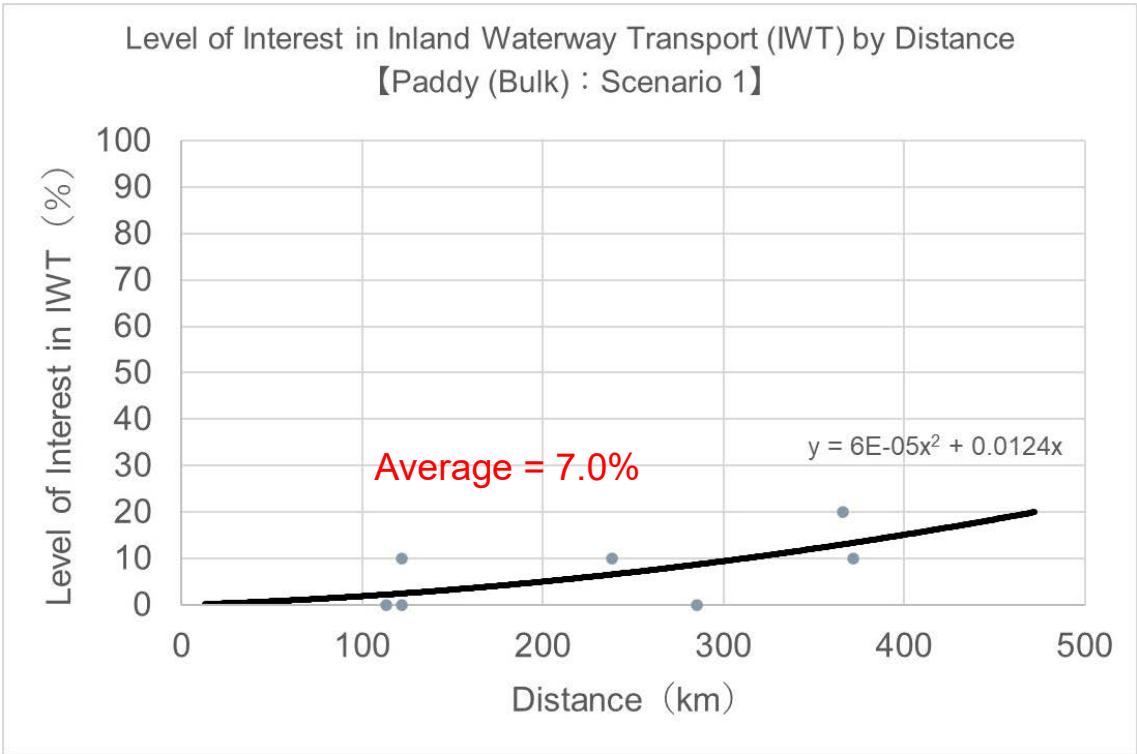


Figure 5-7 Level of interest in IWT and transport distance (paddy: Navigation scenario 1)

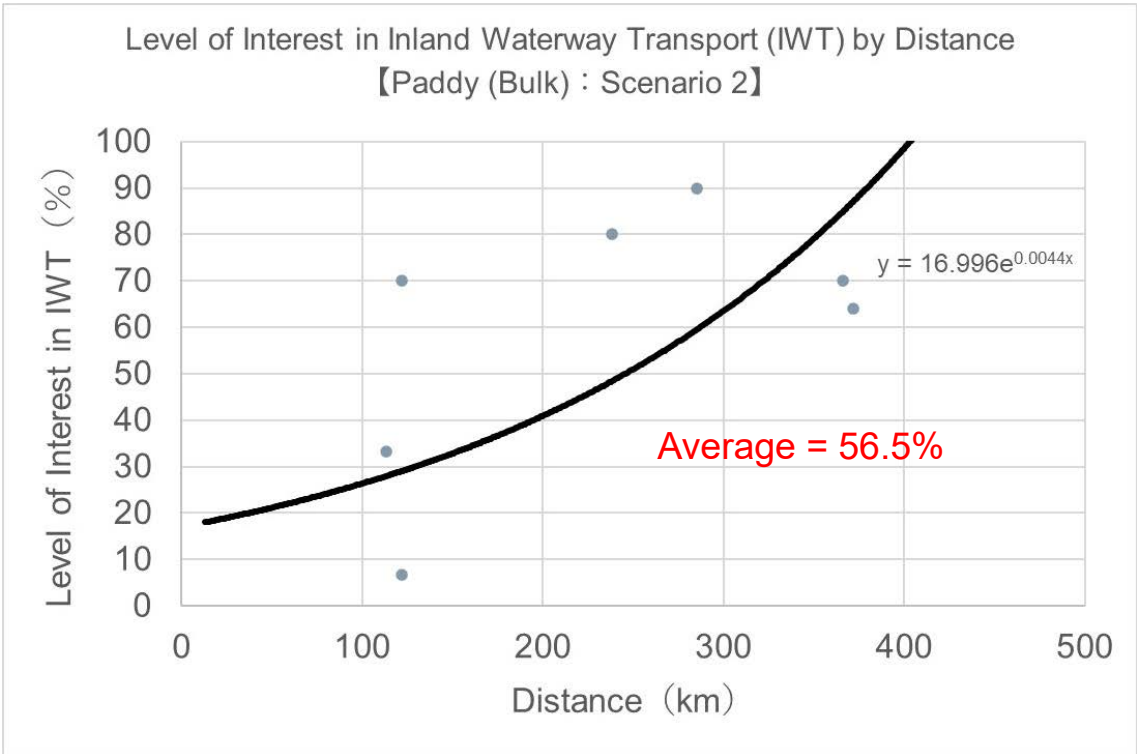


Figure 5-8 Level of interest in IWT and transport distance (paddy: Navigation scenario 2)

5.4.2 Case setting for a modal choice simulation(repost)

In this section, we set the case for modal choice simulation on bulk cargoes as well as containers (Table 5-13).

Case 0: The current transportation condition in 2023. Land and inland water transportation is the same as in 2023.

Case 1: The future infrastructure projects aim to significantly improve Cambodia's logistics network.

a) Road upgrades (Ring Road 3 and NR4 rehabilitation) will reduce domestic travel time, cutting the Phnom Penh-Sihanoukville journey from 6 to 4 hours, and lowering overall transportation costs.
b) International connectivity is expected to improve with a 10% travel time reduction across the Cambodia-Vietnam-Thailand network, while port efficiency will increase by reducing vessel wait and dwell times.
c) Sihanoukville Port will become a deeper seaport by 2029 with the completion of three new container terminals (NCT-1, NCT-2, NCT-3), enabling it to accommodate larger mother vessels.

Case 2: Funan Techo canal will also be realized in addition to the road network and port operation improvement.

Case 3: A 3,000DWT or 5,000 DWT class vessel can navigate up to the upper Mekong River and Tonle Sap Lake in addition to the transport conditions in Case 2.

Note that Case 1 only serves as the reference case in the logit model to distinguish the effects of the “Funan Techo Canal Project” and “improvements to land transportation and port operations.” The individual port selection model is not able to differentiate the results between Case 1 and Case 2.

Table 5-13 Case settings for the modal choice model

Logit model (Container)	Individual port selection model (Bulk Cargo)	Remarks
Case 0	Case 0	Current condition in 2023 (Land and inland waterway transportation remain the same as the current condition.)
Case 1	-	Development infrastructure without Funan Techo Canal (Enhancing the efficiency of port operations and administrative processes. Road network improvements will lead to faster land transportation.)
Case 2	Case 2	Development infrastructure with Funan Techo Canal
Case 3	Case 3	Entire canal and riverports development by MPWT

5.4.3 Setting transport means/route and IWT share by province

In this section, we will apply the individual port selection model to bulk cargoes. The cargo items are (1) paddy (export), (2) raw rubber (export), (3) cereal, fertilizer, and energy (import), and (4) mineral resources (export).

(1) Agriculture goods: paddy (export)

The JICA expert team will select the transport route and modes from each province when the production area is close to the river. The detailed selection criteria are shown below. Since the majority of paddy are currently exported to rice mill factories in Vietnam, the exporting paddy will not use the canal even if the canal is materialized in Case 2 or Case 3.

a) Identify provinces where shippers potentially use barge transport, (in other words, exclude provinces where production areas are too far from river ports),
b) Select the nearest river port in the province, and
c) When applying the level of IWT preference, follow the level as specified in the previous sub-section 5.4.1, (the level of IWT preference is set at 10% for Case 0 and Case 2, and that at 60% for Case 3).

The results are shown below in Table 5-14, Table 5-15, and Table 5-16. Provinces which generate cargo, departing port, transport means, final port and IWT share are listed in the tables. Provinces with potential for IWT use are highlighted in light blue and the level of IWT use is also indicated in the tables.

Table 5-14 Transport means/route and IWT share for Case 0 (agriculture goods: paddy)

Zone	Province	Transport mean	Departing port	Transport mean	Final destination (rice mill)	IWT share
1	Kampot	Truck	→	→	Vietnam	
	Kep	Truck	→	→	Vietnam	
	Koh Kong	Truck	→	→	Vietnam	
	Preah Sihanouk	Truck	→	→	Vietnam	
2	Kampong Thom	Truck	UM2	Barge	Vietnam	10%
	Kratie	Truck	UM2	Barge	Vietnam	10%
	Mondul Kiri	Truck	→	→	Vietnam	
	Preah Vihear	Truck	UM2	Barge	Vietnam	10%
	Ratanak Kiri	Truck	→	→	Vietnam	
	Stung Treng	Truck	UM2	Barge	Vietnam	10%
3	Banteay Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Battambang	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Oddar Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Pailin	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Pursat	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Siem Reap	Truck	Kampong Chhnang	Barge	Vietnam	10%
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Kampong Speu	Truck	PPP	Barge	Vietnam	10%
	Takeo	Truck	PPP	Barge	Vietnam	10%
5	Kampong Cham	Truck	UM2	Barge	Vietnam	10%
	Prey Veng	Truck	LM26	Barge	Vietnam	10%
	Svay Rieng	Truck	LM26	Barge	Vietnam	10%
	Tboung Khmum	Truck	UM2	Barge	Vietnam	10%
6	Kandal	Truck	PPP	Barge	Vietnam	10%
	Phnom Penh	Truck	PPP	Barge	Vietnam	10%

Table 5-15 Transport means/route and IWT share for Case 2 (agriculture goods: paddy)

Zone	Province	Transport mean	Departing port	Transport mean	Final destination (rice mill)	IWT share
1	Kampot	Truck	→	→	Vietnam	
	Kep	Truck	→	→	Vietnam	
	Koh Kong	Truck	→	→	Vietnam	
	Preah Sihanouk	Truck	→	→	Vietnam	
2	Kampong Thom	Truck	UM2	Barge	Vietnam	10%
	Kratie	Truck	UM2	Barge	Vietnam	10%
	Mondul Kiri	Truck	→	→	Vietnam	
	Preah Vihear	Truck	UM2	Barge	Vietnam	10%
	Ratanak Kiri	Truck	→	→	Vietnam	
	Stung Treng	Truck	UM2	Barge	Vietnam	10%
3	Banteay Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Battambang	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Oddar Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Pailin	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Pursat	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Siem Reap	Truck	Kampong Chhnang	Barge	Vietnam	10%
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Vietnam	10%
	Kampong Speu	Truck	PPP	Barge	Vietnam	10%
	Takeo	Truck	PPP	Barge	Vietnam	10%
5	Kampong Cham	Truck	UM2	Barge	Vietnam	10%
	Prey Veng	Truck	LM26	Barge	Vietnam	10%
	Svay Rieng	Truck	LM26	Barge	Vietnam	10%
	Tboung Khmum	Truck	UM2	Barge	Vietnam	10%
6	Kandal	Truck	PPP	Barge	Vietnam	10%
	Phnom Penh	Truck	PPP	Barge	Vietnam	10%

Table 5-16 Transport means/route and IWT share for Case 3 (agriculture goods: paddy)

Zone	Province	Transport mean	Departing port	Transport mean	Final destination (rice mill)	IWT share
1	Kampot	Truck	→	→	Vietnam	
	Kep	Truck	→	→	Vietnam	
	Koh Kong	Truck	→	→	Vietnam	
	Preah Sihanouk	Truck	→	→	Vietnam	
2	Kampong Thom	Truck	UM2	Barge	Vietnam	60%
	Kratie	Truck	Kratie	Barge	Vietnam	60%
	Mondul Kiri	Truck	→	→	Vietnam	
	Preah Vihear	Truck	Stung Treng	Barge	Vietnam	60%
	Ratanak Kiri	Truck	→	→	Vietnam	
	Stung Treng	Truck	Stung Treng	Barge	Vietnam	60%
3	Banteay Meanchey	Truck	Chong Khneas	Barge	Vietnam	60%
	Battambang	Truck	Chong Khneas	Barge	Vietnam	60%
	Oddar Meanchey	Truck	Chong Khneas	Barge	Vietnam	60%
	Pailin	Truck	Chong Khneas	Barge	Vietnam	60%
	Pursat	Truck	Kampong Chhnang	Barge	Vietnam	60%
	Siem Reap	Truck	Chong Khneas	Barge	Vietnam	60%
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Vietnam	60%
	Kampong Speu	Truck	PPP	Barge	Vietnam	60%
	Takeo	Truck	PPP	Barge	Vietnam	60%
5	Kampong Cham	Truck	UM2	Barge	Vietnam	60%
	Prey Veng	Truck	LM26	Barge	Vietnam	60%
	Svay Rieng	Truck	LM26	Barge	Vietnam	60%
	Tboung Khmum	Truck	UM2	Barge	Vietnam	60%
6	Kandal	Truck	PPP	Barge	Vietnam	60%
	Phnom Penh	Truck	PPP	Barge	Vietnam	60%

(2) Agriculture goods: raw rubber (export)

We next apply the individual port selection model to raw rubber. The detailed selection criteria are the same as for paddy. However, raw rubber's market is worldwide, therefore the raw rubber will use the canal if it is materialized in Case 2 and Case 3.

The results are shown below in Table 5-17, Table 5-18, and Table 5-19. Provinces which generate cargo, departing port, transport means, final port and IWT share are listed in the tables. Provinces with potential for IWT use are highlighted in light blue and the level of IWT use is also indicated in the tables.

Table 5-17 Transport means/route and IWT share for Case 0 (agriculture goods: raw rubber)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	IWT share
1	Kampot	Truck	→	→	SHV	
	Kep	Truck	→	→	SHV	
	Koh Kong	Truck	→	→	SHV	
	Preah Sihanouk	Truck	→	→	SHV	
2	Kampong Thom	Truck	UM2	Barge	Cai Mep	10%
	Kratie	Truck	UM2	Barge	Cai Mep	10%
	Mondul Kiri	Truck	→	→	Vietnam	
	Preah Vihear	Truck	UM2	Barge	Cai Mep	10%
	Ratanak Kiri	Truck	→	→	Vietnam	
	Stung Treng	Truck	UM2	Barge	Cai Mep	10%
3	Banteay Meanchey	Truck	→	→	Thai	
	Battambang	Truck	→	→	SHV	
	Oddar Meanchey	Truck	→	→	Thai	
	Pailin	Truck	→	→	Thai	
	Pursat	Truck	→	→	SHV	
	Siem Reap	Truck	Kampong Chhnang	Barge	Cai Mep	10%
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Cai Mep	10%
	Kampong Speu	Truck	→	→	SHV	
	Takeo	Truck	→	→	SHV	
5	Kampong Cham	Truck	UM2	Barge	Cai Mep	10%
	Prey Veng	Truck	LM26	Barge	Cai Mep	10%
	Svay Rieng	Truck	LM26	Barge	Cai Mep	10%
	Tboung Khmum	Truck	UM2	Barge	Cai Mep	10%
6	Kandal	Truck	PPP	Barge	Cai Mep	10%
	Phnom Penh	Truck	PPP	Barge	Cai Mep	10%

Table 5-18 Transport means/route and IWT share for Case 2 (agriculture goods: raw rubber)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	IWT share
1	Kampot	Truck	→	→	SHV	
	Kep	Truck	→	→	SHV	
	Koh Kong	Truck	→	→	SHV	
	Preah Sihanouk	Truck	→	→	SHV	
2	Kampong Thom	Truck	UM2	Barge	Zone1 sea port	60%
	Kratie	Truck	UM2	Barge	Zone1 sea port	60%
	Mondul Kiri	Truck	→	→	Vietnam	
	Preah Vihear	Truck	UM2	Barge	Zone1 sea port	60%
	Ratanak Kiri	Truck	→	→	Vietnam	
	Stung Treng	Truck	UM2	Barge	Zone1 sea port	60%
3	Banteay Meanchey	Truck	→	→	Thai	
	Battambang	Truck	→	→	SHV	
	Oddar Meanchey	Truck	→	→	Thai	
	Pailin	Truck	→	→	Thai	
	Pursat	Truck	→	→	SHV	
	Siem Reap	Truck	Kampong Chhnang	Barge	Zone1 sea port	60%
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Zone1 sea port	60%
	Kampong Speu	Truck	→	→	SHV	
	Takeo	Truck	→	→	SHV	
5	Kampong Cham	Truck	UM2	Barge	Zone1 sea port	60%
	Prey Veng	Truck	LM26	Barge	Zone1 sea port	60%
	Svay Rieng	Truck	LM26	Barge	Zone1 sea port	60%
	Tboung Khmum	Truck	UM2	Barge	Zone1 sea port	60%
6	Kandal	Truck	PPP	Barge	Zone1 sea port	60%
	Phnom Penh	Truck	PPP	Barge	Zone1 sea port	60%

Table 5-19 Transport means/route and IWT share for Case 3 (agriculture goods: raw rubber)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	IWT share
1	Kampot	Truck	→	→	SHV	
	Kep	Truck	→	→	SHV	
	Koh Kong	Truck	→	→	SHV	
	Preah Sihanouk	Truck	→	→	SHV	
2	Kampong Thom	Truck	UM2	Barge	Zone1 sea port	60%
	Kratie	Truck	Kratie	Barge	Zone1 sea port	60%
	Mondul Kiri	Truck	→	→	Vietnam	
	Preah Vihear	Truck	Stung Treng	Barge	Zone1 sea port	60%
	Ratanak Kiri	Truck	→	→	Vietnam	
	Stung Treng	Truck	Stung Treng	Barge	Zone1 sea port	60%
3	Banteay Meanchey	Truck	→	→	Thai	
	Battambang	Truck	Chong Khneas	Barge	Zone1 sea port	60%
	Oddar Meanchey	Truck	→	→	Thai	
	Pailin	Truck	→	→	Thai	
	Pursat	Truck	→	→	SHV	
	Siem Reap	Truck	Chong Khneas	Barge	Zone1 sea port	60%
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Zone1 sea port	60%
	Kampong Speu	Truck	→	→	SHV	
	Takeo	Truck	→	→	SHV	
5	Kampong Cham	Truck	UM2	Barge	Zone1 sea port	60%
	Prey Veng	Truck	LM26	Barge	Zone1 sea port	60%
	Svay Rieng	Truck	LM26	Barge	Zone1 sea port	60%
	Tboung Khmum	Truck	UM2	Barge	Zone1 sea port	60%
6	Kandal	Truck	PPP	Barge	Zone1 sea port	60%
	Phnom Penh	Truck	PPP	Barge	Zone1 sea port	60%

(3) Agriculture goods: cereal, fertilizer, and energy (import)

We next apply the individual port selection model to import goods such as cereal, fertilizer and energy. The detailed selection criteria are the same as for paddy. The first import port is a seaport where a mother vessel calls.

The results are shown below in Table 5-20, Table 5-21, and Table 5-22. The first port (a mother vessel call port), transport means, second port, transport mean to the final destination, and IWT share are listed by province. Provinces with potential for IWT use are highlighted in light blue and the level of IWT use is also indicated in the tables.

Table 5-20 Transport means/route and IWT share for Case 0 (agriculture goods and energy)

Zone	First port	Transport mean	Second port	Transport mean	Province	IWT share
1	SHV	Truck	→	→	Kampot	
	SHV	Truck	→	→	Kep	
	SHV	Truck	→	→	Koh Kong	
	SHV	Truck	→	→	Preah Sihanouk	
2	Cai Mep	Barge	UM2	Truck	Kampong Thom	10%
	Cai Mep	Barge	UM2	Truck	Kratie	10%
	Cai Mep	Barge	UM2	Truck	Mondul Kiri	10%
	Cai Mep	Barge	UM2	Truck	Preah Vihear	10%
	Cai Mep	Barge	UM2	Truck	Ratanak Kiri	10%
	Cai Mep	Barge	UM2	Truck	Stung Treng	10%
3	SHV	Truck	→	→	Banteay Meanchey	
	SHV	Truck	→	→	Battambang	
	Cai Mep	Barge	Kampong Chhnang	Truck	Oddar Meanchey	10%
	SHV	Truck	→	→	Pailin	
	SHV	Truck	→	→	Pursat	
	Cai Mep	Barge	Kampong Chhnang	Truck	Siem Reap	10%
4	Cai Mep	Barge	Kampong Chhnang	Truck	Kampong Chhnang	10%
	SHV	Truck	→	→	Kampong Speu	
	SHV	Truck	→	→	Takeo	
5	Cai Mep	Barge	UM2	Truck	Kampong Cham	10%
	Cai Mep	Barge	LM26	Truck	Prey Veng	10%
	Cai Mep	Barge	LM26	Truck	Svay Rieng	10%
	Cai Mep	Barge	UM2	Truck	Tboung Khmum	10%
6	Cai Mep	Barge	PPP	Truck	Kandal	10%
	Cai Mep	Barge	PPP	Truck	Phnom Penh	10%

Table 5-21 Transport means/route and IWT share for Case 2 (agriculture goods and energy)

Zone	First port	Transport mean	Second port	Transport mean	Province	IWT share
1	SHV	Truck	→	→	Kampot	
	SHV	Truck	→	→	Kep	
	SHV	Truck	→	→	Koh Kong	
	SHV	Truck	→	→	Preah Sihanouk	
2	Zone1 sea port	Barge	UM2	Truck	Kampong Thom	60%
	Zone1 sea port	Barge	UM2	Truck	Kratie	60%
	Zone1 sea port	Barge	UM2	Truck	Mondul Kiri	60%
	Zone1 sea port	Barge	UM2	Truck	Preah Vihear	60%
	Zone1 sea port	Barge	UM2	Truck	Ratanak Kiri	60%
	Zone1 sea port	Barge	UM2	Truck	Stung Treng	60%
3	SHV	Truck	→	→	Banteay Meanchey	
	SHV	Truck	→	→	Battambang	
	Zone1 sea port	Barge	Kampong Chhnang	Truck	Oddar Meanchey	60%
	SHV	Truck	→	→	Pailin	
	SHV	Truck	→	→	Pursat	
	Zone1 sea port	Barge	Kampong Chhnang	Truck	Siem Reap	60%
4	Zone1 sea port	Barge	Kampong Chhnang	Truck	Kampong Chhnang	60%
	SHV	Truck	→	→	Kampong Speu	
	SHV	Truck	→	→	Takeo	
5	Zone1 sea port	Barge	UM2	Truck	Kampong Cham	60%
	Zone1 sea port	Barge	LM26	Truck	Prey Veng	60%
	Zone1 sea port	Barge	LM26	Truck	Svay Rieng	60%
	Zone1 sea port	Barge	UM2	Truck	Tboung Khmum	60%
6	Zone1 sea port	Barge	PPP	Truck	Kandal	60%
	Zone1 sea port	Barge	PPP	Truck	Phnom Penh	60%

Table 5-22 Transport means/route and IWT share for Case 3 (agriculture goods and energy)

Zone	First port	Transport mean	Second port	Transport mean	Province	IWT share
1	SHV	Truck	→	→	Kampot	
	SHV	Truck	→	→	Kep	
	SHV	Truck	→	→	Koh Kong	
	SHV	Truck	→	→	Preah Sihanouk	
2	Zone1 sea port	Barge	UM2	Truck	Kampong Thom	60%
	Zone1 sea port	Barge	Kratie	Truck	Kratie	60%
	Zone1 sea port	Barge	Kratie	Truck	Mondul Kiri	60%
	Zone1 sea port	Barge	Stung Treng	Truck	Preah Vihear	60%
	Zone1 sea port	Barge	Stung Treng	Truck	Ratanak Kiri	60%
	Zone1 sea port	Barge	Stung Treng	Truck	Stung Treng	60%
3	Zone1 sea port	Barge	Chong Khneas	Truck	Banteay Meanchey	60%
	Zone1 sea port	Barge	Chong Khneas	Truck	Battambang	60%
	Zone1 sea port	Barge	Chong Khneas	Truck	Oddar Meanchey	60%
	Zone1 sea port	Barge	Chong Khneas	Truck	Pailin	60%
	SHV	Truck	→	→	Pursat	
	Zone1 sea port	Barge	Chong Khneas	Truck	Siem Reap	60%
4	Zone1 sea port	Barge	Kampong Chhnang	Truck	Kampong Chhnang	60%
	SHV	Truck	→	→	Kampong Speu	
	SHV	Truck	→	→	Takeo	
5	Zone1 sea port	Barge	UM2	Truck	Kampong Cham	60%
	Zone1 sea port	Barge	LM26	Truck	Prey Veng	60%
	Zone1 sea port	Barge	LM26	Truck	Svay Rieng	60%
	Zone1 sea port	Barge	UM2	Truck	Tboung Khmum	60%
6	Zone1 sea port	Barge	PPP	Truck	Kandal	60%
	Zone1 sea port	Barge	PPP	Truck	Phnom Penh	60%

(4) Mineral resources (export)

We next apply the individual port selection model to mineral resources. The detailed selection criteria are the same as for paddy. As mineral resources are produced in the northeastern province and their market is worldwide, mineral resources will use the canal if it is materialized in Case 2 and Case 3.

The results are shown below in Table 5-23, Table 5-24, and Table 5-25. Provinces which generate cargo, departing port, transport means, final port and IWT share are listed in the tables. Provinces with potential for IWT use are highlighted in light blue and the level of IWT use is also indicated in the tables.

Table 5-23 Transport means/route and IWT share for Case 0 (mineral resources)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	IWT share	Produced minerals
1	Kampot						
	Kep						
	Koh Kong						
	Preah Sihanouk						
2	Kampong Thom						
	Kratie	Truck	UM2	Barge	Vietnam	100%	Stone Pebbles
	Mondul Kiri	Truck	UM2	Barge	Vietnam	100%	Bauxite
	Preah Vihear	Truck	UM2	Barge	Vietnam	100%	Iron ore Manganese ore
	Ratanak Kiri						
	Stung Treng	Truck	UM2	Barge	Vietnam	100%	Iron ore, Pebbles Manganese ore
3	Banteay Meanchey						
	Battambang						
	Oddar Meanchey						
	Pailin						
	Pursat						
	Siem Reap						
4	Kampong Chhnang						
	Kampong Speu						
	Takeo						
5	Kampong Cham						
	Prey Veng						
	Svay Rieng						
	Tboung Khmum						
6	Kandal						
	Phnom Penh	-	River	Barge	Vietnam	100%	Sand

Table 5-24 Transport means/route and IWT share for Case 2 (mineral resources)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	IWT share	Produced minerals
1	Kampot						
	Kep						
	Koh Kong						
	Preah Sihanouk						
2	Kampong Thom						
	Kratie	Truck	UM2	Barge	Zone1 sea port	100%	Stone Pebbles
	Mondul Kiri	Truck	UM2	Barge	Zone1 sea port	100%	Bauxite
	Preah Vihear	Truck	UM2	Barge	Zone1 sea port	100%	Iron ore Manganese ore
	Ratanak Kiri						
	Stung Treng	Truck	UM2	Barge	Zone1 sea port	100%	Iron ore, Pebbles Manganese ore
3	Banteay Meanchey						
	Battambang						
	Oddar Meanchey						
	Pailin						
	Pursat						
	Siem Reap						
4	Kampong Chhnang						
	Kampong Speu						
	Takeo						
5	Kampong Cham						
	Prey Veng						
	Svay Rieng						
	Tboung Khmum						
6	Kandal						
	Phnom Penh	-	River	Barge	Vietnam	100%	Sand

Table 5-25 Transport means/route and IWT share for Case 3 (mineral resources)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	IWT share	Produced minerals
1	Kampot						
	Kep						
	Koh Kong						
	Preah Sihanouk						
2	Kampong Thom						
	Kratie	Truck	Kratie	Barge	Zone1 sea port	100%	Stone Pebbles
	Mondul Kiri	Truck	Kratie	Barge	Zone1 sea port	100%	Bauxite
	Preah Vihear	Truck	Stung Treng	Barge	Zone1 sea port	100%	Iron ore Manganese ore
	Ratanak Kiri						
	Stung Treng	Truck	Stung Treng	Barge	Zone1 sea port	100%	Iron ore, Pebbles Manganese ore
3	Banteay Meanchey						
	Battambang						
	Oddar Meanchey						
	Pailin						
	Pursat						
	Siem Reap						
4	Kampong Chhnang						
	Kampong Speu						
	Takeo						
5	Kampong Cham						
	Prey Veng						
	Svay Rieng						
	Tboung Khmum						
6	Kandal						
	Phnom Penh	-	River	Barge	Vietnam	100%	Sand

5.4.4 Inland water transport volume from/to each province by cargo item

(1) Method for calculating volume of IWT transport (for export cargo)

The volume of IWT transport in each province will be obtained by the forecasted cargo generation/consumption volume and the IWT preference in each province. For example, Table 5-26 shows the volume of paddy in each province transported by IWT in Case 0. 395, 840 tons out of 4,191,400 tons of paddy will be transported through IWT. The IWT volumes of other cargo items are listed in Section Appendix-3.

Table 5-26 Example of paddy's inland waterway transport volume from each province (Paddy, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final destination (rice mill)	Estimation volume of Paddy by province in 2050 (ton)	IWT share	IWT Volume (ton)
1	Kampot	Truck	→	→	Vietnam	145,705		0
	Kep	Truck	→	→	Vietnam	3,714		0
	Koh Kong	Truck	→	→	Vietnam	8,176		0
	Preah Sihanouk	Truck	→	→	Vietnam	11,932		0
2	Kampong Thom	Truck	UM2	Barge	Vietnam	303,780	10%	30,378
	Kratie	Truck	UM2	Barge	Vietnam	71,891	10%	7,189
	Mondul Kiri	Truck	→	→	Vietnam	33,976		0
	Preah Vihear	Truck	UM2	Barge	Vietnam	89,726	10%	8,973
	Ratanak Kiri	Truck	→	→	Vietnam	29,488		0
	Stung Treng	Truck	UM2	Barge	Vietnam	23,683	10%	2,368
3	Banteay Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	362,080	10%	36,208
	Battambang	Truck	Kampong Chhnang	Barge	Vietnam	577,641	10%	57,764
	Oddar Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	74,442	10%	7,444
	Pailin	Truck	Kampong Chhnang	Barge	Vietnam	10,059	10%	1,006
	Pursat	Truck	Kampong Chhnang	Barge	Vietnam	241,734	10%	24,173
	Siem Reap	Truck	Kampong Chhnang	Barge	Vietnam	216,704	10%	21,670
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Vietnam	248,635	10%	24,864
	Kampong Speu	Truck	PPP	Barge	Vietnam	123,479	10%	12,348
	Takeo	Truck	PPP	Barge	Vietnam	411,772	10%	41,177
5	Kampong Cham	Truck	UM2	Barge	Vietnam	204,471	10%	20,447
	Prey Veng	Truck	LM26	Barge	Vietnam	576,535	10%	57,654
	Svay Rieng	Truck	LM26	Barge	Vietnam	185,623	10%	18,562
	Tboung Khmum	Truck	UM2	Barge	Vietnam	102,590	10%	10,259
6	Kandal	Truck	PPP	Barge	Vietnam	129,301	10%	12,930
	Phnom Penh	Truck	PPP	Barge	Vietnam	4,263	10%	426
					Total	4,191,400		395,840

(2) Overall export cargo volume through inland waterway transport

We will calculate the total export cargo volume transported via IWT by summing up all export cargoes such as agriculture goods (paddy, raw rubber) and mineral resources. Table 5-27 shows a summary of export cargo volume through IWT in each region in Case 0. All IWT cargoes (76,704, 656 tons) will head to Vietnam. In addition, the volume of mineral resources (76,704, 656 tons) represents 99.5% of the total volume of export cargo (77,109,848 tons) through IWT.

Table 5-27 Export cargo volume through IWT (Case 0)

Zone	Cargo Item	Cargo generation esimated volume	Inland waterway traffic				
			IWT use volume	Departing port	Route	Final port	Export volume by port
1	Agriculture (Paddy)	169,527	0	―	―	―	0
	Agriculture (Raw rubber)	2,741	0	―	―	―	0
2	Agriculture (Paddy)	552,544	48,908	UM2	Mekong river	Vietnam port	48,908
	Agriculture (Raw rubber)	83,468	5,495	UM2	Mekong river	Vietnam port	5,495
	Mineral resources	31,704,656	31,704,656	UM2	Mekong river	Vietnam port	31,704,656
3	Agriculture (Paddy)	1,482,660	148,265	Kampong Chhnang	Mekong river	Vietnam port	148,265
	Agriculture (Raw rubber)	8,235	101	Kampong Chhnang	Mekong river	Vietnam port	101
4	Agriculture (Paddy)	783,886	78,389	Kampong Chhnang	Mekong river	Vietnam port	24,864
				Phnom Penh	Mekong river	Vietnam port	53,525
	Agriculture (Raw rubber)	322	16	Kampong Chhnang	Mekong river	Vietnam port	16
5	Agriculture (Paddy)	1,069,219	106,922	UM2	Mekong river	Vietnam port	30,706
				LM26	Mekong river	Vietnam port	76,216
	Agriculture (Raw rubber)	37,402	3,740	UM2	Mekong river	Vietnam port	3,605
				LM26	Mekong river	Vietnam port	135
6	Agriculture (Paddy)	133,564	13,356	Phnom Penh	Mekong river	Vietnam port	13,356
	Mineral resources	45,000,000	45,000,000	Phnom Penh	Mekong river	Vietnam port	45,000,000
Sub total	Agriculture (Paddy)	4,191,400	395,840			Vietnam port	395,840
	Agriculture (Raw rubber)	132,168	9,352			Vietnam port	9,352
	Mineral resources	76,704,656	76,704,656			Vietnam port	76,704,656
Grand total		81,028,224	77,109,848				77,109,848

Table 5-28 shows a summary of export cargo volume through IWT in each region in Case 2. The total volume of cargo that could potentially use IWT (77,156,600 tons) will be transported by IWT. With the development of the Funan Techo Canal, 31,760,760 tons of cargoes would head to Zone 1 and the rest (45,395,840 tons) to Vietnam.

Table 5-28 Export cargo volume through IWT (Case 2)

Zone	Cargo Item	Cargo generation esimated volume	Inland waterway traffic				
			IWT use volume	Departing port	Route	Final port	Export volume by port
1	Agriculture (Paddy)	169,527	0	―	―	―	0
	Agriculture (Raw rubber)	2,741	0	―	―	―	0
2	Agriculture (Paddy)	552,544	48,908	UM2	Mekong river	Vietnam port	48,908
	Agriculture (Raw rubber)	83,468	32,966	UM2	Funan Techo Canal	Zone1 sea port	32,966
	Mineral resources	31,704,656	31,704,656	UM2	Funan Techo Canal	Zone1 sea port	31,704,656
3	Agriculture (Paddy)	1,482,660	148,265	Kampong Chhnang	Mekong river	Vietnam port	148,265
	Agriculture (Raw rubber)	8,235	603	Kampong Chhnang	Funan Techo Canal	Zone1 sea port	603
4	Agriculture (Paddy)	783,886	78,389	Kampong Chhnang	Mekong river	Vietnam port	24,864
				Phnom Penh	Mekong river	Vietnam port	53,525
	Agriculture (Raw rubber)	322	93	Kampong Chhnang	Funan Techo Canal	Zone1 sea port	93
5	Agriculture (Paddy)	1,069,219	106,922	UM2	Mekong river	Vietnam port	30,706
				LM26	Mekong river	Vietnam port	76,216
	Agriculture (Raw rubber)	37,402	22,442	UM2	Funan Techo Canal	Zone1 sea port	21,631
				LM26	Funan Techo Canal	Zone1 sea port	811
6	Agriculture (Paddy)	133,564	13,356	Phnom Penh	Mekong river	Vietnam port	13,356
	Mineral resources	45,000,000	45,000,000	Phnom Penh	Mekong river	Vietnam port	45,000,000
Sub total	Agriculture (Paddy)	4,191,400	395,840			Vietnam port	395,840
	Agriculture (Raw rubber)	132,168	56,104			Zone1 sea port	56,104
	Mineral resources	76,704,656	76,704,656			Zone1 sea port	31,704,656
						Vietnam port	45,000,000
Grand total		81,028,224	77,156,600				77,156,600
						Zone1 sea port	31,760,760
						Vietnam port	45,395,840

Table 5-29 shows a summary of export cargo volume through IWT in each region in Case 3. The total volume of cargo that could potentially use IWT (79,136, 278 tons) will be transported by IWT. The total cargo volume in Case 3 (79,136, 278 tons) becomes slightly larger than that in Case 2 (77,156,600 tons). New riverports such as Stung Treng, Kratie, and Chong Khneas and channel development will facilitate the use of IWT. With the development of the Funan Techo Canal and the riverports, 31,761,232 tons of cargo would head to Zone 1 and the rest (47,375,046 tons) to Vietnam.

Table 5-29 Export cargo volume through IWT (Case 3)

Zone	Cargo Item	Cargo generation esimated volume	Inland waterway traffic				
			IWT use volume	Departing port	Route	Final port	Export volume by port
1	Agriculture (Paddy)	169,527	0	―	―	―	0
	Agriculture (Raw rubber)	2,741	0	―	―	―	0
2	Agriculture (Paddy)	552,544	293,449	Stung Treng	Mekong river	Vietnam port	68,046
				Kratie	Mekong river	Vietnam port	43,135
				UM2	Mekong river	Vietnam port	182,268
	Agriculture (Raw rubber)	83,468	32,966	Stung Treng	Funan Techo Canal	Zone1 sea port	4,694
				Kratie	Funan Techo Canal	Zone1 sea port	13,716
				UM2	Funan Techo Canal	Zone1 sea port	14,556
	Mineral resources	31,704,656	31,704,656	Stung Treng	Funan Techo Canal	Zone1 sea port	9,540,012
				Kratie	Funan Techo Canal	Zone1 sea port	22,164,644
3	Agriculture (Paddy)	1,482,660	889,595	Chong Khneas	Mekong river	Vietnam port	744,555
				Kampong Chhnang	Mekong river	Vietnam port	145,040
	Agriculture (Raw rubber)	8,235	1,075	Chong Khneas	Funan Techo Canal	Zone1 sea port	1,075
4	Agriculture (Paddy)	783,886	470,331	Kampong Chhnang	Mekong river	Vietnam port	149,181
				Phnom Penh	Mekong river	Vietnam port	321,150
	Agriculture (Raw rubber)	322	93	Kampong Chhnang	Funan Techo Canal	Zone1 sea port	93
5	Agriculture (Paddy)	1,069,219	641,532	UM2	Mekong river	Vietnam port	184,237
				LM26	Mekong river	Vietnam port	457,295
	Agriculture (Raw rubber)	37,402	22,442	UM2	Funan Techo Canal	Zone1 sea port	21,631
				LM26	Funan Techo Canal	Zone1 sea port	811
6	Agriculture (Paddy)	133,564	80,139	Phnom Penh	Mekong river	Vietnam port	80,139
	Mineral resources	45,000,000	45,000,000	Phnom Penh	Mekong river	Vietnam port	45,000,000
Sub total	Agriculture (Paddy)	4,191,400	2,375,046			Vietnam port	2,375,046
	Agriculture (Raw rubber)	132,168	56,576			Zone1 sea port	56,576
	Mineral resources	76,704,656	76,704,656			Zone1 sea port	31,704,656
						Vietnam port	45,000,000
Grand total		81,028,224	79,136,278				79,136,278
						Zone1 sea port	31,761,232
						Vietnam port	47,375,046

(3) Overall import cargo volume through inland waterway transport

As with the calculation of export cargo volume in the previous sub section (2), we will calculate the total import cargo volume through inland waterway transport by summing up all import cargoes such as agriculture goods (cereal, fertilizer) and energy.

(a) Case 0

Table 5-30 shows a summary of import cargo volume through IWT in each region in Case 0. All IWT cargoes (959,806 tons) would be imported from ports in Vietnam. The volume of energy imports (933,250 tons, 97.2% of the total) is the largest followed by that of agriculture goods (26,556 tons).

Table 5-30 Import cargo volume through IWT (Case 0)

Zone	Cargo Item	Demand cargo esimated volume	Inland waterway traffic				
			IWT use volume	First port	Route	Final port	Import volume by port
1	Agriculture	43,468	0	SHV	—	—	0
	Energy	1,086,485	0	SHV	—	—	0
2	Agriculture	78,778	7,877	Viet Nam port	Mekong river	UM2	7,877
	Energy	1,099,551	109,955	Viet Nam port	Mekong river	UM2	109,955
3	Agriculture	130,061	4,002	Viet Nam port	Mekong river	Kampong Chhnang	4,002
	Energy	2,096,473	65,583	Viet Nam port	Mekong river	Kampong Chhnang	65,583
4	Agriculture	41,496	1,350	Viet Nam port	Mekong river	Kampong Chhnang	1,350
	Energy	1,447,483	37,078	Viet Nam port	Mekong river	Kampong Chhnang	37,078
5	Agriculture	104,354	10,436	Viet Nam port	Mekong river	UM2	5,498
						LM26	4,938
	Energy	1,792,403	179,240	Viet Nam port	Mekong river	UM2	94,142
						LM26	85,098
6	Agriculture	28,915	2,891	Viet Nam port	Mekong river	Phnom Penh	2,891
	Energy	5,413,941	541,394	Viet Nam port	Mekong river	Phnom Penh	541,394
Sub total	Agriculture	427,072	26,556				26,556
	Energy	12,936,336	933,250				933,250
Grand total		13,363,408	959,806				959,806

(b) Case 2

Table 5-31 shows a summary of import cargo volume through IWT in each region in Case 2. The total volume of cargo that could potentially use IWT (5,758, 849 tons) will be transported by IWT. With the development of the Funan Techo Canal, all cargoes would be imported in Zone 1 and be transported through the Canal to the final river ports in Cambodia.

Table 5-31 Import cargo volume through IWT (Case 2)

Zone	Cargo Item	Demand cargo esimated volume	Inland waterway traffic				
			IWT use volume	First port	Route	Final port	Import volume by port
1	Agriculture	43,468	0	SHV	―	―	0
	Energy	1,086,485	0	SHV	―	―	0
2	Agriculture	78,778	47,268	Zone1 sea port	Funan Techo Canal	UM2	47,268
	Energy	1,099,551	659,729	Zone1 sea port	Funan Techo Canal	UM2	659,729
3	Agriculture	130,061	24,014	Zone1 sea port	Funan Techo Canal	Kampong Chhnang	24,014
	Energy	2,096,473	393,500	Zone1 sea port	Funan Techo Canal	Kampong Chhnang	393,500
4	Agriculture	41,496	8,099	Zone1 sea port	Funan Techo Canal	Kampong Chhnang	8,099
	Energy	1,447,483	222,473	Zone1 sea port	Funan Techo Canal	Kampong Chhnang	222,473
5	Agriculture	104,354	62,613	Zone1 sea port	Funan Techo Canal	UM2	32,990
						LM26	29,623
	Energy	1,792,403	1,075,441	Zone1 sea port	Funan Techo Canal	UM2	564,852
						LM26	510,589
6	Agriculture	28,915	17,348	Zone1 sea port	Funan Techo Canal	Phnom Penh	17,348
	Energy	5,413,941	3,248,364	Zone1 sea port	Funan Techo Canal	Phnom Penh	3,248,364
Sub total	Agriculture	427,072	159,342				159,342
	Energy	12,936,336	5,599,507				5,599,507
Grand total		13,363,408	5,758,849				5,758,849

(c) Case 3

Table 5-32 shows a summary of import cargo volume through IWT in each region in Case 3. The total volume of cargo that could potentially use IWT (6,490,298 tons) will be transported by IWT. The total cargo volume in Case 3 (6,490,298 tons) becomes slightly larger than that in Case 2 (5,758, 849 tons). New riverports such as Stung Treng, Kratie, and Chong Khneas and channel development will facilitate the use of IWT. With the development of the Funan Techo Canal and riverports, all cargo (6,490,298 tons) would use the Canal.

Table 5-32 Import cargo volume through IWT (Case 3)

Zone	Cargo Item	Demand cargo esimated volume	Inland waterway traffic				
			IWT use volume	First port	Route	Final port	Import volume by port
1	Agriculture	43,468	0	SHV	―	―	0
	Energy	1,086,485	0	SHV	―	―	0
2	Agriculture	78,778	47,268	Zone1 sea port	Funan Techo Canal	Stung Treng	26,381
						Kratie	13,560
						UM2	7,327
	Energy	1,099,551	659,729	Zone1 sea port	Funan Techo Canal	Stung Treng	252,457
						Kratie	183,234
						UM2	224,038
3	Agriculture	130,061	67,453	Zone1 sea port	Funan Techo Canal	Chong Khneas	67,453
	Energy	2,096,473	1,081,510	Zone1 sea port	Funan Techo Canal	Chong Khneas	1,081,510
4	Agriculture	41,496	8,099	Zone1 sea port	Funan Techo Canal	Kampong Chhnang	8,099
	Energy	1,447,483	222,473	Zone1 sea port	Funan Techo Canal	Kampong Chhnang	222,473
5	Agriculture	104,354	62,613	Zone1 sea port	Funan Techo Canal	UM2	32,990
						LM26	29,623
	Energy	1,792,403	1,075,441	Zone1 sea port	Funan Techo Canal	UM2	564,852
						LM26	510,589
6	Agriculture	28,915	17,348	Zone1 sea port	Funan Techo Canal	Phnom Penh	17,348
	Energy	5,413,941	3,248,364	Zone1 sea port	Funan Techo Canal	Phnom Penh	3,248,364
Sub total	Agriculture	427,072	202,781				202,781
	Energy	12,936,336	6,287,517				6,287,517
Grand total		13,363,408	6,490,298				6,490,298

5.5 Overall IWT cargo flow in Cambodia (container and bulk cargo)

In this sub section, we will specify both the container and the bulk cargo flows in each zone. In addition, to help understand each cargo flow, we have prepared IWT cargo flow diagrams in Cambodia.

5.5.1 IWT cargo flow in Case 0

(1) Export IWT flow

Table 5-33 shows export container and bulk cargo volume through IWT to foreign ports in Case 0. For container, the total generated volume in Cambodia is 2,742,411 TEUs. Of this, 1,415,434 TEUs will be loaded onto mother vessels at seaports in Zone 1. A further 785,105 TEUs will be loaded onto barges at Phnom Penh port (Zone 6) and transshipped to Cai Mep ports. The remaining 541,872 TEUs will cross the border by truck to foreign ports (Cai Mep or Laem Chabang).

For bulk (agriculture goods), the total volume amounts to 405,192 tons. Of this, Kampong Chhnang port (Zone 4) will handle 173,246 tons, UM2 or LM26 (Zone 5) will handle 165,065 tons, and Phnom Penh port (Zone 6) 66,881 tons, respectively. Out of the total volume transported by barge, 9,352 tons will be transported by truck to Cai Mep ports, while 395,840 tons are consumed in Vietnam.

For bulk (mineral resources), the total volume amounts to 76,704,656 tons. Of this, UM2 or LM26 (Zone 5) will handle 31,704,656 tons (cargo will be loaded onto barge), and Phnom Penh port (Zone 6) will handle 45,000,000 tons. Out of the total volume transported by barge, 31,704,656 tons will be transported to Cai Mep ports, while 45,000,000 tons (river sand) are consumed in Vietnam.

Table 5-33 Export container and bulk cargo volume through IWT by zone (Case 0)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	1,415,434 (truck 1,415,434)	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	173,246	0	0
5	0	165,065	31,704,656	0
6	785,105	66,881	45,000,000	0
Sub total (Seaports and riverports in Cambodia)	2,200,539	405,192	76,704,656	0
Transported by truck to foreign ports	541,872	-	-	-
Grand total	2,742,411	405,192	76,704,656	0
Included number				
Consumed in Vietnam	-	395,840	45,000,000	0
Transshipped to Vietnam through the Mekong river	785,105	9,352	31,704,656	0

(2) Import IWT flow

Next, Table 5-34 shows import container and bulk cargo volume through IWT from seaports in

Case 0. For container, the total demand in Cambodia amounts to 2,909,135 TEUs. Of this, 1,956,466 TEUs are discharged from mother vessels at seaports (Zone 1). A further 291,644 TEUs are transshipped by barge from Cai Mep ports and discharged at Phnom Penh port (Zone 6). The remaining 661,025 TEUs are transported directly from foreign ports (Cai Mep or Laem Chabang) by truck.

For bulk (Agriculture), the total import volume amounts to 26,556 tons, transported by barge from Cai Mep ports. Of this, 5,352 tons will be discharged in Kampong Chhnang port (Zone 4), 18,313 tons in UM2 or LM26 (Zone 5), and 2,891 tons at Phnom Penh port (Zone 6) respectively.

For bulk (Energy), the total import volume amounts to 28,401,796 tons. Of this, 27,468,546 tons are discharged from mother vessels at seaports (Zone 1) while 933,250 tons are transshipped by barge from Cai Mep ports. Of the volume transshipped by barge, 102,661 tons are discharged at Kampong Chhnang port (Zone 4), 289,195 tons at UM2 or LM26 (Zone 5), and 541,394 tons at Phnom Penh port (Zone 6), respectively.

Table 5-34 Import container and bulk cargo volume through IWT by zone (Case 0)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	1,956,466 (truck 1,956,466)	0	0	27,468,546
2	0	0	0	0
3	0	0	0	0
4	0	5,352	0	102,661
5	0	18,313	0	289,195
6	291,644	2,891	0	541,394
Sub total (Seaports and riverports in Cambodia)	2,248,110	26,556	0	28,401,796
Transported by truck from foreign ports	661,025	-	-	-
Grand total	2,909,135	26,556	0	28,401,796
Included number				
Transshipped from Vietnam through the Mekong river	291,644	26,556	0	933,250

Table 5-35 shows total (export and import) container and bulk cargo volume through IWT from seaports in Case 0.

Table 5-35 Total (export and import) container and bulk cargo volume through IWT (Case 0)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	3,371,900 (truck 3,371,900)	0	0	27,468,546
2	0	0	0	0
3	0	0	0	0
4	0	178,598	0	102,661
5	0	183,378	31,704,656	289,195
6	1,076,749	69,772	45,000,000	541,394
Sub total (Seaports and riverports in Cambodia)	4,448,649	431,748	76,704,656	28,401,796
Transported by truck to/from foreign ports	1,202,897	-	-	-
Grand total	5,651,546	431,748	76,704,656	28,401,796
Included number				
Consumed in Vietnam	-	395,840	45,000,000	0
Transshipped to/from Vietnam through the Mekong river	1,076,749	35,908	31,704,656	933,250

(3) Cargo flow diagram

Next, we will draw the cargo flow diagrams (see from Figure 5-9 to Figure 5-12). Four pairs (import and export) of diagrams are prepared for containers and bulk cargoes (agricultural goods, mineral resources, and energy).

Referring to the left side of Figure 5-9, 785,105TEUs of containers are generated and loaded onto barges at Phnom Penh port. 1,415,434 TEUs of containers will arrive at seaports in Zone 1 and be loaded onto mother vessels. 785,105 TEUs of containers will be transported down the Mekong River and loaded onto mother vessels in Cai Mep ports. 541,872 TEUs of containers will cross the border by truck and be loaded on to mother vessels in foreign ports such as Cai Mep or Leam Chabang. No containers from the Upper Mekong area and Tonle Sap area will use barges.
Other cargo flows have similar patterns but are not described in detail here for the sake of brevity.

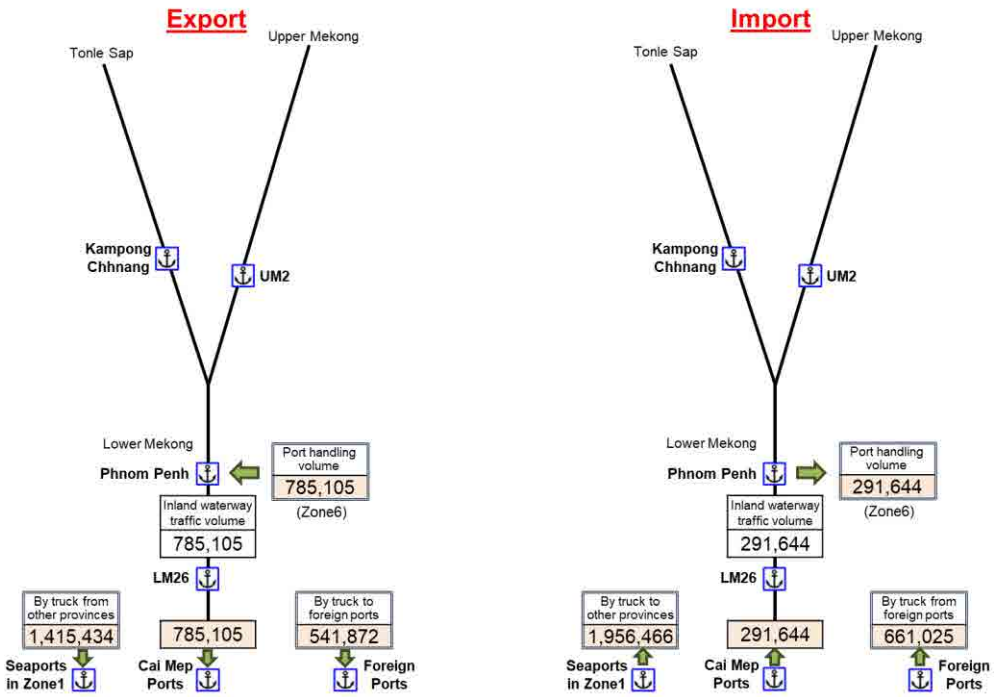


Figure 5-9 Flow of inland waterway traffic (Case 0: Container)

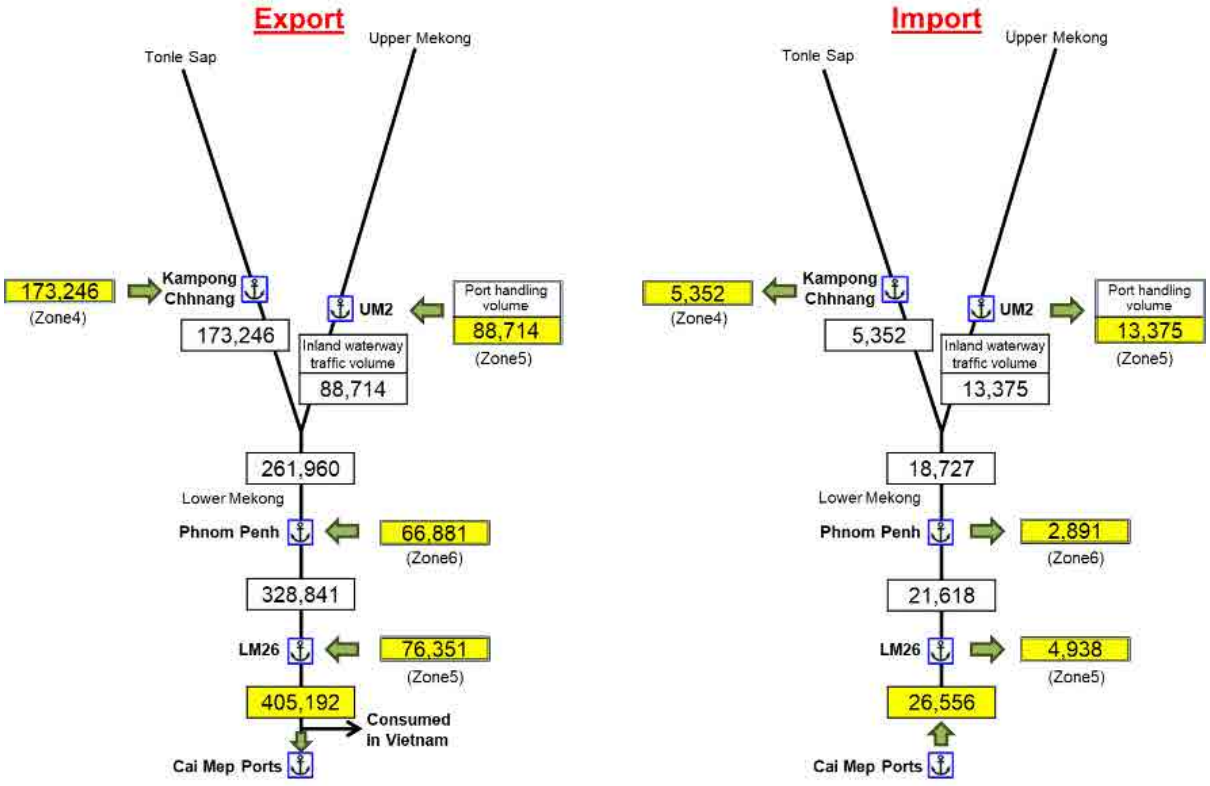


Figure 5-10 Flow of inland waterway traffic (Case 0: Agriculture goods)

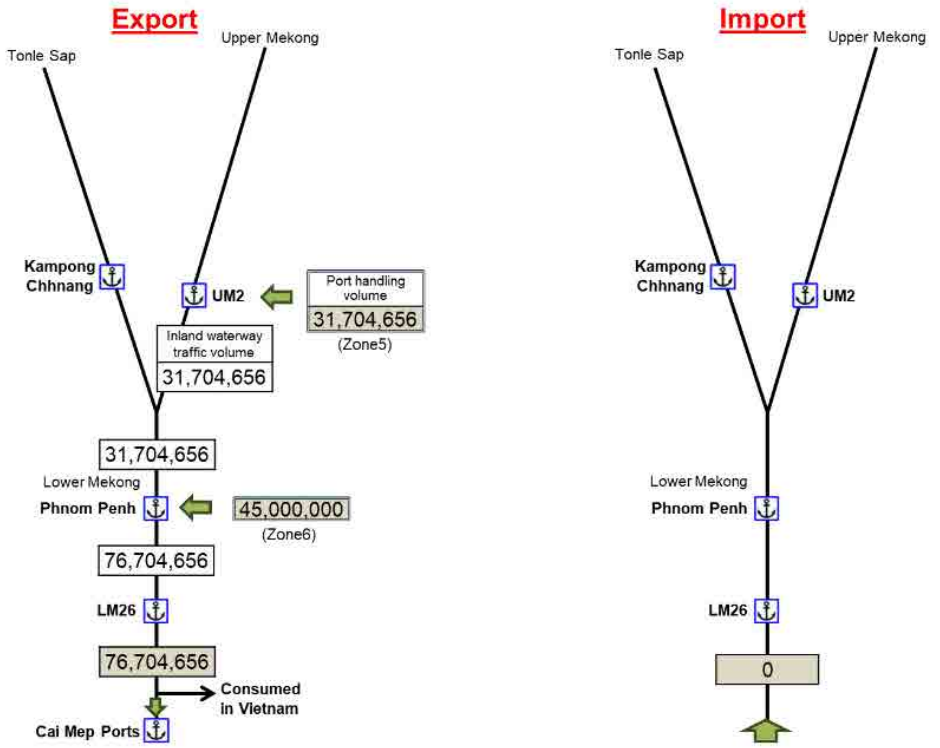


Figure 5-11 Flow of inland waterway traffic (Case 0: Mineral resources)

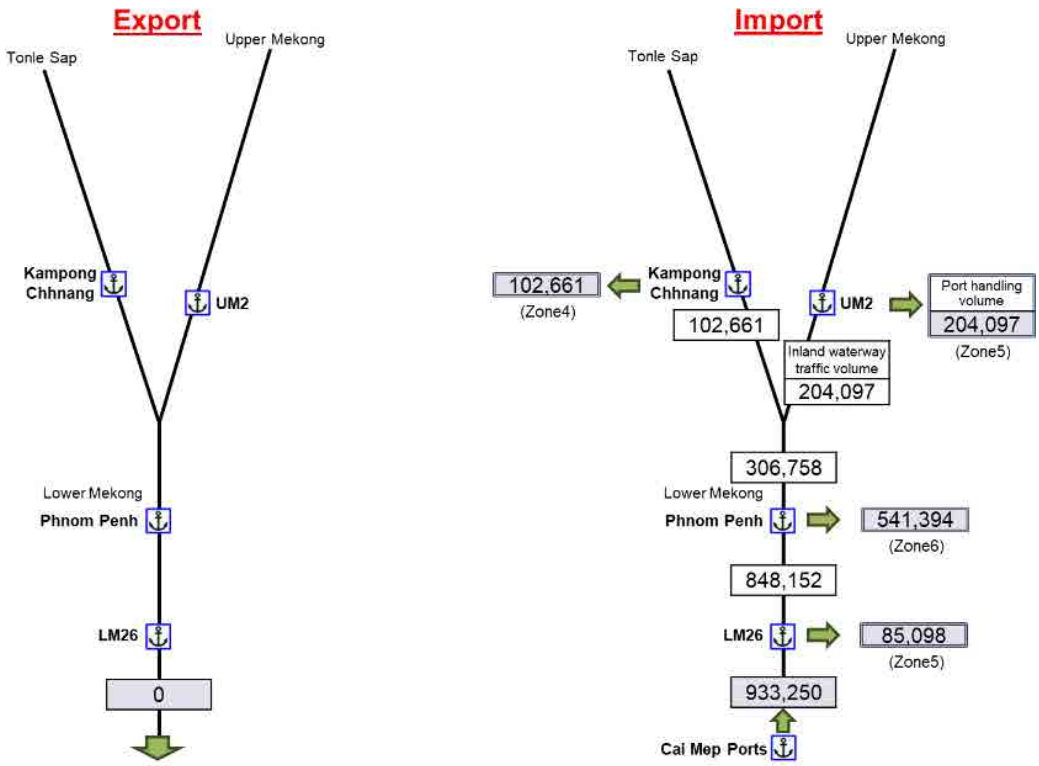


Figure 5-12 Flow of inland waterway traffic by cargo items (Case 0: Energy)

5.5.2 IWT cargo flow in Case 1 (only containers)

(1) Export IWT flow

Table 5-36 shows export container cargo volume through IWT to foreign ports in Case 1 (bulk cargoes are excluded). The total export container volume in Cambodia is 2,742,410 TEUs. Of this, 2,049,863 TEUs are loaded onto mother vessels at seaports (Zone1). A further 433,340 TEUs are loaded onto barges at Phnom Penh port (Zone6) and transshipped to Cai Mep ports through the lower Mekong. The remaining 433,340 TEUs are directly transported to foreign ports (Cai Mep or Laem Chabang) by truck.

Table 5-36 Export container volume through IWT by zone (Case 1)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	2,049,863 (truck 2,049,863)	-	-	-
2	0	-	-	-
3	0	-	-	-
4	0	-	-	-
5	0	-	-	-
6	433,340	-	-	-
Sub total (Seaports and riverports in Cambodia)	2,483,203	-	-	-
Transported by truck to foreign ports	259,207	-	-	-
Grand total	2,742,410	-	-	-
Included number				
Consumed in Vietnam	-	-	-	-
Transshipped to Vietnam through the Mekong river	433,340	-	-	-

(2) Import IWT flow

Next, the volume of import cargo via IWT is summarized in Table 5-37. The total volume of containers imported to Cambodia amounts to 2,909,135 TEUs. Of this, 2,484,650 TEUs will be discharged from mother vessels at seaports in Zone 1 and then transported by truck to each inland zone. A further 197,611 TEUs will be transshipped by barge from Cai Mep ports and discharged at Phnom Penh port (Zone 6). The remaining 226,874 TEUs will be transported directly by truck from foreign ports (Cai Mep or Laem Chabang) to each zone.

Table 5-37 Import container volume through IWT by zone (Case 1)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	2,484,650 (truck 2,484,650)	-	-	-
2	0	-	-	-
3	0	-	-	-
4	0	-	-	-
5	0	-	-	-
6	197,611	-	-	-
Sub total (Seaports and riverports in Cambodia)	2,682,261	-	-	-
Transported by truck from foreign ports	226,874	-	-	-
Grand total	2,909,135	-	-	-
Included number				
Transshipped from Vietnam through the Mekong river	197,611	-	-	-

Table 5-38 shows total (export and import) container through IWT from seaports in Case 1.

Table 5-38 Total (import and export) container and bulk cargo volume through IWT (Case 1)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	4,534,513 (truck 4,534,513)	-	-	-
2	0	-	-	-
3	0	-	-	-
4	0	-	-	-
5	0	-	-	-
6	630,951	-	-	-
Sub total (Seaports and riverports in Cambodia)	5,165,464	-	-	-
Transported by truck to/from foreign ports	486,081	-	-	-
Grand total	5,651,545	-	-	-
Included number				
Consumed in Vietnam	-	-	-	-
Transshipped to/from Vietnam through the Mekong river	630,951	-	-	-

(3) Cargo flow diagram

Next, we will draw the cargo flow diagrams of containers. Referring to the left side of Figure 5-13, 509,660TEUs of containers will be generated and loaded onto barges at Phnom Penh port. These containers will be transported down the Mekong River and loaded onto mother vessels in Cai Mep ports. 1,996,779 TEUs of containers will arrive at seaports by truck in Zone 1 and be loaded onto mother vessels. 235,972 TEUs of containers will cross the border by truck and be loaded onto mother vessels in foreign ports such as Cai Mep or Leam Chabang. No containers from the Upper Mekong area and Tonle Sap area will use barges.

Import cargo flows have similar patterns but are not described in detail here for the sake of brevity.

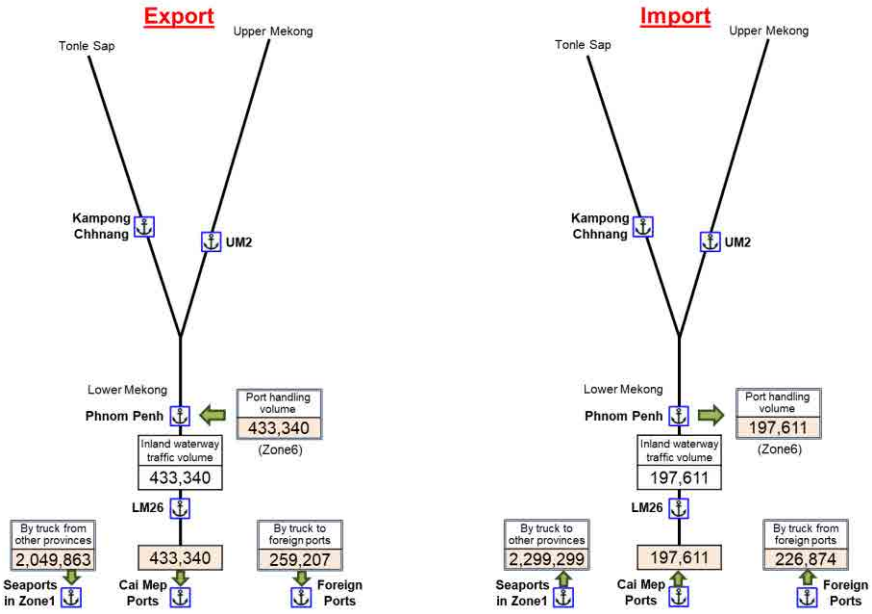


Figure 5-13 Flow of inland waterway traffic (Case 1: Container)

5.5.3 IWT cargo flow in Case 2

(1) Export cargo flow

Table 5-39 shows export container and bulk cargo handled in each zone through IWT to foreign ports in Case 2. For container cargo, the total volume generated in Cambodia amounts to 3,924,075 TEUs. River ports will handle these export containers. For example, Kampong Chhnang port in Zone 4 will handle 135,264 TEUs, UM2 or LM26 in Zone 5 will handle 371,554 TEUs, and Phnom Penh port in Zone 6 will handle 985,267 TEUs, respectively. Of the above total, 1,181,664 TEUs will be transshipped through the Funan Techo Canal to seaports in Zone 1 and subsequently loaded onto mother vessels there. The remaining 310,421 TEUs will be transshipped to Cai Mep ports through the lower Mekong River. In addition, 1,119,787 TEUs will be transported by truck from inland zones to seaports in Zone 1 and will be loaded onto mother vessels there. A further 130,539 TEUs will be directly transported by truck to foreign ports (mainly Cai Mep or Laem Chabang).

For bulk (Agriculture), the total volume amounts to 508,048 tons. Of this, Kampong Chhnang port (Zone 4) will handle 173,825 tons, UM2 or LM26 (Zone 5) will handle 211,238 tons, and Phnom Penh port (Zone 6) will handle 66,881 tons (this cargo will be loaded onto barges), respectively. The seaports in Zone 1 will receive 56,104 tons by barge through the Funan Techo Canal. These cargoes will be subsequently loaded onto mother vessels once again. The remaining 395,840 tons will head to Vietnam through the lower Mekong River for domestic consumption.

For bulk (Mineral resources), the total volume amounts to 108,409,312 tons. River ports in UM2 (Zone 5) will export 31,704,656 tons. This cargo will be sent to seaports in Zone 1 through the Funan Techo Canal and loaded onto mother vessels once again there. The remaining 45,000,000 tons of dredged river sand will be loaded onto barges in Zone 6 and exported to Vietnam or to countries further beyond through the lower Mekong River.

Table 5-39 Export container and bulk cargo volume through IWT (Case 2)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	2,301,451 (barge 1,181,664) (truck 1,119,787)	56,104 (barge 56,104)	31,704,656 (barge 31,704,656)	0
2	0	0	0	0
3	0	0	0	0
4	135,264	173,825	0	0
5	371,554	211,238	31,704,656	0
6	985,267	66,881	45,000,000	0
Sub total (Seaports and riverports in Cambodia)	3,793,536	508,048	108,409,312	0
Transported by truck to foreign ports	130,539	-	-	-
Grand total	3,924,075	508,048	108,409,312	0
Included number				
Consumed in Vietnam	-	395,840	45,000,000	0
Transshipped to Vietnam through the Mekong river	310,421	0	0	0

(2) Import cargo flow

Next, the volume of import cargo via IWT is summarized in Table 5-40.
For containers, the total demand in Cambodia amounts to 4,259,047 TEUs. Of this, 2,663,047 TEUs will be discharged from mother vessels at seaports in Zone 1, after which 1,189,020 TEUs will be transported by truck to each zone. The remaining 1,474,027 TEUs will be loaded onto barges at seaports in Zone 1 and transported to each zone through the Funan Techo Canal. Additionally, 121,704 TEUs of the total volume will be transshipped by barge from Cai Mep ports through the lower Mekong River. These containers from the Canal or the lower Mekong River will head for the following river ports: Kampong Chhnang port (193,345 TEUs, Zone 4), UM2 or LM26 (438,750 TEUs, Zone 5) and Phnom Penh port (963,905 TEUs, Zone 6) respectively. In addition, 124,385 TEUs will cross the border by truck from foreign ports (Cai Mep or Laem Chabang),

For bulk (Agriculture), the total volume amounts to 318,684 tons. Of this, 159,342 tons will be unloaded from mother vessels at seaports in Zone 1, then loaded onto barges and transported to each zone through the Funan Techo Canal. 32,113 tons will be unloaded from barges at Kampong Chhnang port (Zone 4), 109,881 tons at UM2 or LM26 (Zone 5), and 17,348 tons at Phnom Penh port (Zone 6).

For bulk (Energy), the total import volume amounts to 34,001,303 tons. 28,401,796 tons will be unloaded from mother vessels at seaports in Zone 1. Of this, 5,599,507 tons will be once again loaded onto barges at seaports in Zone 1 and transported to each zone through the Funan Techo Canal. Kampong Chhnang port will handle 615,973 tons (Zone 4), UM2 or LM will handle 261,735,170 tons (Zone5) and Phnom Penh port will handle 3,248,364 tons (Zone 6), respectively.

Table 5-40 Import container and bulk cargo volume through IWT (Case 2)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	2,663,047 (barge 1,474,027) (truck 1,189,020)	159,342 (barge 159,342)	0	28,401,796 (barge 5,599,507)
2	0	0	0	0
3	0	0	0	0
4	193,345	32,113	0	615,973
5	438,750	109,881	0	1,735,170
6	963,905	17,348	0	3,248,364
Sub total (Seaports and riverports in Cambodia)	4,259,047	318,684	0	34,001,303
Transported by truck from foreign ports	124,385	-	-	-
Grand total	4,383,432	318,684	0	34,001,303
Included number				
Transshipped from Vietnam through the Mekong river	121,704	0	0	0

Table 5-41 shows the combined total of export and import cargo. Export containers transported by barge to the seaports in Zone 1 will be unloaded at a feeder berth and loaded to a mother vessel at a mother vessel berth. Import containers are vice versa. Bulk cargo is handled in the same transportation way. In other words, transshipment will take place at seaports in Zone 1.

Table 5-41 Total (export and import) container and bulk cargo volume through IWT (Case 2)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	4,964,498 (barge 2,655,691) (truck 2,308,807)	215,446 (barge 215,446)	31,704,656 (barge 31,704,656)	28,401,796 (barge 5,599,507)
2	0	0	0	0
3	0	0	0	0
4	328,609	205,938	0	615,973
5	810,304	321,119	31,704,656	1,735,170
6	1,949,172	84,229	45,000,000	3,248,364
Sub total (Seaports and riverports in Cambodia)	8,052,583	826,732	108,409,312	34,001,303
Transported by truck to/from foreign ports	254,924	-	-	-
Grand total	8,307,507	826,732	108,409,312	34,001,303
Included number				
Consumed in Vietnam	-	395,840	45,000,000	0
Transshipped to/from Vietnam through the Mekong river	432,125	0	0	0

(3) Cargo flow diagram

Next, we draw the cargo flow diagrams (see from Figure 5-14 to Figure 5-17). Four pairs (import and export) of diagrams are prepared for containers and bulk cargoes (Agriculture goods, Mineral resources, and Energy).

Referring to the left side of Figure 5-14, unlike in Case 0 and Case 1, containers from the UM2 and the mouth of Tonle Sap area (Kampong Chhnang) start to use barges. 135,264 TEUs of containers will be loaded onto barges at Kampong Chhnang port in Zone 4 and 230,237 TEUs will be loaded at UM2 in Zone 5, respectively.

A total of 365,501 TEUs will be transported down the river. At Phnom Penh port in Zone 6, an additional 985,267 TEUs will be loaded. These containers will either be transported further down the Mekong River or switch to Funan Techo Canal. Of the total, 286,038 TEUs will be transported down the lower Mekong, but will increase to 310,421 TEUs when an additional 141,317 TEUs is loaded at LM26 in Zone 5. This cargo is bound for Cai Mep ports. On the other hand, 1,181,664 TEUs will be transported down the Canal to seaports in Zone 1. In addition, 1,119,787 TEUs will be brought to the seaports in Zone 1 by truck. 130,539 TEUs of containers will cross the border by truck and be loaded onto mother vessels in foreign ports such as Cai Mep or Leam Chabang.

The other cargo flows have similar patterns but are not described in detail here for the sake of brevity.

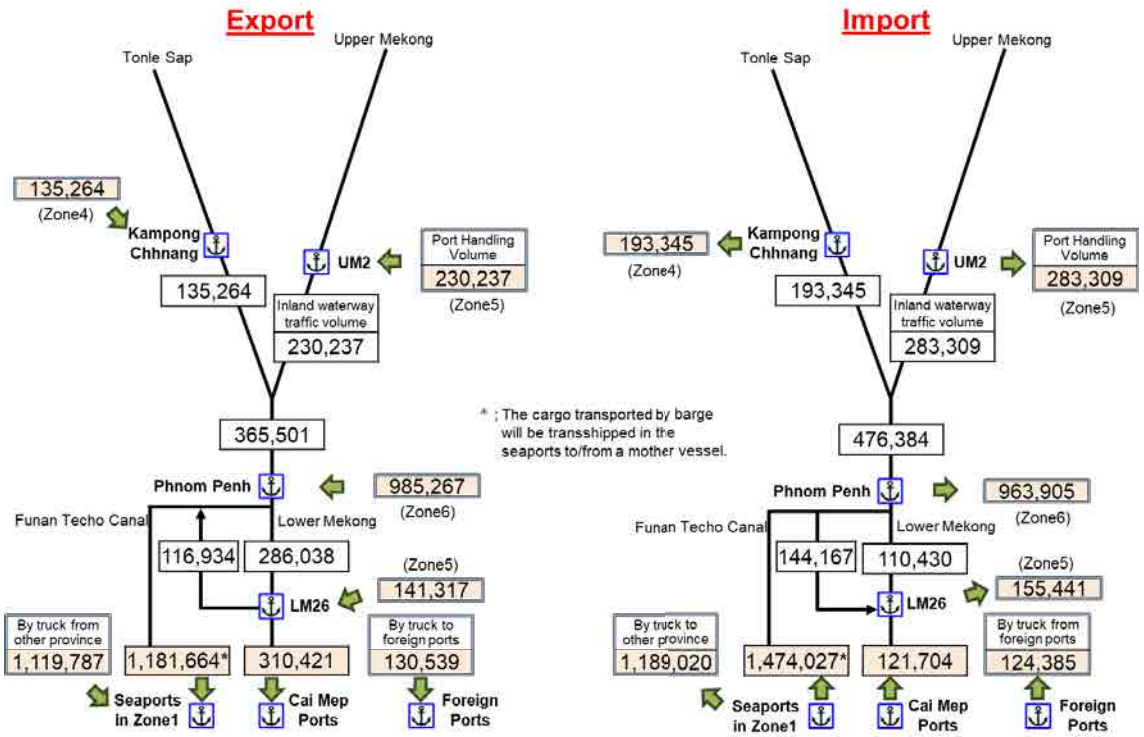


Figure 5-14 Flow of inland waterway traffic (Case 2: Container)

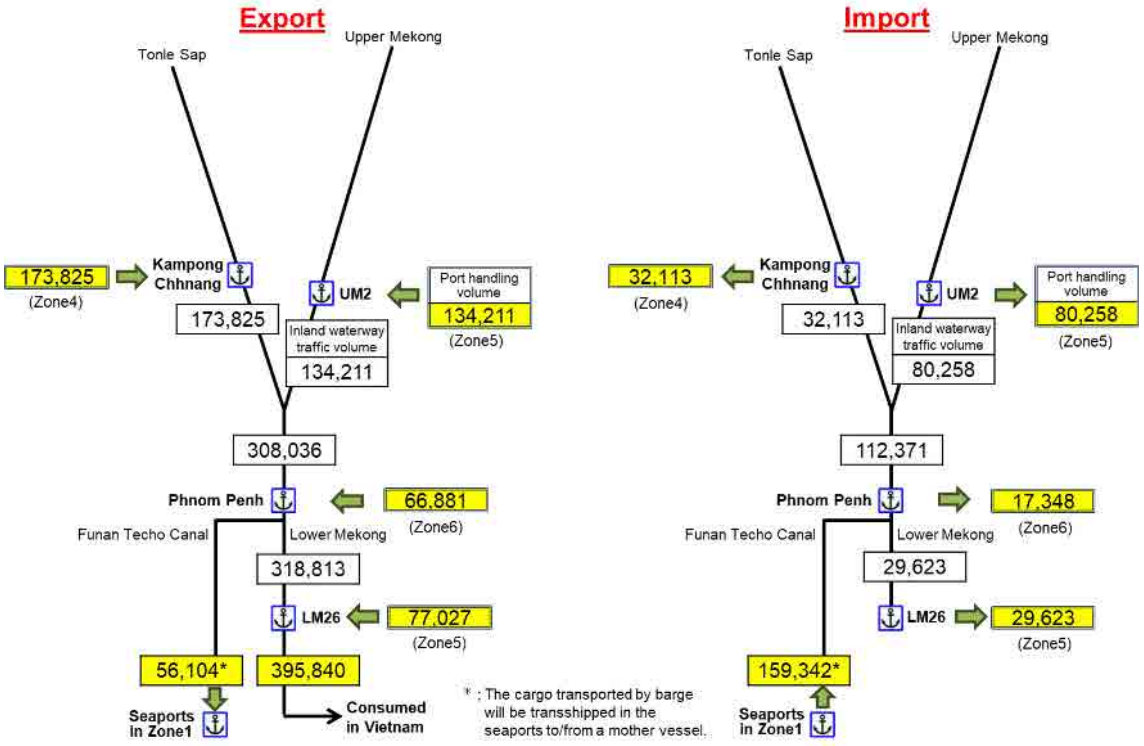


Figure 5-15 Flow of inland waterway traffic (Case 2: Agriculture goods)

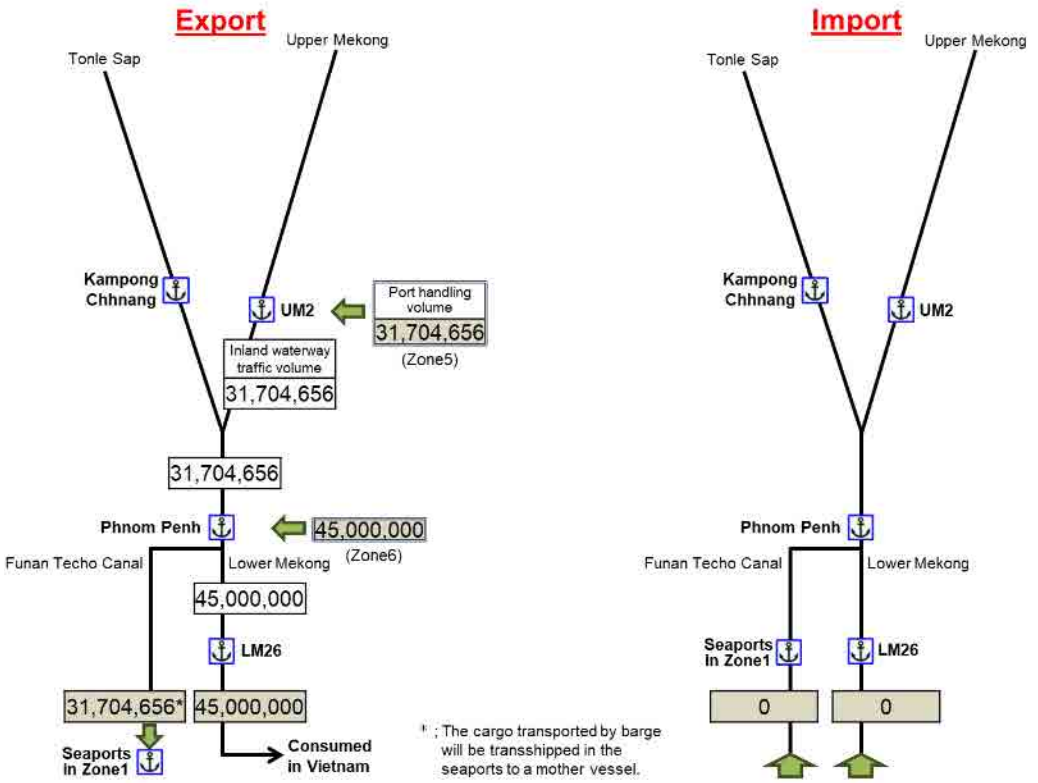


Figure 5-16 Flow of inland waterway traffic (Case 2: Mineral resources)

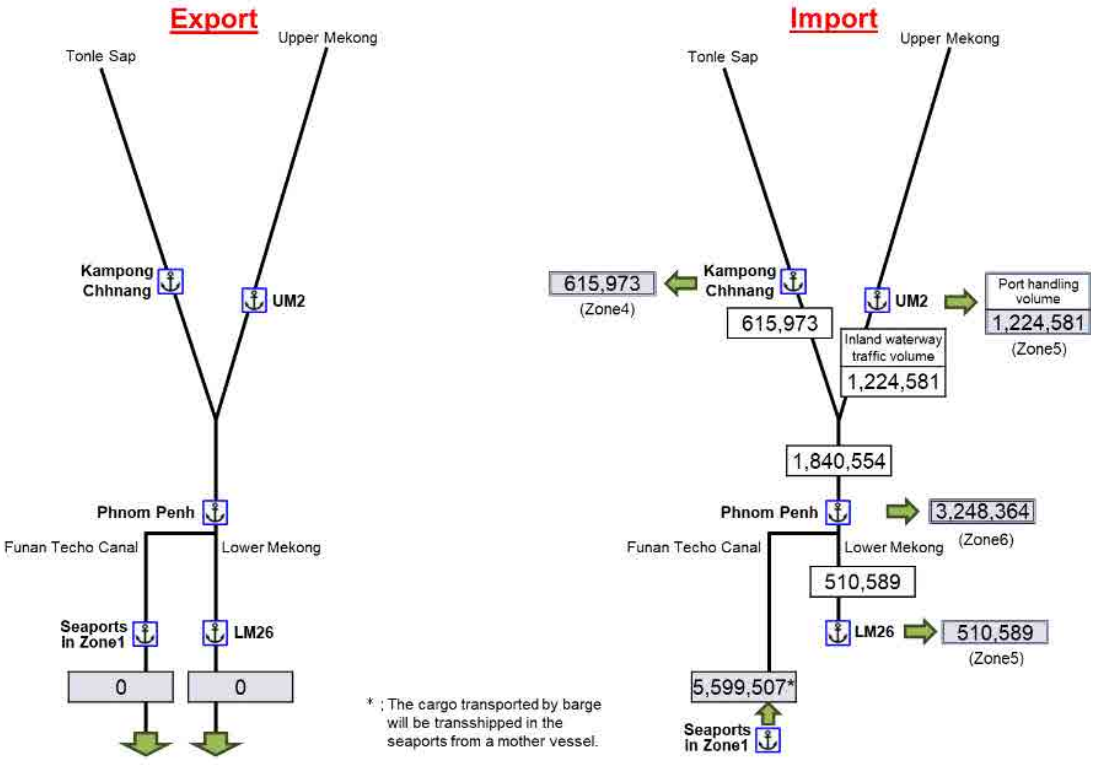


Figure 5-17 Flow of inland waterway traffic (Case 2: Energy)

5.5.4 IWT cargo flow in Case 3

(1) Export cargo flow

Table 5-42 shows export container and bulk cargo volume through IWT to foreign ports in Case 3.

For container cargo, the total volume generated in Cambodia amounts to 4,015,211 TEUs. River ports will handle these export containers. For example, Stung Treng or Kratie port in Zone 2 will handle 154,827 TEUs, Chong Khneas port in Zone 3 will handle 165,701 TEUs, Kampong Chhnang port in Zone 4 will handle 89,419 TEUs, UM2 or LM26 in Zone 5 will handle 255,520 TEUs, and Phnom Penh port in Zone 6 will handle 927,275 TEUs, respectively. Of the above total, 1,272,800 TEUs will be transshipped through the Funan Techo Canal to seaports in Zone 1 and subsequently loaded onto mother vessels there. The remaining 319,942 TEUs will be transshipped to Cai Mep ports through the lower Mekong River. In addition, 1,027,069 TEUs will be transported by truck from inland zones to seaports in Zone 1 and will be loaded onto mother vessels there. A further 122,600 TEUs will be directly transported by truck to foreign ports (mainly Cai Mep or Laem Chabang).

For bulk (Agriculture), the total volume amounts to 2,488,198 tons. Of this, Stung Treng or Kratie port in Zone 2 will handle 129,591 tons, Chong Khneas port in Zone 3 will handle 745,630 tons, Kampong Chhnang port in Zone 4 will handle 294,314 tons, UM2 or LM26 in Zone 5 will handle 860,798 tons, and Phnom Penh port in Zone 6 will handle 401,289 tons to be loaded onto barges respectively. The seaports in Zone 1 will receive 56,576 tons by barge through the Funan Techo Canal. These cargoes will be subsequently loaded onto mother vessels once again. The remaining 2,375,046 tons will head to Vietnam through the lower Mekong River for domestic consumption.

For bulk (Mineral resources), the total volume amounts to 108,409,312 tons. River ports in Stung Treng or Kratie port (Zone 2) will export 31,704,656 tons. This cargo will be sent to seaports in Zone 1 through the Funan Techo Canal and loaded onto mother vessels once again there. The remaining 45,000,000 tons of dredged river sand will be loaded onto barges in Zone 6 and exported to Vietnam or to countries further beyond through the lower Mekong River.

Table 5-42 Export container and bulk cargo volume through IWT (Case 3)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	2,299,869 (barge 1,272,800) (truck 1,027,069)	56,576 (barge 56,576)	31,704,656 (barge 31,704,656)	0
2	154,827	129,591	31,704,656	0
3	165,701	745,630	0	0
4	89,419	294,314	0	0
5	255,520	860,798	0	0
6	927,275	401,289	45,000,000	0
Sub total (Seaports and riverports in Cambodia)	3,892,611	2,488,198	108,409,312	0
Transported by truck to foreign ports	122,600	-	-	-
Grand total	4,015,211	2,488,198	108,409,312	0
Included number				
Consumed in Vietnam	-	2,375,046	45,000,000	0
Transshipped to Vietnam through the Mekong river	319,942	0	0	0

(2) Import cargo flow

Next, Table 5-43 presents the summary of import cargo while Table 5-44 shows the combined total of export and import cargo.

For containers, the total demand in Cambodia amounts to 4,477,845 TEUs. Of this, 2,669,633 TEUs will be discharged from mother vessels at seaports in Zone 1, after which 1,100,923 TEUs will be transported by truck to each zone. The remaining 1,568,710 TEUs will be loaded onto barges at seaports in Zone 1 and transported to each zone through the Funan Techo Canal. Additionally, 129,641 TEUs of the total volume will be transshipped by barge from Cai Mep ports through the lower Mekong River. These containers from the Canal or the lower Mekong River will head for the following river ports: Stung Treng or Kratie port in Zone 2 (101,312 TEUs), Chong Khneas port in Zone 3 (213,758 TEUs), Kampong Chhnang port in Zone 4 (140,811 TEUs), UM2 or LM26 in Zone 5 (337,706 TEUs) and Phnom Penh port in Zone 6 (904,764 TEUs) respectively. In addition, 109,861 TEUs will cross the border by truck from foreign ports (Cai Mep or Laem Chabang).

For bulk (Agriculture), the total volume amounts to 405,562 tons. Of this, 202,781 tons will be unloaded from mother vessels at seaports in Zone 1, then loaded onto barges and transported to each zone through the Funan Techo Canal. 39,941 tons are unloaded from barges at Stung Treng or Kratie port (Zone 2), 67,453 tons at Chong Khneas port (Zone 3), 8,099 tons at Kampong Chhnang port (Zone 4), 69,940 tons at UM2 or LM26(Zone 5), and 17,348 tons at Phnom Penh port (Zone 6), respectively.

For bulk (Energy), the total import volume amounts to 34,689,313 tons. 28,401,796 tons will be unloaded from mother vessels at seaports in Zone 1. Of this, 6,287,517 tons will be once again loaded onto barges at seaports in Zone 1 and transported to each zone through the Funan Techo Canal. 435,691 tons will be unloaded from barges at Stung Treng or Kratie port (Zone 2), 1,081,510 tons will be unloaded at Chong Khneas port (Zone 3), 222,473 tons will be unloaded

at Kampong Chhnang port (Zone 4), 1,299,479 tons will be unloaded at UM2 or LM26 (Zone5), and 3,248,364 tons will be unloaded at Phnom Penh port (Zone 6), respectively.

Table 5-43 Import container and bulk cargo volume through IWT (Case 3)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	2,669,633 (barge 1,568,710) (truck 1,100,923)	202,781 (barge 202,781)	0	28,401,796 (barge 6,287,517)
2	101,312	39,941	0	435,691
3	213,758	67,453	0	1,081,510
4	140,811	8,099	0	222,473
5	337,706	69,940	0	1,299,479
6	904,764	17,348	0	3,248,364
Sub total (Seaports and riverports in Cambodia)	4,367,984	405,562	0	34,689,313
Transported by truck from foreign ports	109,861	-	-	-
Grand total	4,477,845	405,562	0	34,689,313
Included number				
Transshipped from Vietnam through the Mekong river	129,641	0	0	0

Table 5-44 shows the combined total of export and import cargo.

Table 5-44 Total (export and import) container and bulk cargo volume through IWT (Case 3)

Zone	Container (Total) (TEUs)	Bulk (Agriculture) (Tons)	Bulk (Mineral resources) (Tons)	Bulk (Energy) (Tons)
1	4,969,502 (barge 2,841,510) (truck 2,127,992)	259,357 (barge 259,357)	31,704,656 (barge 31,704,656)	28,401,796 (barge 6,287,517)
2	256,139	169,532	31,704,656	435,691
3	379,459	813,083	0	1,081,510
4	230,230	302,413	0	222,473
5	593,226	930,738	0	1,299,479
6	1,832,039	418,637	45,000,000	3,248,364
Sub total (Seaports and riverports in Cambodia)	8,260,595	2,893,760	108,409,312	34,689,313
Transported by truck to/from foreign ports	232,461	-	-	-
Grand total	8,493,056	2,893,760	108,409,312	34,689,313
Included number				
Consumed in Vietnam	-	2,375,046	45,000,000	0
Transshipped to/from Vietnam through the Mekong river	449,583	0	0	0

(3) Cargo flow diagram

Next, we draw the cargo flow diagrams (see from Figure 5-18 to Figure 5-21). Four pairs (import and export) of diagrams are prepared for containers and bulk cargoes (Agriculture goods, Mineral resources, and Energy).

Referring to the left side of Figure 5-18, unlike in Case 0, Case 1 and Case 2, containers from the Upper Mekong area and the Tonle Sap area will start to use barges. In the Tonle Sap area, a total of 255,119 TEUs will be generated: 165,701 TEUs from Chong Khneas (Zone 3) and 89,419 TEUs from Kampong Chhnang (Zone 4). In the Upper Mekong area, a total of 296,563 TEUs will be generated: 45,548 TEUs from Stung Treng, 109,280 TEUs from Kratie in Zone 2, and 141,736 TEUs from UM2 in Zone 5, respectively.

A total of 551,682 TEUs will be transported down the river. At Phnom Penh port in Zone 6, an additional 927,275 TEUs will be loaded. These containers will either be transported further down the Mekong River or switch to Funan Techo Canal. Of the total, 298,429 TEUs will be transported down the lower Mekong, but will increase to 319,942 TEUs when an additional 113,784 TEUs is loaded at LM26 in Zone 5. This cargo is bound for Cai Mep ports. On the other hand, 1,272,800 TEUs will be transported down the Canal to seaports in Zone 1. In addition, 1,027,069 TEUs will be brought to the seaports in Zone 1 by truck. 122,600 TEUs of containers will cross the border by truck and be loaded onto mother vessels in foreign ports such as Cai Mep or Leam Chabang.

The other cargo flows have similar patterns but are not described in detail here for the sake of brevity.

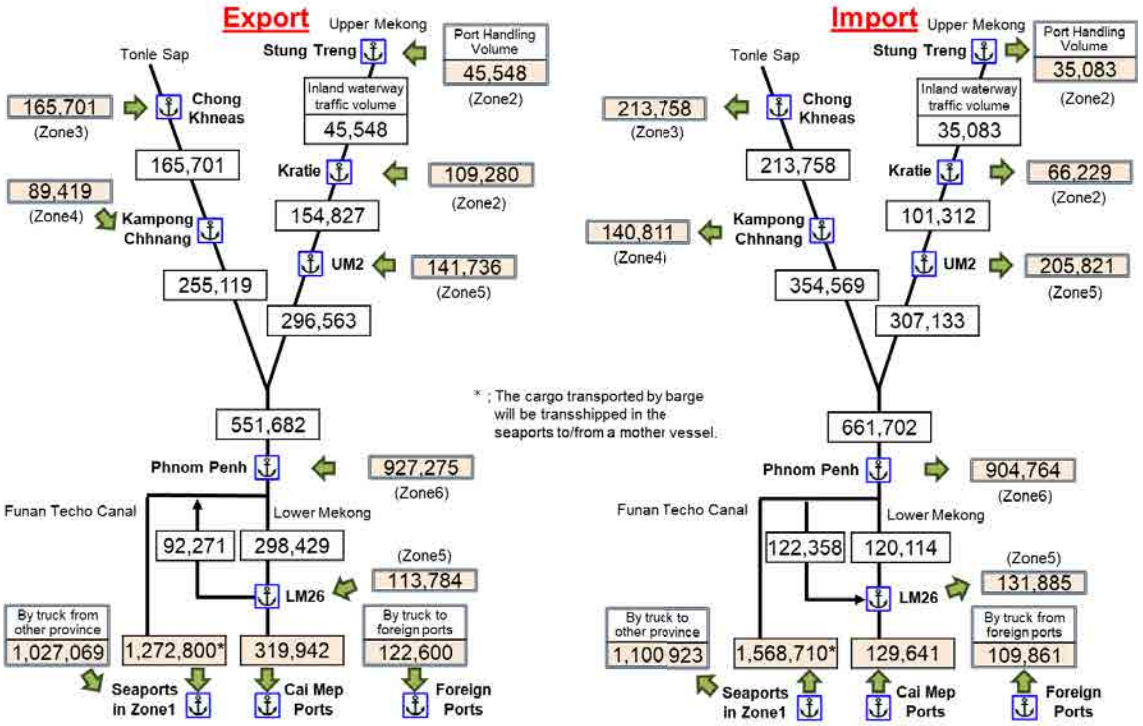


Figure 5-18 Flow of inland waterway traffic (Case 3: Container)

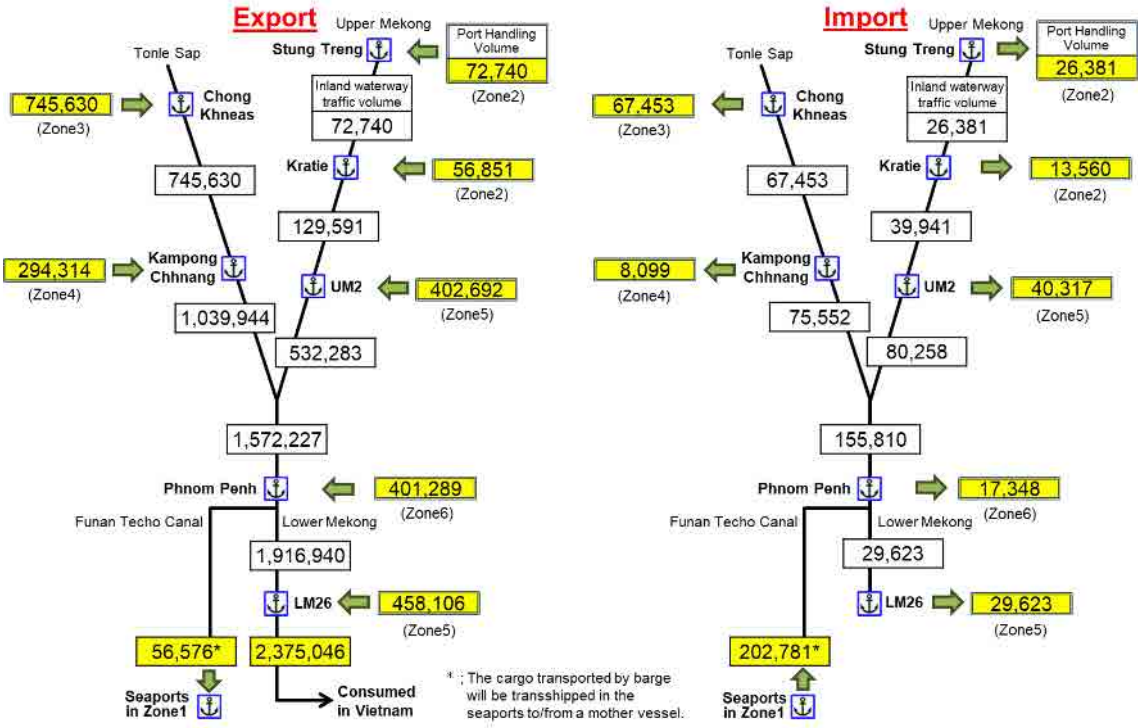


Figure 5-19 Flow of inland waterway traffic (Case 3: Agriculture goods)

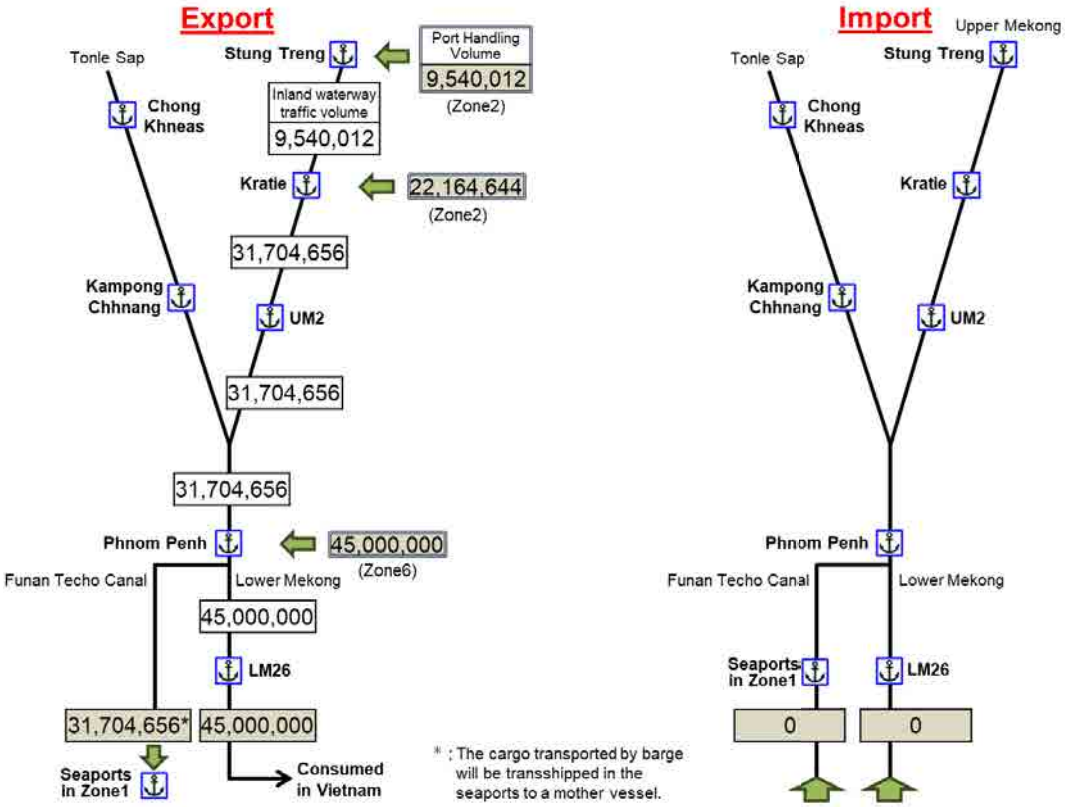


Figure 5-20 Flow of inland waterway traffic (Case 3: Mineral resources)

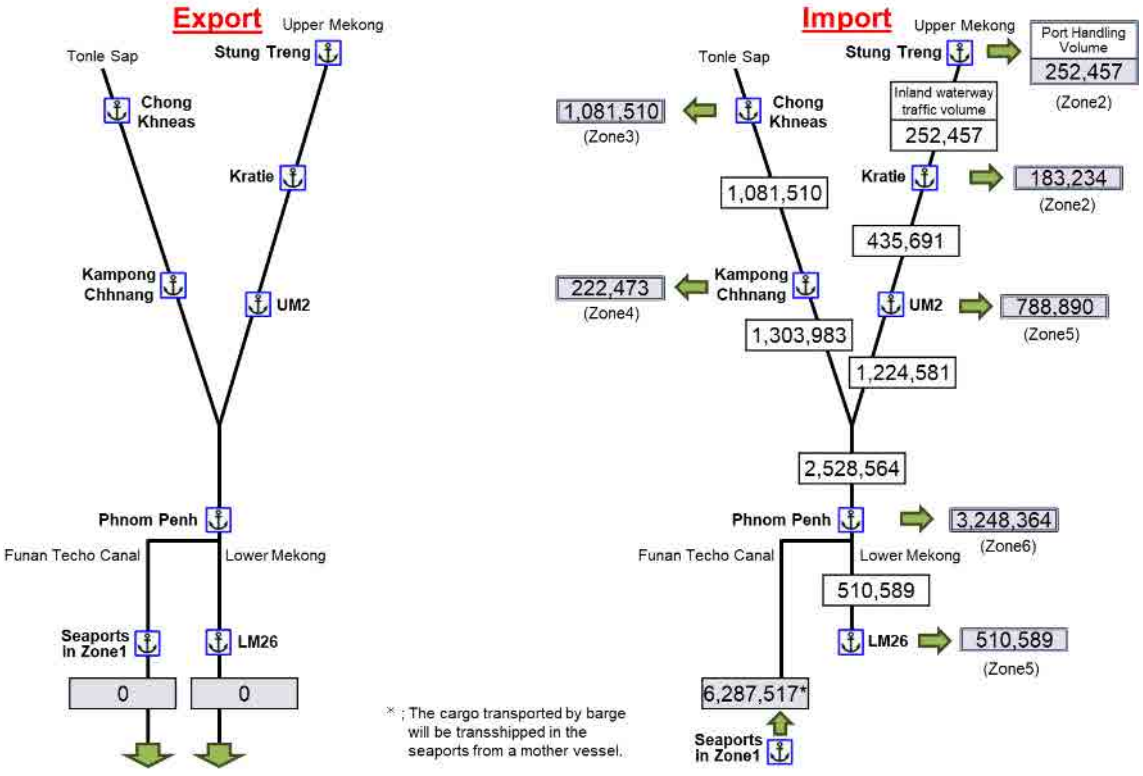


Figure 5-21 Flow of inland waterway traffic (Case 3: Energy)

Chapter-6 Increasing cargo volume and port facilities to be developed

In this chapter, we will estimate port facilities volume (here defined as the number of berths) to accommodate the forecast cargo volume in 2050 in each zone. The forecast cargo volume was presented in Chapters 3 and 4. The estimation will be carried out for five cargo types: containers, bulk- agriculture goods, bulk-mineral resources, bulk-energy (liquid), and bulk-energy (solid). These cargo types were selected based on the cargo handling method. When estimating the number of berths, we first set the annual cargo handling capacity by cargo type. Next, we estimate the number of berths by the increased cargo volume and the annual cargo handling capacity.

6.1 Setting annual cargo handling capacity by cargo type

6.1.1 Container

The annual cargo handling capacity per berth for containers was calculated for three types of berths: seaport berths where ocean going mother vessels berth, river port berths, and feeder berths at seaports. Regarding cargo handling methods, Quay Container Cranes (QCC) were assumed for seaports, Fixed Cargo Cranes (FCC) for river ports, and Travelling Cargo Cranes (TCC) for feeder berths. Each berth was equipped with two QCCs at seaports and one FCC or TCC at river ports and feeder berths. For the target vessels, based on actual performance data, medium-sized 4,000 TEU vessels were assumed for seaports, while small 250 TEU and 125 TEU vessels were assumed for river ports and feeder berths. The various parameters used in the calculations were set based on data, including actual performance, obtained from interviews with PPAP and PAS.

Table 6-1 shows the calculated annual handling capacity per berth. The results are 330,003 TEU for seaports, 80,767 TEU for river ports, and 135,502 TEU for feeder berths.

Table 6-1 Container handling capacity per berth

Estimate conditions	Unit	Seaport	River port	Sea feeder
Crane	Type	QCC	FCC	TCC
(a) Number of crane	Number	2	1	1
(b) Efficiency	-	0.95	1.00	1.00
(c) Min per cycle	Min/cycle	2.00	3.33	2.60
(d) Cycle per hour = (60min/(c))*(b)*(a)	cycle/hour	57.00	18.02	23.08
(e) TEUs per hour = (d) * 1.48 TEUs/Box	TEUs/hour	84.36	27.67	34.15
(f) Daily Losses = (1)+(2)+(3)+(4)	Hours/day	4.25	3.75	4.25
(1) Mealtime	Hours/day	3.00	3.00	3.00
(2) Change Operation	Hours/day	0.25	0.25	0.25
(3) Gantry Travel	Hours/day	0.50	-	0.50
(4) Other Daily Losses	Hours/day	0.50	0.50	0.50
(g) Holiday = (1a) + (1b)	Day	5.00	5.00	5.00
(1a) Non-Working holiday	Day	-	-	-
(1b) Bad Weather	Day	5.00	5.00	5.00
(h) Berthing/Deberthing per ship	Hour/ship	3.00	0.17	0.17
(i) Target load of ship	TEUs/ship	4,000	250	120
(j) Net Working Hour per Ship = (i) / (e)	Hours/ship	47.42	9.38	3.51
(k) Required Service time per Ship = (j) + (h)	Hours/ship	50.42	9.55	3.68
(l) Remaining Hours for Operation (Actual Working Hour) = 24 - (f)	Hours/day	19.75	20.25	19.75
(m) Time Conversion = (k) / (l)	Day/ship	2.55	0.47	0.19
(n) Net Working Hour per Day =(j) / (m)	Hours/day	18.57	19.89	18.84
(o) Capacity of Berth per Day = (e) * (n)	**TEUs/day**	**1,566.97**	**530.38**	**643.41**
(p) Gross Working days	Day/year	365	365	365
(q) Net Working days/year (NDY) = (p) - (g)	Day/year	360	360	360
(r) downtime (dt) 5 to10%	-	0.10	0.10	0.10
(s) allowable berth occupancy rate (ABOR)	-	0.65	0.47	0.65
(t) Net Working Hour Per Year = (n) * (q) * [1- (r)]* (s)	Hours/year	3,911.85	3,028.75	3,967.39
(u) Port Capacity per Berth (TEUs/Berth/Year) = (t) * (e)	**TEUs/year**	**330,003**	**80,767**	**135,502**

Figure 6-1 shows examples of container terminal layouts at seaports, river ports, and feeder berths, based on the conditions set for the throughput capacity calculations. For seaports, assuming a 50,000 DWT container vessel with an LOA of 269m, a width of 32.3m, and a draft of 12.8m, the required berth length is estimated to be 301.3m.

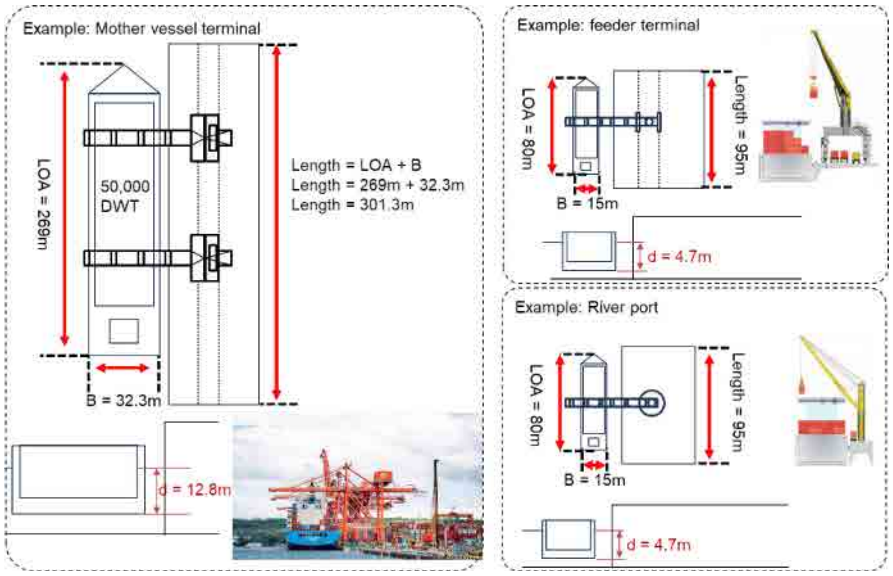


Figure 6-1 Examples of container terminal layouts

6.1.2 Bulk cargo (Agriculture goods)

The annual cargo handling capacity per berth for bulk (agriculture goods) was calculated for three types of berths: seaport berths where ocean going mother vessels berth, river port berths, and feeder berths at seaports. However, for paddy within agriculture goods, calculations were performed separately from other cargo items due to its limited harvest period. Reflecting MPWT's recommendation, the harvest period was set at 6 months (180 days) for this study. As noted in the previous chapter, paddy is assumed to be exported to Vietnam through the Mekong River, so only river ports are considered for paddy. Unlike containers, agriculture goods involve various packaging forms per item. For this study, the cargo was assumed to be bagged, with each bag weighing 50 kg, and handling was assumed to be performed by lifting the bagged cargo using nets (refer to Figure 6-2).

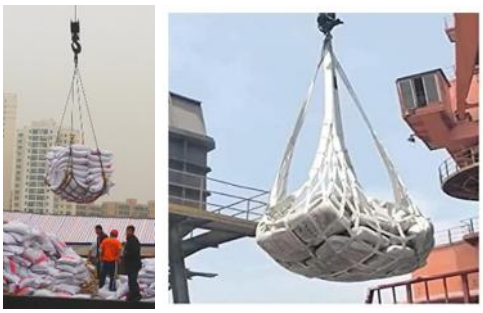


Figure 6-2 Example of bagged cargo handling using nets

The handling volume per cycle is assumed to be 500 bags at seaports and 50 bags at other ports, with 20 cycles per hour. Handling equipment was assumed to be two cranes per berth under all conditions. For the target vessels, medium-sized 55,000 DWT vessels were assumed for seaports, and small 3,000 DWT vessels for river ports and feeder berths. Table 6-2 shows the calculated annual handling capacity per berth. The annual handling capacity is 2,628,000 tons for seaports, 262,800 tons for river ports and feeder berths, and 129,600 tons for berths handling paddy.

Table 6-2 Bulk cargo (agriculture goods) handling capacity per berth

	Raw rubber, Cereal, Fertilizer			Paddy
	Seaport		River port	River port
Estimate conditions	Mother vessel berth	Feeder berth	Loading/ Unloading	Loading
(a) Weight per cargo unit (kg/bag)	50	50	50	50
(b) Number of cargo units per handling operation (bag/cycle)	500	50	50	50
(c) Number of cargo handling operations per hour (cycle/hour)	20	20	20	20
(d)=(a)×(b)×(c) Work volume per hour (ton/hour)	500	50	50	50
(e) Number of gangs per berth (gang/berth)	2	2	2	2
(f)=(d)×(e) Work volume per hour per berth (ton/hour/berth)	1,000	100	100	100
(g) Daily working hours (hour/day)	12	12	12	12
(h)=(f)×(g) Daily work volume (ton/day/berth)	12,000	1,200	1,200	1,200
(i) Target load of ship (ton)	55,000	3,000	3,000	3,000
(j)=(i)/(h) Loading days per ship (day/berth)	4.58	2.50	2.50	2.50
(k) Number of working days per year (day/year)	365	365	365	180*
(l) Berth occupancy rate	0.60	0.60	0.60	0.60
(m)=(i)/(j)×(k)×(l) Anuual handling capacity per berth (ton/year/berth)	2,628,000	262,800	262,800	129,600

Figure 6-3 shows an example of a berth layout at a river port based on "Average vessel specifications based on actual data by PPAP" and "Technical Standards and Commentaries for Port and Harbour Facilities in Japan". Assuming a 3,000 DWT barge with an LOA of 87m, width of 14.3m, and draft of 5.3m, the required berth length is estimated to be 110m while the water depth is estimated to be 6m. The table shows examples of standard dimensions of design vessels and berths for mooring facilities, with seaports on the left and river ports on the right.

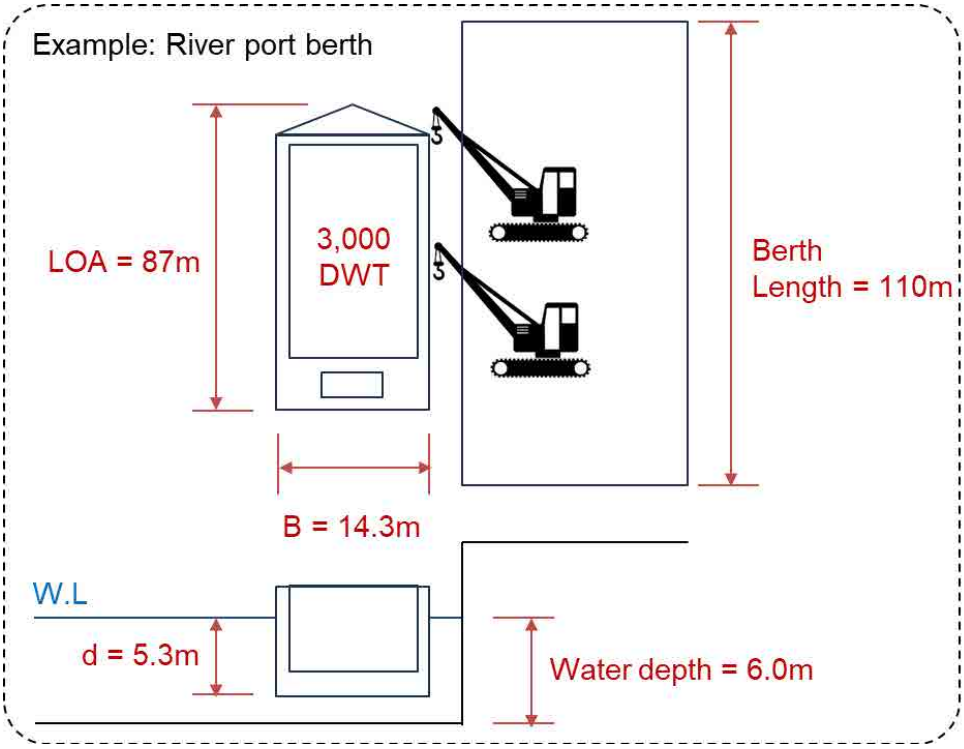


Figure 6-3 Example layout of bulk cargo (agriculture goods) berth

6.1.3 Bulk cargo (Mineral resources)

The annual cargo handling capacity per berth for bulk (mineral resources) was calculated for three types of berths: seaport berths where mother vessels berth, river port berths, and feeder berths at seaports. Unlike agricultural goods, mineral resources are handled in bulk in large volumes at a dedicated berth. Therefore, loading and unloading works were assumed to be performed using higher capacity ship loaders and ship unloaders, respectively. Figure 6-4 shows examples of a mobile ship loader and a grab bucket-type ship unloader.



Figure 6-4 Example of ship loader and ship unloader

For cargo handling capacity, based on equipment manufacturer catalogs and other references,

seaports were assumed to handle 6,000 tons per hour, while river ports and feeder berths were assumed to handle 1,000 tons per hour. In all cases, two units of handling equipment were assumed per berth. For target vessels, medium-sized 55,000 DWT vessels were assumed in the case of seaports, while small 3,000 DWT vessels were assumed for river ports and feeder berths. Table 6-3 shows the calculated annual handling capacity per berth. The annual handling capacity is 31,536,000 tons for seaports, 5,256,000 tons for river ports and feeder berth. Figure 6-5 shows an example of a berth layout at a river port.

Table 6-3 Bulk cargo (mineral resources) handling capacity per berth

Estimate conditions	Seaport		River port
	Mother vessel berth	Feeder berth	Loading
(a) Work volume per hour (ton/hour)	6,000	1,000	1,000
(b) Number of gangs per berth (shiploader or unloader/berth)	2	2	2
(c)=(a)×(b) Work volume per hour per berth (ton/hour/berth)	12,000	2,000	2,000
(d) Daily working hours (hour/day)	12	12	12
(e)=(c)×(d) Daily work volume (ton/day/berth)	144,000	24,000	24,000
(f) Target load of ship (ton)	55,000	3,000	3,000
(g)=(f)/(e) Loading days per ship (day/berth)	0.38	0.13	0.13
(h) Number of working days per year (day/year)	365	365	365
(i) Berth occupancy rate	0.60	0.60	0.60
(j)=(f)/(g)×(h)×(i) Anuual handling capacity per berth (ton/year/berth)	31,536,000	5,256,000	5,256,000

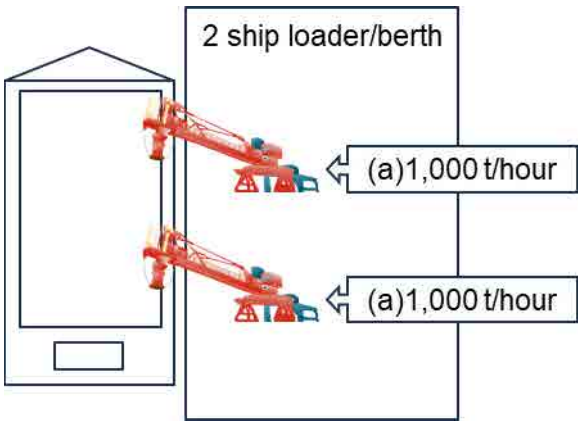


Figure 6-5 Example layout of bulk cargo (mineral resources) berth

6.1.4 Bulk cargo (Energy: Liquid)

The annual cargo handling capacity per berth for bulk (energy: liquid) was calculated for three

types of berths: seaport berths where mother vessels berth, river port berths, and feeder berths at seaports. Unlike other bulk cargoes, all energy (liquid) items are transported in liquid form. Therefore, loading and unloading works were performed using pumps installed on the vessels. Figure 6-6 shows an example of an energy (liquid) carrier berthing at a port.



Figure 6-6 Example of energy (liquid) carrier berthing at port

For cargo handling capacity, based on examples of vessel pumps and other references, seaports were assumed to handle 4,800 tons per hour, while river ports and feeder berths were assumed to handle 1,200 tons per hour. For the target vessels, based on actual performance data, medium-sized 70,000 DWT vessels were assumed for seaports, while small 4,600 DWT vessels were assumed for river ports and feeder berths. Table 6-4 shows the calculated annual handling capacity per berth. The annual handling capacity is 10,060,891 tons for seaports, 2,099,714 tons for river ports and feeder berth.

Table 6-4 Bulk cargo (energy: liquid) handling capacity per berth

Estimate conditions	Unit	Seaport	River port
(a) Capacity Pumping	Tons/hour	4,800	1,200
(b) Daily Losses = (1)+(2)+(3)+(4)	Hours/day	-	-
(1) Mealtime	Hours/day	-	-
(2) Change Operation	Hours/day	-	-
(3) Gantry Travel	Hours/day	-	-
(4) Other Daily Losses	Hours/day	-	-
(c) Holiday = (1a) + (1b)	Day	5.00	5.00
(1a) Non-Working holiday	Day	-	-
(1b) Bad Weather	Day	5.00	5.00
(d) Berthing/Deberthing per ship	Hour/ship	3.00	0.17
(e) Target load of ship	Tons/ship	70,000	4,600
(f) Net Working Hour per Ship = (e) / (a)	Hours/ship	14.58	3.83
(g) Required Service time per Ship = (f) + (d)	Hours/ship	17.58	4.00
(h) Remaining Hours for Operation (Actual Working Hour) = 12 - (b)	Hours/day	12.00	12.00
(i) Time Conversion = (g) / (h)	Day/ship	1.47	0.33
(j) Net Working Hour per Day =(f) / (i)	Hours/day	9.95	11.49
(k) Capacity of Berth per Day = (a) * (j)	**Tons/day**	**47,773**	**13,789**
(l) Gross Working days	Day/year	365	365
(m) Net Working days/year (NDY) = (l) - (c)	Day/year	360	360
(n) Downtime (dt) 5 to10%	-	0.10	0.10
(o) Allowable berth occupancy rate (ABOR)	-	0.65	0.47
(p) Net Working Hour Per Year = (j) * (m) * [1-(n)]* (o)	Hours/year	2,096.02	1,749.76
(q) Port Capacity per Berth (Tons/berth/year) = (p) * (a)	**Tons/year**	**10,060,891**	**2,099,714**

Figure 6-7 shows an example of a berth layout at a seaport.

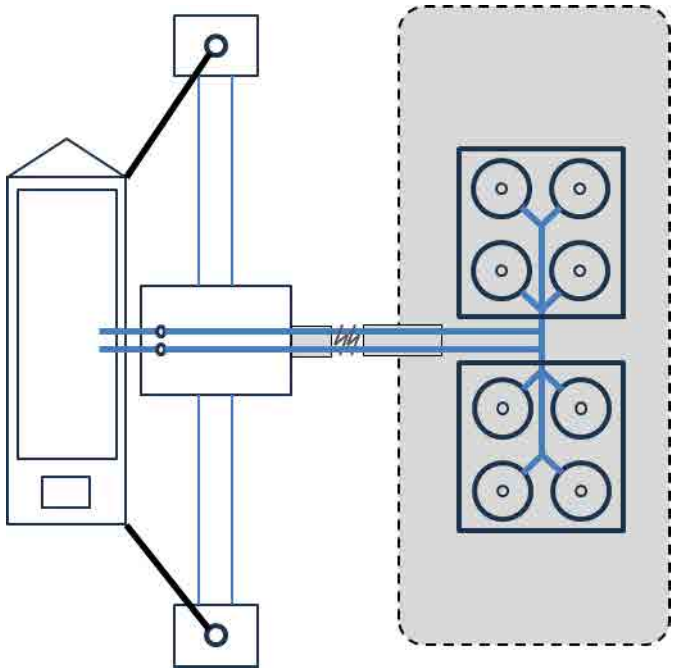


Figure 6-7 Example layout of bulk cargo (energy: liquid) berth

6.1.5 Bulk cargo (Energy: Solid)

The target commodity for bulk (energy: solid) is coal. As noted in the previous chapter, it is primarily used at thermal power plants in the seaport hinterland. Therefore, the annual handling capacity per berth for energy (solid) was calculated only for seaport berths where ocean going mother vessels berth. For cargo handling methods, cranes were assumed to be used as ship unloaders, with three cranes per berth. Figure 6-8 shows an example of a grab bucket type ship unloader.



Figure 6-8 Example of ship unloader

For handling capacity, based on actual performance, a rate of 2,492 tons per hour was assumed. The target vessels were assumed to be medium-sized ships of 70,000 DWT. Table 6-5 shows the calculated annual handling capacity per berth which is estimated to be 5,694,220 tons.

Table 6-5 Bulk cargo (energy: solid) handling capacity per berth

Estimate conditions	Unit	Seaport
(a) Capacity	Tons/hour	2,492
(b) Daily Losses = (1)+(2)+(3)+(4)	Hours/day	-
(1) Mealtime	Hours/day	-
(2) Change Operation	Hours/day	-
(3) Gantry Travel	Hours/day	-
(4) Other Daily Losses	Hours/day	-
(c) Holiday = (1a) + (1b)	Day	5.00
(1a) Non-Working holiday	Day	-
(1b) Bad Weather	Day	5.00
(d) Berthing/Deberthing per ship	Hour/ship	3.00
(e) Target load of ship	Tons/ship	70,000
(f) Net Working Hour per Ship = (e) / (a)	Hours/ship	28.09
(g) Required Service time per Ship = (f) + (d)	Hours/ship	31.09
(h) Remaining Hours for Operation (Actual Working Hour) = 12 - (b)	Hours/day	12.00
(i) Time Conversion = (g) / (h)	Day/ship	2.59
(j) Net Working Hour per Day =(f) / (i)	Hours/day	10.85
(k) Capacity of Berth per Day = (a) * (j)	**Tons/day**	**27,038**
(l) Gross Working days	Day/year	365
(m) Net Working days/year (NDY) = (l) - (c)	Day/year	360
(n) Downtime (dt) 5 to10%	-	0.10
(o) Allowable berth occupancy rate (ABOR)	-	0.65
(p) Net Working Hour Per Year = (j) * (m) * [1- (n)]* (o)	Hours/year	2,285
(q) Port Capacity per Berth (Tons/berth/year) = (p) * (a)	**Tons/year**	**5,694,220**

Figure 6-9 shows an example of a berth layout at a seaport.

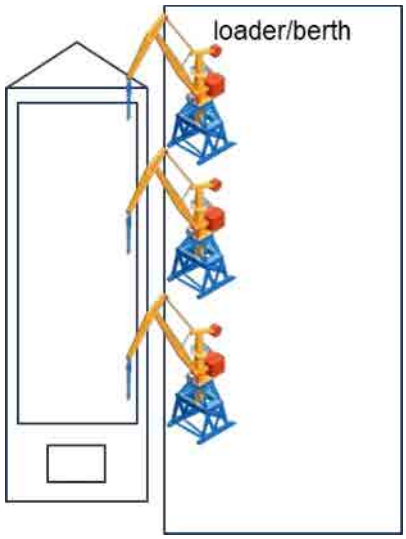


Figure 6-9 Example layout of bulk cargo (energy: solid) berth

6.2 The number of berths to be developed

6.2.1 Method for calculating the number of berths

Table 6-6 summarizes the annual cargo handling capacity per berth by cargo type obtained in Section 6.1. Table 6-7 and Table 6-8 show the cargo handling volume by zone in 2050 in Case 2 and Case 3 respectively obtained in the previous Chapter. When dividing the cargo volume by the cargo handling capacity by cargo type, we can obtain the number of berths by zone by cargo type as shown in Table 6-9 and Table 6-10 respectively.

It should be noted that in case 2 it is assumed that the road network and port operations will be improved and the Funan Techo Canal will be materialized. A 4,000 DWT class vessel will thus be able to navigate up to Kampong Cham and Kampong Chhnang. Case 3 presents more challenging transportation condition as it assumes that a 5,000 DWT class vessel can navigate up to Stung Treng and Chong Kneas. It should also be noted that, for mineral resources, the quantity of 45,000,000 tons indicated for Zone 6 represents river sand dredged from the river. The dredged sand is loaded directly onto barges and transported through inland waterways, where it is eventually consumed within Vietnam. Therefore, since port facilities are not used for this loading, it was excluded from this study.

Table 6-6 Summary of cargo handling capacity per berth

	Container (1,000TEU/ year/berth)	Bulk (1,000ton/year/berth)			
		Agriculture goods	Mineral resources	Energy	
				Liquid	Solid
Berth for mother vessel	330	2,628	31,536	10,061	5,694
Berth for feeder vessel	136	263	5,256	2,100	-
Berth for river vessel	81	263 130*	5,256	2,100	-

*: For export paddy only

Table 6-7 Result of route choice in 2050 by zone (Case 2)

Zone	Container (TEUs)		Bulk			
			Agriculture (Tons)		Mineral resources (Tons)	Energy (Tons)
	Export	Import	Export	Import	Export	Import
1	2,301,451 (barge 1,181,664) (truck 1,119,787)	2,663,047 (barge 1,474,027) (truck 1,189,020)	56,104 (barge 56,104)	159,342 (barge 159,342)	31,704,656 (barge 31,704,656)	28,401,796 (barge 5,599,507)
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	135,264	193,345	173,825	32,113	0	615,973
5	371,554	438,750	211,238	109,881	31,704,656	1,735,170
6	985,267	963,905	66,881	17,348	45,000,000	3,248,364

Table 6-8 Result of route choice in 2050 by zone (Case 3)

Zone	Container (TEUs)		Bulk			
			Agriculture (Tons)		Mineral resources (Tons)	Energy (Tons)
	Export	Import	Export	Import	Export	Import
1	2,299,869 (barge 1,272,800) (truck 1,027,069)	2,669,633 (barge 1,568,710) (truck 1,100,923)	56,576 (barge 56,576)	202,781 (barge 202,781)	31,704,656 (barge 31,704,656)	28,401,796 (barge 6,287,517)
2	154,828	101,312	129,591	39,941	31,704,656	435,691
3	165,701	213,758	745,630	67,453	0	1,081,510
4	89,419	140,811	294,314	8,099	0	222,473
5	255,520	337,706	860,798	69,940	0	1,299,479
6	927,275	904,764	401,289	17,348	45,000,000	3,248,364

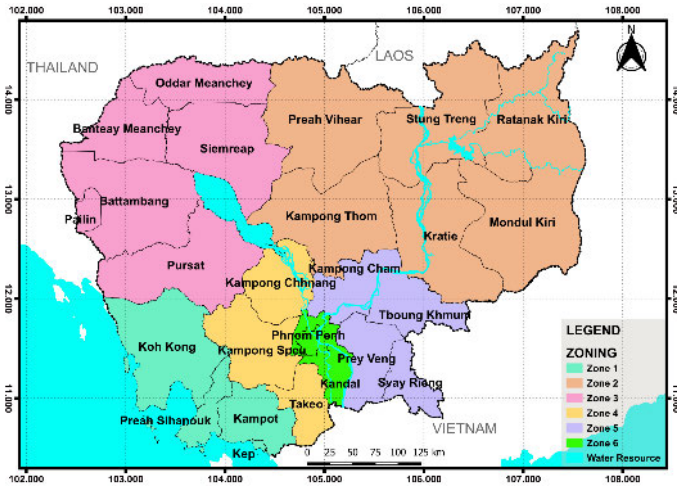


Figure 6-10 Zoning in Cambodia

6.2.2 Summary of the number of berths by zone

(1) The number of berths of by zone

The number of berths by zone by cargo are shown in Table 6-9 (Case 2) and Table 6-10 (Case 3) respectively. Here, we will mainly discuss container berths and bulk berths (agriculture goods) because these berths will be located at public terminals. The other berths (Mineral resource, Energy (Liquid) and Energy (Solid) will be handled mainly in dedicated private terminals.

Table 6-9 (Case 2) indicates that 13 mother vessel container berths, 20 feeder berths and 33 river port berths are needed for container transportation. One mother vessel berth, one feeder berth and 5 river port berths are required for bulk agriculture goods transportation. Berths will be newly developed in Shoreline (Zone 1) and Lower Mekong (Zones 4, 5 and 6).

Table 6-10 (Case 3) indicates that 13 mother vessel container berths, 21 feeder berths and 35 river port berths are needed for container transportation. One mother vessel berth, one feeder berth and 23 river port berths are required for bulk agriculture goods transportation. It will become possible to transport agricultural goods between the Upper Mekong (Zone 2) and Tonle Sap area (Zone 3).

Table 6-9 The estimated number of berths by zone in 2050 (Case 2)

Zone	Container (Number of berth)			Bulk (Number of berth)											
				Agriculture			Mineral resources			Energy (Liquid)			Energy (Solid)		
	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
1	13	20	-	1	1	-	2	7	-	3	3	-	2	-	-
2	-	-	0	-	-	0	-	-	0	-	-	0	-	-	-
3	-	-	0	-	-	0	-	-	0	-	-	0	-	-	-
4	-	-	5	-	-	2	-	-	0	-	-	1	-	-	-
5	-	-	10	-	-	2	-	-	7	-	-	1	-	-	-
6	-	-	18	-	-	1	-	-	0	-	-	2	-	-	-
Total	13	20	33	1	1	5	2	7	7	3	3	4	2	-	-

Table 6-10 The estimated number of berths by zone in 2050 (Case 3)

Zone	Container (Number of berth)			Bulk (Number of berth)											
				Agriculture			Mineral resources			Energy (Liquid)			Energy (Solid)		
	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
1	13	21	-	1	1	-	2	7	-	3	3	-	2	-	-
2	-	-	4	-	-	2	-	-	7	-	-	1	-	-	-
3	-	-	5	-	-	7	-	-	0	-	-	1	-	-	-
4	-	-	3	-	-	3	-	-	0	-	-	1	-	-	-
5	-	-	7	-	-	7	-	-	0	-	-	1	-	-	-
6	-	-	16	-	-	4	-	-	0	-	-	2	-	-	-
Total	13	21	35	1	1	23	2	7	7	3	3	6	2	-	-

(2) Difficulty in indicating the number of ports in Port Zoning Development

The number of berths shown in this study indicates the quantity of berths required for future cargo increases by zone and cargo type. A port unit consists of waterside breakwaters, approach channel and anchorage as well as landside facilities such as berths, yards, warehouses, roads, and administrative offices. The extent of the land and water areas is considered to be the minimum necessary for managing the port.

The Port Zoning Development study shows the number of potential berths for each zone, however does not indicate specific development locations. It also does not show them as port units. When constructing berths in the future, there are many uncertainties at this stage such as to whether to build additional berths in a port that already has roads, logistics facilities and port facilities, or whether to construct new ports and build berths there. In our study, by indicating only the number of berths, we believe that port development will proceed rationally by giving developers the freedom to select berth locations.

MPWT is obligated to review the feasibility of berth construction based on the guiding principles on port development established under Article 206 of the Waterway Transport Law. Too many uncertain factors exist to clearly specify the berth development location, such as what cargo demand will materialize in the future, where the most reasonable berth location would be from the perspective of the point of origin (consumption), whether the natural conditions allow for low-cost and safe berth construction, whether it would constitute excessive investment given the surplus capacity of nearby port facilities, and whether the necessary natural and social conditions can be fully addressed. In addition, it is difficult to explain in terms of the number of ports because the port unit varies depending on whether a berth is developed as a new port or built in an existing port.

We will show the detailed calculation process in the following sub sections.

6.2.3 Container

We conducted three kinds of container demand forecasts: general (import/export), agriculture (import/export), and fishery (import). The total demand forecast volume by zone will be used to estimate the number of berths by zone. Table 6-11 shows the demand forecast and allocation results in Case 2, and Table 6-12 shows the demand forecast and allocation results in Case 3. Furthermore, since the handling capacities of the existing container terminals at Sihanoukville Port and Phnom Penh Port are available from published data, we subtract the current cargo handling volume of these ports in 2023 from the forecasted demand in 2050 to estimate the number of berths. In other words, the number of berths is calculated by the increased cargo volume from 2023.

In Case 2, the results indicate that Zone 1 requires 13 berths for mother vessels and 20 feeder berths at seaports. In Zone 4, 5 river port berths are required, while Zone 5 requires 10 berths and Zone 6 requires 25 berths. In total, the number of river port berths amounts to 33.

In Case 3, the results indicate that Zone 1 requires 13 berths for mother vessels and 21 feeder berths at seaports. In Zone 2, 4 river port berths are required, while Zone 3 requires 5 berths, Zone 4 requires 3 berths, Zone 5 requires 7 berths, and Zone 6 requires 16 berths. In total, the number of river port berths amounts to 35.

Table 6-11 The estimated number of berths by zone (Container, Case 2)

Zone	General		Agriculture		Fishery	Total				
	Import	Export	Import	Export	Import					
	Volume TEUs	Volume TEUs	Volume TEUs	Volume TEUs	Volume TEUs	Volume TEUs	Capacity 2024 TEUs	Capacity need for 2050	Calculate berths	Round number
1	2,535,570	1,576,524	104,417	724,928	23,060	4,964,499	1,000,000	3,964,499	12.01	13 (mother vessel)
						2,655,691	0	2,655,691	19.60	20 (feeder berth)
4	184,235	4,995	7,587	130,269	1,523	328,609	0	328,609	4.07	5
5	417,587	144,924	17,197	226,630	3,698	810,036	70,000	740,036	9.16	10
6	921,357	838,839	37,942	146,427	4,605	1,949,170	560,000	1,389,170	17.20	18
Total	4,058,749	2,565,281	167,143	1,228,255	32,885	10,708,004	1,630,000	9,078,004	62.04	66
								(Total of river berth)		33

Table 6-12 The estimated number of berths by zone (Container, Case 3)

Zone	General		Agriculture		Fishery	Total				
	Import	Export	Import	Export	Import					
	Volume TEUs	Volume TEUs	Volume TEUs	Volume TEUs	Volume TEUs	Volume TEUs	Capacity 2024 TEUs	Capacity need for 2050	Calculate berths	Round number
1	2,541,896	1,576,178	104,677	723,691	23,060	4,969,502	1,000,000	3,969,502	12.03	13 (mother vessel)
						2,841,510	0	2,841,510	20.97	21 (feeder berth)
2	96,459	61,519	3,972	93,308	881	256,139	0	256,139	3.17	4
3	203,246	5,499	8,370	160,202	2,142	379,458	0	379,458	4.7	5
4	134,136	2,969	5,524	86,449	1,151	230,231	0	230,231	2.85	3
5	321,472	111,787	13,239	143,733	2,995	593,225	70,000	523,225	6.48	7
6	864,976	827,129	35,620	100,147	4,168	1,832,039	560,000	1,272,039	15.75	16
Total	4,162,185	2,585,081	171,402	1,307,530	34,397	11,102,104	1,630,000	9,472,104	65.95	69
								(Total of river berth)		35

6.2.4 Bulk cargo (Agriculture goods)

For bulk (agriculture goods), the required port facility capacity by zone was estimated using the forecast demand for four items: paddy (export), raw rubber (export), cereal (import), and fertilizer (import). Table 6-13 shows the results for Case 2, while Table 6-14 shows the results for Case 3.

In Case 2, the results indicate that Zone 1 requires 1 berth for mother vessels and 1 feeder berth at seaports. In Zone 4, 2 river port berths are required, while Zone 5 requires 2 berths and Zone 6 requires 1 berth. In total, the number of river port berths amounts to 5.

In Case 3, the results indicate that Zone 1 requires 1 berth for mother vessels and 1 feeder berth at seaports. In Zone 2, 2 river port berths are required, while Zone 3 requires 7 berths, Zone 4 requires 3 berths, Zone 5 requires 7 berths, and Zone 6 requires 4 berths. In total, the number of river port berths amounts to 23.

Table 6-13 The estimated number of berths by zone (Bulk - agriculture, Case 2)

	Export volume (ton)			Import volume (ton)				Number of berth			Round number of berth		
	Paddy	Raw ruber		Cereal		Fertilizer		Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
Zone	Loading	Loading	Unloading	Loading	Unloading	Loading	Unloading						
1	0	56,104	56,104	81,407	81,407	77,935	77,935	0.08	0.82	-	1	1	-
2	0	0	0	0	0	0	0	-	-	0.00	-	-	0
3	0	0	0	0	0	0	0	-	-	0.00	-	-	0
4	173,129	696	0	0	14,276	0	17,837	-	-	1.46	-	-	2
5	155,830	55,408	0	0	61,445	0	48,436	-	-	1.83	-	-	2
6	66,881	0	0	0	5,686	0	11,662	-	-	0.58	-	-	1
total	395,840	112,208	56,104	81,407	162,814	77,935	155,870				1	1	5

Table 6-14 The estimated number of berths by zone (Bulk - agriculture, Case 3)

	Export volume (ton)			Import volume (ton)				Number of berth			Round number of berth		
	Paddy	Raw ruber		Cereal		Fertilizer		Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
Zone	Loading	Loading	Unloading	Loading	Unloading	Loading	Unloading						
1	0	56,576	56,576	91,504	91,504	111,277	111,277	0.10	0.99	-	1	1	-
2	111,181	18,410	0	0	27,454	0	12,487	-	-	1.08	-	-	2
3	744,555	1,075	0	0	23,409	0	44,044	-	-	6.01	-	-	7
4	294,221	93	0	0	964	0	7,135	-	-	2.30	-	-	3
5	823,800	36,998	0	0	33,991	0	35,949	-	-	6.76	-	-	7
6	401,289	0	0	0	5,686	0	11,662	-	-	3.16	-	-	4
total	2,375,046	113,152	56,576	91,504	183,008	111,277	222,554				1	1	23

6.2.5 Bulk cargo (Mineral resources)

The results of estimating the required port facilities by zone for bulk (mineral resources) are shown in Table 6-15 for Case 2 and Table 6-16 for Case 3. As mineral resources are expected to be produced from specific provinces in the northeastern part of Cambodia, the zones requiring port facilities are also limited.

In Case 2, the results indicate that Zone 1 requires 2 berths for mother vessels and 7 feeder berths at seaports. In Zone 5, 7 river port berths are required. In Case 3, the results indicate that Zone 1 requires 2 berths for mother vessels and 7 feeder berths at seaports. In Zone 2, 7 river port berths are required.

Table 6-15 The estimated number of berths by zone (Bulk - mineral resources, Case 2)

	Export		Number of berth calculated			Round number of berth		
	Volume (ton)		Seaport		River port	Seaport		River port
Zone	Loading	Unloading	Mother vessel berth	Feeder berth	Loading	Mother vessel berth	Feeder berth	Loading
1	31,704,656	31,704,656	1.01	6.03	-	2	7	-
2	0	0	-	-	0.00	-	-	0
3	0	0	-	-	0.00	-	-	0
4	0	0	-	-	0.00	-	-	0
5	31,704,656	0	-	-	6.03	-	-	7
6	0	0	-	-	0.00	-	-	0
Total	63,409,312	31,704,656				2	7	7

Table 6-16 The estimated number of berths by zone (Bulk - mineral resources, Case 3)

	Export		Number of berth calculated			Round number of berth		
	Volume (ton)		Seaport		River port	Seaport		River port
Zone	Loading	Unloading	Mother vessel berth	Feeder berth	Loading	Mother vessel berth	Feeder berth	Loading
1	31,704,656	31,704,656	1.01	6.03	-	2	7	-
2	31,704,656	0	-	-	6.03	-	-	7
3	0	0	-	-	0.00	-	-	0
4	0	0	-	-	0.00	-	-	0
5	0	0	-	-	0.00	-	-	0
6	0	0	-	-	0.00	-	-	0
Total	63,409,312	31,704,656				2	7	7

6.2.6 Bulk cargo (Energy: Liquid)

The results of estimating the number of berths by zone for bulk (energy: liquid) are shown in Table 6-17 for Case 2 and Table 6-18 for Case 3.

In Case 2, Zone 1 has 3 berths for the main vessel at the seaport and 3 feeder berths. Zone 4 has 1 berth at the river port, Zone 5 has 1 berth at the river port, and Zone 6 has 2 berths. The river port has a total of 4 berths. Case 3 shows 3 berths for ocean ports where mother ships berth and 3 feeder berths in Zone 1. There is 1 berth each for river ports in Zones 2, 3, 4, and 5 and 2 berths in Zone 6 for a total of 6 berths at river ports.

In Case 2, the results indicate that Zone 1 requires 3 berths for mother vessels and 3 feeder berths at seaports. In Zone 4, 1 river port berth is required, while Zone 5 requires 1 berth and Zone 6 requires 2 berths. In total, the number of river port berths amounts to 4.

In Case 3, the results indicate that Zone 1 requires 3 berths for mother vessels and 3 feeder berths at seaports. Zones 2, 3, 4 and 5 each require 1 river port berth, while Zone 6 requires 2 berths. In total, the number of river port berths amounts to 6.

Table 6-17 The estimated number of berths by zone (Bulk - energy (liquid), Case 2)

	Export		Number of berth calculated			Round number of berth		
	Volume (ton)		Seaport		River port	Seaport		River port
Zone	Loading	Unloading	Mother vessel berth	Feeder berth	Loading	Mother vessel berth	Feeder berth	Loading
1	5,599,507	20,449,755	2.03	2.67	-	3	3	-
2	0	0	-	-	0.00	-	-	0
3	0	0	-	-	0.00	-	-	0
4	0	615,973	-	-	0.29	-	-	1
5	0	1,735,170	-	-	0.83	-	-	1
6	0	3,248,364	-	-	1.55	-	-	2
Total	5,599,507	26,049,262				3	3	4

Table 6-18 The estimated number of berths by zone (Bulk - energy (liquid), Case 3)

	Export		Number of berth calculated			Round number of berth		
	Volume (ton)		Seaport		River port	Seaport		River port
Zone	Loading	Unloading	Mother vessel berth	Feeder berth	Loading	Mother vessel berth	Feeder berth	Loading
1	6,287,517	20,449,755	2.03	2.99	-	3	3	-
2	0	435,691	-	-	0.21	-	-	1
3	0	1,081,510	-	-	0.52	-	-	1
4	0	222,473	-	-	0.11	-	-	1
5	0	1,299,479	-	-	0.62	-	-	1
6	0	3,248,364	-	-	1.55	-	-	2
Total	6,287,517	26,737,272				3	3	6

6.2.7 Bulk cargo (Energy: Solid)

The results of estimating the required port facilities by zone for bulk (energy: solid) are shown in Table 6-19 for Case 2 and Case 3. The target item for energy (solid) is coal. As noted in the previous chapter, it is primarily used at thermal power plants in the hinterland of seaports. Therefore, port facilities are only required in Zone 1. For both Case 2 and Case 3, the result was 2 berths for mother vessels at the seaport in Zone 1.

Table 6-19 The estimated number of berths by zone (Bulk - energy (solid), Case 2 and Case 3)

Zone	Total Tons	Calculate Berth	Round number
1	7,952,041	1.40	2
Total	7,952,041	1.40	2

Chapter-7 River Traffic Volume and Channel Capacity

7.1 Inland waterway capacity in the Mekong River System

In this chapter, we will evaluate whether the inland waterway capacity in the Mekong River System is sufficient for future river traffic volume. First, we will calculate the volume of vessel traffic in each stretch of the Mekong River System for Case 2 and Case 3. We assume the following conditions. The channel in the Mekong River System will be two-way traffic and the traffic volumes are also divided into upstream and downstream traffic. Vessel sizes are 250 TEU per container barge and 3,000 DWT for bulk barge respectively. LOA of container barge and that of bulk barge are the same size: 74 m. Operations are conducted 365 days per year.

7.1.1 Estimation of vessel traffic in each stretch

Table 7-1 shows the calculation process for estimating the volume of vessel traffic in a stretch. Based on annual TEU or weight base cargo volume in a stretch, we estimate the daily cargo volume and the number of vessels to carry the daily base cargo volume. As the container barge and bulk barge are almost the same size, we add up the number of vessels for both types. The total number of daily vessels for export is 88 while that for import is 22.

Table 7-1 The estimated number of vessels (on the stretch between Phnom Penh port and the mouth of Funan Techo Canal)

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Phnom Penh port-Mouth of Funan Techo Canal

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	1,350,768	1,440,289	3,701	3,946	15	16	31

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		Number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	319,624	0	876	0	1	0	1
Raw rubber	55,293	0	152	0	1	0	1
Cereal&Fertilizer	0	129,719	0	356	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	45,000,000	0	123,288	0	42	0	42
Energey	0	5,088,918	0	13,943	0	5	5
Total	77,079,573	5,218,637	211,179	14,299	73	6	79

Grand total			
	88	22	110

Figure 7-1 shows the flow of inland waterway vessel traffic in each stretch in Case 2. Left flow chart shows export traffic and the right one shows the import traffic. The largest volume of vessel traffic is found in the export flow just under Phnom Penh port stretch where the total number vessels is 90 per day. The number of vessels traversing the Funan Techo Canal is 43 per day. The largest number of vessels in the import flow is 26 per day also in the Phnom Penh port stretch. The number of vessels traversing the Funan Techo Canal is 24 per day.

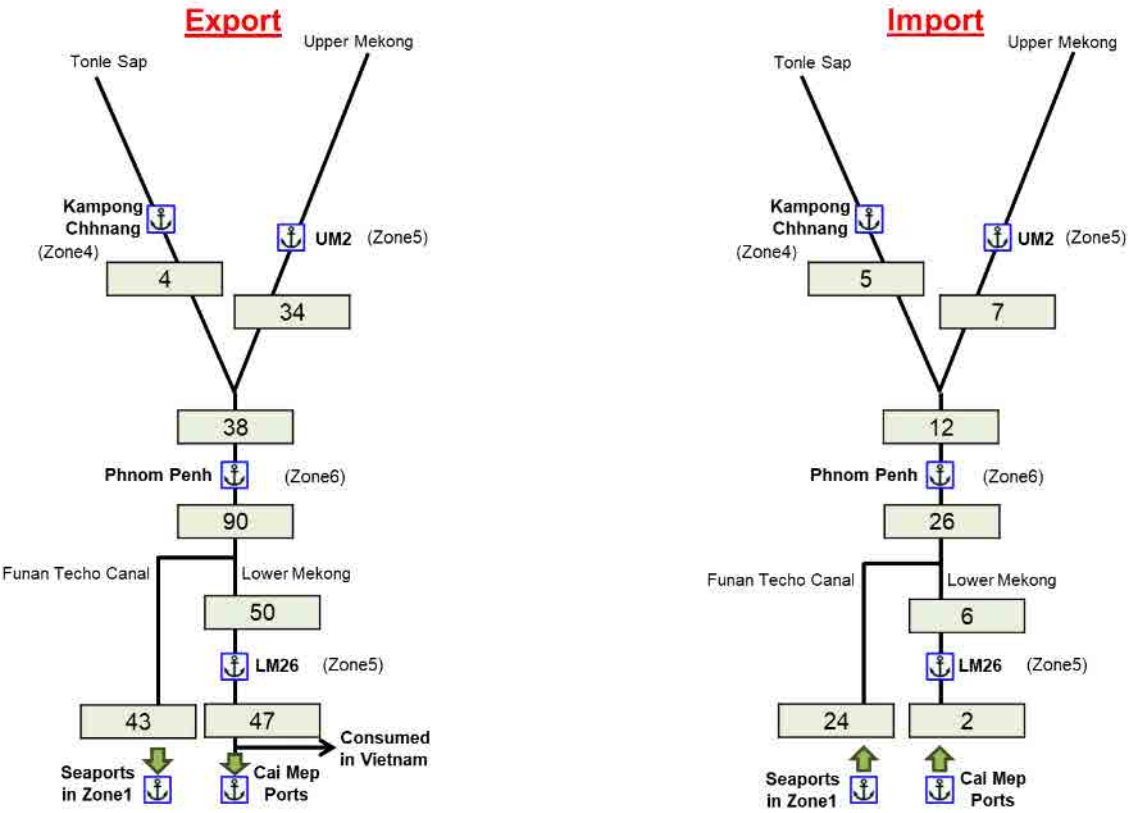


Figure 7-1 Flow of inland waterway vessel traffic (Case 2, the number of vessels per day)

Figure 7-2 shows the flow of inland waterway vessel traffic in each stretch in Case 3. Left flow chart shows export traffic and the right one shows the import traffic. The traffic in Case 3 is slightly larger than that in Case 2. The largest volume of vessel traffic in the export flow is found in the Phnom Penh port stretch where the total number of vessels is 93 per day. The number of vessels traversing the Funan Techo Canal is 44 per day. The largest number of vessels for imports is 27 per day also in the Phnom Penh port stretch. The number of vessels traversing the Funan Techo Canal is 25 per day.

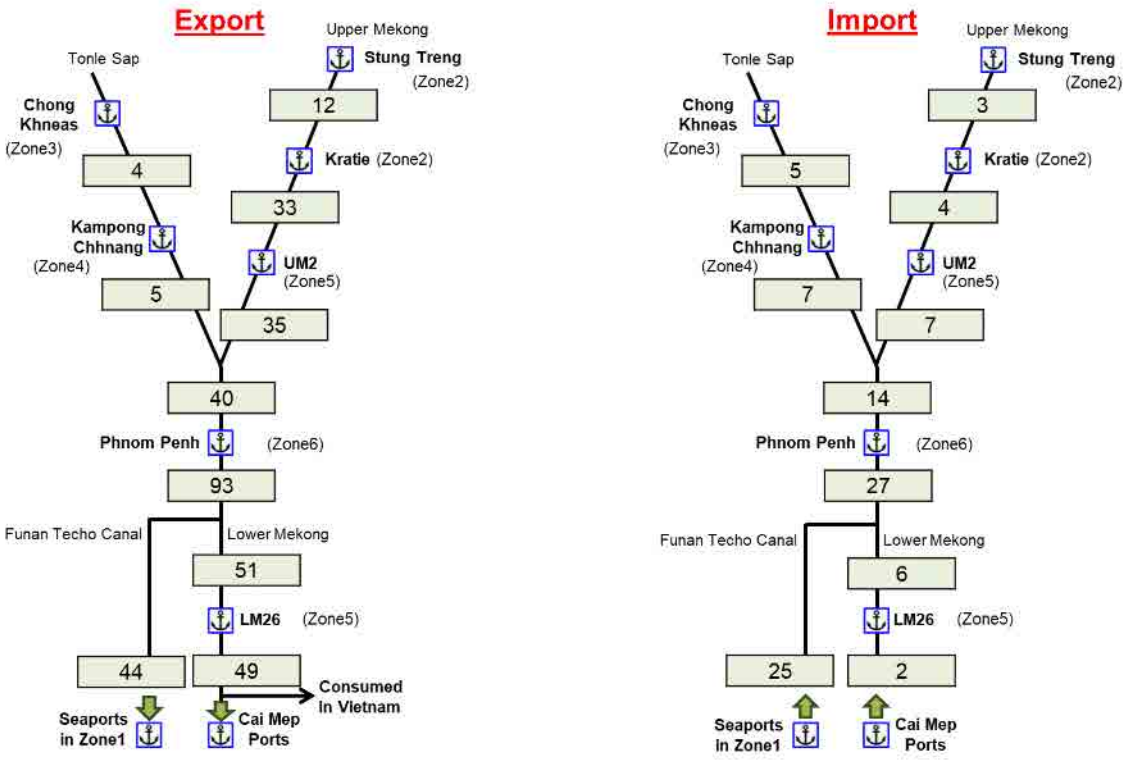


Figure 7-2 Flow of inland waterway vessel traffic (Case 3, the number of vessels per day)

7.1.2 Occupancy rate of vessel traffic

A computer simulation model is a reliable way to dynamically estimate the congestion level in a waterway. However, due to shortage of current water navigation information, we adopted a simple static water occupancy model. The basic principle in the static model is the same as that in the dynamic model. Based on the static method, the waterway occupancy rate S represents the proportion of the vessel navigation and safe distance area in a specified period occupied in the total area of waterway. If the waterway occupancy rate S is 60% or higher, the waterway is empirically considered to be congested. The waterway occupancy rate S is calculated using the following formula. Figure 7-3 shows a conceptual diagram of the waterway occupancy rate.

$$S = \left(\frac{\sum a_i \cdot L / v_i}{L \cdot W \cdot T \times 60^2} \right) \times 100\% = \left(\frac{\sum a_i / v_i}{W \cdot T \times 60^2} \right) \times 100\% \qquad (1)$$

Here,

S: Waterway utilization rate (%)

a_i: Safe distance to be maintained in broad water area (Bumper) (m^2)

$a_i = 1.6 \times LOA \times (6.4 + 1.6) / 2 \times LOA \times \pi$

v_i: Vessel speed (m/s)

L: Channel length (m)

W: Channel width (m)

T: Time (hour)

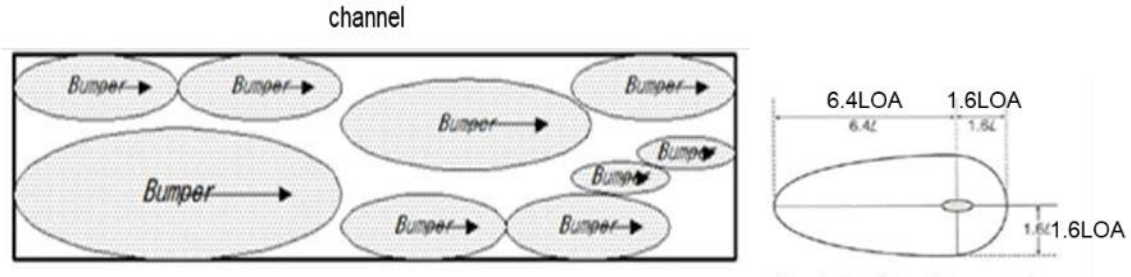


Figure 7-3 Conceptual diagram of waterway occupancy rate

7.2 Evaluation of channel capacity

7.2.1 Volume of vessel traffic in Case 2

(1) The stretch between Phnom Penh port and the mouth of the Funan Techo Canal

We will apply the largest vessel traffic figure of 90 into the waterway utilization rate S. The number is the largest in the Mekong River System. The number comes from the stretch between Phnom Penh port and the mouth of the Funan Techo Canal. The result is S=57.2%, which is below the 60% threshold, and thus not considered to be congested.

$$S = \left[\frac{93 \times 35{,}046.4 \times \pi / (6 \times 1{,}852 / 3{,}600)}{65 \times 24 \times 60 \times 60}\right] \times 100\% = 57.2\% < 60\%$$

Inland waterway vessel traffic = 90 vessels (maximum traffic on one side of the channel)

LOA = 74 m (based on the average actual data for a 3,000 DWT vessel)

$a_i = 1.6 \times LOA \times (6.4 + 1.6) / 2 \times LOA \times \pi = 1.6 \times 74 \times 4.0 \times 74 \times \pi = 35{,}046.4 \times \pi$

$v_i = 6$ (kts) × 1,852 / 3,600 m/s

W = 65 m (half the channel width)

T = 24 hours

(2) The stretch in the Funan Techo Canal

Next, we will calculate the waterway utilization rate S at the Funan Techo Canal. The result of S is 44.4%, confirming it is below the 60% threshold.

$$S = \left[\frac{43 \times 35{,}046.4 \times \pi / (6 \times 1{,}852 / 3{,}600)}{40 \times 24 \times 60 \times 60}\right] \times 100\% = 44.4\% < 60\%$$

Inland waterway vessel traffic = 43 vessels (maximum traffic on one side of the channel)

LOA = 74 m (based on the average actual data for a 3,000 DWT vessel)

$a_i = 1.6 \times LOA \times (6.4 + 1.6) / 2 \times LOA \times \pi = 1.6 \times 74 \times 4.0 \times 74 \times \pi = 35{,}046.4 \times \pi$

$v_i = 6$ (kts) × 1,852 / 3,600 m/s

W = 40 m (half the channel width)

T = 24 hours

7.2.2 Volume of vessel traffic in Case 3

(1) The stretch between Phnom Penh port and the mouth of the Funan Techo Canal

We will apply the largest vessel traffic figure of 93 into the waterway utilization rate S. The number is the largest in the Mekong River System. The number comes from the stretch between Phnom Penh port and the mouth of the Funan Techo Canal. The result was S=59.1%, which is below the 60% threshold.

$$S = \left[\frac{93 \times 35{,}046.4 \times \pi / (6 \times 1{,}852 / 3{,}600)}{65 \times 24 \times 60 \times 60}\right] \times 100\% = 59.1\% < 60\%$$

Inland waterway vessel traffic = 93 vessels (maximum traffic on one side of the channel)

LOA = 74 m (based on the average actual data for a 3,000 DWT vessel)

$a_i = 1.6 \times LOA \times (6.4 + 1.6) / 2 \times LOA \times \pi = 1.6 \times 74 \times 4.0 \times 74 \times \pi = 35{,}046.4 \times \pi$

$v_i = 6$ (kts) × 1,852 / 3,600 m/s

W = 65 m (half the channel width)

T = 24 hours

(2) The stretch in the Funan Techo Canal

Next, we will calculate the waterway utilization rate S at the Funan Techo Canal. The result of S is 45.4%, which is below the 60% threshold.

$$S = \left[\frac{44 \times 35{,}046.4 \times \pi / (6 \times 1{,}852 / 3{,}600)}{40 \times 24 \times 60 \times 60}\right] \times 100\% = 45.4\% < 60\%$$

Inland waterway vessel traffic = 44 vessels (maximum traffic on one side of the channel)

LOA = 74 m (based on the average actual data for a 3,000 DWT vessel)

$a_i = 1.6 \times LOA \times (6.4 + 1.6) / 2 \times LOA \times \pi = 1.6 \times 74 \times 4.0 \times 74 \times \pi = 35{,}046.4 \times \pi$

$v_i = 6$ (kts) × 1,852 / 3,600 m/s

W = 40 m (half the channel width)

T = 24 hours

Chapter-8 A conceptual river port design

8.1 Channel Development

4,000 DWT vessels are able to navigate downstream from Phnom Penh and upstream from Phnom Penh to Kampong Cham and Kampong Chhnang; during the rainy season. However, large vessels cannot navigate upstream from Kampong Cham and Kampong Chhnang during the rainy season due to the limited water depth. During the dry season only small vessels ranging from 20 to 80 DWT are allowed to navigate the river. In future, MPWT intends to make it possible for 3,000 to 5,000 DWT vessels to navigate inland waterways at all times. For this purpose, regular maintenance of navigation channel needs to be conducted to ensure a sufficient water depth.

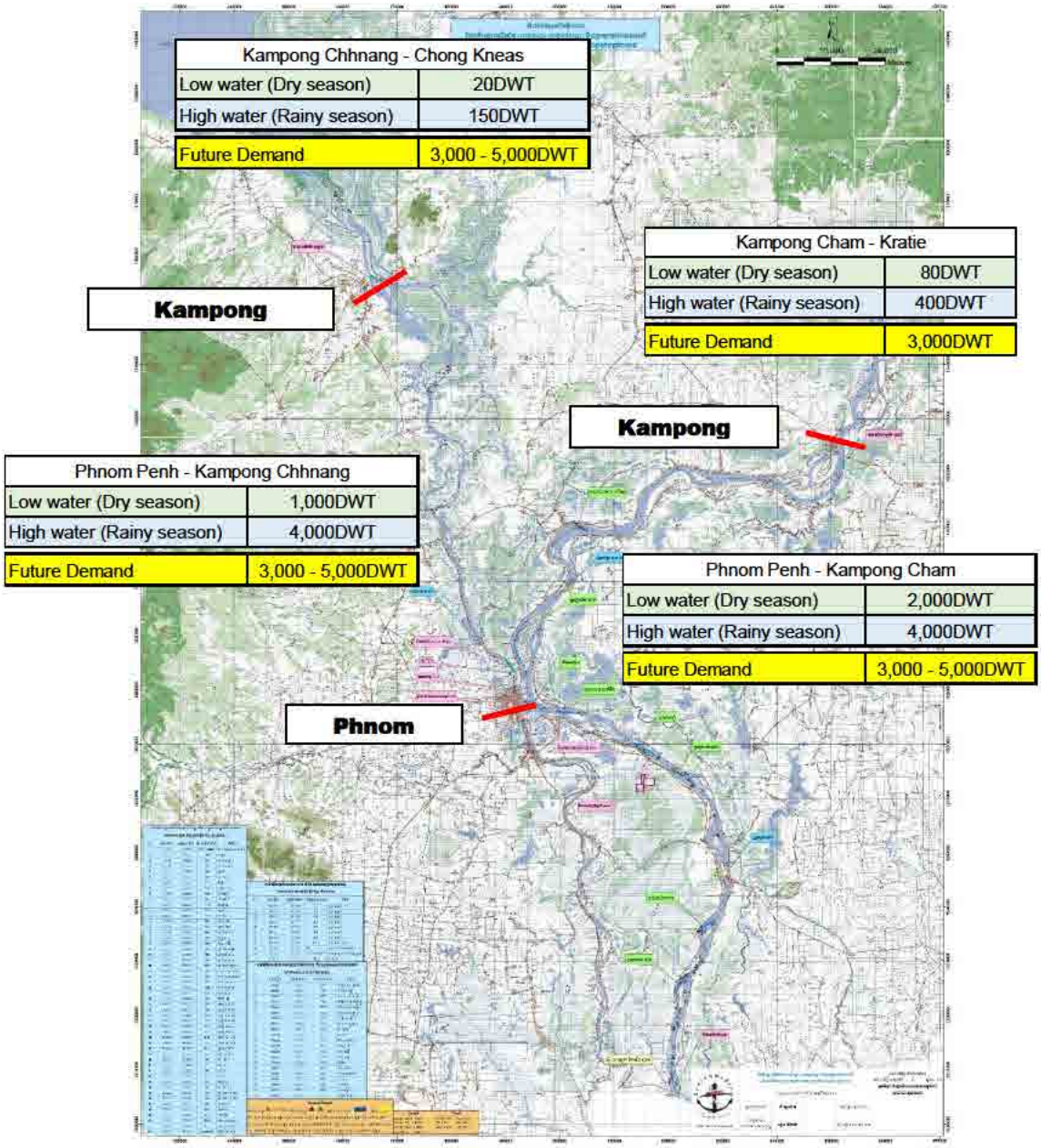


Figure 8-1 Navigable vessels in inland waterways

Standard vessel specifications are defined by MRC in Table 8-1 while Table 8-2 shows the actual data (2007 – 2021) on vessels that navigated in inland waterways; the vessel specifications generally match.

Table 8-1 Vessel specifications for each size based on MRC

Nr.	Type of vessel	Ls (m)	Hs (m)	Bs (m)	Ts (m)
1	general cargo vessel of 500 DWT				
2	general cargo vessel of 1000 DWT				
3	general cargo vessel of 1500 DWT				4
4	general cargo vessel of 2000 DWT				4,5
5	general cargo vessel of 3000 DWT	80-90		11.0-14.0	5,1
6	general cargo vessel of 5000 DWT			13.0-16.0	5,9
7	river-sea vessel of 2000 DWT	80-100	7	9.0-12	4,5
8	river-sea vessel of 4000 DWT	95-120	8	9.5-13	4,8
9	container vessel of 3000 DWT			11.0-14.0	5,1
10	container vessel of 5000 DWT			13.0-16.0	5,9
11	container vessel of 7000 DWT			16.0-19.0	6,8
12	container vessel of 10000 DWT			18.0-22.0	7,3
13	bulk carrier of 5000 DWT			16.0-19.0	6,4

Source MRC Secretariat

Ls (m) Length of vessel
Hs (m) Vertical distance between the water line and the highest point of a stationary vessel
Bs (m) Width of vessel
Ts (m) Draft of vessel

Table 8-2 Average vessel specifications based on actual data (2007-2021)

Dry Season (Nov. - Apr.)			
Vessel Size	avr.Loa	avr.Breadth	avr.Draft
300-500DWT	42.6	8.5	3.2
- 1000DWT	50.7	9.8	3.6
- 2000DWT	55.7	10.8	3.9
- 3000DWT	73.8	12.2	5.5
- 5000DWT	94.5	16.4	5.5

Rainy Season (May - Oct.)			
Vessel Size	avr.Loa	avr.Breadth	avr.Draft
300-500DWT	40.6	8.1	2.8
- 1000DWT	47.9	9.9	3.4
- 2000DWT	55.1	10.6	3.9
- 3000DWT	70.0	12.2	5.3
- 5000DWT	82.0	13.3	6.1

All Season			
Vessel Size	avr.Loa	avr.Breadth	avr.Draft
300-500DWT	41.6	8.3	3.0
- 1000DWT	49.3	9.9	3.5
- 2000DWT	55.4	10.7	3.9
- 3000DWT	71.9	12.2	5.4
- 5000DWT	88.2	14.8	5.8

*Source: PPAP

Table 8-3 Vessel specifications based on actual data (2007-2021)

N°	NATIONALITY	GRT	DW	B	Loa	df	Date
1	VN	298	1213	8.2	43.08	2.78	02-Jun-13
2	VN	447	1020	10.22	52.09	3.25	06-Sep-11
3	VN	481	1100	10	51.6	4	30-Aug-13
4	VN	280	1069	8.5	40.4	2.6	21-Oct-16
5	VN	443	1120	8.84	48.32	3.5	21-Jan-16
6	VN	326	669	8.5	44	3.5	18-Dec-17
7	VN	270	498	8	43.1	2.46	16-Aug-11
8	VN	224	565	8	44.34	2.8	24-Oct-12
9	VN	324	598	8.34	43.6	2.75	07-Feb-13
10	VN	325	600	824	44.2	2.76	17-Jan-12
11	VN	204	540	9	42.5	2.83	31-May-11
12	VN	482	1310	10	48.54	3.8	27-Jul-12
13	VN	483	1310	10.22	52.5	3.53	29-Oct-11
14	VN	443	2722	9.9	48.15	3.95	12-Aug-13
15	VN	350	745	8.4	42.5	3.4	26-Oct-13
16	VN	499	1527	11.04	57.25	3.68	04-Jan-12
17	VN	409	1310	10.8	56.2	3.7	06-May-11
18	VN	300	723.7	8.5	45.5	3.05	05-Sep-11
19	VN	376	1066	9.9	51.07	3.36	06-Mar-12
20	VN	383	1040	9	44.5	3.5	20-Sep-13
21	VN	492	1100	11	52	3.82	21-Sep-13
22	VN	497	1343	10.1	54.16	3.63	27-May-13
23	VN	370	1040	8.7	43	3.34	16-Oct-13
24	VN	430	1060	9.7	47.2	3.45	01-Aug-13
25	VN	498	1230	10.4	54.16	3.63	27-Jul-12
26	VN	498	1640	11.24	59.31	3.93	04-Aug-13
27	VN	140	640	6.4	22.5	1.5	01-May-13
28	VN	488	1320	9.6	49.5	3.5	12-Sep-16
29	VN	450	1920	11.75	65.55	4.5	09-Nov-16
30	VN	312	1323	8.4	43.1	3.05	17-Aug-16
31	VN	492	1246	10.5	49.02	3.5	10-May-13
32	VN	379	1563	8.7	45.1	3.5	10-Sep-14
33	VN	472	1532	10	49.9	3.9	13-Feb-14
34	VN	499	1014	10.5	51.5	4.05	27-Dec-13
35	VN	499	1234	11.82	63	4.03	15-Sep-11
36	VN	496	1608	10.8	58.2	4.3	07-May-15
37	VN	492	1540	11	52	420	28-Jun-17
38	VN	446	1452	10.59	54.59	4.05	21-Mar-17
39	VN	489	1391	10.2	51.74	3.99	23-May-15
40	VN	339	865	9	44.77	3.5	11-Jan-14
41	VN	490	1326	10.6	56.5	4.3	11-Apr-16
42	VN	490	1690	10.8	55.5	4.3	03-Jul-16
43	VN	490	1509	10.8	54.5	4.5	03-Jul-16
44	VN	499	2500	12.27	67	4.5	13-Oct-19
45	VN	490	1949	11.5	58.84	4.7	26-Jan-20
46	VN	430	1030	9.6	49.9	3.4	05-Jul-16
47	VN	495	1245	12.8	71.07	4	03-Nov-16
48	VN	495	1679	12.9	73.2	4	06-Nov-16
49	VN	490	1678	13	64.26	4.7	01-Apr-17
50	VN	481	1463	10.8	59.5	4.3	05-May-17
51	VN	442	1532	10.8	59.5	4.3	17-May-17
52	VN	490	1354	12.9	63.63	4.7	16-May-17
53	VN	495	1643	12	62.62	4.4	16-May-17
54	VN	499	1644	13.2	75.5	5.2	15-Jun-17
55	VN	450	1642	11	58.45	4.25	23-Apr-17
56	VN	490	1610	11.8	59.73	3.9	21-Jan-17
57	VN	490	1499	10.2	53.99	4.2	01-Jun-17
58	VN	348	1344	8.85	47.7	3.5	18-Jan-20
59	VN	336	945	8.1	42	3.3	04-Dec-19
60	VN	274	861	8.3	42	3	29-Oct-19
61	VN	470	1456	11.7	57.51	4.35	25-Jun-19
62	VN	448	1458	11.7	61	4.5	01-Aug-18
63	VN	499	1456	11.7	60.83	4.4	02-Jun-18
64	VN	496	1610	10.8	56.55	4.3	20-May-18
65	VN	433	1645	10	49.55	3	05-May-18
66	VN	310	978	12.9	65.85	4.7	15-Apr-18
67	VN	350	987	8.6	43.2	3.4	04-Apr-18
68	VN	283	758	10	53.06	3.95	24-Mar-18
69	VN	497	1157	9.9	54	3.4	28-Mar-17
70	VN	475	1458	10.2	53.99	3.65	21-Mar-18
71	VN	277	1114	10	51	3.5	20-Feb-18
72	VN	410	1435	11.7	60.83	4.4	02-Feb-18
73	VN	448	1687	13	62.6	4.6	22-Jan-18
74	VN	428	1387	10.8	57.1	4.4	12-Dec-17
75	VN	341		10.5	54.69	3.9	20-Nov-17
76	VN	352	1342	8.7	45.2	3.6	08-May-17
77	VN	277		9.74	49.91	3.44	19-Oct-17
78	VN	410		11.7	59.95	3.8	22-Mar-18
79	VN	257		8.1	41.7	3.28	02-Jul-19
80	VN	278		8.6	43.33	3.5	03-Sep-19
81	VN	214		8	40	3.5	01-Nov-19
82	VN	212		7.25	40.7	3.5	01-Nov-19
83	VN	271	612	8.4	44.7	2.69	11-Dec-19
84	VN	430		10.8	56.54	4.2	28-Jul-17
85	VN	430		9.6	49.9	3.39	01-Feb-16
86	VN	490	1700	10.9	59		01-Aug-20
87	VN	495	1286	10.34	56.38		08-Jan-21
88	VN	496	1500	13.24	75	5.4	16-Jun-20
89	VN	393	653	8.42	43.8	2.78	10-Jun-20
90	VN	478	1062	10.5	47.96	4.5	28-Jun-20
91	VN	395	1020	12.8	70.45	4.5	04-Jun-20
92	VN	250	998	9.8	48.12	3.9	06-Jun-20
93	VN	495	1206	14.1	76.59	4.5	29-Jun-20
94	VN	497	1157	9.9	54	4.5	03-Jan-19
95	VN	488	1861	11	58.14	4.5	20-Apr-20
96	VN	498	1221	10	52.98	3.4	20-Apr-20
116	VN	446	1085	9.6	54.5	3.5	10-Jul-14
117	VN	455		10	49.58	3.5	23-May-15
118	VN	465	1610	10.6	58	3.9	24-Dec-14
119	VN	448		9.4	47.9	3.5	07-Sep-14
120	VN	420	1140	10	53.1	4.4	20-May-14
121	VN	440		9.6	49.9	3.75	02-Jan-14
122	VN	493	1096	12.3	57.95	4.2	10-Aug-16
123	VN	495		13.14	70.58	5.2	12-Oct-20
124	VN	498		10.2	53.44	4.3	08-Nov-16
125	VN	477	1250	9.6	49.78	4.2	06-Sep-17
126	VN	490	1599	10.6	55.4	4.4	05-May-07
127	VN	355	828	8.8	45.59	3.5	05-Jun-16
128	VN	239	735	8	38.96	2.9	23-May-19
129	VN	345	793	8.4	43.5	3	09-Jul-18
130	VN	446		11	56.28	4.4	24-Apr-18
131	VN	504	1130	9.6	53.22	3.7	15-Oct-18
132	VN	368	554.5	5	41.56	3.5	06-Sep-17
133	VN	460	1240	10.24	54	3.64	13-Apr-12
134	VN	435		10.22	52.22	3.6	16-Apr-11
135	VN	457	2122	11.6	59.86	3.89	25-Apr-13
136	VN	430	1309	10.5	49.02	3.43	18-May-17
137	VN	495		11.9	61.5	3.5	07-Jun-14
138	VN	548	775	#####	46.34	3.5	27-Jan-18
139	VN	445	1746	11.24	60.34	4.2	15-Aug-19
140	VN	380		12.6	61.8	4.4	06-Jan-17
141	VN	428	790	10.2	45.5	2.96	31-Jul-11
142	VN	320		10.6	54	3.7	05-Apr-13
143	VN	310		12.6	70.85	5.1	24-Dec-17
144	VN	470		12.5	68.28	4.5	27-Jan-18
145	VN	1054	1948	12.62	65.22	3.62	16-Aug-13
146	VN	460	1250	10	53.9	4	21-May-16
147	VN	249	631	8.3	44.1	2.75	25-Aug-11
148	VN	403		9	45.91	3.25	15-Aug-13
149	VN	298		10.9	43.23	3.5	30-Oct-13
150	VN	476	880	10.15	53.23	3.82	01-May-15
151	VN	277	1005	9.5	46.91	3.79	25-May-16
152	VN	496			57	3.5	03-Sep-13
153	VN	540	998	9.82	55.55	3.1	15-Jul-12
154	VN	414	998	9.82	55.55	3.25	08-May-11
155	VN	152		8.2	35.5	2.4	31-May-13
156	VN	476		10	54.92	4.25	17-Feb-14
157	VN	420		10	54.92	4.25	03-Sep-15
158	VN	256	1055	9.8	50.14	3.44	22-Nov-16
159	VN	441	1159	10	49.8	4	11-Jan-14
160	VN	298		8.38	44.88	3.1	01-Jan-14
161	VN	490	1300	10.5	49.96	3.5	20-Oct-16
162	VN	435		10	54.03		14-Jul-16
163	VN	320	1089	9.8	49.56	3.8	13-Sep-16
164	VN	183		8.1	42.09	3.1	17-Jan-16
165	VN	320		9.8	49.32	3.8	01-Nov-15
166	VN	283		10	56.06	3.78	05-May-13
167	VN	331	824	8.7	47	3.5	25-Oct-15
168	VN	414	764	8.6	44.86	3.5	11-Jul-17
169	VN	280	785	44	8.5	3.12	01-Jul-20
170	VN	483	1215	11.25	53.2		15-May-20
171	VN	349	1310	10	53.06	3.5	22-Sep-19
172	VN	499	1460	12.5	72.5	4.5	23-Oct-18
173	VN	183	608	8.1	42.9	3.5	23-May-19
174	VN	422	921	9.6	45.75	3.65	28-May-19
175	VN	403		9	45.91	3.5	13-Jun-18
176	VN	483		11.25	53.2	3.8	12-Jun-18
177	VN	480		10.7	59		30-Apr-18
178	VN	470		11.25	52.6	3.8	22-May-18
179	VN	448	1305	11.25	52	3.8	06-Jun-18
180	VN	403		9	45.91	3.6	10-Nov-18
181	VN	495		12.6	72	4.5	26-Jun-18
182	VN	497		10	48.46	4.2	01-Jul-14
183	VN	535		10.8	60.09	3.5	16-Apr-12
184	VN	251		9.5	44.5	3.2	01-Jan-07
185	VN	271		10.05	51.11	3.2	07-Jun-07
186	VN	271		10.5	51.11	3	07-Apr-07
187	VN	271	900	10.5	51.11	3	04-Jun-07
188	VN	271	900	10.5	51.11	3.2	06-Dec-11
189	VN	271	900	10.5	51.11	3	23-Apr-12
190	VN	271	900	10.5	51.11	3	23-Apr-12
191	VN	271	900	10.5	51.11		14-Dec-12
192	VN	271		10.5	51.11	3.45	02-Jan-09
193	VN	251	900	10.5	51.11	3.2	21-Feb-09
194	VN	271	900	10.5	51.11	3.2	23-Feb-08
195	VN	535		11	58.5	3.45	01-Oct-10
196	VN	535		11.2	59.65		08-Jan-09
197	VN	490		11	57.35	4.05	01-Jul-14
198	VN	490	1272	10.5	59.6	3.7	01-Jul-14
199	VN	283		9.74	50.91	3.7	22-Mar-12
200	VN	283	1547	11.26	58.6	3.5	27-Jan-14
201	VN	498	2473	12.86	74.42		18-Jul-20
202	VN	498	1560	12.5	70.9	5.8	18-Jul-20
203	VN	290	695	7.6	38.85	3.5	19-Jun-20
204	VN	451		10.26	54.86	4.12	09-May-18
205	VN	454	695	9.24	47.15	3	27-Apr-18
206	VN	433		10	54.08	4.1	22-Apr-18
207	VN	335		9.8	50	3.85	28-Apr-18
208	VN	498	1560	10.5	57.6		12-Mar-18
209	VN	307		10	53.9	4	22-Nov-18
210	VN	351	891	9	44.5	3.2	14-Dec-18
211	VN	625	1305	10	53.45	4	14-Mar-18
231	VN	421	595	8	40.5	3.1	09-Apr-17
232	VN	210	710	8.6	44.9		10-May-15
233	VN	240	704.4	8	37.8	2.9	10-Mar-15
234	VN	357	635	8.34	43.87	3.5	25-Aug-15
235	VN	283	1214	10.23	54.95	3.82	08-Sep-15
236	VN	490	1280	10.2	53.12	3.95	31-Oct-18
237	VN	277	900	9.74	49.91	3.44	23-Mar-18
238	VN	329	607	8.04	43	3.2	30-May-15
239	VN	193	645	8.2	41.66	3.3	06-Apr-15
240	VN	435	1286	10.1	53.26	3.9	19-Jun-17
241	VN	490		10.5	57.09	4.25	15-Mar-17
242	VN	451	1420	10.5	57.9	3.75	31-Jan-16
243	VN	1355	2489	11.2	74.7	4.88	06-Dec-14
244	VN	331	779	8.75	48.5	3.5	28-Dec-13
245	VN	353	635	9	44.83	3.16	01-Jan-14
246	VN	345					28-Dec-13
247	VN	307	1240	10.2	57.4	3.45	24-Oct-13
248	VN	280		9.6	49.35	3.7	06-Jan-14
249	VN	498	693	11.7	57.75	4.5	14-Apr-14
250	VN	244		8	40.5	2.9	06-Feb-15
251	VN	451		10.26	54.86	3.5	02-Feb-16
252	VN	376		10.2	53.12	3.9	21-Jan-16
253	VN	207	694	8.1	39.44	3.44	09-Jul-16
254	VN	421		10	53.92	4	24-Aug-16
255	VN	451	1420	10.5	57.9	3.75	17-Jan-16
256	VN	430		10	53.5	3.6	15-Apr-13
257	VN	446	856	11	53.4	4.2	10-Sep-14
258	VN	218	564	7.36	37.67	2.4	16-Aug-11
259	VN	328	607	8.3	44	2.66	28-Jun-11
260	VN	443	1715	12	59.8	3.75	22-May-20
261	VN	490	1064	10.35	55.2	3.85	24-Apr-17
262	VN	540	998	9.8	51.6	3.5	07-Mar-13
263	VN	316	1050	9.6	47.7	3.33	30-Jul-16
264	VN	449	785	8.8	47	3.4	05-Jun-16
265	CHINA	4380	6502	17.2	100.8	9	25-Mar-21
266	CAM	1445	1646	14.5	8	2.4	10-Apr-20
267	TANZANIA	2389	3900	13.8	87	6.15	26-Oct-17
268	CAMBODIA	2660	4217	14.5	84.45	5.4	16-Oct-08
269	CHINA	6055	7409	17.8	106.95		13-Nov-09
270	SIERRE LEON	1998	4080	13.8	87.8	5.2	12-Nov-10
271	PANAMA	5688	7500	18.2	110.8	6.96	17-Mar-11
272	CHINA	6113	8514	18.8	100.64	8.192	21-Aug-11
273	PANAMA	4843	5250	19.5	99.57	6.2	22-Jan-11
274	PANAMA	5549	8213	17.6	125.96	6.68	23-Dec-11
275	PANAMA	2995	5300	16.2	106.2	6.8	12-Oct-11
276	PANAMA	5702	8700.6	18.8	120	6.8	25-Dec-12
277	CHINA	5484	7257.2	18.2	97.95	7.5	12-Dec-13
278	CAMBODIAN	4333	6500	16.2	116.66	8.2	16-Dec-14
279	VN	1599	3075.4	12.6	79.2	6.84	14-Apr-15
280	VN	2551	4375	13	90.72	6.16	07-Aug-18
281	VN	1599	3093	12.6	78.63	6.48	21-Jul-18
282	VN	1599	3101	12.6	79.2	6.48	21-Jul-18
283	SIERRA LEONE	2772	3740	15	84.57	5.8	14-Jul-18
284	VN	1599	3068.5	12.6	74.82	6.48	06-May-18
285	VN	1598	2996	12.9	79.8	6.08	30-Jul-18
286	VN	1596	3085	12.6	79.6	5.3	29-Aug-18
287	VN	1599	3162	12.6	78.63	6.48	06-Jul-18
288	VN	1598	2969	12.8	79.8	6.08	15-Sep-18
289	VN	1660	3040	12.6	79.99	6.48	03-Nov-18
290	VN	1593	2854	12.3	74.24	6.3	17-Nov-18
291	TOGO	2938	4600	15.8	96.23	5.2	30-Apr-15
292	VN	1355	2471	11.22	74.7	6	15-Feb-16
293	VIET NAMESE	1599	2850	12.6	79.57	5.14	03-Feb-16
294	VIET NAMESE	1593	6101	12.6	79.2	6.48	11-Dec-16
295	TOGO	5519	6830	18	97.13	7.49	25-Oct-16
296	INDONESIA	1982					20-Apr-17
297	INDONESIA	1961					06-Aug-15
298	INDONESIA	2120					06-Jan-15
299	INDONESIA	2084					13-May-15
300	MALAYSIA	3852					16-Jan-14
301	VIET NAMESE	519	960				10-Oct-13
302	MALAYSIA	1479					06-Dec-11
303	SINGAPORE	133					22-May-07
304	SINGAPORE	1826					12-Mar-07
305	SINGAPORE	1863				4.57	30-May-12
306	SINGAPORE	1784				4.57	18-Apr-12
307	SINGAPORE	2512	6192			5.49	20-Mar-11
308	SINGAPORE	2512					17-Dec-10
309	SINGAPORE	2512					17-Dec-10
310	THAI	4302	8000				01-Sep-11
311	SINGAPORE	1497					24-Aug-11
312	SINGAPORE	927					25-Aug-11
313	VIET NAMESE	836		5.19	18.75	3.8	05-Jan-12
314	VIET NAMESE	251	301	10.72	36.33	1.74	22-Jan-11
315	VIET NAMESE	)	.)				26-Jun-12
316	SINGAPORE	2127				3.35	31-Jan-11
317	SINGAPORE MALAYSIA	170					30-Aug-12
318	MALAYSIA	195				3.65	19-Jun-14
319	INDONESIA	109				2.9	09-Apr-15
320	VN						14-Aug-15
321	INDONESIA	109		21.34	82.3	4.88	09-Dec-15
322	INDONESIA	131	4000				13-Mar-17
323	VIET NAMESE	435	804				13-Jul-12
324	VIET NAMESE	181.00					15-Jan-13
325	VIET NAMESE	178					07-Jan-14
326	VIET NAMESE	178.00					15-Jan-13

97	VN	378		13	70.48	5.2	05-Nov-19
98	VN	495	1986	13.2	62.7	4.25	28-Aug-10
99	VN	499	2790	13.5	57.87	4.6	08-Apr-17
100	VN	302	727	8.6	45.5	3.1	17-Dec-13
101	VN	412	761	9.24	47	2.85	09-Jun-11
102	VN	215		9.88	47.7	3.7	07-Dec-19
103	VN	847	1565	10.9	58.2	3.85	07-Jan-12
104	VN	495	1460	10.5	55	3.5	21-Feb-20
105	VN	149		7.2	38	3.5	27-Oct-19
106	VN	295		7.7	44.4	4	17-Nov-18
107	VN	268	494	8.8	44.7	2.25	06-Oct-18
108	VN	286	737	8.48	47.07	3.22	01-Jun-19
109	VN	437		9.29	45.8	3.5	26-Aug-18
110	VN	233	430	8.65	42.59	2.3	08-Dec-11
111	VN	354		8.7	45.2	3.6	26-Sep-13
112	VN	397	855	9.24	48.5	3.5	15-Aug-17
113	VN	402		9.6	49.9	3.75	05-Dec-12
114	VN	440	812	9.8	47.26	2.95	27-Feb-12
115	VN	466		10	56.25	3.63	01-Sep-11
212	VN	33	610	8.1	40	3.25	11-Nov-13
213	VN	283		9.74	50.91	18323	15-Apr-13
214	VN	400	1657	11.96	63.93	3.9	14-Dec-12
215	VN	535		10.72	59	3.9	15-Mar-10
216	VN	270		9.6	51.32	3.5	13-Oct-13
217	VN	450		10.44	59.02	3.66	30-Jun-13
218	VN	495	1580	11.13	61.09	3.73	15-Apr-13
219	VN	420		10	53.45	4	11-Sep-16
220	VN	420	1256	10.1	57	4	31-Jul-16
221	VN	320	1096	9.9	49.96	4.5	09-Apr-16
222	VN	343	1145	10.24	52.4	3.8	20-Apr-16
223	VN	253	565	7.93	41.95	2.8	01-Dec-20
224	VN	498	2473	12.5	70.9	5.8	11-May-20
225	VN	488	1125	9.6	48	3.75	11-Sep-16
226	VN	432	1366	10.15	53.23	4.16	23-Sep-16
227	VN	421	1115	9.8	53.16	3.35	24-Nov-16
228	VN	405		10	53.94	4.05	29-Mar-16
229	VN	491	1509	10.6	55	4.3	29-May-17
230	VN	432	680	8.2	42.47	3.3	10-Apr-17

*Source: PPAP

The two-way channel specification by MRC is shown in Table 8-4 The channel width in the case of 3,000 DWT vessels is 76 m and 90 m for 5,000 DWT vessels. The water depth is 8.6 m for 3,000 DWT vessels and 10.5 m in the case of 5,000 DWT vessels. However, considering the currently planned vessel size (draft 4–5 m), water depth was set at 5.4 m in this study. It should be noted that the channel width means the width of the channel bed; therefore, the actual channel width is greater than that shown in the table.

Table 8-4 Waterway classification

Class	Type	Ton	Min. waterway dimensions (*)			Bend radius R (m)	Min. bridge dimensions		Cables
			Water depth T (m)	Bed width one-way	Bed width two-way		Span two-way Wb (m)	Height Hb (m)	Min. height Hc (m)
I	seagoing	5,000	10.5	58	90	670	79	35.5	37.0
II	seagoing	3,000	8.6	48	76	580	67	31.5	33.0
IIIa	seagoing	2,000	7.2	42	65	550	57	29.2	30.7
IIIb	barge (**)	2,000	5.7			335		18.5	20.0
IV	barge	1,000	4.7	38	60	300	53	16.0	17.5
V	barge	600	4.0	33	52	235	46	13.0	14.5
VI	barge	300	3.3	27	42	150	37	11.5	13.0
VII	barge	100	2.6	17	26	105	23	9.4	10.9
VIII	barge	50	2.2	16	25	85	22	8.0	9.5
IX	barge	20	1.4	9	14	60	12	6.0	7.5

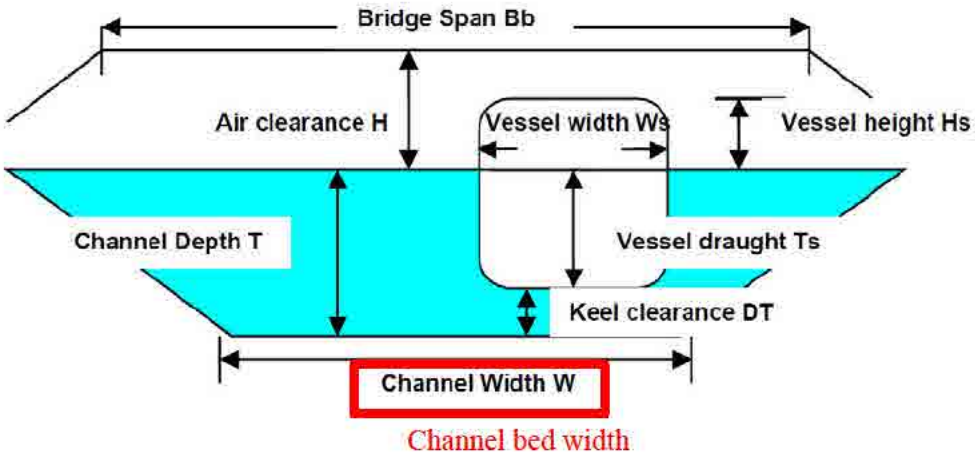


Figure 8-2 Channel specifications

8.1.1 Channel Design

(1) Kampong Cham to Kratie

Figure 8-3 shows the designed channel from Kampong Cham to Kratie. The future vessel size for upstream transport from Kampong Cham is assumed to be 3,000 DWT class. According to MRC, the channel width of the two-way channel is set at 76 m; however, in this study, the channel width is assumed to be 80 m. The channel was designed to take advantage of the deepest water as much as possible; however, bathymetric data (L.W.L) has not been updated since 1997. Therefore, a bathymetric survey should be conducted again before the actual planning phase. Since it is difficult to have enough water depth between Kampong Cham and Kratie in L.W.L, the channel is required to take dredging in all over the area.

(2) Kampong Chhnang to Chong Khneas

Figure 8-4 shows the designed channel from Kampong Chhnang to Chong Khneas. The future vessel size for transport upstream from Kampong Chhnang is assumed to be up to 5,000 DWT class. According to MRC, the channel width of the two-way channel is set at 90 m. The channel was designed to take advantage of the deepest water as much as possible; however, bathymetric data (L.W.L) has not been updated since 1997. Therefore, a bathymetric survey should be conducted again before the actual planning phase. Since it is difficult to have enough water depth between Kampong Chhnang and Chong Khneas in L.W.L, the channel is required to take dredging in all over the area.

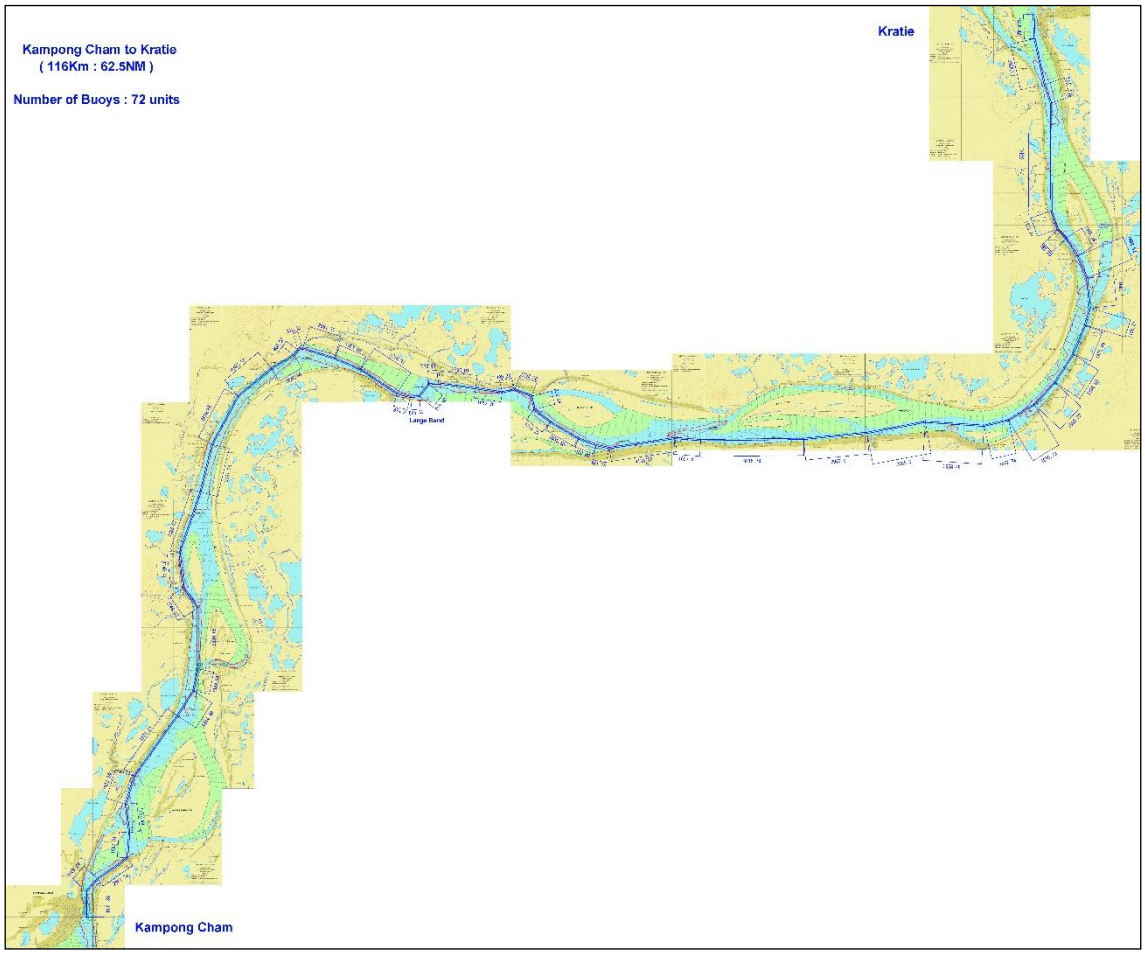


Figure 8-3 Channel design for Kampong Cham to Kratie

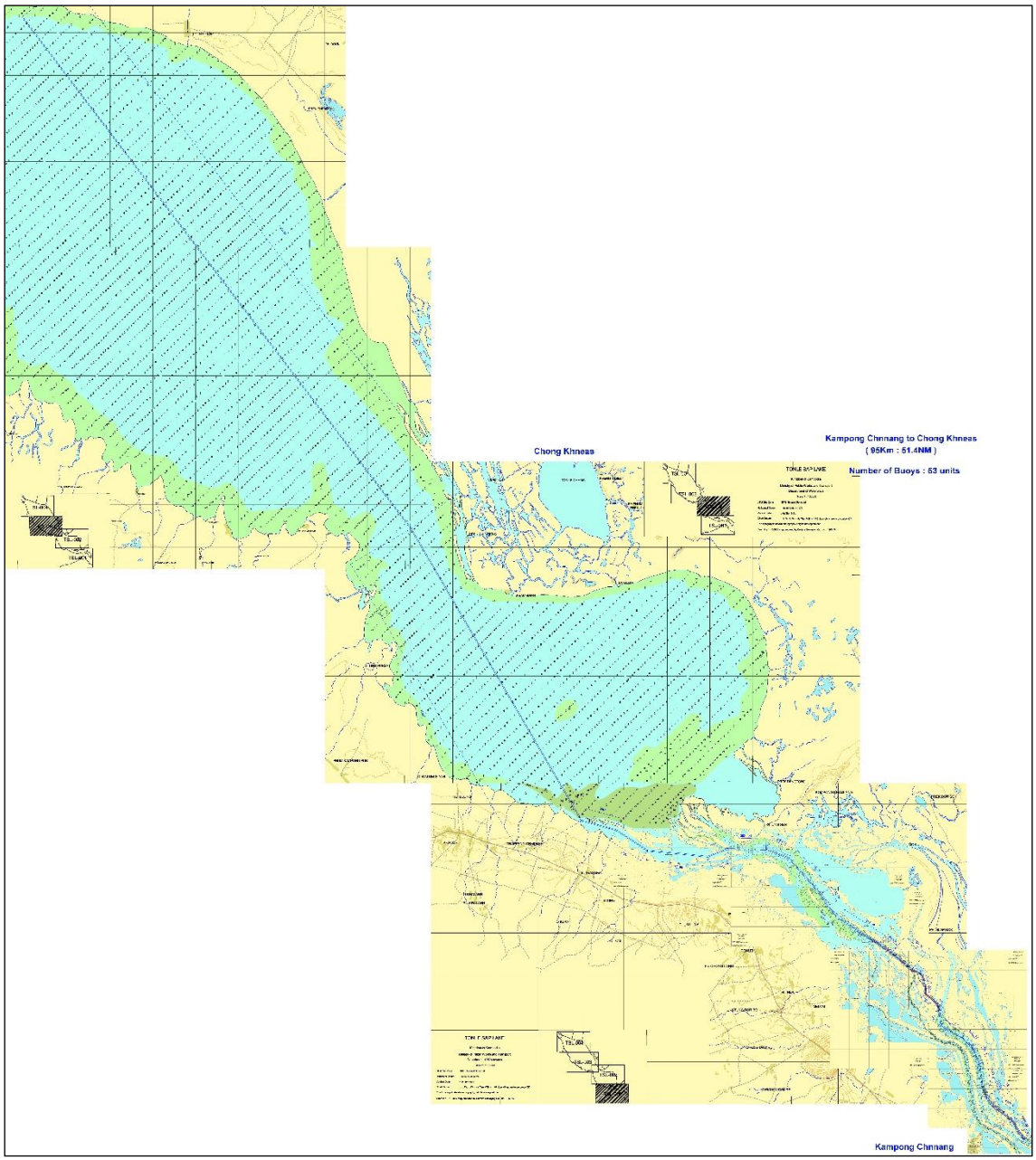


Figure 8-4 Channel design for Kampong Chhnang to Chong Khneas

8.1.2 Channel Dredging

(1) Dredging Volume

Figure 8-5 shows the estimated dredging volume in the channel. The dredging volume was estimated for each channel section based on the required water depth.

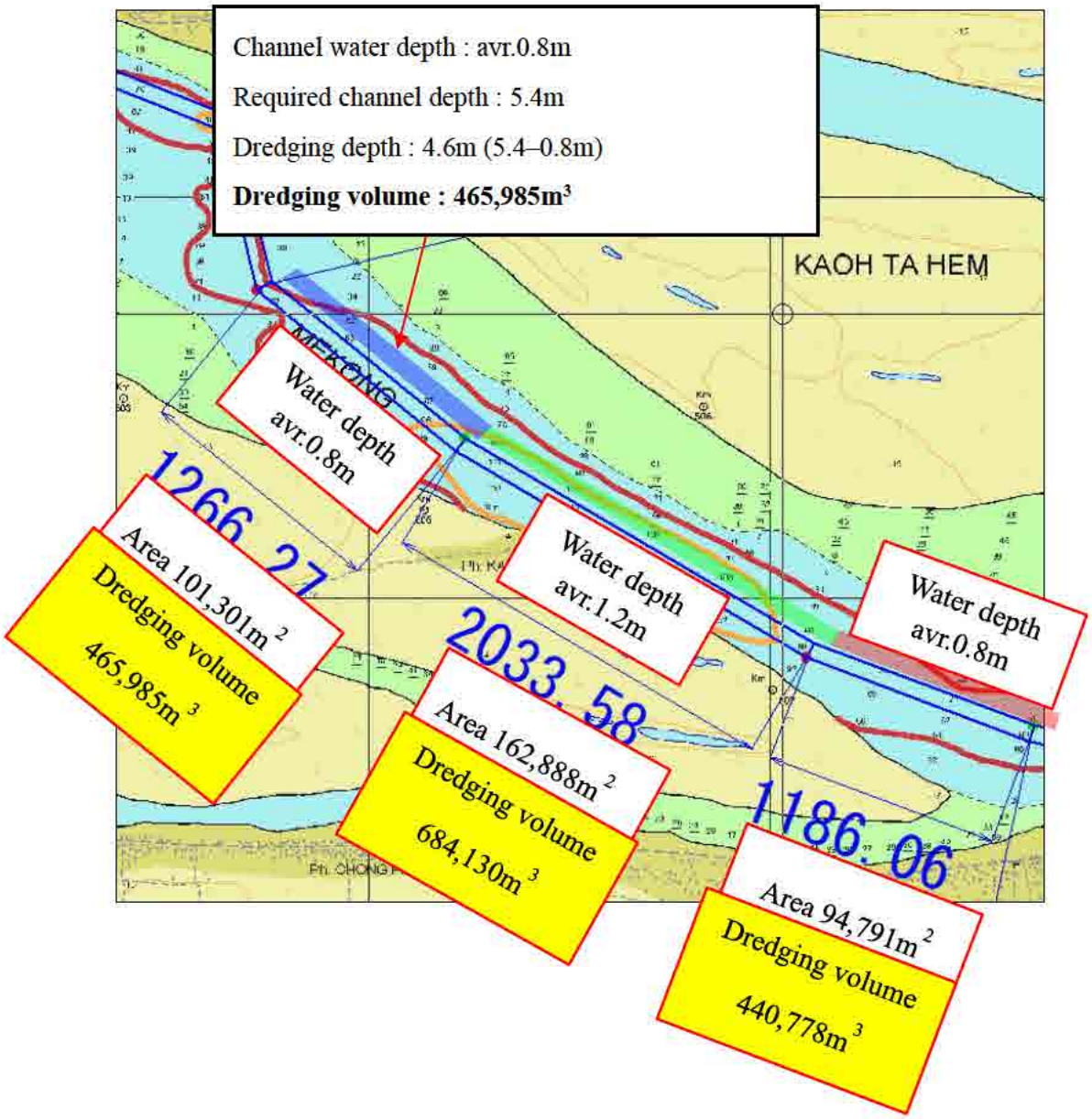


Figure 8-5 Estimated dredging volume (Kampong Cham to Kratie)

Table 8-5 Estimated dredging volume

Channel	Dredging Volume
Kampong Cham to Kratie	41,869,694 m^3
Kampong Chhnang to Chong Khneas	70,154,980 m^3

(2) Dredging Cost

The dredging cost is expected 3 to 5 USD per cubic meter based on past data. If we assume a dredging cost of 5 USD per cubic meter, the total cost of dredging the channel from Kampong Cham to Kratie channel would be 209 million USD. The cost of maintenance dredging also has to be considered. The maintenance cost is unknown at this stage; however, it is expected to be high because frequent dredging will be necessary due to the insufficient stability of the riverbed.

Table 8-6 Estimated dredging cost

Channel	Dredging Cost
Kampong Cham to Kratie	$ 209,348,472
Kampong Chhnang to Chong Khneas	$ 350,774,901

(3) Methods for Reducing the Dredging Volume

(a) Introduction of shallow-draft barge

The dredging volume has a strong correlation with the required water depth. The required water depth is 8.6m for 3,000 DWT class vessels and 10.5 m for 5,000 DWT class vessels based on the MRC standard. The required dredging volume can be reduced by introducing a shallow-draft barge. However, a shallow draft barge is wider than a conventional barge and its wide-hull shape is more affected by the water pressure. In addition, the course stability of a wider vessel is generally poorer compared with conventional vessels. Therefore, it is necessary to examine the feasibility of introducing such a wide-hull barge into a river with a strong flow.



Figure 8-6 Image of wide-hull barge

(b) Collection of Real-time Bathymetric Data

Frequent bathymetric surveys cannot be conducted in a long channel due to the exorbitant costs. Accordingly, one yearly bathymetric survey is considered reasonable. Therefore, when the channel is established in the future, real-time bathymetric data should be collected using an echo sounder. This will make it possible to easily identify the required dredging points at an early stage, thereby minimizing dredging work.

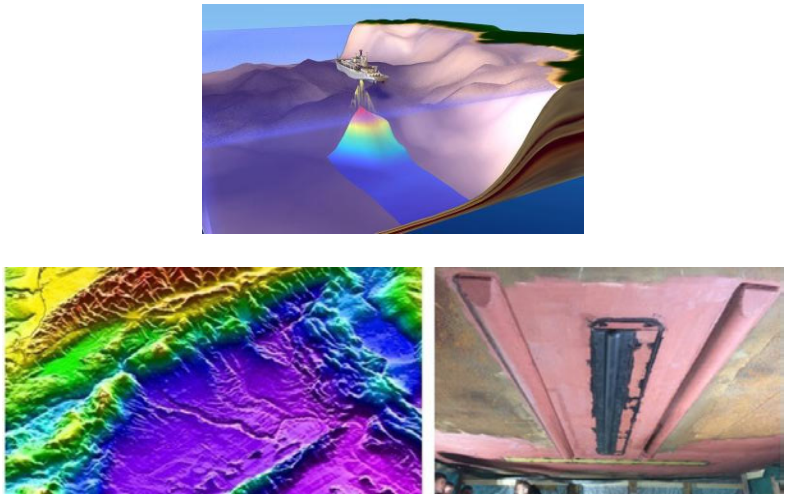


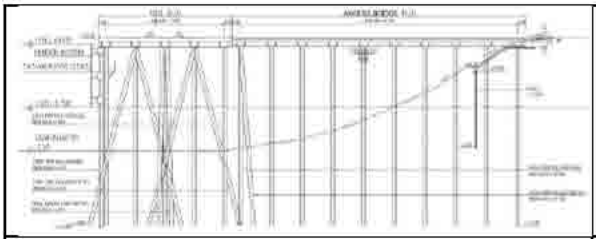
Figure 8-7 Image of echo sounder

8.2 River Port Development

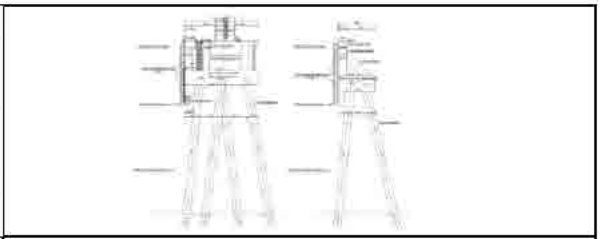
8.2.1 Present Situation of Existing River Ports

(1) Existing River Wharves

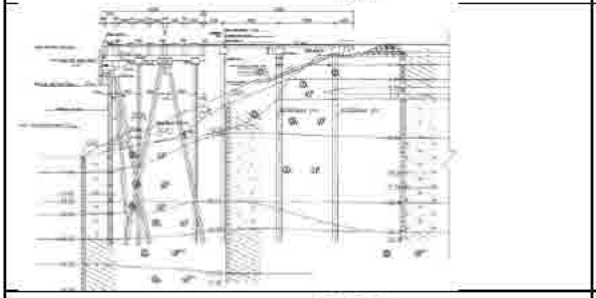
The mooring facilities of existing ports built on the Mekong River and the Tonle Sap River are often designed as Coupled Raking Pile Type Structures, as shown in Figure 8-8 to cope with large fluctuations in river water levels and strong fluid forces due to fast river currents. In the era when it was difficult to procure large construction machinery (Pile Driving Equipment), the main type used was the Concrete Rigid Frame Type Structure, as shown in the lower part of Figure 8-8 The Rigid Frame Structure had to be constructed above the river water level, and since the construction period was limited to the low water season, the construction period became long.



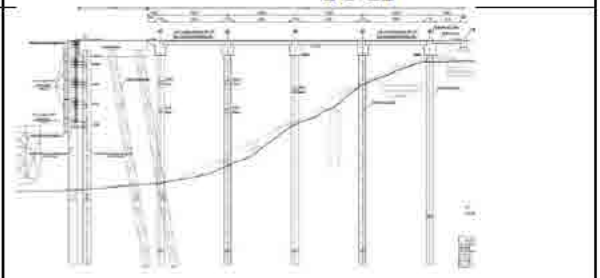
TS3



TS 11



LM17



UM2

Concrete Deck on Coupled Raking Piles Type Piers



TS3 (Phnom Penh)



Boeung Ket (Upper Mekong)
Concrete deck height 14.5m above water level

Concrete (RC) Rigid Frame Type Piers

Source: JICA Team

Figure 8-8 Typical Structural Type of River Wharves

(2) Existing River Vessel

The particulars and photos of the currently operating River Vessels are shown in Table 8-7 and Figure 8-9 below. These River Vessels travel downstream along the Mekong River in Cambodia, cross the border into Vietnam, and continue down the Mekong River without going out to the open sea, connecting with Saigon ports such as Cat Lai and Cai Mep via canals within Vietnamese territory. Due to the low air draft restriction of approximately 8 meters on the canal bridges, the loading capacity of the River Vessels is limited to around 200–250 TEU.

Table 8-7 Particulars of Existing Typical River Vessel (Container Vessels)

Type	Name of Container Vessel	GRT (tons)	DW (tons)	Breadth (m)	LOA (m)	Draft (m)	Capacity (TEUs)	Owner
MV	NEWPORT CYPRESS 99	1384	4102	15.33	79.99	04.35	213	NEW PORT CYPRESS J.S.Co.
MV	NEWPORT CYPRESS 89	1384	4100	15.33	79.99	04.35	213	NEW PORT CYPRESS J.S.Co.
MV	HO NAM 06	914	2400	12.60	72.50	04.50	128	NEW PORT CYPRESS J.S.Co.
MV	PHOUC LONG 12	1964	3800	15.45	79.89	5.65	248	GEMADEPT TP. CO.LTD.

Notes: GRT: Gross Tonnage, DW: Dead Weight Tonnage, LOA: Length Overall, Source: PPAP





MV New Port Cypress19

Source: JICA Team

Figure 8-9 Typical Existing River Barges at Lower Mekong River

8.2.2 Conceptual Design of River Port

(1) Essential Points of River Port Design

The purpose of constructing River Ports is to transport cargo from the surrounding hinterland via river shipping, which is cheaper compared to land transport. Furthermore, it directly connects to the seaport, a hub port in Cambodia, through the Funan Techo Canal. By connecting directly to Asia, America, and Europe via mother boats calling at the seaport, it aims to reduce transshipment costs through foreign ports and enhance Cambodia's international competitiveness.

For this purpose, River Vessels and River Ports must meet the following key points:

1) Target River vessel types that can navigate the Funan Techo Canal, while maximizing the cargo capacity per vessel as much as possible in order to reduce transportation costs per unit of cargo.

2) River Vessels must be ships equipped with seaworthiness that allows navigation both on rivers and along coastal routes to seaports. Specifically, it is considered necessary to have hatch covers to enhance wave resistance.

3) For a Container River Vessel, the River Wharf should provide a space for temporarily placing hatch covers. (For Bulk vessels, if collapsible hatch covers are used, a temporary hatch cover placement space on the wharf is not necessary.)

4) The mooring facilities of River Ports constructed on the Mekong River and the Tonle Sap River should have structures and strength capable of handling large water level fluctuations and river currents. On the other hand, vessels performing cargo handling at riverside mooring facilities have the advantage that if they need to shift position along the pier, it can be done easily due to the river flow.
5) When constructing a River Port within a Canal, since there is no river current, the structural components of the mooring facilities can be smaller compared to those built in a river.
6) In order to export cargo directly from a River Port via a Sea Port, the River Port must comply with the ISPS security code.

(2) Conceptual Design Conditions

(a) Objective Ships and water depth of Wharf

Assuming that the maximum navigable ship type for the Funan Techo Canal is the target, the ship types and depths shown in Table 8-8 below were used as the design conditions.

Table 8-8 Conceptual Design River Vessel Size and Wharf Water Depth

River Barge	LOA （m）	Breadth (m)	Draft (m)	Tonnage (DWT)	Wharf Depth (m)
Container Barge	80	15	4.7	3,000	5.4
Bulk Barge	87	14.3	5.3	3,000	6.0

Note: Wharf Water depth:Below L.L.W.L at candidate port site as indicated in the river Chart based on the Hatien MSL (Mean Sea Level))

(b) Candidate River Port Sites

- At Zone 4
- At Zone 5

(c) Actions on the Port Facilities

i) Fluid force due to River Current and River Water Level

The action (horizontal force) on the wharf due to the fluid force from a high flow velocity of 3–5 knots (1.5–2.5 m/sec) shown in Table 8-9 acts as the predominant force on the wharf, greater than other berthing or mooring forces.

Table 8-9 River Current Velocity and Water Level

Zone / Location	Season	Zone 4 / Tonle Sap	Zone 5 / Upper Mekong	Remarks
Current Velocity	Rainy Season	3 knots	5 knots	1/
Water Level	Rainy Season	+10.35m	+16.5 m	2/
	Dry Seson	+0.68 m	+1.75 m	3/

Source: 1/ PPAP
2/MRC Cambodia (MoWRAM 2000-2022) Hatien MSL/Chart datum
3/River Charts 1997-1998

Figure 8-10 is a longitudinal profile of the Mekong River from the Vietnam border to the Laos border, with the horizontal axis showing the distance from the river mouth, taking the Mekong River mouth as 0 km. Figure 8-11 is a longitudinal profile of the Tonle Sap River from Phnom Penh to Kampong Chhnang, with the horizontal axis showing the distance from the confluence of the Mekong and Tonle Sap rivers (Chaktomuk, Phnom Penh). In each figure, the black broken line and the light blue solid line indicate the Highest High-Water Level and the Lowest Low Water Level at each location, respectively, and the difference between them represents the water level difference at each point. This water level difference is about 15 m at UM2 in the Upper Mekong basin and about 18 m at Kratie (Chhlong), with the water level difference at Kratie being the largest in Cambodia. Especially in the Upper Mekong, such large water level differences generate significant river fluid forces, and as a result, the structural members of wharves have large cross-sections.

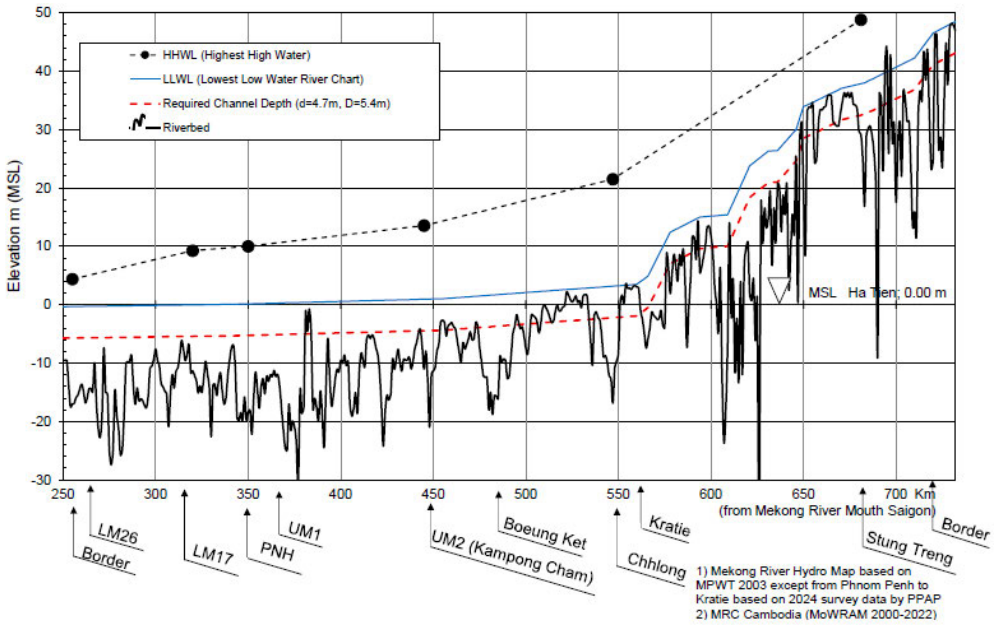


Figure 8-10 Longitudinal Profile of Mekong River (from Vietnam Border to Lao Border)

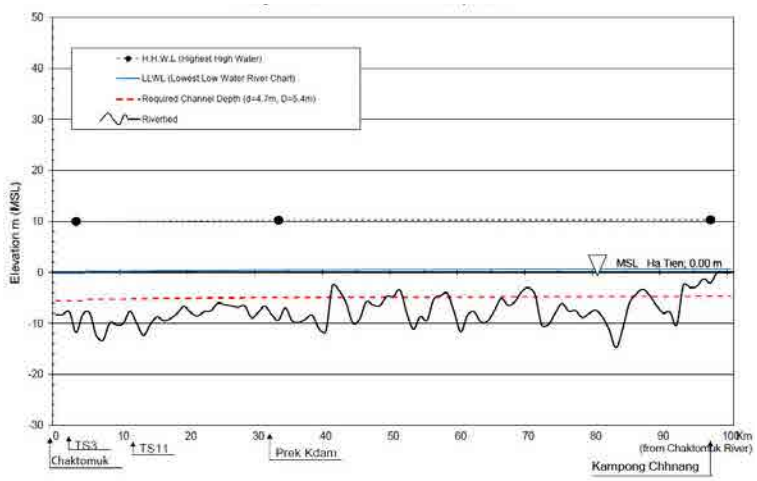


Figure 8-11 Longitudinal Profile of Tone Sap River from Phnom Penh to Kampong Chhnang

ii) Berthing and Mooring Force

Since river vessels are smaller in size compared to ocean-going vessels, berthing and mooring forces do not become the predominant action. Only the berthing and mooring forces in the cross-sectional way of the mooring facilities need to be considered as predominant actions.

iii) Seismic Force and Wind Force

The seismic coefficient applied to structural design in Cambodia is relatively small, about Kh=0.05. Also, since the impact of typhoons is minor, the design wind speed is around 25–30 m/sec, so it does not become the predominant action.

iv) Self-weight of Cargo Handling Equipment

The quay crane being considered at the river port is a fixed crane, so its own weight and reaction force are small. The RS (Reach Stacker) as yard handling equipment has a large wheel load due to the container weight, so the pavement of the marshalling yard needs to be heavy-duty.

(d) Sub-soil conditions

It was assumed that a bearing stratum exists beneath the alluvial layer, which is approximately 15 to 25 meters thick below the riverbed.

(e) Cargo Volume per River Berth

A river terminal facility was planned for the cargo handling capacity in Table 8-10.

Table 8-10 Cargo Handling Capacity per Berth for River Vessel

Commodity	Container Cargo	Bulk Cargo (Agriculture goods)	
	(1,000 TEU/year/berth)	(1,000 ton/year/berth)	
Berth for river vessel	81	Agricultural products	263
		Paddy	130
		Total	393

(3) Conceptual Design of River Port Facilities

(a) Wharf

The results of the study on the approximate structural dimensions and structural types of Zones 4 and 5 containers and bulk terminals based on the above Design Condition have been compiled in Table 8-11.

Table 8-11 Principal Dimensions of River Wharves

Zone		Zone 4		Zone 5	
Berth		Container	Bulk	Container	Bulk
Wharf Top Elevation		+10.95 m		+17.1 m	
HHWL		+10.35 m		+16.5 m	
LLWL (Chart Datum)		+0.68 m		+1.75 m	
Hatien MSL		±0.00 m			
River-bed Depth		-4.72 m	-5.32 m	-3.65 m	-4.25 m
Wharf Design Depth		5.4 m	6.0 m	5.4 m	6.0 m
Wharf Structural type		Open Type Wharves on Coupled Raking Piles			
Mid-level Mooring Bollard		1 stage		2 stages	
Wharf Crane		One Fixed Crane	Two Crawler Cranes	One Fixed Crane	Two Crawler Cranes
Wharf deck width	Total Width	15m		15m	
	Crane space	5 m	7 m	5 m	7 m
	Hatch cover space		NA: Colapsible cover		NA: Colapsible cover
	Track/Chasis lane	2 lanes @5m	2 lanes @4m	2 lanes @5m	2 lanes @4m
Wharf Length		95 m	110 m	95 m	110 m

➢ Structural Type of Wharf

Up until now, not only in Cambodia but also in other countries, numerous types of wharves have been adopted and constructed in river ports with large differences in water levels and strong currents. The main types include the vertical-pile type, coupled raking-pile type, concrete rigid-frame type, sheet-pile type, pontoon type, and multi-tier (stair-step) type. Before container cargo

became mainstream, all these types were feasible and constructed and operated. However, considering the operation of container cargo and the handling machinery, the feasible structural types for the River wharf are limited to pile-type and sheet-pile type. Moreover, to resist the residual water levels and the strong horizontal forces caused by large fluctuations in river water levels, the coupled raking-pile type is considered an appropriate structural form.

- Wharf Dimensions

The face line of the wharf should ideally be a location with minimal erosion or sedimentation and where the required river depth can be obtained. Terminal yards such as the container marshalling yard and warehouses behind it need to set the top elevation considering allowance for past high-water levels, resulting in a significant difference in height compared to the berth depth on the river side. To account for this height difference, it is economical for the wharf to be of the detached type and connected to the land yard via access bridge(s) to maintain a distance that ensures slope stability.

The wharf should have crane spaces and hatch cover storage areas along the river side face line, with truck lanes and overtaking lanes positioned behind them, requiring an upper deck width of approximately 15 meters. Depending on the fluctuations of the river water level, it is preferable to install mooring bollards not only on the upper deck of the wharf but also at several intermediate height levels.

- Typical Section of Container and Bulk Cargo Wharves

Reflecting the above design conditions and the items to be noted, the typical cross-sections of the container and bulk wharves of Zones 4 and 5 are shown in Figure 8-12 to Figure 8-15.

i) Typical Cross Sections of Container Wharves

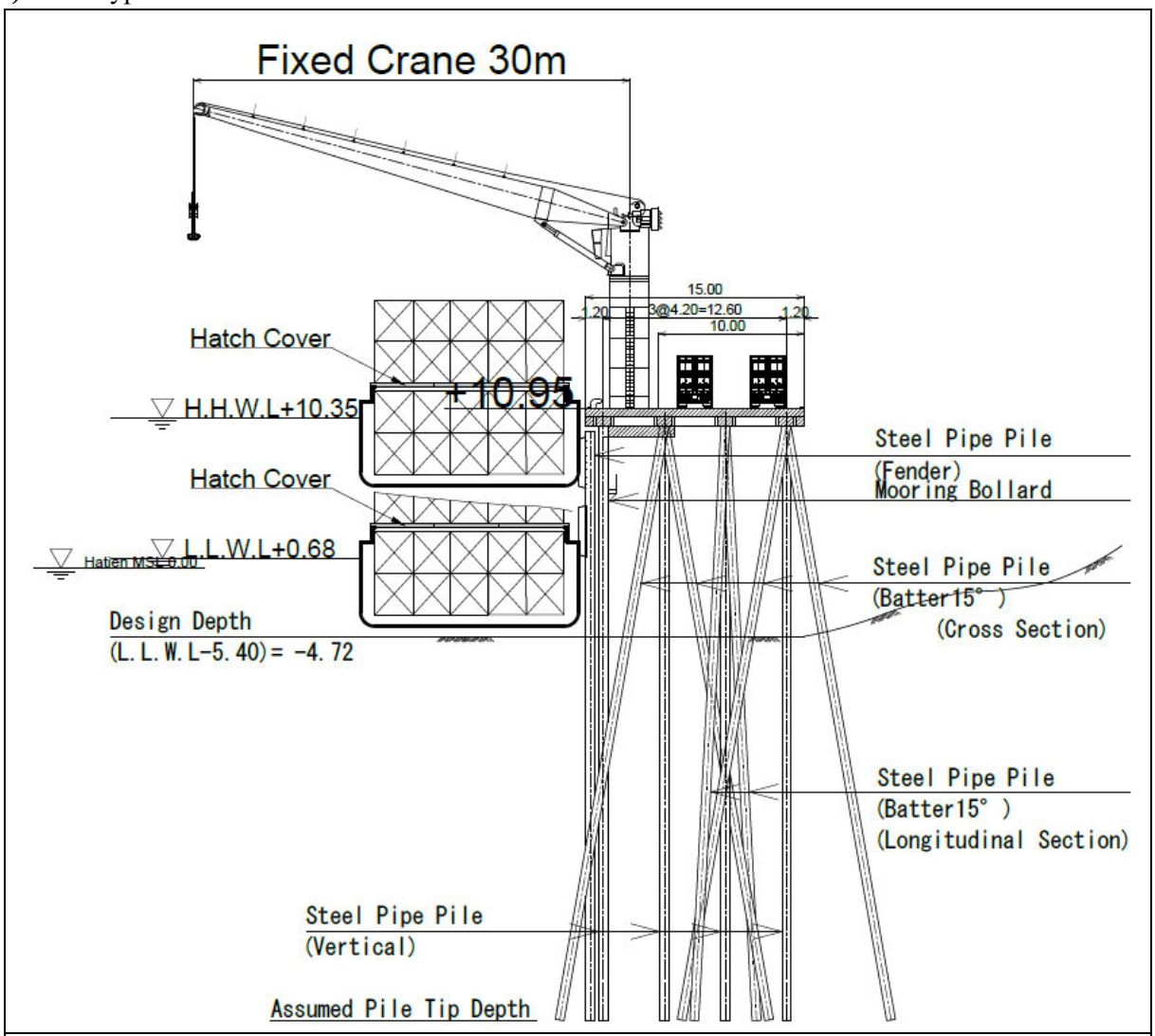


Figure 8-12 Typical Cross Section of Container Wharf for Zone 4

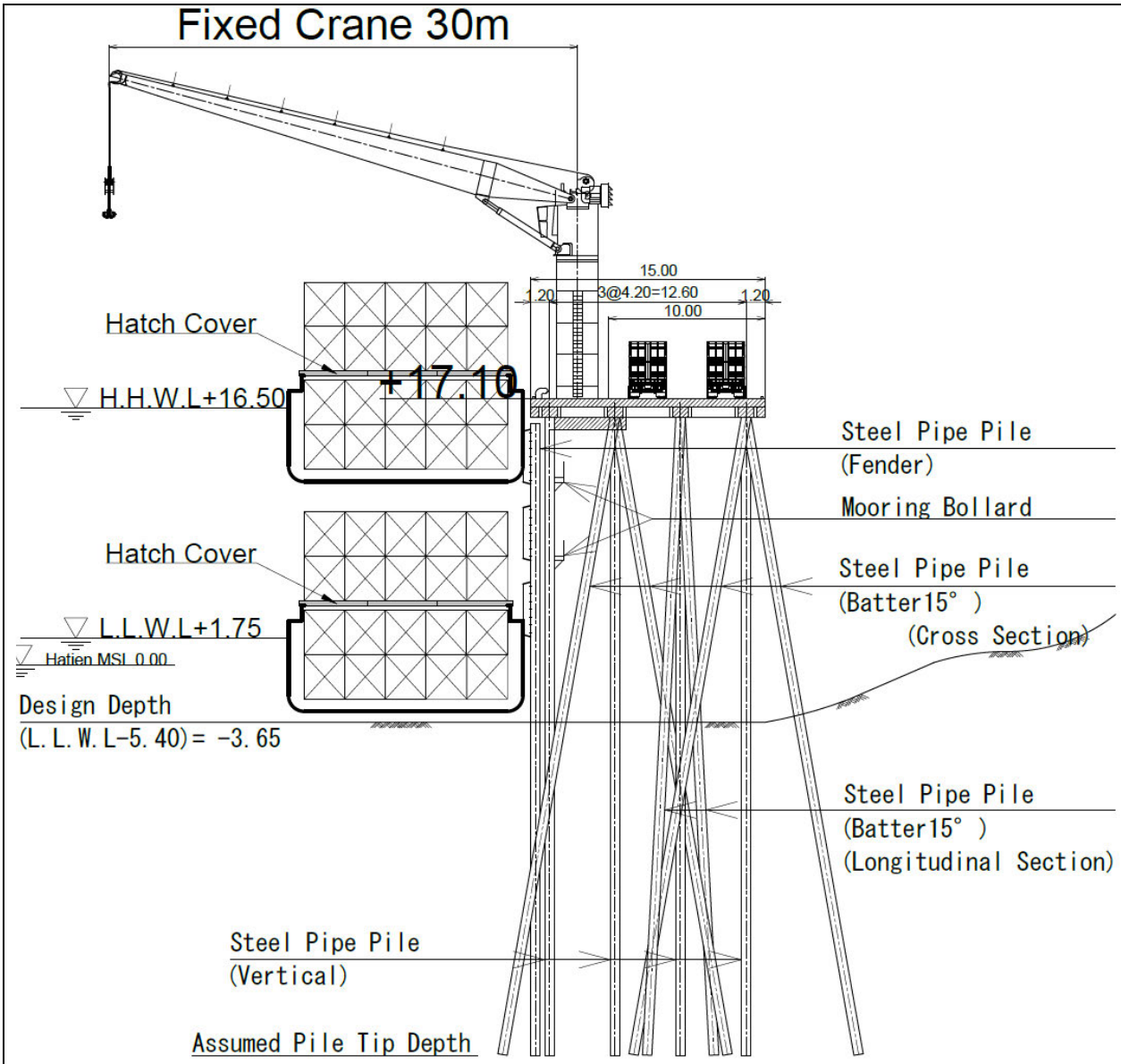


Figure 8-13 Typical Cross Section of Container Wharf for Zone 5

ii) Typical Cross Section of Bulk Cargo Wharves

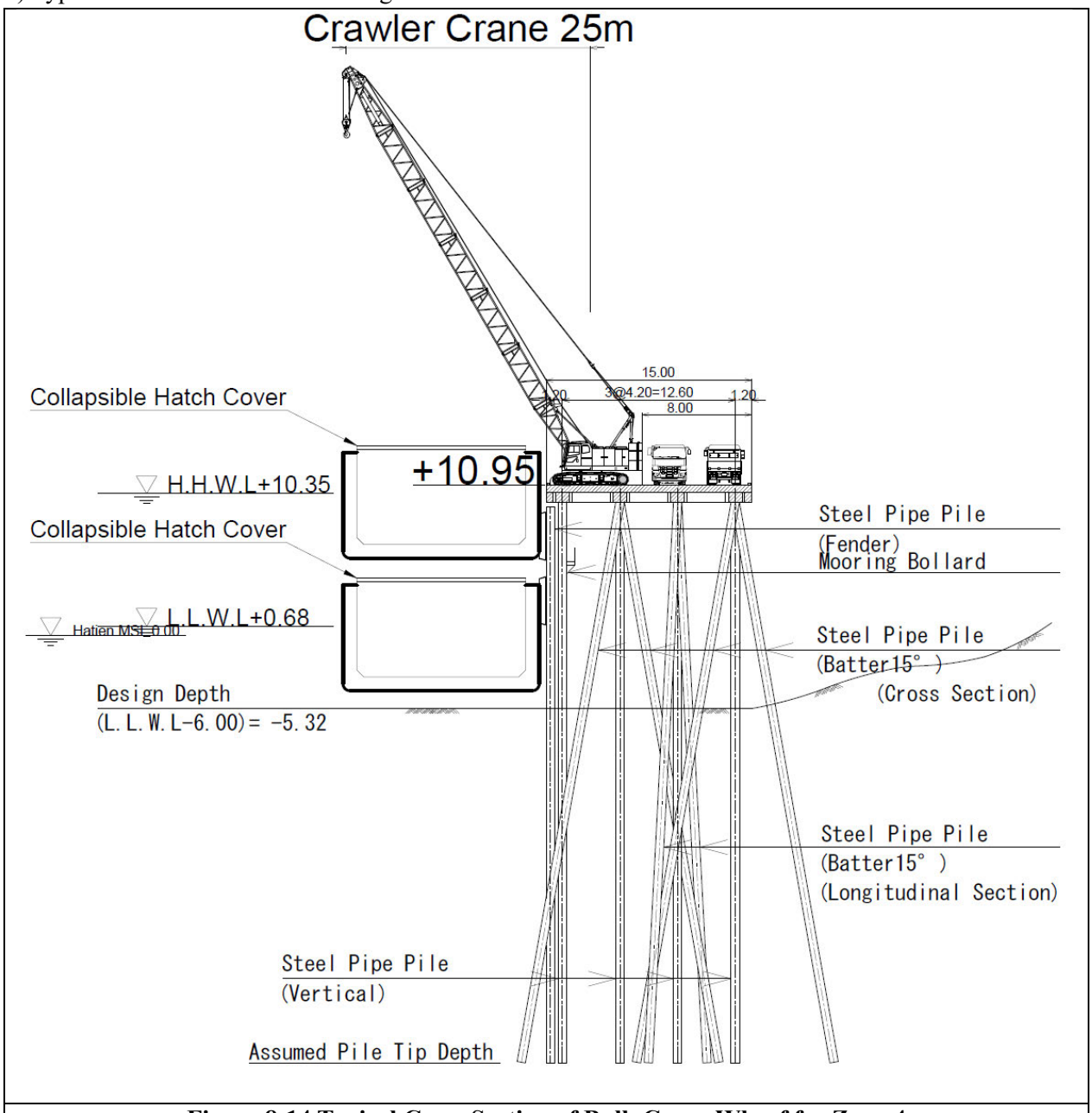


Figure 8-14 Typical Cross Section of Bulk Cargo Wharf for Zone 4

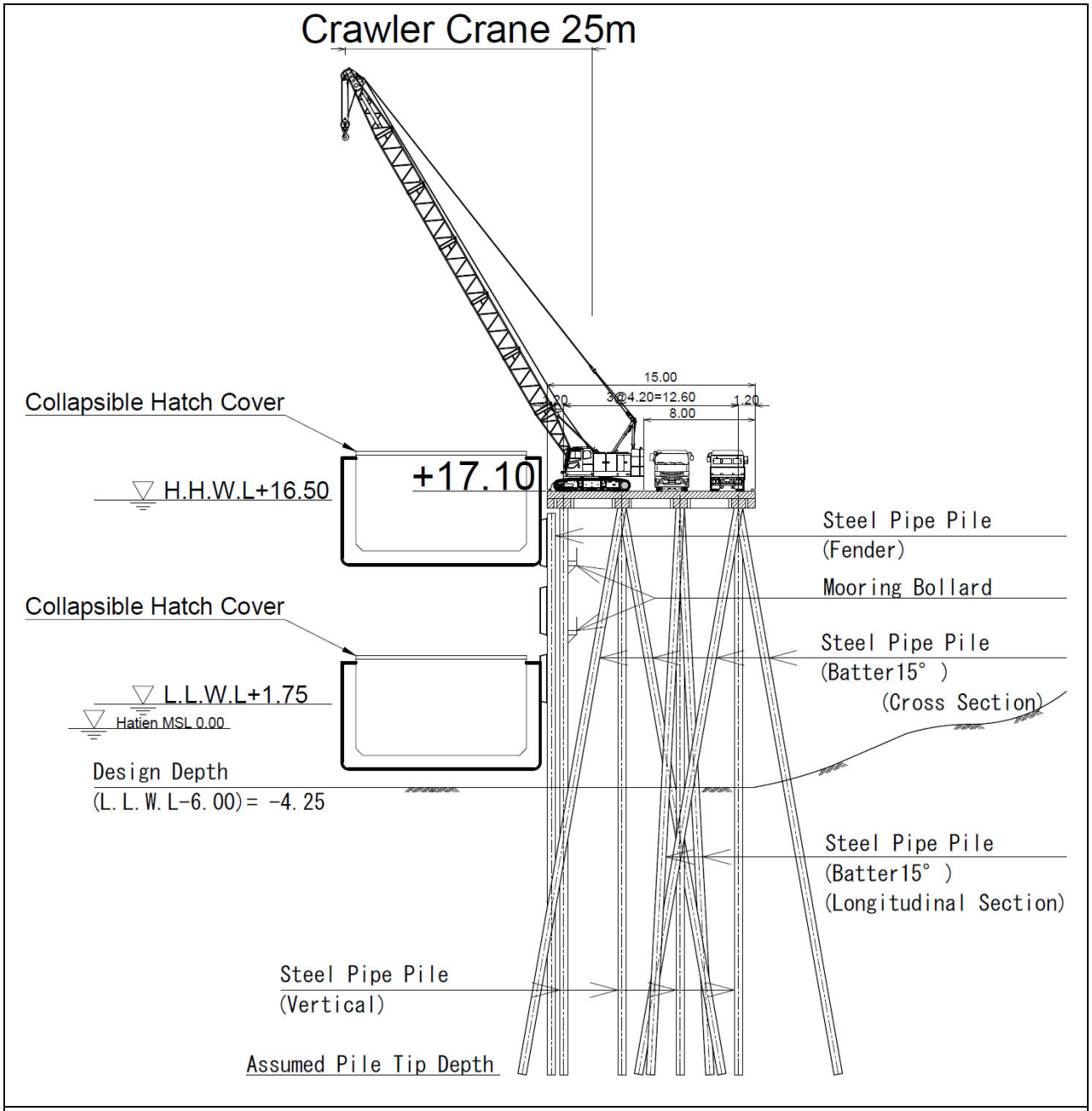


Figure 8-15 Typical Cross Section of Bulk Cargo Wharf for Zone 5

(b) Container Terminal

➢ Container Marshalling Area

At the time of the port's opening, container handling is conducted using Reach Stackers (RS), and it is assumed that it would transition to the RTG system in response to increasing demand.

The area of marshalling area by RS system can be calculated by following equation.[128]

$V_1=f \cdot V_0/e$

$V_2=V_1/(g_1 \cdot g_2)$

where

V_0: planned handling volume (TEU) =81,000TEU/year

V_1: number of target containers to plan the Marshalling Area(TEU)

e: annual number of rotation (time/year)

e=Dy/Dt =365/5=73 times/year

where

Dy: annual number of workdays (day) =365 days

Dt: average storage days in the yard (day)=5 days

f: peak coefficient =1.3

V_2: number of ground slots (TEU)

g_1: maximum stack coefficient = 3 layers

g_2: effective factor =0.80

$V_1=f \cdot V_0/e$=1.3x81,000/73=1,442 TEU

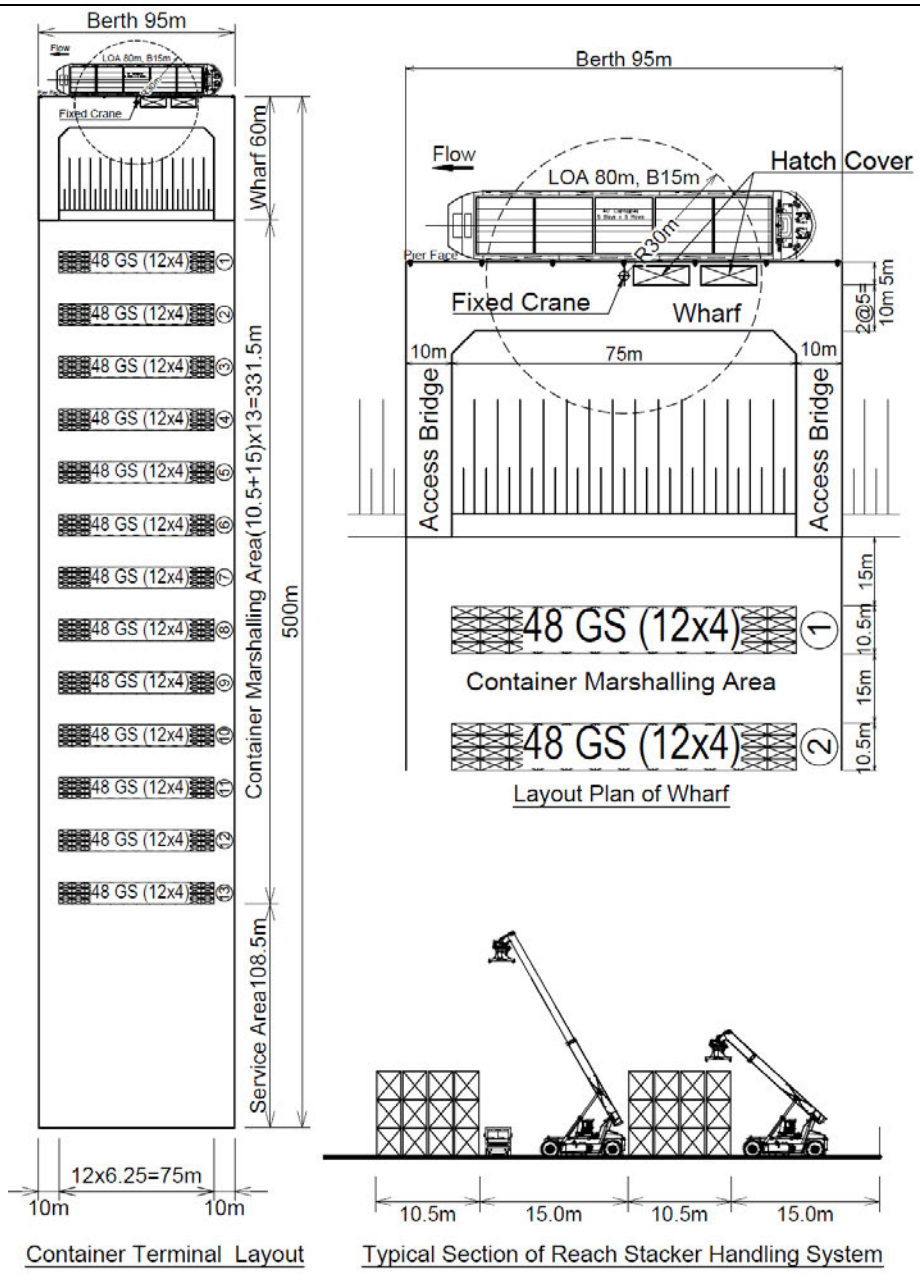
$V_2=V_1/(g_1 \cdot g_2)$ = 1,442 / (3 x 0.80) = **601 TEU**

Ground Slot (GS): 4 row x 12 bay=48 GS

Total GS =48 x 13=624

The Container Terminal Layout is shown in Figure 8-16.

[128] Technical Standards and Commentaries for Port and Harbour Facilities in Japan, 2020



CONTAINER TERMINAL

- Container vessel: 3,000 DWT
- Berth Length 95m
- Fixed Crane 1 unit
- 624 GS(Ground Slot)
- Land Area:4.2 ha
- Reach Stacker System

Figure 8-16 River Container Terminal (one berth) by RS (Reach Stacker) System

(c) Bulk Terminal

It was assumed that all bulk cargo would be handled via the warehouse, and the required area was calculated as follows.

$V_1=f \cdot V_0/e$

$V_2=V_1/(g_1 \cdot g_2)$

where

V_0: planned handling volume (ton) = (Paddy)+(Agriculture products) = 263,000 ton +130,000 ton= 393,000 ton/year

V_1: number of target volumes handled at Warehouse (ton)

e: annual number of rotation (time/year)
e=Dy/Dt =365/3=122 times/year

where

Dy: annual number of workdays (day) =365 days

Dt: average storage days in the Warehouse (day)=3 days

f: peak coefficient =1.3

V_2: Required floor area of Warehouse (m^2)

g_1: Average volume in the Warehouse floor area= 3 ton/m^2

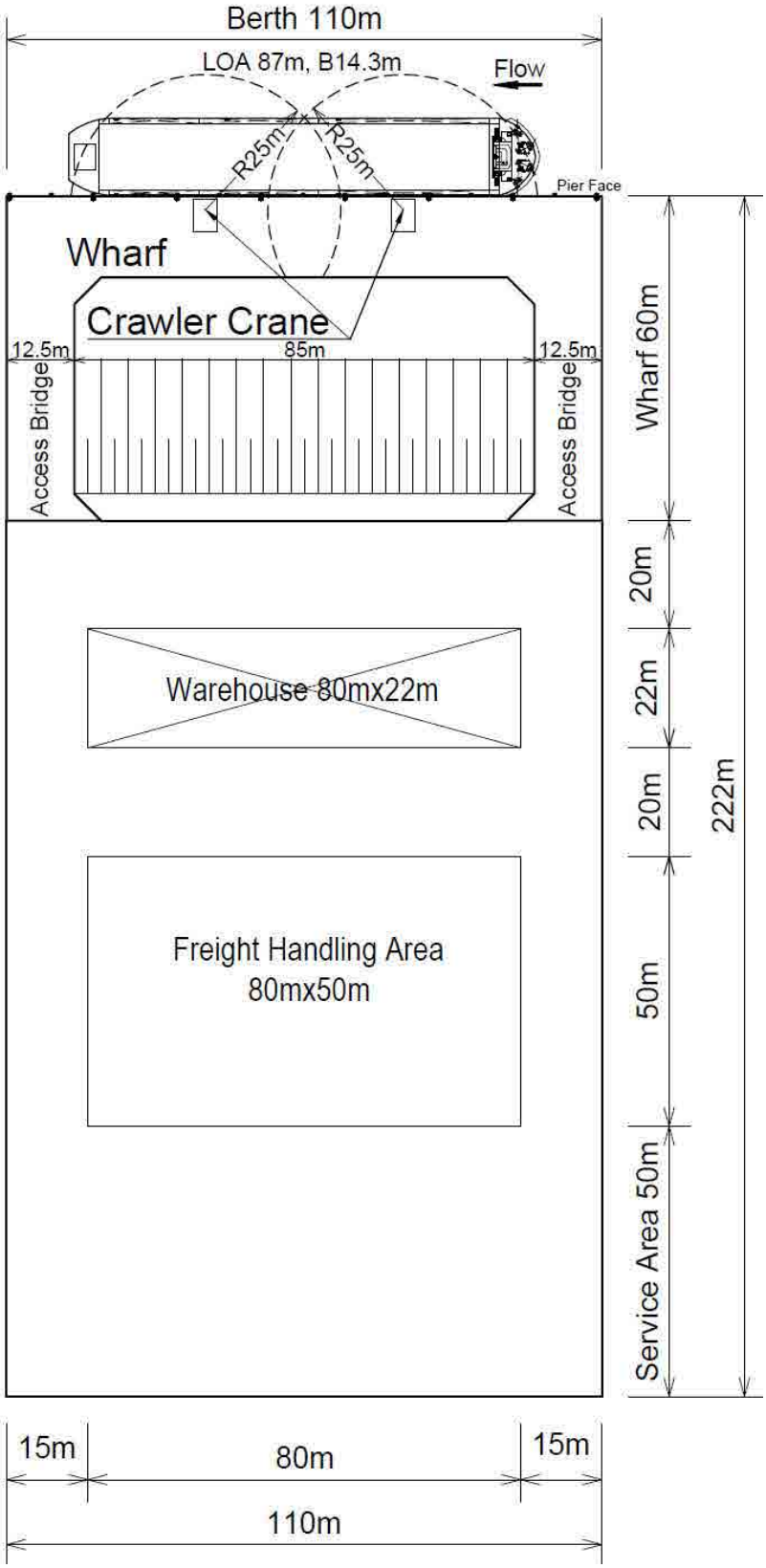
g_2: effective factor =0.80

$V_1=f \cdot V_0/e$=1.3x393,000/122=4,187 ton

$V_2=V_1/(g_1 \cdot g_2)$ = 4187 / (3 x 0.80) = **1,744 m^2**

Warehouse 22m x 80m =1,760 m^2

The Bulk Terminal Layout is shown in Figure 8-17.



BULK TERMINAL

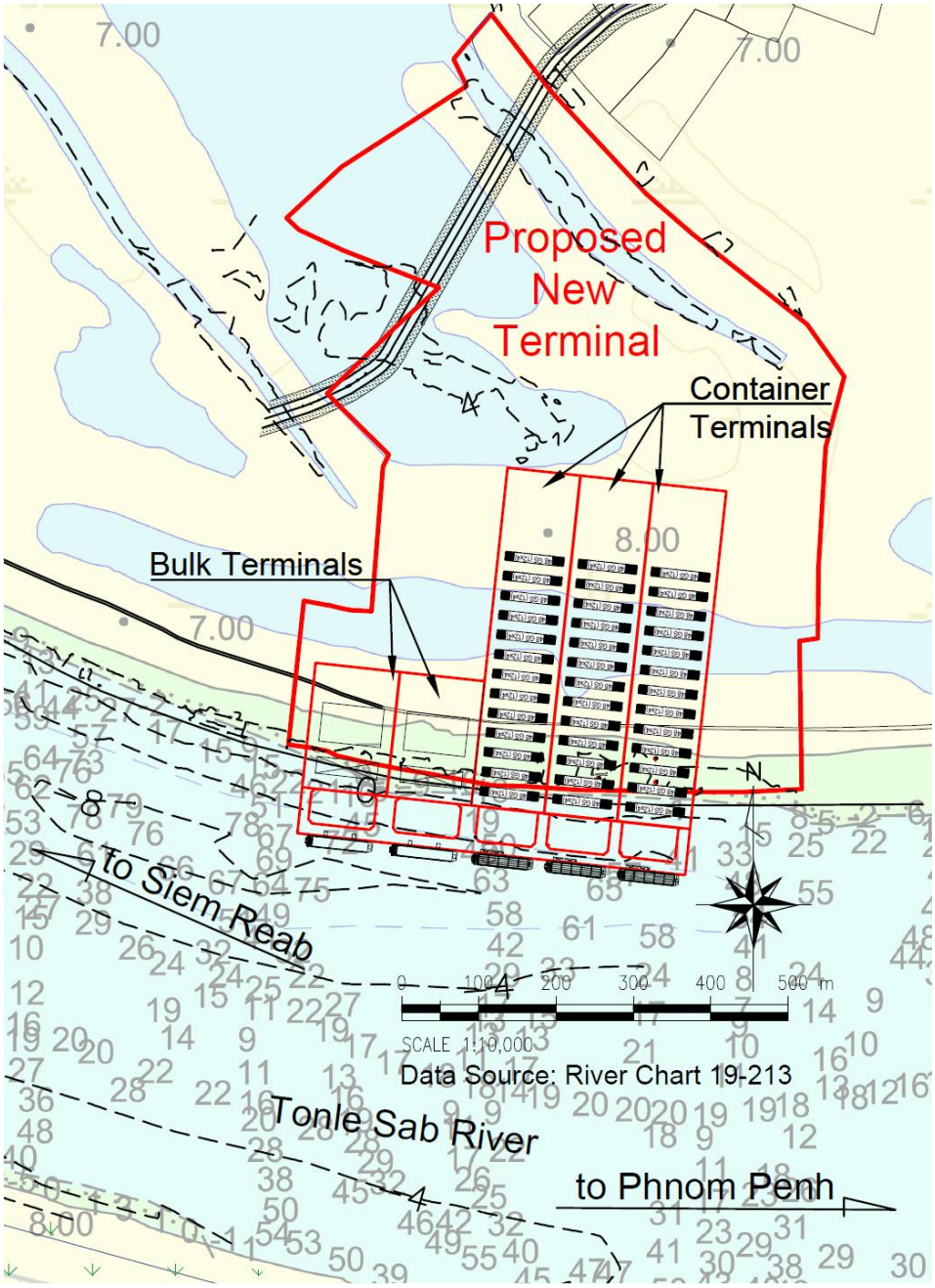
- Bulk vessel:3,000 DWT
- Berth Length 110m
- Crawler Crane 2 units
- Warehouse: 1.760 m^2
- Land Area: 1.8 ha

Figure 8-17 Layout Plan of River Bulk Terminal

(4) River Ports Layout

Based on the above container and Bulk Terminals Layout, the River Port Layouts for Zones 4 and 5 are shown in Figure 8-18 and Figure 8-19 below.

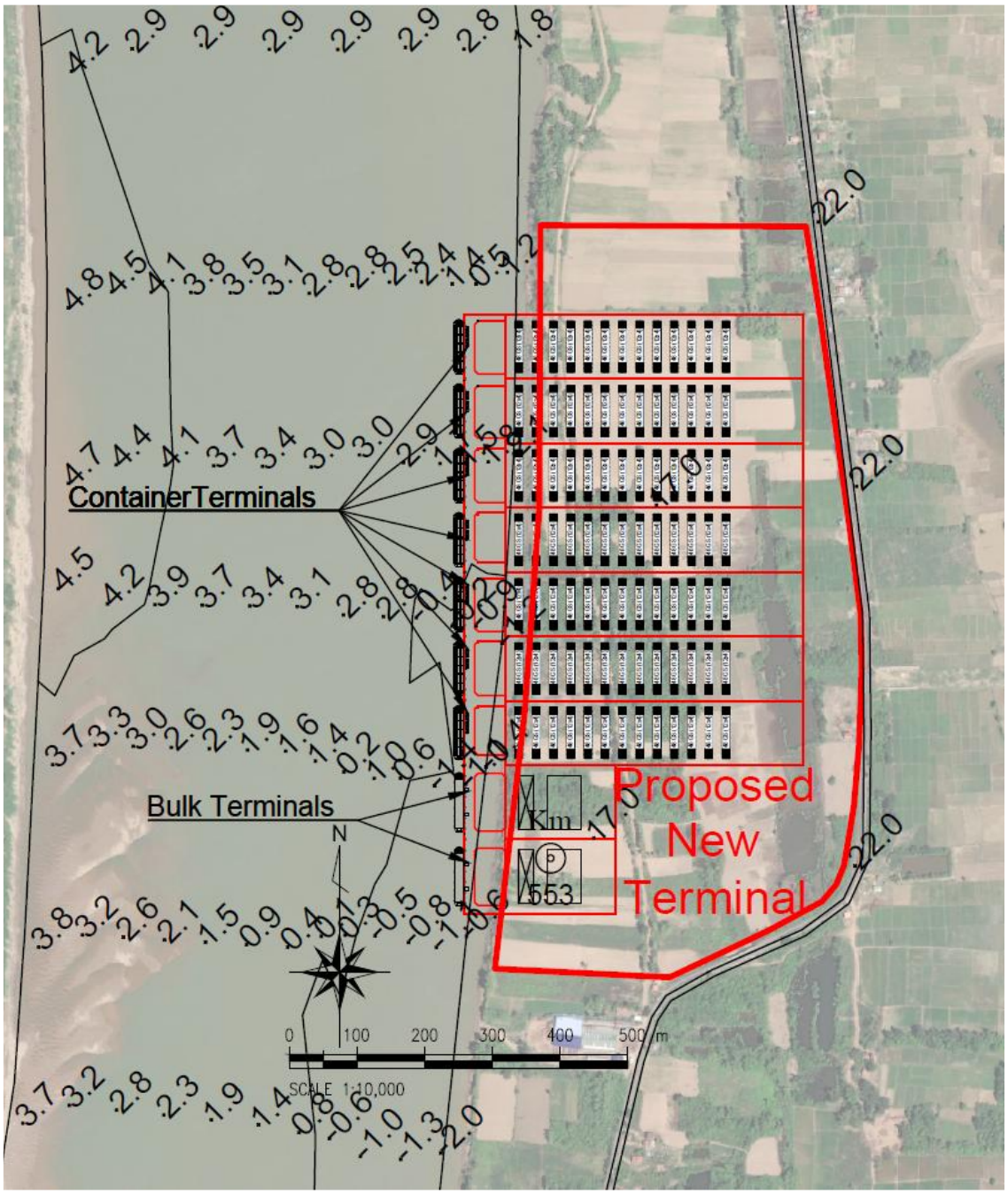
(a) Zone 4 Port



Note: The Implementing Agency will modify the number of Terminals (Container or Bulk) and associate Access Bridge, depending on the available land area and phased development plan.

Figure 8-18 Layout Plan of Proposed Port at Zone 4

(b) Zone 5 Port



Notes: 1) Since, at the time of this Reporting, the candidate port land plan for Zone 5 had not been finalized, the land plan for "Chhlong" is provisionally applied.
2) The Implementing Agency will modify the number of Terminals (Container or Bulk) and associate Access Bridge, depending on the available land area and phased development plan.

Figure 8-19 Layout Plan of Proposed Port at Zone 5

(5) Construction Cost

The rough construction cost for each terminal (per 1berth) is estimated and summarized in Table 8-12.

Table 8-12 Rough Construction Cost per terminal (1 Berth)

(1,000 US$)

No.	Facilities	Zone	Zone 4		Zone 5	
		Terminal	CC	Bulk	CC	Bulk
1	Wharf and Access Bridge		6,864	7,692	8,898	9,996
2	Pavement, Fence		3,536	1,122	3,536	1,122
3	Reclamation, Revetment		4,619	2,668	4,619	2,668
4	Cargo Handling Equipment, Scanner		5,430	1,146	5,070	1,146
5	Work Shop equipment, Building		630	1,883	630	1,883
6	Electric Supply, Lighting, Utilities		550	342	550	342
Sub Total			21,629	14,852	23,303	17,156
Contingency, Detail Design/Supervision/Site Investigation			7,700	5,287	8,296	6,108
Total			29,328	20,140	31,598	23,264

Notes 1) CC: Container Cargo Terminal, Bulk: Bulk (General) Cargo Terminal
2) Above cost shows per each terminal (1 berth)
3) Sub-soil conditions are assumption bases
4) The number and width of access bridges will be modified depend on the Phasing of the port development
5) Water depth and ground height are based on the rough information of river charts.

8.3 Total project cost estimation

The investment amount for container berths and bulk berths that handle public cargo was calculated as follows based on the conceptual design study. For container berths, the construction unit cost per berth was estimated to be US$29,328,000 (approximately 4.4 billion yen for 1 dollar = 150 yen) in Zone 4 and Zone 6 and US$31,598,000 (approximately 4.7 billion yen) in Zone 5.

For bulk berths, the construction unit cost per berth was estimated to be US$20,140,000 (approximately 3 billion yen) in Zoen 4 and Zone 6 and US$23,264,000 (approximately 3.5 billion yen) in Zone 5.

The unit cost of river cruise berth was estimated one-third of that of container river berth in Zone 4 and 6. In addition, the unit cost of cruise berth in Kampot is also considered to be the same as that of river cruise berth as the Kampot river port is located at the mouth of the river.

The unit cost of marine cruise berth was estimated 3.5 times longer than that of river cruise berth as the length of marine berth is 3.5 times longer than that of river cruise berth.

The unit cost of commuter berth was estimated US$ 6.0 million per berth, and that of fishery port was US$ 8.0 million respectively.

Table 8-13 Unit cost of construction of port facilities (per berth)

Unit cost		Zone	US$	Rate	JPY
Container	River berth	4,6	US$29,328,000	150	¥4,399,200,000
		5	US$31,598,000	150	¥4,739,700,000
	Marine berth	1	US$195,333,333	150	¥29,300,000,000
	Feeder berth		US$35,193,600	150	¥5,279,040,000
Bulk	River berth	4,6	US$20,140,000	150	¥3,021,000,000
		5	US$23,264,000	150	¥3,489,600,000
	Marine berth	1	US$103,333,333	150	¥15,500,000,000
	Feeder berth		US$24,168,000	150	¥3,625,200,000
Cruise	River berth	3,4,6	US$10,000,000	150	¥1,500,000,000
	Marine berth	1	US$35,000,000	150	¥5,250,000,000
	Kampot berth		US$10,000,000	150	¥1,500,000,000
Commuter	River berth	6	US$6,000,000	150	¥900,000,000
Fishery	Marine and River port	1,2,3,4,5,6	US$8,000,000	150	¥1,200,000,000

Based on this construction unit cost, the construction cost of each berth and total construction cost of each berth are calculated, resulting in a total of US$ 5.0 billion, with container berths of 4.2 billion and bulk berths of US$ 234 million.

Table 8-14 The total construction cost of container and bulk berths(agriculture)

Cost	Container			Bulk (Agriculture)		
Zone	Marine berth	Feeder berth	River berth	Marine berth	Feeder berth	River berth
1	US$2,539,333,333	US$703,872,000	US$0	US$103,333,333	US$24,168,000	US$0
2	US$0	US$0	US$0	US$0	US$0	US$0
3	US$0	US$0	US$0	US$0	US$0	US$0
4	US$0	US$0	US$146,640,000	US$0	US$0	US$40,280,000
5	US$0	US$0	US$315,980,000	US$0	US$0	US$46,528,000
6	US$0	US$0	US$527,904,000	US$0	US$0	US$20,140,000
Sub total	US$2,539,333,333	US$703,872,000	US$990,524,000	US$103,333,333	US$24,168,000	US$106,948,000
Sub total	US$4,233,729,333			US$234,449,333		

Cost	Cruise			Commuter	Fishery
Zone	River berth	Marine berth	Kampot berth	River berth	Marine and River port
1	US$0	US$35,000,000	US$100,000,000	US$0	US$16,000,000
2	US$0	US$0	US$0	US$0	US$24,000,000
3	US$50,000,000	US$0	US$0	US$0	US$48,000,000
4	US$10,000,000	US$0	US$0	US$0	US$32,000,000
5	US$0	US$0	US$0	US$0	US$40,000,000
6	US$80,000,000	US$0	US$0	US$18,000,000	US$48,000,000
Sub total	US$140,000,000	US$35,000,000	US$100,000,000	US$18,000,000	US$208,000,000
Sub total	US$275,000,000			US$18,000,000	US$208,000,000
Grand total	US$4,969,178,666				

In addition, regarding the opening of the channel, it is estimated that the draft of the target vessel will be 5.4 meters. The JICA expert team calculated the cost of excavation between Kratie - Kampong Cham and Kampong Cham - Phnom Penh. The total amount is US$210 million. Since the amount of sediment stagnation is unknown for each year's maintenance dredging, if we assume that 15% of the initial investment is the annual maintenance dredging cost, US$32 million per year will be required. In addition, the stretch between Stung Treng and Kratie cannot be calculated because the nautical chart is unknown. Although there are nautical charts are available in the stretch between Kampong Chhnang and Phnom Penh, the actual depth is unknown due to frequent dredging work in the stretch. However, like Lower Mekong, the cost is assumed to be almost zero.

Table 8-15 Construction costs associated with the opening of the route

Channel development and maintenance	Kratie - Kampong Cham	Kampong Cham - Phnom Penh	Total
Development cost	US$209,348,472	US$784,963	US$210,133,435
Maitenanace cost per year	US$31,402,271	US$117,744	US$31,520,015

As the study team estimated three cases of container demand forecast (base, high and low). Based on three cases, we calculate the berth development cost. Note that we estimate only one case for the bulk cargo as cargo volume estimation uncertainty of bulk is much more than that of container. In addition, we cannot estimate the cost of container or bulk cargo in case 3 as the geographic and hydraulic condition in the upper Mekong and Tonle Sap is not available.

Table 8-16 Sensitive cost analysis (2035/2050, Low/Base/High) in Case 2

(Unit: Billion US$)	2035			2050		
	Low	Base	High	Low	Base	High
Total cost (Case 2)	1.8	2.1	2.4	4.2	5.0	5.9
(Included Container berth cost)	1.2	1.5	1.8	3.5	4.2	5.2

Chapter-9 Strategic Environmental Assessment

9.1 Background and Objective

Strategic Environmental Assessment (SEA) is a systematic process for evaluating the potential environmental consequences of proposed development policies, plans, or programs, and is now a requirement under the Code on Environment and Natural Resources (2023). Its main purpose is to ensure that environmental and sustainability considerations are integrated early in the decision-making process, when broader alternatives and options are still open. This SEA has been undertaken to assess the environmental risks associated with the Port Zoning Plan, and to provide recommendations that will guide future port planning.

9.2 Outline of the Port Zoning Plan

Based on forecasted demand for containers, bulk cargo, cruise ships, and other cargo types, the Port Zoning Plan estimates the additional number of berths required in Cambodia by 2050. Estimates were prepared for the six predefined geographic zones (see Figure 9-1) under the following development scenarios:

- Scenario 1: Funan Techo Canal project is operational with improved land transportation and port operation.
- Scenario 2: Funan Techo Canal project is operational and inland navigational network is developed to accommodate large size barges (3,000 DWT barges to Stung Treng and 5,000 DWT barges to Tonle Sap Lake).

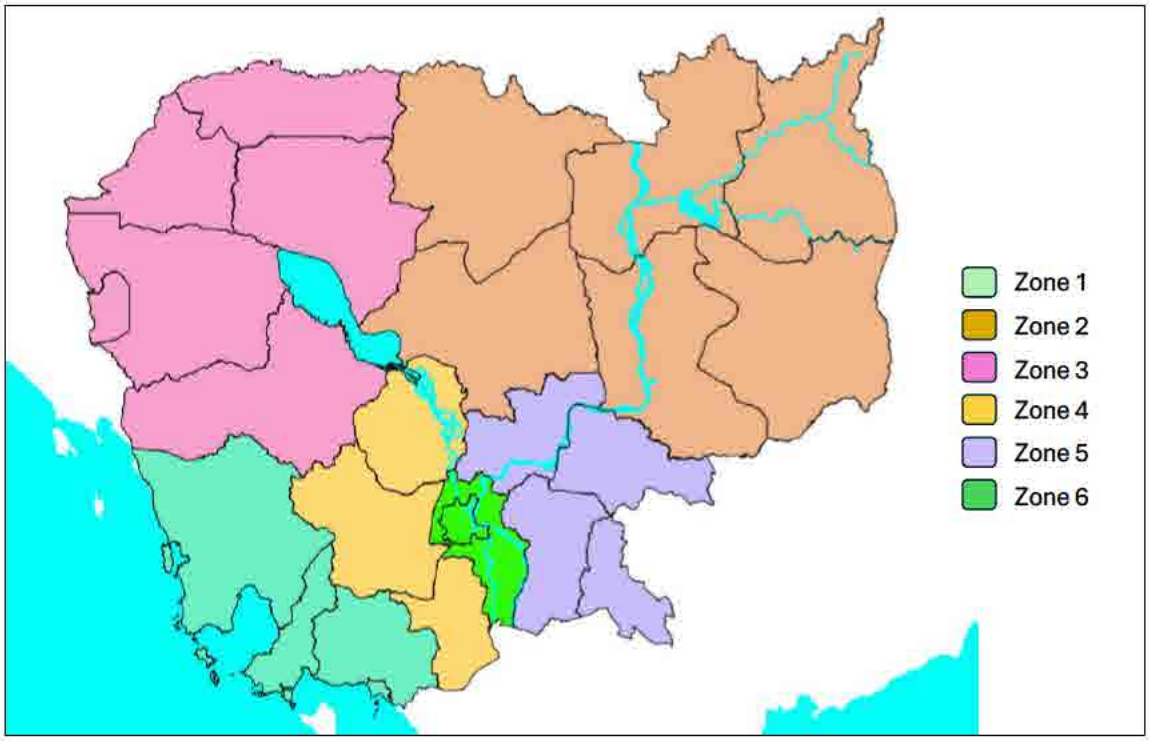


Figure 9-1 Six geographic zones

Table 9-1 and Table 9-2 show the estimated number of berths required in 2050 under Scenario 1 and 2 respectively.

Table 9-1 The estimated number of berths required in 2050 (Scenario 1)

Zone	Container (Number of berth)			Bulk (Number of berth)											
				Agriculture			Mineral resources			Energy (Liquid)			Energy (Solid)		
	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
1	13	20	-	1	1	-	2	7	-	3	3	-	2	-	-
2	-	-	0	-	-	0	-	-	0	-	-	0	-	-	-
3	-	-	0	-	-	0	-	-	0	-	-	0	-	-	-
4	-	-	5	-	-	2	-	-	0	-	-	1	-	-	-
5	-	-	10	-	-	2	-	-	7	-	-	1	-	-	-
6	-	-	18	-	-	1	-	-	0	-	-	2	-	-	-
Total	13	20	33	1	1	5	2	7	7	3	3	4	2	-	-

Zone	Cruise (Number of berth)			Commuter (Nember of berth)	Fishery (Number of port)
	Inland waterway	Seashore			
		PAS	Kampot		
1	-	1	10	-	2
2	-	-	-	-	3
3	5	-	-	-	6
4	1	-	-	-	4
5	-	-	-	-	5
6	8	-	-	3	6
Total	14	1	10	3	26

Table 9-2 The estimated number of berths required in 2050 (Scenario 2)

Zone	Container (Number of berth)			Bulk (Number of berth)											
				Agriculture			Mineral resources			Energy (Liquid)			Energy (Solid)		
	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port	Mother vessel berth	Feeder berth	River port
1	13	21	-	1	1	-	2	7	-	3	3	-	2	-	-
2	-	-	4	-	-	2	-	-	7	-	-	1	-	-	-
3	-	-	5	-	-	7	-	-	0	-	-	1	-	-	-
4	-	-	3	-	-	3	-	-	0	-	-	1	-	-	-
5	-	-	7	-	-	7	-	-	0	-	-	1	-	-	-
6	-	-	16	-	-	4	-	-	0	-	-	2	-	-	-
Total	13	21	35	1	1	23	2	7	7	3	3	6	2	-	-

Zone	Cruise (Number of berth)			Commuter (Nember of berth)	Fishery (Number of port)
	Inland waterway	Seashore			
		PAS	Kampot		
1	-	1	10	-	2
2	-	-	-	-	3
3	5	-	-	-	6
4	1	-	-	-	4
5	-	-	-	-	5
6	8	-	-	3	6
Total	14	1	10	3	26

9.3 National environmental policies, strategies and plans

This section provides an overview of national environmental policies, strategies, and plans that are relevant to the port sector:

- **National Environment Strategy and Action Plan (NESAP) 2016–2023**

The NESAP provides a roadmap for balancing environmental conservation with the sustainable use of natural resources, outlining 70 specific activities under four key strategies. Port-sector–related activities include:

- Strengthening intersectoral collaboration for oil and hazardous cargo spill prevention and response
- Enhancing organizational and human capacity for environmental impact assessment
- Improving chemical and hazardous waste management

- **National Protected Area Strategic Management Plan (NPASMP) 2017–2031**

The NPASMP sets out strategies and activities for effective planning and management of the country's protected areas, prioritizing the establishment of protected areas in marine, coastal, and wetland regions.

- **National Biodiversity Strategy and Action Plan (NBSAP) 2016–2020**

Formulated under the Convention on Biological Diversity, the NBSAP includes 37 specific activities under four key strategies. Port-sector–related issues addressed include oil spill pollution, coastal erosion, invasive species introduction, and ecosystem degradation.

- **Cambodia Climate Change Strategic Plan 2014–2023**

The plan outlines national goals and strategies to address climate change, with a key objective of transitioning toward a low-carbon society.

- **Cambodia's Updated Nationally Determined Contribution (NDC) 2020**

The updated NDC aims for a 41.7% reduction in greenhouse gas emissions by 2030 compared to a business-as-usual scenario. It also presents mitigation and adaptation measures, including MPWT-related initiatives such as promoting an integrated public transport system and shifting freight from trucks to rail.

- **National Strategic Plan on Green Growth 2013–2030**

Based on the 2013 National Policy on Green Growth, this strategy promotes sustainable development, emphasizing green transportation and infrastructure development as part of MPWT-related activities.

9.4 Relevant national environmental legislation

The Environment and Natural Resources Code, a comprehensive environmental law with a high level of regulatory responsibility, was enacted in 2023 and came into effect in 2024. The Code covers a wide range of areas, including environmental assessment, waste and pollution management, coastal management, and biodiversity conservation. Its enactment is expected to fundamentally strengthen the Cambodian government's environmental administration, requiring corresponding compliance measures in the port sector. Port-related provisions of the Code include:

- Public participation and information disclosure in development planning
- Implementation of Strategic Environmental Assessments (SEA) in development planning
- Review of coastal development plans by the National Committee on Coastal Area Management and Development (NCCMD)
- Prohibition of development activities that result in the loss or damage of coral reefs, seagrass beds, and mangroves
- Establishment of a legal framework to prevent and mitigate pollution from ship sewage and discharges

The Waterway Transport Law was enacted in 2024, which has the following provisions on environment under Section 5 of Chapter 10.

- Article 212: A port shall have a port reception facility for ship waste.
- Article 213: A port shall have a contingency plan for response to oil spills or hazardous substances within the port.

9.5 Environment and social status

9.5.1 Upper Mekong River

(1) Ecosystem

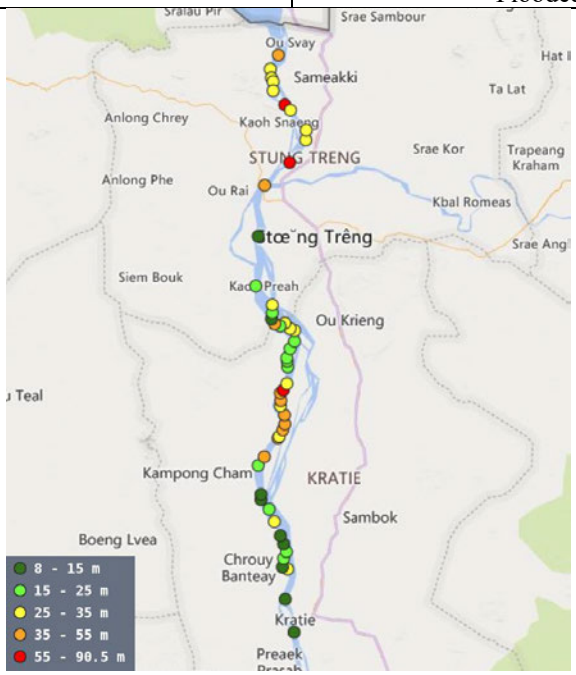
The Mekong River flows from the north of the country (near the border with Laos) to the south, connecting with the Tonle Sap River and the Mekong Delta in Vietnam. The upper reaches of the river, including Kratie and Stung Treng provinces, still maintain a diverse range of habitats, including flooded forests, seasonal wetlands, sandbars, islands, and deep pools. Figure 9-2 shows the representative habitats in the upper Mekong River.



Sandbar/islands



Flooded forest



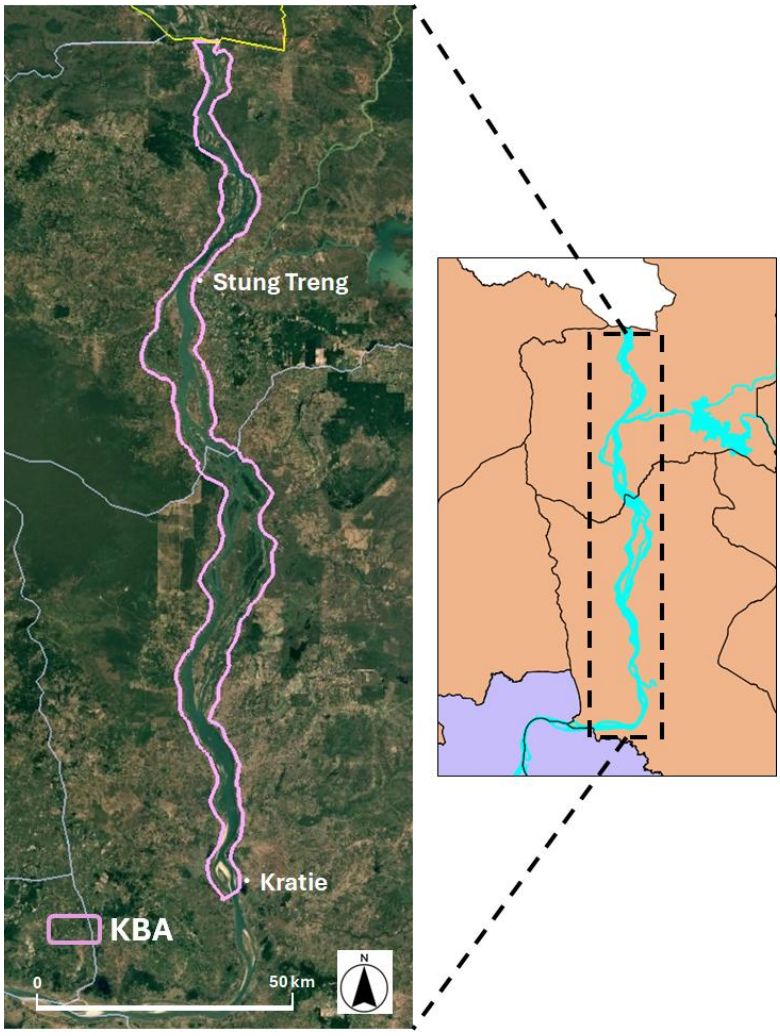
Deep pool distribution

Source: MRC Data Portal

Figure 9-2 Representative habitats in the upper Mekong River

The river's water level fluctuates significantly with the seasons. During the rainy season, the river rises, flooding large areas of floodplain forests and surrounding lowlands, creating important

spawning and nursery grounds for fish and aquatic organisms. Meanwhile, during the dry season, the water level drops, and the deep pools serve as important refuges for river dolphins and other fish. This dynamic and diverse aquatic environment supports a diverse range of flora and fauna, including rare species of freshwater fish, amphibians, waterfowl, and mammals. This makes the region particularly biodiverse within the Mekong River, and due to its ecological importance has been internationally designated as a Key Biodiversity Area (KBA). Figure 9-3 shows the KBA of the upper Mekong River.



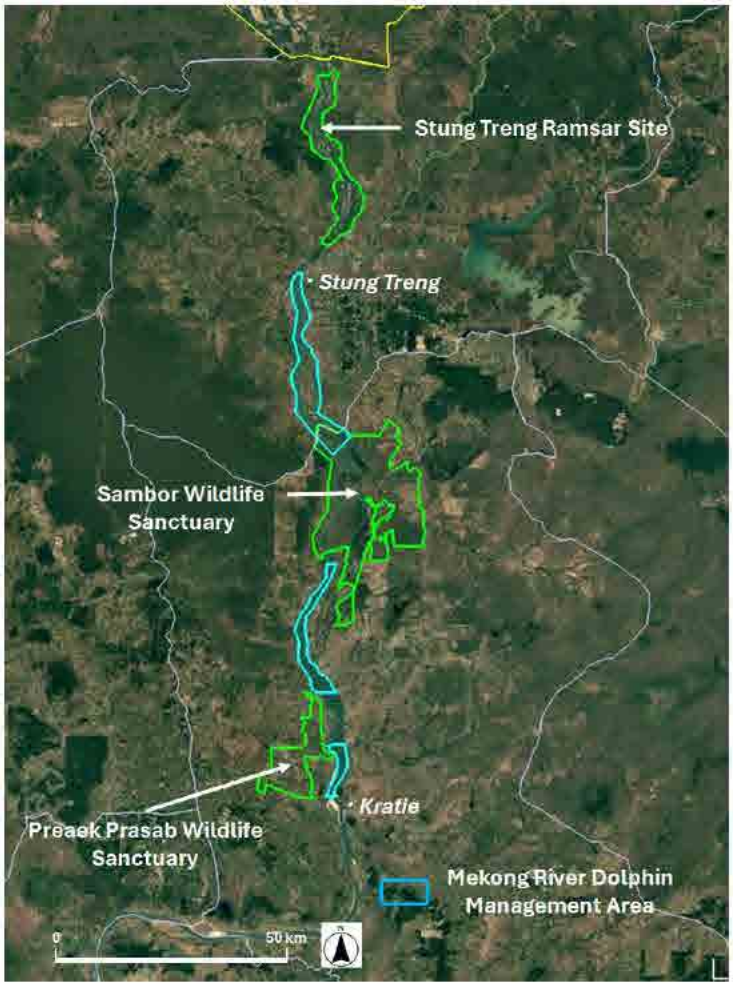
Source: Open Development Cambodia (prepared with Google Earth)

Figure 9-3 KBA of the upper Mekong River

(2) Protected area

The upper Mekong River includes several key conservation areas. Three protected areas (Stung Treng Ramsar Site, Sambor Wildlife Sanctuary, and Preaek Prasab Wildlife Sanctuary) have been designated by the Ministry of Environment (MoE), while a dolphin sanctuary (the Mekong River Dolphin Management Area) has been designated by the Ministry of Agriculture, Forestry and

Fisheries (MAFF). Figure 9-4 shows the distribution of the protected areas within the upper Mekong River.



Name	Established year	Area (ha)	Legislation
Stung Treng Ramsar Site	1999	14,600	Sub-Decree No. 164
Sambor Wildlife Sanctuary	2018	50,093	Sub-decree No. 129
Preaek Prasab Wildlife Sanctuary	2018	12,770	Sub-decree No. 128
Mekong River Dolphin Management Area	2023	62,100	Sub-decree No. 47

Source: Open Development Cambodia (prepared with Google Earth)

Figure 9-4 Protected areas in the upper Mekong River

(3) Threatened species

According to the Information Sheet on the Stung Treng Ramsar Site, a total of 20 fauna species within the site are classified as threatened under the IUCN Red List, including eight fish, two reptiles, seven birds, and three mammals. Among these, five species (two fish, two reptiles, and one mammal) are also listed as threatened under Cambodian national law (Sub-Decree No. 123), underscoring the site's significance as a habitat for rare species of both international and national

importance. Furthermore, the endangered and iconic Irrawaddy dolphin (*Orcaella brevirostris*) serves as an important ecotourism attraction and holds substantial cultural and economic value for the local communities. Table 9-3 is a list of threatened species recorded in the Stung Treng Ramsar site.

Table 9-3 List of threatened species recorded in the Stung Treng Ramsar site

	Common name	Scientific name	IUCN Redlist	Sub-decree 123*
Fish	Giant Mekong Catfish	*Pangasianodon gigas*	CR	CR
	Small Scaled Mud Carp	*Cirrhinus microlepis*	VU	-
	-	*Hypsibarbus lagleri*	VU	-
	-	*Mystus bocourti*	VU	-
	Elephant Ear Gourami	*Osphronemus exodon*	VU	EN
	Pangasid-catfish	*Pangasius sanitwongsei*	CR	-
	Yellow Tail Brook Barb	*Poropuntius deauratus*	EN	-
	Mekong herring	*Tenualosa thibaudeaui*	VU	-
Reptiles	Siamese Crocodile	*Crocodylus siamensis*	CR	VU
	Asiatic Softshell Turtle	*Amyda cartilaginea*	VU	VU
Bird	Green Peafowl	*Pavo muticus*	EN	-
	White-winged Duck	*Cairina scutulata*	CR	-
	Masked Finfoot	*Heliopais personatus*	CR	-
	White-rumped Vulture	*Gyps bengalensis*	CR	-
	Long-billed Vulture	*Gyps indicus*	CR	-
	Red-headed vulture	*Sarcogyps calvus*	CR	-
	White-shouldered Ibis	*Pseudibis davisoni*	CR	-
Mammals	Eld's Deer	*Rucervus eldii*	EN	-
	Irrawaddy Dolphin	*Orcaella brevirostris*	EN	CR
	Smooth-coated Otter	*Lutrogale perspicillata*	VU	-

* National list of endangered fishery taxa in Cambodia

Source: Information Sheet of Stung Treng Ramsar site and Sub-decree 123

9.5.2 Tonle Sap Lake/River

(1) Hydrology

Tonle Sap Lake, the largest freshwater lake in Southeast Asia, is connected to the Mekong River system through the Tonle Sap River, which serves as its only inlet and outlet. The lake's water level fluctuates significantly with the seasonal hydrological cycle. During the rainy season (May to October), the Tonle Sap River reverses its flow, carrying water back into the lake. As a result, the water level rises to around 10 meters, and the lake expands to over 15,000 km², creating an extensive floodplain around its margins. In contrast, during the dry season (November to April), the flow direction returns toward the Mekong River, the water level drops below 2 meters, and the lake area contracts to approximately 2,500 km². Table 9-4 shows the hydrological features of the Tonle Sap Lake.

Table 9-4 Hydrological features of the Tonle Sap Lake

	Dry season	Wet season
Water surface area (km2)	Approx. 2,500	Approx. 15,278
Length (km)	Approx. 120	Approx. 250
Width (km)	3-35	Approx. 100
Depth (m)	<2	<11
Volume (million m3)	1,300	8,000
Average rainfall (mm/year)	1,300-1,500	
Discharge	380-8,176 (outflow)	104-7,032 (inflow)

Source: Water and Life in Tonle Sap Lake (2022)

At the junction between Tonle Sap Lake and the Tonle Sap River, there is a broad sandbar, locally known as the "bottleneck" (see Figure 9-5). This natural formation functions as a natural dam, helping to maintain the lake's water level during the dry season.

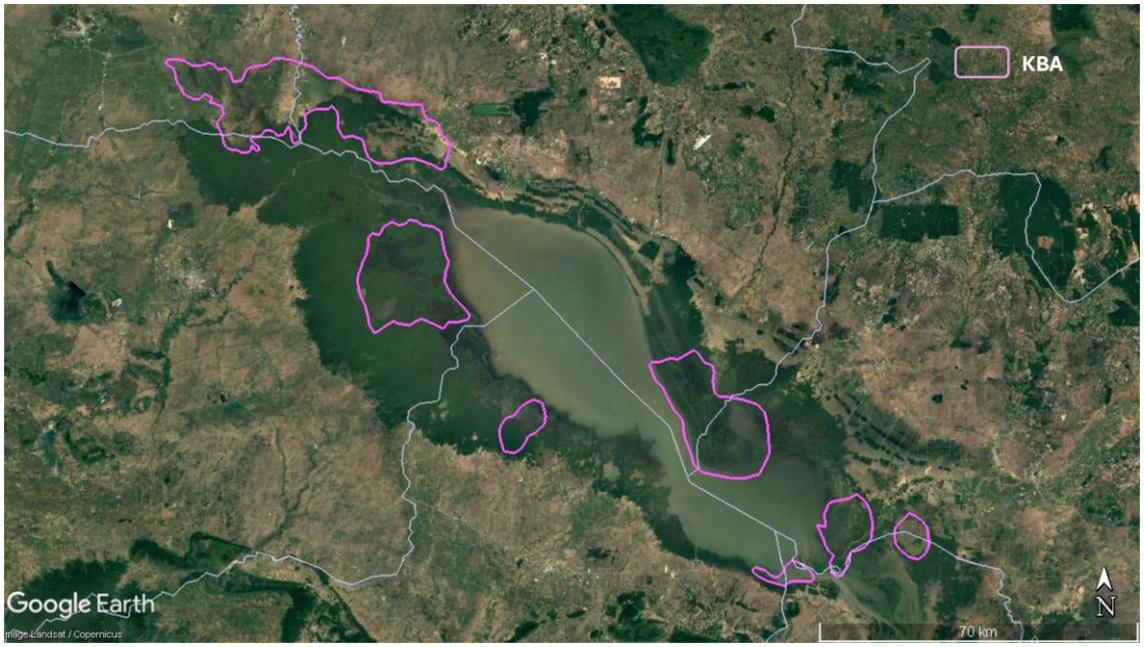


Source: Water and Life in Tonle Sap Lake (2022)

Figure 9-5 Broad sandbar at the junction between Tonle Sap Lake and Tonle Sap River

(2) Ecosystem

The area surrounding Tonle Sap Lake forms a mosaic of diverse habitats, including flooded forests, shallow water zones, wetlands, and agricultural land. These habitats serve as nursery and breeding grounds for a wide variety of aquatic and terrestrial species, such as fish, birds, and reptiles. Numerous endangered species have also been recorded in the region, and owing to its high ecological significance, a broad area around the lake has been designated as a KBA. Figure 9-6 shows the KBAs in the Tonle Sap Lake area.



Source: Open Development Cambodia (prepared with Google Earth)

Figure 9-6 KBAs in the Tonle Sap Lake area

A total of 167 fish species have been confirmed in Tonle Sap Lake, primarily belonging to the Cypriniformes, Siluriformes, and Perciformes. These species can be broadly categorized into two groups: migratory species, which move seasonally between the lake and the Mekong River, and sedentary species, which remain within the lake year-round. Migratory species swim upstream from the Mekong River to Tonle Sap Lake during the rainy season, where they spawn and grow in flooded forests, before returning to the Mekong River in the dry season. Sedentary species inhabit the lake and surrounding wetlands and waterways throughout the year, forming a group adapted to the unique environmental conditions of Tonle Sap Lake. The lake also supports numerous large waterfowl, including storks, pelicans, and ibises, which are particularly abundant during the dry season, when lower water levels make prey more accessible. Table 9-5 shows the threatened species recorded in the Tonle Sap Lake area.

Table 9-5 List of threatened species recorded in the Tonle Sap Lake

	Common name	Scientific name	IUCN Red List	Sub-decree 123*
Fish	Giant Mekong Catfish	*Pangasianodon gigas*	CR	CR
	-	*Glyptothorax fuscus*	LC	EN
	Goonch	*Bagarius yarrelli*	VU	VU
	Giant Carp	*Catlocarpio siamensis*	CR	CR
	Thinlip barb	*Probarbus labeaminor*	NT	CR
	Thicklipped Barb	*Probarbus labeamajor*	EN	CR
	Jullien's Golden Carp	*Probarbus jullieni*	CR	CR
	Mekong herring	*Tenualosa thibaudeaui*	VU	-
Reptiles	Siamese Crocodile	*Crocodylus siamensis*	CR	VU
	Yellow-headed Temple Turtle	*Heosemys annandalii*	CR	EN
Bird	Milky stork	*Mycteria cinerea*	EN	-
	Sarus crane	*Grus antigone*	VU	-
	Masked Finfoot	*Heliopais personatus*	CR	-
	Bengal Florican	*Houbaropsis bengalensis*	CR	-
	White-shouldered ibis	*Pseudibis davisoni*	CR	-

* National list of endangered fishery taxa in Cambodia

Source: Water and Life in Tonle Sap Lake (2022)

(3) Protected area

The floodplain of Tonle Sap Lake was designated as the Tonle Sap Biosphere Reserve (TSBR) by royal decree in 2001. Within this reserve, three sites—Prek Toal, Boeng Chhmar, and Stung Sen—have been designated as Ramsar wetlands by MoE, corresponding to the reserve's core zones. Figure 9-7 shows the distribution of protected areas around Tonle Sap Lake.



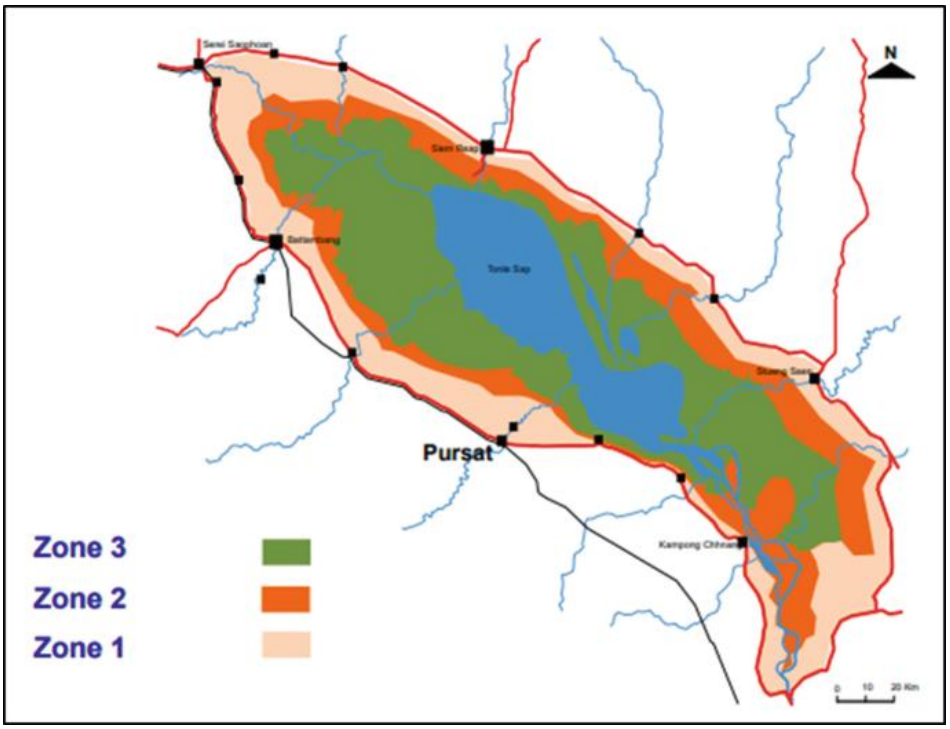
Name	Established year	Area (ha)	Legislation
Prek Toal Ramsar Site	2015	21,342	Sub-decree No. 139
Boeung Chhmar Ramsar Site	1999	28,000	-
Stung Sen Ramsar Site	2018	9,293	Sub-decree No. 151
Tonle Sap Biosphere Reserve	2001	316,250	Royal decree No.

Source: Open Development Cambodia (prepared with Google Earth)

Figure 9-7 Protected areas in the Tonle Sap Lake

(4) Land use zoning

To support flooded forest conservation and sustainable land-use management, the area surrounding Tonle Sap Lake has been divided into three management zones: Zone 1 (395,578 ha), Zone 2 (369,865 ha), and Zone 3 (647,406 ha). Agriculture and other subsistence activities are permitted in Zones 1 and 2, whereas agriculture and fishing are strictly prohibited in Zone 3, in accordance with Decree No. 197. These zonings are administered by the Tonle Sap Authority (TSA), with coordination from relevant ministries and provincial government agencies. Figure 9-8 shows the land use zoning around the Tonle Sap Lake.



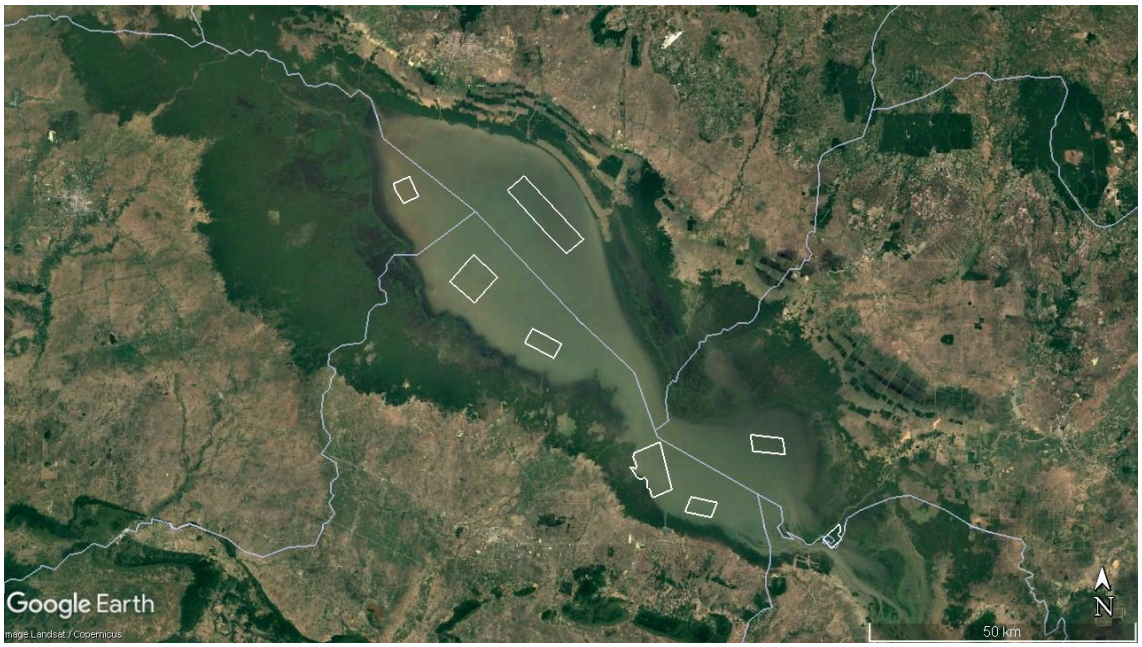
Source: Water and Life in Tonle Sap Lake (2022)

Figure 9-8 Land use zoning around the Tonle Sap Lake

(5) Fisheries

Approximately 1.7 million people live around Tonle Sap Lake, the majority of whom rely on fishing for their livelihoods. Annual fish catches range from 300,000 to 400,000 tons, representing roughly 60% of Cambodia's total freshwater fish production. Key target species include catfish, snakeheads, and carp, which are typically caught using gillnets and fixed nets.

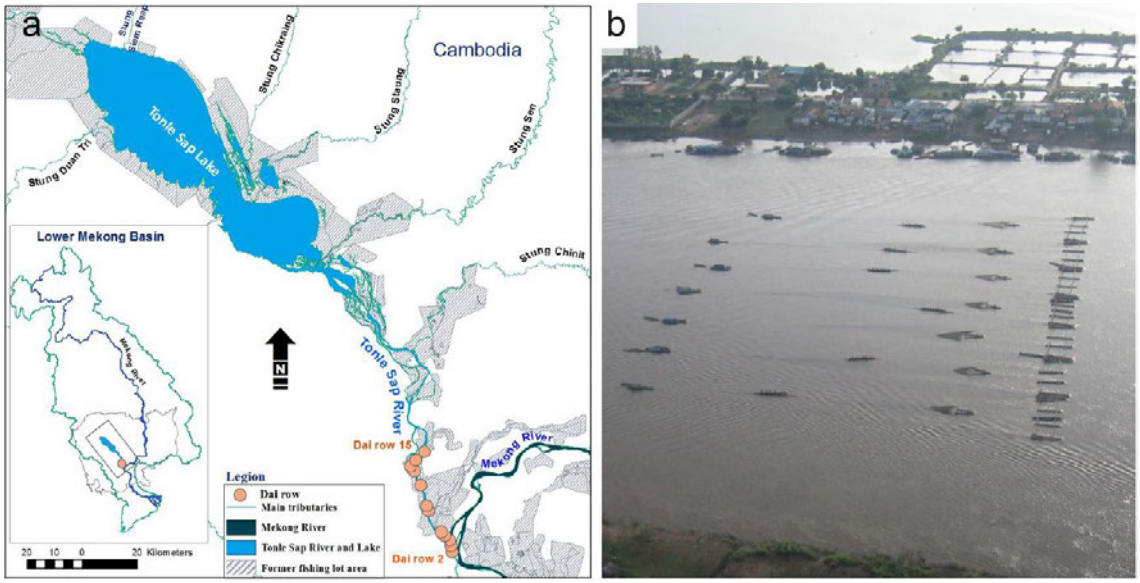
To protect critical fish habitats and breeding grounds, eight Fish Conservation Areas (FCAs) were established in 2013. These FCAs primarily focus on deep pools, where adult fish gather during the dry season, when water levels drop significantly, providing essential refuges for resident fish. Collectively, the eight FCAs cover approximately 24,000 hectares, equivalent to about 10% of Tonle Sap Lake's surface area during the dry season. Figure 9-9 shows the FCAs in the Tonle Sap Lake.



Source: Open Development Cambodia (prepared with Google Earth)

Figure 9-9 FCAs in the Tonle Sap Lake (white squares)

In the lower reaches of the Tonle Sap River, particularly between Phnom Penh and Kandal Province, large-scale trap net fishing (commonly referred to as Dai fishing) is conducted during the dry season (typically from December to February) to capture migratory fish moving from Tonle Sap Lake to the Mekong River. The nets are positioned across the river, with the current guiding fish into the traps. The primary species caught are *Cirrhinus* spp., which are commonly processed into fish paste products.



Source: PB Ngor et al. (2018)

Figure 9-10 Dai fishing areas (left) and positioned fishing nets (right)

9.5.3 Coastal area

(1) Ecosystem

Cambodia's coastal areas host a variety of ecosystems, including coral reefs, seagrass beds, mangrove forests, and tidal flats. These ecosystems support high biodiversity and serve as important spawning and nursery grounds for numerous species. However, population growth, coastal development, and pollution have led to the rapid loss and degradation of these marine ecosystems in recent decades. For instance, approximately 40% of mangrove forests were lost between 1987 and 2017[129]. In response to this critical situation, the Environmental Code (Article 633), enacted in 2023, prohibits, in principle, large-scale development in areas containing coral reefs, seagrass beds, and mangrove forests.

(2) Protected area

In the coastal areas, six protected areas have been designated by the MoE, and two areas have been designated by the MAFF. Figure 9-11 and Figure 9-12 show the distribution and overview of the protected areas designated by the MoE and MAFF, respectively.

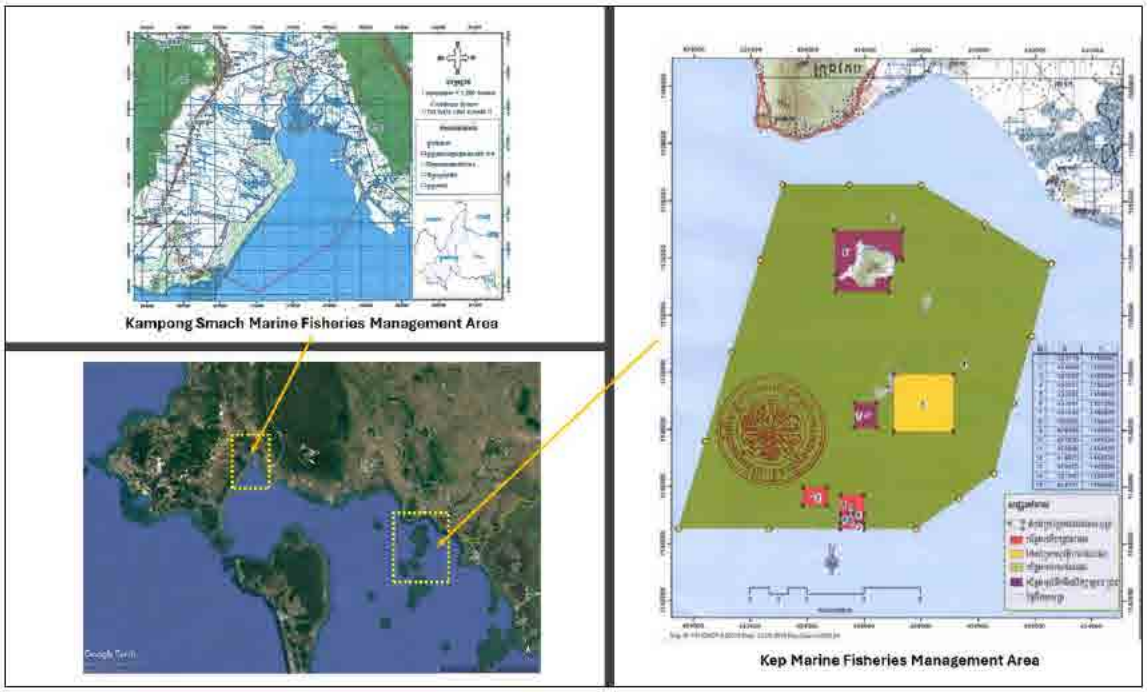


	Name	Established year	Area (ha)	Legislation
1	Peam Krasop Wildlife Sanctuary	1993	23,750	Royal decree
2	Koh Kapik and Associated Islets	1999	12,000	Royal decree
3	Botum Sakor National Park	1993	171,250	Royal decree
4	Koh Rong Marine National Park	2018	52,498	Sub-decree no.188
5	Ream National Park	1993	15,000	Royal decree
6	Kep National Park	1993	1,152	Sub-decree no.138

Source: Open Development Cambodia (prepared with Google Earth)

Figure 9-11 MoE designated protected areas in the coastal area

[129] Veettil et al., 2019



	Name	Established year	Area (ha)	Legislation
1	Kep Marine Fisheries Management Area	2018	10,412	Praka no. 193
2	Kampong Smach Marine Fisheries Management Area	2022	10,923	Praka no. 504

Source: Open Development Cambodia (prepared with Google Earth)

Figure 9-12 MAFF designated protected areas in the coastal area

9.6 Environmental risk

9.6.1 Risks associated with the expansion of inland navigational network

Under the development Scenario 2, the current inland navigation network will undergo substantial expansion including up to the upper Mekong River and Tonle Sap Lake area, with a design channel depth and width of around -5 m and 80 m respectively. Such channel development will entail significant capital and maintenance dredging, especially in areas where the dry-season water level is relatively low such as in the upper Mekong River (especially between Kratie and Stung Treng) and Tonle Sap Lake areas. Potential environmental risks of channel development are discussed below focusing on these two areas:

(1) Upper Mekong River

The Upper Mekong River (between Kratie and Stung Treng) has a highly complex morphology, characterized by multiple braided channels, numerous islands and sandbars, and several deep-pool sections. Extensive channel development in such complex and shallow environment could substantially alter the river's natural flow pattern, potentially leading to significant environmental and social impacts if not carefully planned and implemented. The main environmental risks of channel development are as follows:

- Channel development may increase flow velocities in specific sections of the river, which may enhance erosion of the riverbank.
- Channel development may indirectly degrade critical habitats (e.g. flooded forest, deep pools, sandbars) and protected areas (e.g. Stung Treng Ramsar Site), for instance, through reduction of river surface area. Figure 9-13 is a conceptual illustration of the potential changes in the river surface area before and after channel development. Note that after channel development, the river surface area is reduced as the flow becomes concentrated in the deepened channel.

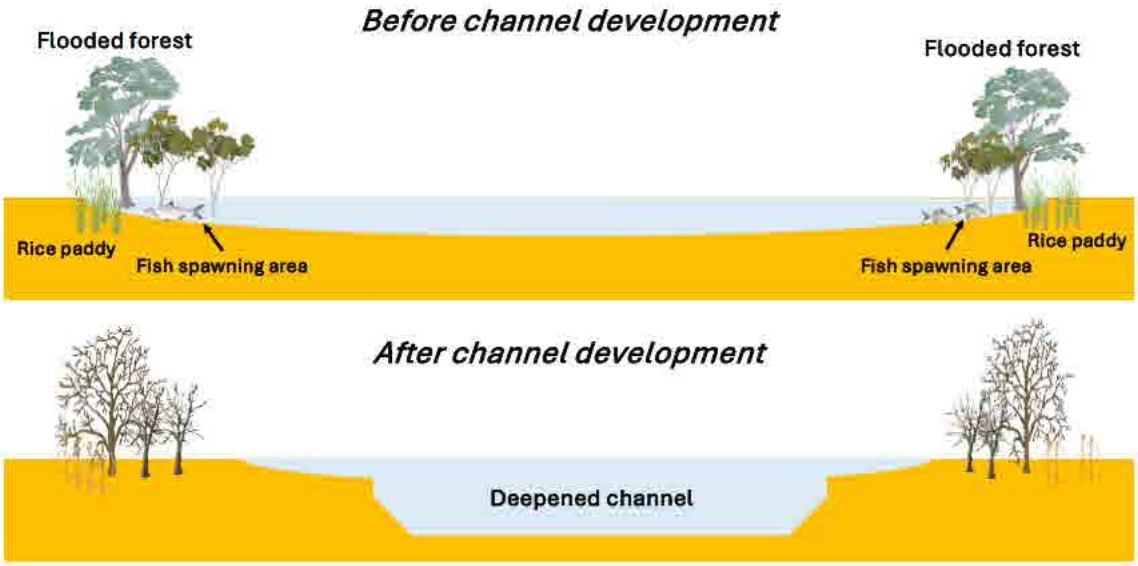


Figure 9-13 Conceptual illustration of potential changes in the river surface area before (above) and after (below) channel development

- Channel development may affect sensitive species such as the endangered Irrawaddy dolphin.
- Channel development may affect the local communities, especially those whose livelihoods depend on fisheries, water-based tourism, and agriculture.

(2) Tonle Sap Lake

Channel development in the Tonle Sap Lake may affect the lake's natural flow dynamics, particularly through the dredging of the broad sandbar located at the junction between the Tonle Sap Lake and the Tonle Sap River (see Figure 9-5). The sandbar functions as a natural dam, playing a crucial role in maintaining the lake's minimum water level during the dry season. Therefore, its modification by channel development could lead to a reduction in the lake's water level and surface area during the dry season, as water would more readily flow out toward the Tonle Sap River (a conceptual image of this process is depicted in Figure 9-14). This in turn could potentially harm the lake ecosystems and local communities that are adapted to the established hydrological rhythms.

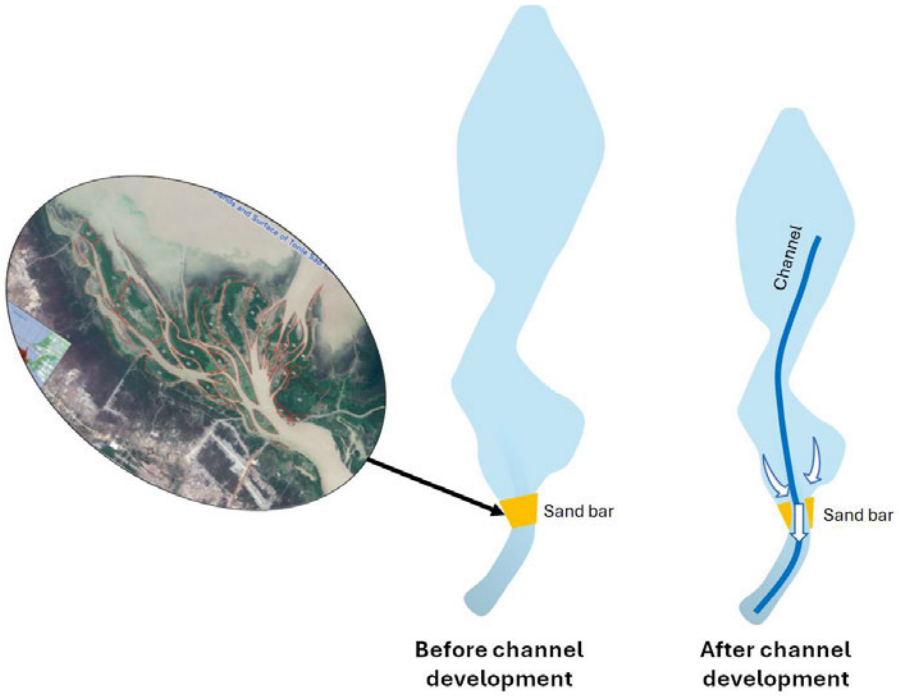


Figure 9-14 Conceptual image of lake's surface area changes before and after channel development

9.6.2 Risks associated with port development

Table 9-6 shows the main environmental risks of port development in each zone under Scenarios 1 and 2. The main findings of the risk assessment are outlined as follows:

- The environmental risks in Zone 1 (coastal area) are similar between Scenarios 1 and 2, as the required scale of port development is nearly the same under both scenarios. Nevertheless, the overall environmental risks remain high due to the following factors:
  - Zone 1 will require extensive port development, which may lead to substantial loss and degradation of ecologically sensitive areas—such as coral reefs, seagrass beds, mangrove forests, and protected areas—distributed along the coastline.
  - Zone 1 will involve the export of mineral resources (e.g., bauxite, iron ore) by bulk carriers, which may introduce invasive species through ballast water discharge.
  - Zone 1 will involve the import and handling of liquid energy (e.g., fuel oil), increasing the risk of major oil spills.
  - A wide range of international and domestic vessels will operate in Zone 1, potentially causing water pollution from uncontrolled discharges of ship-generated wastewater.
- The environmental risks in Zones 2 and 3 differ significantly between Scenarios 1 and 2. Scenario 2 poses considerably higher risks for both zones, as it is likely to involve port development and operations in ecologically sensitive areas such as the upper Mekong River (Zone 2) and Tonle Sap Lake (Zone 3).

- The environmental risks in Zones 4, 5, and 6 for both scenarios are relatively lower than those in Zones 1 to 3, primarily because these areas do not contain notable ecologically sensitive zones.

Table 9-6 Environmental risks of port development

Zone	Scenario 1	Scenario 2
1	**[Port development]** Container (13M, 20F), Agriculture (1M, 1F), Mineral (2M, 7F), Liquid energy (3M, 3F), Solid energy (2M), Cruise (11), Fishery (2) **[Potential environmental risks]** ● Loss and degradation of important coastal ecosystems and protected areas ● Introduction of invasive species through incoming international vessels (e.g. exporting mineral bulk carriers) ● Water pollution due to uncontrolled discharge of ship wastewater ● Oil spill from liquid bulk carriers and oil handling facilities **[Overall environmental risks]** High	**[Port development]** Container (13M, 21F), Agriculture (1M, 1F), Mineral (2M, 7F), Liquid energy (3M, 3F), Solid energy (2M), Cruise (11), Fishery (2) **[Potential environmental risks]** ● Similar to Scenario 1 **[Overall environmental risks]** High
2	**[Port development]** Fishery (3) **[Potential environmental risks]** No notable risk **[Overall environmental risks]** Low	**[Port development]** Container (4R), Agriculture (2R), Mineral (7R), Liquid energy (1R), Fishery (3) **[Potential environmental risks]** ● Loss and degradation of important river ecosystems and protected areas ● Oil spill from liquid bulk carriers and oil handling facilities ● Water pollution due to uncontrolled discharge of ship wastewater **[Overall environmental risks]** High
3	**[Port development]** Cruise (3), Fishery (6) **[Potential environmental risks]** ● Water pollution due to uncontrolled discharge of ship wastewater **[Overall environmental risks]** Low	**[Port development]** Container (5R), Agriculture (7R), Liquid energy (1R), Cruise (3), Fishery (6) **[Potential environmental risks]** ● Loss and degradation of important river/lake ecosystems and protected areas ● Oil spill from liquid bulk carriers and oil handling facilities ● Water pollution due to uncontrolled discharge of ship wastewater **[Overall environmental risks]** High
4	**[Port development]**	**[Port development]**

Zone	Scenario 1	Scenario 2
	Container (5R), Agriculture (2R), Liquid energy (1R), Cruise (1), Fishery (4) **[Potential environmental risks]** ● Oil spill from liquid bulk carriers and oil handling facilities ● Water pollution due to uncontrolled discharge of ship wastewater **[Overall environmental risks]** Moderate	Container (3R), Agriculture (3R), Liquid energy (1R), Cruise (1), Fishery (4) **[Potential environmental risks]** ● Similar to Scenario 1 **[Overall environmental risks]** Moderate
5	**[Port development]** Container (10R), Agriculture (2R), Mineral (7R), Liquid energy (1R), Fishery (5) **[Potential environmental risks]** ● Oil spill from liquid bulk carriers and oil handling facilities ● Water pollution due to uncontrolled discharge of ship wastewater **[Overall environmental risks]** Moderate	**[Port development]** Container (7R), Agriculture (7R), Liquid energy (1R), Fishery (5) **[Potential environmental risks]** ● Similar to Scenario 1 **[Overall environmental risks]** Moderate
6	**[Port development]** Container (18R), Agriculture (1R), Liquid energy (2R), Cruise (4), Fishery (6) **[Potential environmental risks]** ● Oil spill from liquid bulk carriers and oil handling facilities ● Water pollution due to uncontrolled discharge of ship wastewater **[Overall environmental risks]** Moderate	**[Port development]** Container (16R), Agriculture (4R), Liquid energy (2R), Cruise (4), Fishery (6) **[Potential environmental risks]** ● Similar to Scenario 1 **[Overall environmental risks]** Moderate

M: Mother vessel berth, F: Feeder berth, R: River port

9.7 Conclusion and recommendations

(1) Implementation of a comprehensive environmental and social impact assessment study of the inland navigational network

Development of the inland navigation network under Scenario 2 may have serious adverse impacts on the natural and social environment. In particular, channel deepening in the upper Mekong River and Tonle Sap Lake areas may significantly modify the existing hydrological regime of rivers and lakes, leading to cascading secondary impacts on sensitive ecosystems and local communities in the region. Therefore, it is strongly recommended to conduct a comprehensive Environmental and Social Impact Assessment (ESIA) of the inland navigation network prior to planning of new ports in the upper Mekong River and Tonle Sap Lake areas, and alternative development scenarios should be considered in case channel development is likely to

cause irreversible environmental and social impacts. An outline of the proposed ESIA is as follows:

- **Study area:** Upper Mekong River and Tonle Sap Lake/River
- **Study method:**
  - Mapping of environmental and social features along the study area such as land/water use, infrastructures, sensitive ecosystems/species, protected areas and so on.
  - Assessment of environmental and social impacts of channel deepening through development and application of hydrodynamic model
  - Stakeholder and public consultations

(2) Implementation of Strategic Environmental Assessment

Port development may have significant environmental impacts, particularly if the planned site is located in or near ecologically sensitive areas, such as those in Zones 1 to 3. Therefore, in accordance with the "Guiding Principles for Port Development Planning" and the "Environment and Natural Resources Code," it is recommended to conduct a Strategic Environmental Assessment (SEA) at the initial port planning stage. The SEA should include a comparison and analysis of multiple alternative site options to identify the least environmentally damaging and most sustainable development approach.

(3) Strengthening of ship pollution control

Although Cambodia has ratified the MARPOL Convention (Annex I–V), it does not yet conduct ship inspections as required under the convention. As a result, many domestic and foreign vessels may be operating without full compliance, potentially causing water pollution through uncontrolled wastewater discharge (e.g. bilge water, sewage) which may become more serious in line with the anticipated increase in vessel traffic. To address these risks, Cambodia should promptly establish and strengthen its ship inspection system through the following initiatives:

- **Establishing a legal framework:** Building on the Waterway Transport Law (2024), implementing regulations should be developed to ensure full alignment with the requirements of international conventions.
- **Strengthening organizational capacity and human resources:** A dedicated department within the MPWT should be established to oversee inspections, with major ports serving as inspection bases. In addition, inspectors should receive targeted training, necessary inspection equipment should be procured, and a centralized database system should be established to manage inspection records.
- **Enhancing international cooperation:** Cambodia should join regional agreements, such as the Tokyo MoU, and strengthen collaboration with international partners.

In addition, as per the requirement of MARPOL Convention, Environment and Natural Resources Code and Waterway Transport Law (2024), adequate waste reception facilities should be

established for ports to ensure the proper management and disposal of ship-generated waste. The necessary waste reception facilities should be determined by assessing the needs of port users, stakeholder consultation (e.g. port authorities, ship operators, waste service providers and government agencies) and reference to IMO guidelines.

(4) Ratification of Ballast Water Convention

International vessels may introduce invasive species into Cambodian waters through their ballast water. This risk is expected to increase in line with the growth of bulk commodity exports, as bulk carriers typically arrive in Cambodia with full ballast loads. Therefore, Cambodia should ratify the Ballast Water Management Convention to ensure that incoming vessels comply with its requirements.

(5) Preparation of National Oil Spill Contingency Plan

The risk of oil spills is expected to increase in line with the anticipated growth in the import of liquid bulk cargoes (e.g., fuel oil, diesel, gasoline) and the associated development of oil handling facilities in both coastal and river areas. Therefore, to prepare against potential oil spills, Cambodia should develop a National Oil Spill Contingency Plan and implement the necessary measures outlined in the plan. In line with the National Oil Spill Contingency Plan, ports should develop a contingency plan against oil spill as required under the Waterway Transport Law (2024).

(6) Study on sustainable sand mining

According to the demand forecast, annual sand export volume is projected to reach 45 million tons by 2050, which is an increase of approximately 1.5 times compared to the present volume of 28 million tons (year 2023). As sand is primarily extracted from rivers, such a substantial increase in mining activity could significantly alter river hydrology, geomorphology, and ecology, potentially leading to irreversible environmental degradation and adverse social impacts. It is therefore strongly recommended to undertake a comprehensive study with the relevant authorities on sustainable sand mining, including assessment of the environmental carrying capacity of major river systems, formulation of extraction limits, and development of appropriate management and monitoring frameworks to ensure long-term sustainability. The study should also be coordinated with inland navigation and port development studies to ensure integrated management of river systems.

Chapter-10 Points to be noted and study limitations

Finally, the JICA expert team notes that it will be necessary to further refine the port zoning development study after confirming/addressing the following issues.

1. In estimating future cargo volumes, the government should have data on future domestic production, demand, and overseas trade volume for each commodity. Unfortunately, the Cambodian government does not fully specify the target of future cargo demand and supply for many cargo items. The JICA expert team estimated future cargo volumes by setting several hypotheses based on interviews and discussions with relevant ministries and organizations. However, it will be necessary to revise the future cargo volumes after the government's policy is disclosed. For instance,

a) The containerized cargo volume in 2050 is estimated by the total GDP growth rate by 2050. However, potential changes in Cambodia’s future industrial structure have not been fully considered.

b) In the case of bulk exports (agricultural products), it is necessary for Cambodia to clarify the future agricultural goods yields, foster price competitiveness with foreign production, as well as secure quarantine qualification for exports. In this forecast, JICA team assumes that these challenges will be met.

c) The fishing yield is calculated based on the forecast consumption of fish by Cambodian citizens. However, available natural resources in Cambodia's rivers and nearby waters are not taken into account in our estimation.

2. There are many hydraulic challenges in developing river ports and waterways in Tonle Sap Lake and the upper Mekong. Our study assumes that these issues will be overcome.
3. The presence of Cambodian inland water transport operators is essential for the river port network to effectively function in Cambodian territorial waters. Otherwise, Cambodia will still rely on foreign operators for domestic water transport. When allocating cargoes, the expert team assumes that Cambodia operators will be able to successfully compete with land transport and Vietnamese inland waterway business operators.
4. The development of the Funan Techo Canal is expected to allow Cambodia to reduce dependency on southern Vietnamese ports for inland waterway. The expert team assumes that the transportation conditions of the Funan Techo Canal in terms of freight rates and time will be competitive with ports in southern Vietnam.
5. To improve the efficiency of container and bulk cargo transportation through the Funan Techo Canal, it is necessary to develop a barge system that allows barges to navigate in both inland waterways and coastal routes, rather than transshipping the cargo between inland waterways and coastal shipping routes. Our study assumes that this new barge system will be materialized.

Appendix

Appendix-1 Seminar on modal choice survey in the Mekong River System

To examine the modal share by transport mode in Cambodia, The JICA expert team sent questionnaires on inland waterway utilization to waterway transport operators, forwarders, and relevant organizations who currently engaged in barge transport between Phnom Penh Port and Vietnamese ports through the Mekong River. At the same time, we also requested interviews to them. Despite repeated follow-ups requesting questionnaire responses and interview arrangements, their reactions were not favorable.

Therefore, The JICA expert team held a seminar inviting stakeholders such as shippers, freight forwarders, waterway operators, and relevant organizations as an alternative. The seminar aimed to capture stakeholders' intentions and level of interest of using IWT. The seminar was held on the 12th May 2025 at the Fairfield by Marriott Phnom Penh with 86 participants.

The JICA expert team deliver the below handout document. Participants were asked to fill out their modal preference on-site. A local staff explained in Khmer to ensure participants fully understood the survey's content. After the explanation, the team prepared 20-minute response session and dispatch several local staff to help participants answer the questionnaires.

The Project for Strengthening Capacity for Ports Administration

Port Zoning Development
(Modal choice survey in the Mekong River System)

Date 12 May 2025

Expert team

1

Purpose of survey

Currently, the Mekong River System is not fully utilized to transport goods even though the cargo traffic in Cambodia is rapidly increasing. The JICA expert team proposes that river ports be developed along the Mekong River (as shown in the figure below) to alleviate traffic congestion and reduce exhaust emissions from trucks.

This survey aims to examine how many transporters and cargo owners are interested in using the inland waterways when transporting their cargoes from provinces to Phnom Penh. We selected major cities in the provinces, indicate distances, travel times and freights to Phnom Penh on trucks and barges.



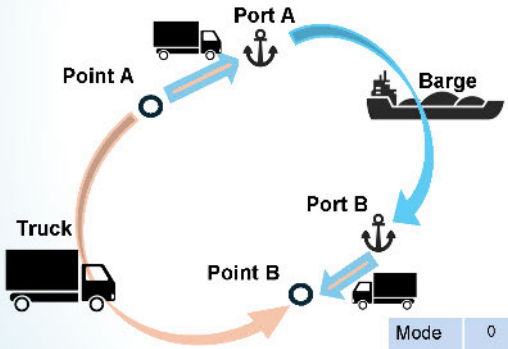
Target Cities and river ports

In addition, we specify navigable vessel size in each stretch, and the candidate sites for port development. Each port can accommodate the specified vessel size, and is to be equipped with proper cargo handling machines. While target cargoes are not limited to agricultural goods, in this survey, we selected paddy and milled rice as representative cargoes from provinces to Phnom Penh. Based on these assumptions, we would like to know whether you would consider selecting inland waterways to transport your cargo.

2

Survey method

The transport conditions by barge and truck such as distance, travel time and freight rate to Phnom Penh as well as the names of cities in each province are indicated in the survey sheet.
There are two transport modes: truck or barge. The future navigable barge size and project ports are specified.
You are requested to indicate the mode choice probability in percentages for each mode in the sheet provided. Railway is excluded from this survey for the sake of simplicity. Paddy and milled rice are selected as sample cargoes; however, please indicate other cargoes that you will handle. You are requested to answer one by one.



Two modes from Point A to Point B

Mode Truck: Cargo is transported from Point A to Point B
Or
Mode Barge: Cargo is transported from Point A to Point B including truck drayage from Point A to Port A, and Port B to Point B.

Modal preference choice sheet (sample)

Mode	0	10%	20%	30%	40%	50%	60%	70%	80%	90%	100 %
Truck							✓				
Barge					✓						

3

(Survey condition)
Navigable vessel size and port site 【Case1】

- The map shows 7 major cities in the provinces and 6 existing or projected river port locations.
- Two navigation scenarios are considered;
  Case 1 : Current navigable vessel size
  Case 2 : Future canal and channel development (by MPWT)



Target cities and river ports

Stretch	Vessel size (rainy season)	Vessel size (dry season)
Stung Treng~Kratie	50DWT	20DWT
Kratie~Kampong Cham	400DWT	80DWT
Kampong Cham~Phnom Penh	4,000DWT	2,000DWT
Chong Kneas~Kampong Chhnang	150DWT	20DWT
Kampong Chhnang~Phnom Penh	4,000DWT	2,000DWT
Takeo~Phnom Penh	50DWT	20DWT

Port (existing or projected)	Vessel size	Distance from a city	City
Stung Treng	50DWT	1km	Stung Treng
Kratie	400DWT	1km	Kratie
Kampong Cham	4,000DWT	6km	Kampong Cham
Chong Kneas	150DWT	107km 20km	Battambang Siem Reap
Kampong Chhnang	4,000DWT	3km	Kampong Chhnang
Phnom Penh	4,000DWT	10km	Phnom Penh
Takeo	50DWT	56km	Takeo

(Source: Survey team organized the tables based on the interview to a forwarder and Inland Waterway Transport in Cambodia, 8 June 2024)

4

(Survey condition)
Navigable vessel size and port site 【Case2】

- The map shows 7 major cities in the provinces and 6 existing or projected river port locations.
- Two navigation scenarios are considered;
  Case 1 : Current navigable vessel size
  Case 2 : Future canal and channel development (by MPWT)



Target cities and river ports

Stretch	Vessel size (Maximum)
Stung Treng～Kratie	3,000DWT
Kratie～Kampong Cham	3,000DWT
Kampong Cham～Phnom Penh	5,000DWT
Chong Kneas～Kampong Chhnang	5,000DWT
Kampong Chhnang～Phnom Penh	5,000DWT
Takeo～Phnom Penh	5,000DWT
Kep～Phnom Penh (Funan Techo Canal)	5,000DWT

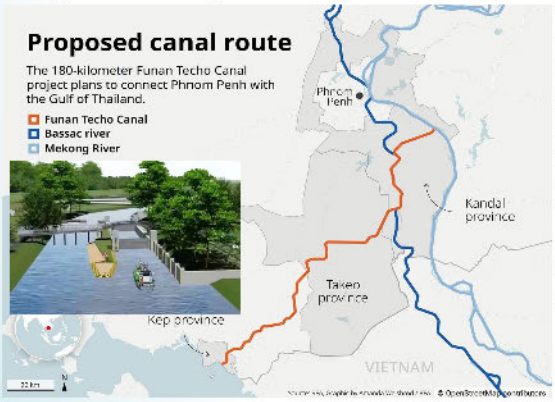
Port (existing or projected)	Vessel size	Distance from a city	City
Stung Treng	3,000DWT	1km	Stung Treng
Kratie	3,000DWT	1km	Kratie
Kampong Cham	5,000DWT	6km	Kampong Cham
Chong Kneas	5,000DWT	107km 20km	Battambang Siem Reap
Kampong Chhnang	5,000DWT	3km	Kampong Chhnang
Phnom Penh	5,000DWT	10km	Phnom Penh
Takeo	5,000DWT	56km	Takeo

(Source: Survey team organized the tables based on the interview to a forwarder and Inland Waterway Transport in Cambodia, 8 June 2024)

5

Outline of Funan Techo Canal

- Here is information related to the Funan Techo Canal from **Department of Waterway and Maritime Transport and Ports** of **Ministry of Public Works and Transport**:
- The canal was developed with an investment of 1.7 billion USD under the BOT model. It has **a total length of 168 km** and **a water depth of 5.4 meters**. The **width is 80 meters in the lower reaches and expected Travel time is 7.5 hours from upstream to downstream and 8.5 hours from downstream to upstream**.
- This section can accommodate ships of up to **3,000 DWT in the dry season and 5,000 DWT in the rainy season. A 3,000 DWT-barge can be transport 100 to 120 TEU. They will form a convoy with a tug and four barges.**



Funan Techo Canal	
Length	168 Km
Depth Water	5.4 meters (8-9 m in Rainy Season)
Width at lower reaches	80 meters
Travel Time	7.5 to 8.5 hours
Ship accommodate	3,000 to 5,000 DWT

Source: Department of Waterway and Maritime Transport and Ports of Ministry of Public Works and Transport.

6

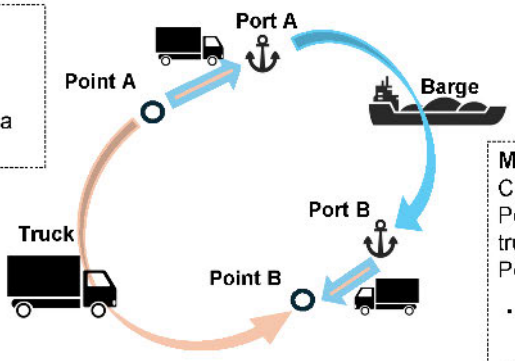
(Survey conditions)
Travel distance and freight from the provinces to Phnom Penh

【Case1 : current navigable condition】

- Travel distance, time, freight rate from the cities in the province to Phnom Penh by trucks and barges are shown on page 8.
- The capacity of a **truck is 20 tons** while that of a **barge is 1,000 DWT**.
- Barge freight includes truck drayage from the city to the port, and cargo handling charge in the ports.
- Freight is calculated assuming **2,000 tons of cargo** will be transported.

Mode Truck (20 tons):
Cargo is transported from Point A to Point B.

・100 trips required using a 20-ton truck



Mode Barge (1,000DWT):
Cargo is transported from Point A to Point B including truck drayage from Point A to Port A, and Port B to Point B.

・2 trips required using a 1,000 DWT barge
・100 trips required using a 20-ton truck (twice)

7

(Survey conditions)
Travel distance and freight from the provinces to Phnom Penh

【Case1 : current navigable condition】

Cargo origin city	Mode	Distance (km)	Travel time (hour)	Freight for transporting 2,000 tons (US$ per 20ton truck, or 1,000DWT barge)	Freight per ton (US$/ton)
Stung Treng city, Stung Treng	Truck(20t)	371	7	US$54,200	US$27.1
	Barge(1,000DWT)	366	36	US$19,200	US$9.6
Kratie city, Kratie	Truck(20t)	237	5	US$34,6000	US$17.3
	Barge(1,000DWT)	238	23	US$14,200	US$7.1
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	US$20,400	US$10.2
	Barge(1,000DWT)	122	11	US$10,400	US$5.2
Battambang city, Battambang	Truck(20t)	316	6	US$46,200	US$23.1
	Barge(1,000DWT)	372	28	US$30,800	US$15.4
Siem Reap city, Siem Reap	Truck(20t)	344	5	US$50,200	US$25.1
	Barge(1,000DWT)	285	27	US$18,200	US$9.1
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	US$17,600	US$8.8
	Barge(1,000DWT)	113	10	US$9,800	US$4.9
Takeo city, Takeo	Truck(20t)	87	2	US$12,800	US$6.4
	Barge(1,000DWT)	122	10	US$15,800	US$7.9

(Reference) Note; Freight unit rates for both barge and truck are based on small-size.

Sihanoukville port～ Phnom Penh port	Barge(1,000DWT)	298	13.3 *1 14.3 *2	US$15,300	US$7.7

*1: Upstream to downstream *2: Downstream to upstream

8

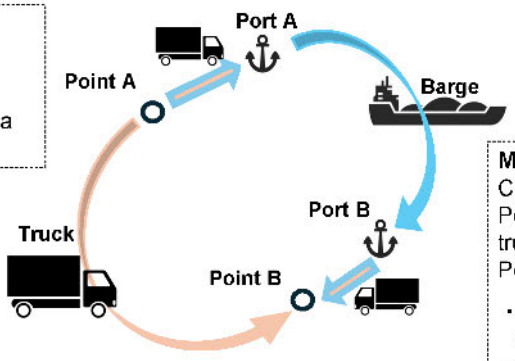
(Survey conditions)
Travel distance and freight from the provinces to Phnom Penh

【Case2 : future canal and channel development】

- Travel distance, time, freight rate from the cities in the province to Phnom Penh by trucks and barges are shown on page 10.
- The capacity of a **truck is 20 tons** while that of a **barge is 3,000 DWT**.
- Barge freight includes truck drayage from the city to the port, and cargo handling charge in the ports.
- Freight is calculated assuming **10,000 tons of cargo** will be transported.

Mode Truck (20 tons):
Cargo is transported from Point A to Point B.

・500 trips required using a 20-ton truck



Mode Barge (3,000DWT):
Cargo is transported from Point A to Point B including truck drayage from Point A to Port A, and Port B to Point B.

・3.3 trips required using a 3,000 DWT barge
・500 trips required using a 20-ton truck (twice)

9

(Survey conditions)
Travel distance and freight from the provinces to Phnom Penh

【Case2 : future canal and channel development】

Cargo origin city	Mode	Distance (km)	Travel time (hour)	Freight for transporting 10,000 tons (US$ per 20ton truck, or 3,000DWT barge)	Freight per ton (US$/ton)
Stung Treng city, Stung Treng	Truck(20t)	371	7	US$271,000	US$27.1
	Barge(3,000DWT)	366	36	US$64,000	US$6.4
Kratie city, Kratie	Truck(20t)	237	5	US$173,000	US$17.3
	Barge(3,000DWT)	238	23	US$51,000	US$5.1
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	US$102,000	US$10.2
	Barge(3,000DWT)	122	11	US$42,000	US$4.2
Battambang city, Battambang	Truck(20t)	316	6	US$231,000	US$23.1
	Barge(3,000DWT)	372	28	US$131,000	US$13.1
Siem Reap city, Siem Reap	Truck(20t)	344	5	US$251,000	US$25.1
	Barge(3,000DWT)	285	27	US$68,000	US$6.8
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	US$88,000	US$8.8
	Barge(3,000DWT)	113	10	US$40,000	US$4.0
Takeo city, Takeo	Truck(20t)	87	2	US$64,000	US$6.4
	Barge(3,000DWT)	122	10	US$74,000	US$7.4

Note; Freight unit rates for both barge and truck are based on small-size.

(Reference)

Sihanoukville port～ Phnom Penh port	Barge(3,000DWT)	298	13.3 *1 14.3 *2	US$50,000	US$5.0

*1: Upstream to downstream *2: Downstream to upstream

10

(Survey condition)
Road development

Regarding the road network and related infrastructure development in Cambodia, the Comprehensive Master Plan on Cambodia Intermodal Transport and Logistics System 2023-2033 was released in August 2023. By 2050, the national and provincial road network will be constructed in the pattern of 9 radial-pattern roads, 6-line horizontal road, and 6-line vertical road, with a total length of 25,412 km, while national and provincial roads will be 21,000 kilometers long by 2033.



Network of Cambodia's National Road Development Plan in 2050

11

Survey sheet (Paddy or milled rice)

【Case1 : current navigable condition】

Select the boxes you prefer when transporting paddy or milled rice from the provinces to Phnom Penh. Please specify the cargo name paddy or milled rice. You may leave the boxes blank if you are not so familiar with specific provinces.

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)											Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

12

Survey sheet (Paddy or milled rice)

【Case2 : future canal and channel development】

Select the boxes you prefer when transporting paddy or milled rice from the provinces to Phnom Penh. Please specify the cargo name paddy or milled rice. You may leave the boxes blank if you are not so familiar with specific provinces.

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)											Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

13

Survey sheet (specify cargo name : _____)

【Case1 : current navigable condition】

Select the boxes you prefer when transporting cargoes from the provinces to Phnom Penh. You are requested to specify the name of cargoes. You may leave the boxes blank if you are not so familiar with specific provinces.

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)											Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

14

Survey sheet (specify cargo name : _____)

【Case2 : future canal and channel development】

Select the boxes you prefer when transporting cargoes from the provinces to Phnom Penh. You are requested to specify the name of cargoes. You may leave the boxes blank if you are not so familiar with specific provinces.

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%) 0	10	20	30	40	50	60	70	80	90	100	Comments (If necessary)
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$302	US$25.1	US$251,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	138	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

15

(How to Respond to Today's Survey)

- ✓ **Please fill in your Company Name, Full Name, and Phone Number on the document titled "Modal Choice Survey Sheets" included in the handouts.**
- ✓ **Please check the box that corresponds to your level of interest in inland waterway transport on the response sheet for each cargo item.**
- ✓ **Staff will begin collecting the materials at 11:25.**

(For those who could not attend today's meeting)
Please send back "Modal Choice Survey Sheets" by the 16th May to Ms. Phally Tep, Mr. Phy Kosorl or Mr. Sakakibara.
Thank you for your cooperation.

JICA expert team on The Project for Strengthening Capacity for Ports Administration

[redacted]

16

Appendix-2 All Responses to the Modal Choice Survey

(1) Company A

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : A
Full Name :
Phone Number :

Paddy by barge or truck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200		✓										
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200										✓		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200												
	Barge(1,000DWT)	366	36	9,600	9.6	19,200												
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600												
	Barge(1,000DWT)	238	23	7,100	7.1	14,200												
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400												
	Barge(1,000DWT)	122	11	5,200	5.2	10,400												
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200										✓		
	Barge(1,000DWT)	372	28	15,400	15.4	30,800		✓										
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200												
	Barge(1,000DWT)	285	27	9,100	9.1	18,200												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600												
	Barge(1,000DWT)	113	10	4,900	4.9	9,800												
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800												
	Barge(1,000DWT)	122	10	7,900	7.9	15,800												

Paddy by barge or truck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000		✓										
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000										✓		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000												
	Barge(3,000DWT)	366	36	19,300	6.4	64,000												
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000												
	Barge(3,000DWT)	238	23	15,400	5.1	51,000												
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000												
	Barge(3,000DWT)	122	11	12,700	4.2	42,000												
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000								✓				
	Barge(3,000DWT)	372	28	39,500	13.1	131,000				✓								
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000												
	Barge(3,000DWT)	285	27	20,600	6.8	68,000												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000												
	Barge(3,000DWT)	113	10	12,100	4.0	40,000												
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000												
	Barge(3,000DWT)	122	10	22,400	7.4	74,000												

Milled rice container by barge or truck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200		☑										
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100										☑		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200												
	Barge(1,000DWT)	366	36	9,600	9.6	19,200												
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600												
	Barge(1,000DWT)	238	23	7,100	7.1	14,200												
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400												
	Barge(1,000DWT)	122	11	5,200	5.2	10,400												
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200										☑		
	Barge(1,000DWT)	372	28	15,400	15.4	30,800		☑										
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200												
	Barge(1,000DWT)	285	27	9,100	9.1	18,200												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600												
	Barge(1,000DWT)	113	10	4,900	4.9	9,800												
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800												
	Barge(1,000DWT)	122	10	7,900	7.9	15,800												

Milled rice container by barge or truck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000		☑										
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000										☑		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000												
	Barge(3,000DWT)	366	36	19,300	6.4	64,000												
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000												
	Barge(3,000DWT)	238	23	15,400	5.1	51,000												
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000												
	Barge(3,000DWT)	122	11	12,700	4.2	42,000												
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000										☑		
	Barge(3,000DWT)	372	28	39,500	13.1	131,000		☑										
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000												
	Barge(3,000DWT)	285	27	20,600	6.8	68,000												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000												
	Barge(3,000DWT)	113	10	12,100	4.0	40,000												
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000												
	Barge(3,000DWT)	122	10	22,400	7.4	74,000												

(2) Company B

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : B
Full Name :
Phone Number :

(cargo name: Chip Cassava, ~~Container or~~ bulk)

【Case1: current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(cargo name: Chip Cassava, ~~Container or~~ bulk)

【Case2: future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(3) Company C

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : C

Full Name :

Phone Number :

(cargo name : Banana, ~~Container or~~ bulk)

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(cargo name : Banana, ~~Container or~~ bulk)

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(cargo name : Gold, Container ~~or bulk~~)

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200								☑				
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100				☑								
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200											☑	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☑											
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600											☑	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☑											
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400											☑	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☑											
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200												
	Barge(1,000DWT)	372	28	15,400	15.4	30,800												
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200												
	Barge(1,000DWT)	285	27	9,100	9.1	18,200												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600												
	Barge(1,000DWT)	113	10	4,900	4.9	9,800												
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800												
	Barge(1,000DWT)	122	10	7,900	7.9	15,800												

(cargo name : Gold, Container ~~or bulk~~)

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000								☑				
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000				☑								
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000											☑	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☑											
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000											☑	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☑											
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000											☑	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☑											
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000												
	Barge(3,000DWT)	372	28	39,500	13.1	131,000												
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000												
	Barge(3,000DWT)	285	27	20,600	6.8	68,000												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000												
	Barge(3,000DWT)	113	10	12,100	4.0	40,000												
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000												
	Barge(3,000DWT)	122	10	22,400	7.4	74,000												

(4) Company D

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : D
Full Name :
Phone Number :

(cargo name : Mango, Container ~~or bulk~~)

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200								✓				
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100				✓								
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200											✓	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	✓											
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600											✓	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	✓											
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400											✓	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	✓											
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200											✓	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	✓											
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200											✓	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	✓											
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600											✓	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	✓											
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800											✓	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	✓											

(cargo name : Mango, Container ~~or bulk~~)

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000								✓				
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000				✓								
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000										✓		
	Barge(3,000DWT)	366	36	19,300	6.4	64,000		✓										
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000										✓		
	Barge(3,000DWT)	238	23	15,400	5.1	51,000		✓										
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000										✓		
	Barge(3,000DWT)	122	11	12,700	4.2	42,000		✓										
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000										✓		
	Barge(3,000DWT)	372	28	39,500	13.1	131,000		✓										
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000										✓		
	Barge(3,000DWT)	285	27	20,600	6.8	68,000		✓										
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000										✓		
	Barge(3,000DWT)	113	10	12,100	4.0	40,000		✓										
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000										✓		
	Barge(3,000DWT)	122	10	22,400	7.4	74,000		✓										

(5) Company E

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : E

Full Name :

Phone Number :

Paddy by barge or tuck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Paddy by barge or tuck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case1：current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case2：future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(6) Company F

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : F
Full Name :
Phone Number :

Paddy by barge or tuck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	Short Time
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	In case more Quantity
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	Short time and low fee
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Paddy by barge or tuck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	Short Time
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	In case more Quantity
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	Short time and low fee
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case1：current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Travel time take long time
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case2：future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	Travel time take long time, in case more Quantity
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(7) Company G

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : G
Full Name :
Phone Number :

(cargo name : Air Conditioner, EX Phnom Penh, Container)
【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(cargo name : Air Conditioner, EX Phnom Penh, Container)
【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(8) Company H

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : H
Full Name :
Phone Number :

Milled rice container by barge or truck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(9) Company I

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : I
Full Name :
Phone Number :

Paddy by barge or tuck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Paddy by barge or tuck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case1：current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200		☑										
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100										☑		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200										☑		
	Barge(1,000DWT)	366	36	9,600	9.6	19,200		☑										
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600										☑		
	Barge(1,000DWT)	238	23	7,100	7.1	14,200		☑										
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400										☑		
	Barge(1,000DWT)	122	11	5,200	5.2	10,400		☑										
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200											☑	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☑											
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200											☑	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☑											
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600											☑	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☑											
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800											☑	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☑											

Milled rice container by barge or truck

【Case2：future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000		☑										
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000										☑		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000							☑					
	Barge(3,000DWT)	366	36	19,300	6.4	64,000					☑							
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000						☑						
	Barge(3,000DWT)	238	23	15,400	5.1	51,000						☑						
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000								☑				
	Barge(3,000DWT)	122	11	12,700	4.2	42,000				☑								
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000									☑			
	Barge(3,000DWT)	372	28	39,500	13.1	131,000			☑									
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000					☑							
	Barge(3,000DWT)	285	27	20,600	6.8	68,000							☑					
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000					☑							
	Barge(3,000DWT)	113	10	12,100	4.0	40,000							☑					
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000											☑	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☑											

(10) Company J

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : J
Full Name :
Phone Number :

Paddy by barge or tuck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Paddy by barge or tuck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case1：current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case2：future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(11) Company K

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : K
Full Name :
Phone Number :

Paddy by barge or tuck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Paddy by barge or tuck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200		☑										
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100										☑		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200												
	Barge(1,000DWT)	366	36	9,600	9.6	19,200												
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600												
	Barge(1,000DWT)	238	23	7,100	7.1	14,200												
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400												
	Barge(1,000DWT)	122	11	5,200	5.2	10,400												
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200												
	Barge(1,000DWT)	372	28	15,400	15.4	30,800												
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200												
	Barge(1,000DWT)	285	27	9,100	9.1	18,200												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600											☑	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☑											
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800												
	Barge(1,000DWT)	122	10	7,900	7.9	15,800												

Milled rice container by barge or truck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000		☑										
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000										☑		
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000												
	Barge(3,000DWT)	366	36	19,300	6.4	64,000												
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000												
	Barge(3,000DWT)	238	23	15,400	5.1	51,000												
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000												
	Barge(3,000DWT)	122	11	12,700	4.2	42,000												
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000												
	Barge(3,000DWT)	372	28	39,500	13.1	131,000												
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000												
	Barge(3,000DWT)	285	27	20,600	6.8	68,000												
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000										☑		
	Barge(3,000DWT)	113	10	12,100	4.0	40,000		☑										
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000												
	Barge(3,000DWT)	122	10	22,400	7.4	74,000												

(12) Company L

【Modal Choice Survey Sheets】

(Please fill in the following information)

Company Name : L

Full Name :

Phone Number :

Milled rice container by barge or truck

【Case1 : current navigable condition】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 1,000DWT barge)	Freight (US$/ton)	Freight for transporting 2,000t (US$ per 20ton truck, or 1,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$50,200	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	US$9,100	US$9.1	US$18,100	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	54,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	366	36	9,600	9.6	19,200	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	34,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	238	23	7,100	7.1	14,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	20,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	11	5,200	5.2	10,400	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	46,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	
	Barge(1,000DWT)	372	28	15,400	15.4	30,800	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	50,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	285	27	9,100	9.1	18,200	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	17,600	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	113	10	4,900	4.9	9,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	12,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(1,000DWT)	122	10	7,900	7.9	15,800	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Milled rice container by barge or truck

【Case2 : future canal and channel development】

Original city	Mode	Distance (km)	Travel time (hour)	Freight for 1 trip (US$ per 20ton truck or 3,000DWT barge)	Freight (US$/ton)	Freight for transporting 10,000t (US$ per 20ton truck or 3,000DWT barge)	Mode Choice (%)										Comments (If necessary)
							0	10	20	30	40	50	60	70	80	90	100	
Example Siem Reap city, Siem Reap	Truck(20t)	344	5	US$502	US$25.1	US$251,000	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	US$20,600	US$6.8	US$68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	
Stung Treng city, Stung Treng	Truck(20t)	371	7	542	27.1	271,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	366	36	19,300	6.4	64,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Kratie city, Kratie	Truck(20t)	237	5	346	17.3	173,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	238	23	15,400	5.1	51,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Cham city, Kampong Cham	Truck(20t)	139	2	204	10.2	102,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	11	12,700	4.2	42,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Battambang city, Battambang	Truck(20t)	316	6	462	23.1	231,000	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
	Barge(3,000DWT)	372	28	39,500	13.1	131,000	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	
Siem Reap city, Siem Reap	Truck(20t)	344	5	502	25.1	251,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	285	27	20,600	6.8	68,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Kampong Chhnang city, Kampong Chhnang	Truck(20t)	120	2	176	8.8	88,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	113	10	12,100	4.0	40,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Takeo city, Takeo	Truck(20t)	87	2	128	6.4	64,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	Barge(3,000DWT)	122	10	22,400	7.4	74,000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Appendix-3 Inland waterway transport (IWT) share by case for each bulk cargo item

(1) Agriculture goods: Paddy (Export)

For paddy, the demand forecast cargo volumes for 2050 were estimated in the previous chapter under two scenarios. When expressed in terms of the forecasted cargo volumes, the results are as shown in Figure.A 1. In this section, the cargo volume under Scenario 2 is applied to calculate the inland waterway transport share.

- Scenario 1: Cambodia is not expected to further develop its rice milling industry. Consequently, no increase in milled rice exports is anticipated, and the current export conditions for rice will remain unchanged.



- Scenario 2: The rice milling industry in Cambodia is expected to expand, with approximately half of the rice produced projected to be exported as milled rice.

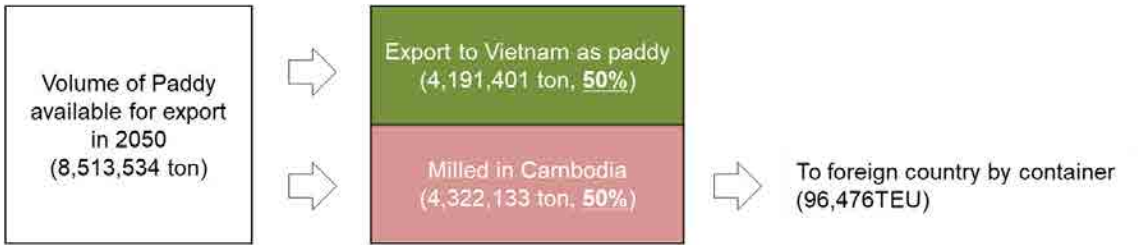


Figure.A 1 Two scenarios for Paddy's export condition

The IWT share for Case 0, calculated using Table 5-14, is presented in Table.A 1.

Table.A 1 IWT share for each province (agriculture goods: paddy, Case0)

Zone	Province	Transport mean	Departing port	Transport mean	Final destination (rice mill)	Estimation volume of Paddy by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot	Truck	→	→	Vietnam	145,705		0
	Kep	Truck	→	→	Vietnam	3,714		0
	Koh Kong	Truck	→	→	Vietnam	8,176		0
	Preah Sihanouk	Truck	→	→	Vietnam	11,932		0
2	Kampong Thom	Truck	UM2	Barge	Vietnam	303,780	10%	30,378
	Kratie	Truck	UM2	Barge	Vietnam	71,891	10%	7,189
	Mondul Kiri	Truck	→	→	Vietnam	33,976		0
	Preah Vihear	Truck	UM2	Barge	Vietnam	89,726	10%	8,973
	Ratanak Kiri	Truck	→	→	Vietnam	29,488		0
	Stung Treng	Truck	UM2	Barge	Vietnam	23,683	10%	2,368
3	Banteay Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	362,080	10%	36,208
	Battambang	Truck	Kampong Chhnang	Barge	Vietnam	577,641	10%	57,764
	Oddar Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	74,442	10%	7,444
	Pailin	Truck	Kampong Chhnang	Barge	Vietnam	10,059	10%	1,006
	Pursat	Truck	Kampong Chhnang	Barge	Vietnam	241,734	10%	24,173
	Siem Reap	Truck	Kampong Chhnang	Barge	Vietnam	216,704	10%	21,670
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Vietnam	248,635	10%	24,864
	Kampong Speu	Truck	PPP	Barge	Vietnam	123,479	10%	12,348
	Takeo	Truck	PPP	Barge	Vietnam	411,772	10%	41,177
5	Kampong Cham	Truck	UM2	Barge	Vietnam	204,471	10%	20,447
	Prey Veng	Truck	LM26	Barge	Vietnam	576,535	10%	57,654
	Svay Rieng	Truck	LM26	Barge	Vietnam	185,623	10%	18,562
	Tboung Khmum	Truck	UM2	Barge	Vietnam	102,590	10%	10,259
6	Kandal	Truck	PPP	Barge	Vietnam	129,301	10%	12,930
	Phnom Penh	Truck	PPP	Barge	Vietnam	4,263	10%	426
					Total	4,191,400		395,840

The IWT share for Case 2, calculated using Table 5-15, is presented in Table.A 2.

Table.A 2 IWT share for each province (agriculture goods: paddy, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final destination (rice mill)	Estimation volume of Paddy by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot	Truck	→	→	Vietnam	145,705		0
	Kep	Truck	→	→	Vietnam	3,714		0
	Koh Kong	Truck	→	→	Vietnam	8,176		0
	Preah Sihanouk	Truck	→	→	Vietnam	11,932		0
2	Kampong Thom	Truck	UM2	Barge	Vietnam	303,780	10%	30,378
	Kratie	Truck	UM2	Barge	Vietnam	71,891	10%	7,189
	Mondul Kiri	Truck	→	→	Vietnam	33,976		0
	Preah Vihear	Truck	UM2	Barge	Vietnam	89,726	10%	8,973
	Ratanak Kiri	Truck	→	→	Vietnam	29,488		0
	Stung Treng	Truck	UM2	Barge	Vietnam	23,683	10%	2,368
3	Banteay Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	362,080	10%	36,208
	Battambang	Truck	Kampong Chhnang	Barge	Vietnam	577,641	10%	57,764
	Oddar Meanchey	Truck	Kampong Chhnang	Barge	Vietnam	74,442	10%	7,444
	Pailin	Truck	Kampong Chhnang	Barge	Vietnam	10,059	10%	1,006
	Pursat	Truck	Kampong Chhnang	Barge	Vietnam	241,734	10%	24,173
	Siem Reap	Truck	Kampong Chhnang	Barge	Vietnam	216,704	10%	21,670
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Vietnam	248,635	10%	24,864
	Kampong Speu	Truck	PPP	Barge	Vietnam	123,479	10%	12,348
	Takeo	Truck	PPP	Barge	Vietnam	411,772	10%	41,177
5	Kampong Cham	Truck	UM2	Barge	Vietnam	204,471	10%	20,447
	Prey Veng	Truck	LM26	Barge	Vietnam	576,535	10%	57,654
	Svay Rieng	Truck	LM26	Barge	Vietnam	185,623	10%	18,562
	Tboung Khmum	Truck	UM2	Barge	Vietnam	102,590	10%	10,259
6	Kandal	Truck	PPP	Barge	Vietnam	129,301	10%	12,930
	Phnom Penh	Truck	PPP	Barge	Vietnam	4,263	10%	426
					Total	4,191,400		395,840

The IWT share for Case 3, calculated using Table 5-16, is presented in Table.A 3.

Table.A 3 IWT share for each province (agriculture goods: paddy, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final destination (rice mill)	Estimation volume of Paddy by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot	Truck	→	→	Vietnam	145,705		0
	Kep	Truck	→	→	Vietnam	3,714		0
	Koh Kong	Truck	→	→	Vietnam	8,176		0
	Preah Sihanouk	Truck	→	→	Vietnam	11,932		0
2	Kampong Thom	Truck	UM2	Barge	Vietnam	303,780	60%	182,268
	Kratie	Truck	Kratie	Barge	Vietnam	71,891	60%	43,135
	Mondul Kiri	Truck	→	→	Vietnam	33,976		0
	Preah Vihear	Truck	Stung Treng	Barge	Vietnam	89,726	60%	53,836
	Ratanak Kiri	Truck	→	→	Vietnam	29,488		0
	Stung Treng	Truck	Stung Treng	Barge	Vietnam	23,683	60%	14,210
3	Banteay Meanchey	Truck	Chong Khneas	Barge	Vietnam	362,080	60%	217,248
	Battambang	Truck	Chong Khneas	Barge	Vietnam	577,641	60%	346,585
	Oddar Meanchey	Truck	Chong Khneas	Barge	Vietnam	74,442	60%	44,665
	Pailin	Truck	Chong Khneas	Barge	Vietnam	10,059	60%	6,035
	Pursat	Truck	Kampong Chhnang	Barge	Vietnam	241,734	60%	145,040
	Siem Reap	Truck	Chong Khneas	Barge	Vietnam	216,704	60%	130,022
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Vietnam	248,635	60%	149,181
	Kampong Speu	Truck	PPP	Barge	Vietnam	123,479	60%	74,087
	Takeo	Truck	PPP	Barge	Vietnam	411,772	60%	247,063
5	Kampong Cham	Truck	UM2	Barge	Vietnam	204,471	60%	122,683
	Prey Veng	Truck	LM26	Barge	Vietnam	576,535	60%	345,921
	Svay Rieng	Truck	LM26	Barge	Vietnam	185,623	60%	111,374
	Tboung Khmum	Truck	UM2	Barge	Vietnam	102,590	60%	61,554
6	Kandal	Truck	PPP	Barge	Vietnam	129,301	60%	77,581
	Phnom Penh	Truck	PPP	Barge	Vietnam	4,263	60%	2,558
					Total	4,191,400		2,375,046

(2) Agriculture goods: Raw rubber (Export)

The IWT share for Case 0, calculated using Table 5-17, is presented in Table.A 4.

Table.A 4 IWT share for each province (agriculture goods: raw rubber, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Raw rubber by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot	Truck	→	→	SHV	137		0
	Kep	Truck	→	→	SHV	0		0
	Koh Kong	Truck	→	→	SHV	2,349		0
	Preah Sihanouk	Truck	→	→	SHV	255		0
2	Kampong Thom	Truck	UM2	Barge	Cai Mep	24,260	10%	2,426
	Kratie	Truck	UM2	Barge	Cai Mep	22,860	10%	2,286
	Mondul Kiri	Truck	→	→	Vietnam	9,505		0
	Preah Vihear	Truck	UM2	Barge	Cai Mep	3,747	10%	375
	Ratanak Kiri	Truck	→	→	Vietnam	19,019		0
	Stung Treng	Truck	UM2	Barge	Cai Mep	4,077	10%	408
3	Banteay Meanchey	Truck	→	→	Thai	53		0
	Battambang	Truck	→	→	SHV	786		0
	Oddar Meanchey	Truck	→	→	Thai	4,530		0
	Pailin	Truck	→	→	Thai	647		0
	Pursat	Truck	→	→	SHV	1,213		0
	Siem Reap	Truck	Kampong Chhnang	Barge	Cai Mep	1,005	10%	101
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Cai Mep	155	10%	16
	Kampong Speu	Truck	→	→	SHV	167		0
	Takeo	Truck	→	→	SHV	0		0
5	Kampong Cham	Truck	UM2	Barge	Cai Mep	9,062	10%	906
	Prey Veng	Truck	LM26	Barge	Cai Mep	489	10%	49
	Svay Rieng	Truck	LM26	Barge	Cai Mep	861	10%	86
	Tboung Khmum	Truck	UM2	Barge	Cai Mep	26,990	10%	2,699
6	Kandal	Truck	PPP	Barge	Cai Mep	0	10%	0
	Phnom Penh	Truck	PPP	Barge	Cai Mep	0	10%	0
					Total	132,168		9,352

The IWT share for Case 2, calculated using Table 5-18, is presented in Table.A 5.

Table.A 5 IWT share for each province (agriculture goods: raw rubber, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Raw rubber by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot	Truck	→	→	SHV	137		0
	Kep	Truck	→	→	SHV	0		0
	Koh Kong	Truck	→	→	SHV	2,349		0
	Preah Sihanouk	Truck	→	→	SHV	255		0
2	Kampong Thom	Truck	UM2	Barge	Zone 1 seaport	24,260	60%	14,556
	Kratie	Truck	UM2	Barge	Zone 1 seaport	22,860	60%	13,716
	Mondul Kiri	Truck	→	→	Vietnam	9,505		0
	Preah Vihear	Truck	UM2	Barge	Zone 1 seaport	3,747	60%	2,248
	Ratanak Kiri	Truck	→	→	Vietnam	19,019		0
	Stung Treng	Truck	UM2	Barge	Zone 1 seaport	4,077	60%	2,446
3	Banteay Meanchey	Truck	→	→	Thai	53		0
	Battambang	Truck	→	→	SHV	786		0
	Oddar Meanchey	Truck	→	→	Thai	4,530		0
	Pailin	Truck	→	→	Thai	647		0
	Pursat	Truck	→	→	SHV	1,213		0
	Siem Reap	Truck	Kampong Chhnang	Barge	Zone 1 seaport	1,005	60%	603
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Zone 1 seaport	155	60%	93
	Kampong Speu	Truck	→	→	SHV	167		0
	Takeo	Truck	→	→	SHV	0		0
5	Kampong Cham	Truck	UM2	Barge	Zone 1 seaport	9,062	60%	5,437
	Prey Veng	Truck	LM26	Barge	Zone 1 seaport	489	60%	294
	Svay Rieng	Truck	LM26	Barge	Zone 1 seaport	861	60%	517
	Tboung Khmum	Truck	UM2	Barge	Zone 1 seaport	26,990	60%	16,194
6	Kandal	Truck	PPP	Barge	Zone 1 seaport	0	60%	0
	Phnom Penh	Truck	PPP	Barge	Zone 1 seaport	0	60%	0
					Total	132,168		56,104

The IWT share for Case 3, calculated using Table 5-19, is presented in Table.A 6.

Table.A 6 IWT share for each province (agriculture goods: raw rubber, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Rubber by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot	Truck	→	→	SHV	137		0
	Kep	Truck	→	→	SHV	0		0
	Koh Kong	Truck	→	→	SHV	2,349		0
	Preah Sihanouk	Truck	→	→	SHV	255		0
2	Kampong Thom	Truck	UM2	Barge	Zone 1 seaport	24,260	60%	14,556
	Kratie	Truck	Kratie	Barge	Zone 1 seaport	22,860	60%	13,716
	Mondul Kiri	Truck	→	→	Vietnam	9,505		0
	Preah Vihear	Truck	Stung Treng	Barge	Zone 1 seaport	3,747	60%	2,248
	Ratanak Kiri	Truck	→	→	Vietnam	19,019		0
	Stung Treng	Truck	Stung Treng	Barge	Zone 1 seaport	4,077	60%	2,446
3	Banteay Meanchey	Truck	→	→	Thai	53		0
	Battambang	Truck	Chong Khneas	Barge	Zone 1 seaport	786	60%	472
	Oddar Meanchey	Truck	→	→	Thai	4,530		0
	Pailin	Truck	→	→	Thai	647		0
	Pursat	Truck	→	→	SHV	1,213		0
	Siem Reap	Truck	Chong Khneas	Barge	Zone 1 seaport	1,005	60%	603
4	Kampong Chhnang	Truck	Kampong Chhnang	Barge	Zone 1 seaport	155	60%	93
	Kampong Speu	Truck	→	→	SHV	167		0
	Takeo	Truck	→	→	SHV	0		0
5	Kampong Cham	Truck	UM2	Barge	Zone 1 seaport	9,062	60%	5,437
	Prey Veng	Truck	LM26	Barge	Zone 1 seaport	489	60%	294
	Svay Rieng	Truck	LM26	Barge	Zone 1 seaport	861	60%	517
	Tboung Khmum	Truck	UM2	Barge	Zone 1 seaport	26,990	60%	16,194
6	Kandal	Truck	PPP	Barge	Zone 1 seaport	0	60%	0
	Phnom Penh	Truck	PPP	Barge	Zone 1 seaport	0	60%	0
					Total	132,168		56,576

(3) Mineral resources: Bauxite (Export)

The IWT share for Case 0, calculated using Table 5-23, is presented in Table.A 7.

Table.A 7 IWT share for each province (mineral resources: bauxite, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Bauxite mining by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri	Truck	UM2	Barge	Vietnam	10,000,000	100%	10,000,000
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	10,000,000		10,000,000

The IWT share for Case 2, calculated using Table 5-24, is presented in Table.A 8.

Table.A 8 12 8 IWT share for each province (mineral resources: bauxite, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Bauxite mining by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri	Truck	UM2	Barge	Zone 1 seaport	10,000,000	100%	10,000,000
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	10,000,000		10,000,000

The IWT share for Case 3, calculated using Table 5-25, is presented in Table.A 9.

Table.A 9 IWT share for each province (mineral resources: bauxite, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Bauxite mining by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri	Truck	Kratie	Barge	Zone 1 seaport	10,000,000	100%	10,000,000
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	10,000,000		10,000,000

(4) Mineral resources: Iron ore (Export)

The IWT share for Case 0, calculated using Table 5-23, is presented in Table.A 10.

Table.A 10 IWT share for each province (mineral resources: iron ore, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Iron ore by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear	Truck	UM2	Barge	Vietnam	4,500,000	100%	4,500,000
	Ratanak Kiri							0
	Stung Treng	Truck	UM2	Barge	Vietnam	4,500,000	100%	4,500,000
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	9,000,000		9,000,000

The IWT share for Case 2, calculated using Table 5-24, is presented in Table.A 11.

Table.A 11 WT share for each province (mineral resources: iron ore, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Iron ore by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear	Truck	UM2	Barge	Zone 1 seaport	4,500,000	100%	4,500,000
	Ratanak Kiri							0
	Stung Treng	Truck	UM2	Barge	Zone 1 seaport	4,500,000	100%	4,500,000
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	9,000,000		9,000,000

The IWT share for Case 3, calculated using Table 5-25, is presented in Table.A 12.

Table.A 12 IWT share for each province (mineral resources: iron ore, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Iron ore by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear	Truck	Stung Treng	Barge	Zone 1 seaport	4,500,000	100%	4,500,000
	Ratanak Kiri							0
	Stung Treng	Truck	Stung Treng	Barge	Zone 1 seaport	4,500,000	100%	4,500,000
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	9,000,000		9,000,000

(5) Mineral resources: Manganese ore (Export)

The IWT share for Case 0, calculated using Table 5-23, is presented in Table.A 13.

Table.A 13 IWT share for each province (mineral resources: manganese ore, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Manganese ore by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear	Truck	UM2	Barge	Vietnam	20,006	100%	20,006
	Ratanak Kiri							0
	Stung Treng	Truck	UM2	Barge	Vietnam	20,006	100%	20,006
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	40,012		40,012

The IWT share for Case 2, calculated using Table 5-24, is presented in Table.A 14.

Table.A 14 IWT share for each province (mineral resources: manganese ore, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Manganese ore by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear	Truck	UM2	Barge	Zone 1 seaport	20,006	100%	20,006
	Ratanak Kiri							0
	Stung Treng	Truck	UM2	Barge	Zone 1 seaport	20,006	100%	20,006
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	40,012		40,012

The IWT share for Case 3, calculated using Table 5-25, is presented in Table.A 15.

Table.A 15 IWT share for each province (mineral resources: manganese ore, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Manganese ore by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear	Truck	Stung Treng	Barge	Zone 1 seaport	20,006	100%	20,006
	Ratanak Kiri							0
	Stung Treng	Truck	Stung Treng	Barge	Zone 1 seaport	20,006	100%	20,006
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	40,012		40,012

(6) Mineral resources: Pebbles (Export)

The IWT share for Case 0, calculated using Table 5-23, is presented in Table.A 16.

Table.A 16 IWT share for each province (mineral resources: pebbles, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Pebbles by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie	Truck	UM2	Barge	Vietnam	500,000	100%	500,000
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng	Truck	UM2	Barge	Vietnam	500,000	100%	500,000
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	1,000,000		1,000,000

The IWT share for Case 2, calculated using Table 5-24, is presented in Table.A 17.

Table.A 17 IWT share for each province (mineral resources: pebbles, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Pebbles by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie	Truck	UM2	Barge	Zone 1 seaport	500,000	100%	500,000
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng	Truck	UM2	Barge	Zone 1 seaport	500,000	100%	500,000
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	1,000,000		1,000,000

The IWT share for Case 3, calculated using Table 5-25, is presented in Table.A 18.

Table.A 18 IWT share for each province (mineral resources: pebbles, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Pebbles by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie	Truck	Kratie	Barge	Zone 1 seaport	500,000	100%	500,000
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng	Truck	Stung Treng	Barge	Zone 1 seaport	500,000	100%	500,000
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	1,000,000		1,000,000

(7) Mineral resources: Sand (Export)

The IWT share for Case 0, calculated using Table 5-23, is presented in Table.A 19.

Table.A 19 IWT share for each province (mineral resources: sand, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Sand by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh	-	River	Barge	Vietnam	45,000,000	100%	45,000,000
					Total	45,000,000		45,000,000

The IWT share for Case 2, calculated using Table 5-24, is presented in Table.A 20.

Table.A 20 IWT share for each province (mineral resources: sand, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Sand by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh	-	River	Barge	Vietnam	45,000,000	100%	45,000,000
					Total	45,000,000		45,000,000

The IWT share for Case 3, calculated using Table 5-25, is presented in Table.A 21.

Table.A 21 IWT share for each province (mineral resources: sand, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Sand by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie							0
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh	-	River	Barge	Vietnam	45,000,000	100%	45,000,000
					Total	45,000,000		45,000,000

(8) Mineral resources: Stone (Export)

The IWT share for Case 0, calculated using Table 5-23, is presented in Table.A 22.

Table.A 22 IWT share for each province (mineral resources: stone, Case 0)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Stone by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie	Truck	UM2	Barge	Vietnam	11,664,644	100%	11,664,644
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	11,664,644		11,664,644

The IWT share for Case 2, calculated using Table 5-24, is presented in Table.A 23.

Table.A 23 IWT share for each province (mineral resources: stone, Case 2)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Stone by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie	Truck	UM2	Barge	Zone 1 seaport	11,664,644	100%	11,664,644
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	11,664,644		11,664,644

The IWT share for Case 3, calculated using Table 5-25, is presented in Table.A 24.

Table.A 24 IWT share for each province (mineral resources: stone, Case 3)

Zone	Province	Transport mean	Departing port	Transport mean	Final port	Estimation volume of Stone by province in 2050 (ton)	IWT share	IWT volume (ton)
1	Kampot							0
	Kep							0
	Koh Kong							0
	Preah Sihanouk							0
2	Kampong Thom							0
	Kratie	Truck	Kratie	Barge	Zone 1 seaport	11,664,644	100%	11,664,644
	Mondul Kiri							0
	Preah Vihear							0
	Ratanak Kiri							0
	Stung Treng							0
3	Banteay Meanchey							0
	Battambang							0
	Oddar Meanchey							0
	Pailin							0
	Pursat							0
	Siem Reap							0
4	Kampong Chhnang							0
	Kampong Speu							0
	Takeo							0
5	Kampong Cham							0
	Prey Veng							0
	Svay Rieng							0
	Tboung Khmum							0
6	Kandal							0
	Phnom Penh							0
					Total	11,664,644		11,664,644

(9) Agriculture goods: Cereal (mainly feed) (Import)

The IWT share for Case 0, calculated using Table 5-20, is presented in Table.A 25.

Table.A 25 IWT share for each province (agriculture goods: cereal, Case 0)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Cereal by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	3,251		0
	SHV	Truck	→	→	Kep	12,720		0
	SHV	Truck	→	→	Koh Kong	4,780		0
	SHV	Truck	→	→	Preah Sihanouk	3,966		0
2	Cai Mep	Barge	UM2	Truck	Kampong Thom	3,521	10%	352
	Cai Mep	Barge	UM2	Truck	Kratie	5,357	10%	536
	Cai Mep	Barge	UM2	Truck	Mondul Kiri	6,723	10%	672
	Cai Mep	Barge	UM2	Truck	Preah Vihear	8,694	10%	869
	Cai Mep	Barge	UM2	Truck	Ratanak Kiri	13,492	10%	1,349
	Cai Mep	Barge	UM2	Truck	Stung Treng	11,492	10%	1,149
3	SHV	Truck	→	→	Banteay Meanchey	544		0
	SHV	Truck	→	→	Battambang	958		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Oddar Meanchey	11,194	10%	1,119
	SHV	Truck	→	→	Pailin	15,327		0
	SHV	Truck	→	→	Pursat	7,577		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Siem Reap	10,994	10%	1,099
4	Cai Mep	Barge	Kampong Chhnang	Truck	Kampong Chhnang	1,606	10%	161
	SHV	Truck	→	→	Kampong Speu	2,114		0
	SHV	Truck	→	→	Takeo	11,478		0
5	Cai Mep	Barge	UM2	Truck	Kampong Cham	1,176	10%	118
	Cai Mep	Barge	LM26	Truck	Prey Veng	9,909	10%	991
	Cai Mep	Barge	LM26	Truck	Svay Rieng	12,937	10%	1,294
	Cai Mep	Barge	UM2	Truck	Tboung Khmum	29,108	10%	2,911
6	Cai Mep	Barge	PPP	Truck	Kandal	2,774	10%	277
	Cai Mep	Barge	PPP	Truck	Phnom Penh	6,703	10%	670
					Total	198,395		13,567

The IWT share for Case 2, calculated using Table 5-21, is presented in Table.A 26.

Table.A 26 IWT share for each province (agriculture goods: cereal, Case 2)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Cereal by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	3,251		0
	SHV	Truck	→	→	Kep	12,720		0
	SHV	Truck	→	→	Koh Kong	4,780		0
	SHV	Truck	→	→	Preah Sihanouk	3,966		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	3,521	60%	2,113
	Zone 1 seaport	Barge	UM2	Truck	Kratie	5,357	60%	3,214
	Zone 1 seaport	Barge	UM2	Truck	Mondul Kiri	6,723	60%	4,034
	Zone 1 seaport	Barge	UM2	Truck	Preah Vihear	8,694	60%	5,216
	Zone 1 seaport	Barge	UM2	Truck	Ratanak Kiri	13,492	60%	8,095
	Zone 1 seaport	Barge	UM2	Truck	Stung Treng	11,492	60%	6,895
3	SHV	Truck	→	→	Banteay Meanchey	544		0
	SHV	Truck	→	→	Battambang	958		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Oddar Meanchey	11,194	60%	6,716
	SHV	Truck	→	→	Pailin	15,327		0
	SHV	Truck	→	→	Pursat	7,577		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Siem Reap	10,994	60%	6,596
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	1,606	60%	964
	SHV	Truck	→	→	Kampong Speu	2,114		0
	SHV	Truck	→	→	Takeo	11,478		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	1,176	60%	706
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	9,909	60%	5,945
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	12,937	60%	7,762
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	29,108	60%	17,465
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	2,774	60%	1,664
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	6,703	60%	4,022
					Total	198,395		81,407

The IWT share for Case 3, calculated using Table 5-22, is presented in Table.A 27.

Table.A 27 IWT share for each province (agriculture goods: cereal, Case 3)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Cereal by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	3,251		0
	SHV	Truck	→	→	Kep	12,720		0
	SHV	Truck	→	→	Koh Kong	4,780		0
	SHV	Truck	→	→	Preah Sihanouk	3,966		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	3,521	60%	2,113
	Zone 1 seaport	Barge	Kratie	Truck	Kratie	5,357	60%	3,214
	Zone 1 seaport	Barge	Kratie	Truck	Mondul Kiri	6,723	60%	4,034
	Zone 1 seaport	Barge	Stung Treng	Truck	Preah Vihear	8,694	60%	5,216
	Zone 1 seaport	Barge	Stung Treng	Truck	Ratanak Kiri	13,492	60%	8,095
	Zone 1 seaport	Barge	Stung Treng	Truck	Stung Treng	11,492	60%	6,895
3	Zone 1 seaport	Barge	Chong Khneas	Truck	Banteay Meanchey	544	60%	326
	Zone 1 seaport	Barge	Chong Khneas	Truck	Battambang	958	60%	575
	Zone 1 seaport	Barge	Chong Khneas	Truck	Oddar Meanchey	11,194	60%	6,716
	Zone 1 seaport	Barge	Chong Khneas	Truck	Pailin	15,327	60%	9,196
	SHV	Truck	→	→	Pursat	7,577		0
	Zone 1 seaport	Barge	Chong Khneas	Truck	Siem Reap	10,994	60%	6,596
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	1,606	60%	964
	SHV	Truck	→	→	Kampong Speu	2,114		0
	SHV	Truck	→	→	Takeo	11,478		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	1,176	60%	706
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	9,909	60%	5,945
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	12,937	60%	7,762
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	29,108	60%	17,465
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	2,774	60%	1,664
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	6,703	60%	4,022
					Total	198,395		91,504

(10) Agriculture goods: Fertilizer (Import)

The IWT share for Case 0, calculated using Table 5-20, is presented in Table.A 28.

Table.A 28 IWT share for each province (agriculture goods: fertilizer, Case 0)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Fertilizer by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	10,748		0
	SHV	Truck	→	→	Kep	6,860		0
	SHV	Truck	→	→	Koh Kong	686		0
	SHV	Truck	→	→	Preah Sihanouk	457		0
2	Cai Mep	Barge	UM2	Truck	Kampong Thom	8,690	10%	869
	Cai Mep	Barge	UM2	Truck	Kratie	6,403	10%	640
	Cai Mep	Barge	UM2	Truck	Mondul Kiri	4,116	10%	412
	Cai Mep	Barge	UM2	Truck	Preah Vihear	7,546	10%	755
	Cai Mep	Barge	UM2	Truck	Ratanak Kiri	1,829	10%	183
	Cai Mep	Barge	UM2	Truck	Stung Treng	915	10%	91
3	SHV	Truck	→	→	Banteay Meanchey	21,724		0
	SHV	Truck	→	→	Battambang	26,526		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Oddar Meanchey	1,829	10%	183
	SHV	Truck	→	→	Pailin	7,318		0
	SHV	Truck	→	→	Pursat	10,062		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Siem Reap	16,007	10%	1,601
4	Cai Mep	Barge	Kampong Chhnang	Truck	Kampong Chhnang	11,891	10%	1,189
	SHV	Truck	→	→	Kampong Speu	229		0
	SHV	Truck	→	→	Takeo	14,178		0
5	Cai Mep	Barge	UM2	Truck	Kampong Cham	9,604	10%	960
	Cai Mep	Barge	LM26	Truck	Prey Veng	24,468	10%	2,447
	Cai Mep	Barge	LM26	Truck	Svay Rieng	2,058	10%	206
	Cai Mep	Barge	UM2	Truck	Tboung Khmum	15,093	10%	1,509
6	Cai Mep	Barge	PPP	Truck	Kandal	18,980	10%	1,898
	Cai Mep	Barge	PPP	Truck	Phnom Penh	457	10%	46
					Total	228,677		12,989

The IWT share for Case 2, calculated using Table 5-21, is presented in Table.A 29.

Table.A 29 IWT share for each province (agriculture goods: fertilizer, Case 2)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Fertilizer by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	10,748		0
	SHV	Truck	→	→	Kep	6,860		0
	SHV	Truck	→	→	Koh Kong	686		0
	SHV	Truck	→	→	Preah Sihanouk	457		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	8,690	60%	5,214
	Zone 1 seaport	Barge	UM2	Truck	Kratie	6,403	60%	3,842
	Zone 1 seaport	Barge	UM2	Truck	Mondul Kiri	4,116	60%	2,470
	Zone 1 seaport	Barge	UM2	Truck	Preah Vihear	7,546	60%	4,528
	Zone 1 seaport	Barge	UM2	Truck	Ratanak Kiri	1,829	60%	1,098
	Zone 1 seaport	Barge	UM2	Truck	Stung Treng	915	60%	549
3	SHV	Truck	→	→	Banteay Meanchey	21,724		0
	SHV	Truck	→	→	Battambang	26,526		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Oddar Meanchey	1,829	60%	1,098
	SHV	Truck	→	→	Pailin	7,318		0
	SHV	Truck	→	→	Pursat	10,062		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Siem Reap	16,007	60%	9,604
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	11,891	60%	7,135
	SHV	Truck	→	→	Kampong Speu	229		0
	SHV	Truck	→	→	Takeo	14,178		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	9,604	60%	5,763
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	24,468	60%	14,681
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	2,058	60%	1,235
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	15,093	60%	9,056
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	18,980	60%	11,388
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	457	60%	274
					Total	228,677		77,935

The IWT share for Case 3, calculated using Table 5-22, is presented in Table.A 30.

Table.A 30 IWT share for each province (agriculture goods: fertilizer, Case 3)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Fertilizer by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	10,748		0
	SHV	Truck	→	→	Kep	6,860		0
	SHV	Truck	→	→	Koh Kong	686		0
	SHV	Truck	→	→	Preah Sihanouk	457		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	8,690	60%	5,214
	Zone 1 seaport	Barge	Kratie	Truck	Kratie	6,403	60%	3,842
	Zone 1 seaport	Barge	Kratie	Truck	Mondul Kiri	4,116	60%	2,470
	Zone 1 seaport	Barge	Stung Treng	Truck	Preah Vihear	7,546	60%	4,528
	Zone 1 seaport	Barge	Stung Treng	Truck	Ratanak Kiri	1,829	60%	1,098
	Zone 1 seaport	Barge	Stung Treng	Truck	Stung Treng	915	60%	549
3	Zone 1 seaport	Barge	Chong Khneas	Truck	Banteay Meanchey	21,724	60%	13,035
	Zone 1 seaport	Barge	Chong Khneas	Truck	Battambang	26,526	60%	15,916
	Zone 1 seaport	Barge	Chong Khneas	Truck	Oddar Meanchey	1,829	60%	1,098
	Zone 1 seaport	Barge	Chong Khneas	Truck	Pailin	7,318	60%	4,391
	SHV	Truck	→	→	Pursat	10,062		0
	Zone 1 seaport	Barge	Chong Khneas	Truck	Siem Reap	16,007	60%	9,604
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	11,891	60%	7,135
	SHV	Truck	→	→	Kampong Speu	229		0
	SHV	Truck	→	→	Takeo	14,178		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	9,604	60%	5,763
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	24,468	60%	14,681
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	2,058	60%	1,235
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	15,093	60%	9,056
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	18,980	60%	11,388
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	457	60%	274
					Total	228,677		111,277

(11) Energy: Gasoline (Import)

The IWT share for Case 0, calculated using Table 5-20, is presented in Table.A 31.

Table.A 31 IWT share for each province (energy: gasoline, Case 0)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Gasoline by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	89,719		0
	SHV	Truck	→	→	Kep	6,136		0
	SHV	Truck	→	→	Koh Kong	24,694		0
	SHV	Truck	→	→	Preah Sihanouk	106,662		0
2	Cai Mep	Barge	UM2	Truck	Kampong Thom	78,087	10%	7,809
	Cai Mep	Barge	UM2	Truck	Kratie	46,732	10%	4,673
	Cai Mep	Barge	UM2	Truck	Mondul Kiri	17,133	10%	1,713
	Cai Mep	Barge	UM2	Truck	Preah Vihear	30,496	10%	3,050
	Cai Mep	Barge	UM2	Truck	Ratanak Kiri	32,107	10%	3,211
	Cai Mep	Barge	UM2	Truck	Stung Treng	25,389	10%	2,539
3	SHV	Truck	→	→	Banteay Meanchey	102,816		0
	SHV	Truck	→	→	Battambang	123,888		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Oddar Meanchey	29,387	10%	2,939
	SHV	Truck	→	→	Pailin	13,097		0
	SHV	Truck	→	→	Pursat	61,474		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Siem Reap	107,765	10%	10,776
4	Cai Mep	Barge	Kampong Chhnang	Truck	Kampong Chhnang	77,542	10%	7,754
	SHV	Truck	→	→	Kampong Speu	117,968		0
	SHV	Truck	→	→	Takeo	107,197		0
5	Cai Mep	Barge	UM2	Truck	Kampong Cham	109,675	10%	10,967
	Cai Mep	Barge	LM26	Truck	Prey Veng	97,548	10%	9,755
	Cai Mep	Barge	LM26	Truck	Svay Rieng	80,415	10%	8,041
	Cai Mep	Barge	UM2	Truck	Tboung Khmum	87,200	10%	8,720
6	Cai Mep	Barge	PPP	Truck	Kandal	175,731	10%	17,573
	Cai Mep	Barge	PPP	Truck	Phnom Penh	956,464	10%	95,646
					Total	2,705,322		195,166

The IWT share for Case 2, calculated using Table 5-21, is presented in Table.A 32.

Table.A 32 IWT share for each province (energy: gasoline, Case 2)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Gasoline by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	89,719		0
	SHV	Truck	→	→	Kep	6,136		0
	SHV	Truck	→	→	Koh Kong	24,694		0
	SHV	Truck	→	→	Preah Sihanouk	106,662		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	78,087	60%	46,852
	Zone 1 seaport	Barge	UM2	Truck	Kratie	46,732	60%	28,039
	Zone 1 seaport	Barge	UM2	Truck	Mondul Kiri	17,133	60%	10,280
	Zone 1 seaport	Barge	UM2	Truck	Preah Vihear	30,496	60%	18,297
	Zone 1 seaport	Barge	UM2	Truck	Ratanak Kiri	32,107	60%	19,264
	Zone 1 seaport	Barge	UM2	Truck	Stung Treng	25,389	60%	15,234
3	SHV	Truck	→	→	Banteay Meanchey	102,816		0
	SHV	Truck	→	→	Battambang	123,888		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Oddar Meanchey	29,387	60%	17,632
	SHV	Truck	→	→	Pailin	13,097		0
	SHV	Truck	→	→	Pursat	61,474		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Siem Reap	107,765	60%	64,659
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	77,542	60%	46,525
	SHV	Truck	→	→	Kampong Speu	117,968		0
	SHV	Truck	→	→	Takeo	107,197		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	109,675	60%	65,805
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	97,548	60%	58,529
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	80,415	60%	48,249
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	87,200	60%	52,320
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	175,731	60%	105,439
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	956,464	60%	573,878
					Total	2,705,322		1,171,002

The IWT share for Case 3, calculated using Table 5-22, is presented in Table.A 33.

Table.A 33 IWT share for each province (energy: gasoline, Case 3)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Gasoline by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	89,719		0
	SHV	Truck	→	→	Kep	6,136		0
	SHV	Truck	→	→	Koh Kong	24,694		0
	SHV	Truck	→	→	Preah Sihanouk	106,662		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	78,087	60%	46,852
	Zone 1 seaport	Barge	Kratie	Truck	Kratie	46,732	60%	28,039
	Zone 1 seaport	Barge	Kratie	Truck	Mondul Kiri	17,133	60%	10,280
	Zone 1 seaport	Barge	Stung Treng	Truck	Preah Vihear	30,496	60%	18,297
	Zone 1 seaport	Barge	Stung Treng	Truck	Ratanak Kiri	32,107	60%	19,264
	Zone 1 seaport	Barge	Stung Treng	Truck	Stung Treng	25,389	60%	15,234
3	Zone 1 seaport	Barge	Chong Khneas	Truck	Banteay Meanchey	102,816	60%	61,690
	Zone 1 seaport	Barge	Chong Khneas	Truck	Battambang	123,888	60%	74,333
	Zone 1 seaport	Barge	Chong Khneas	Truck	Oddar Meanchey	29,387	60%	17,632
	Zone 1 seaport	Barge	Chong Khneas	Truck	Pailin	13,097	60%	7,858
	SHV	Truck	→	→	Pursat	61,474		0
	Zone 1 seaport	Barge	Chong Khneas	Truck	Siem Reap	107,765	60%	64,659
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	77,542	60%	46,525
	SHV	Truck	→	→	Kampong Speu	117,968		0
	SHV	Truck	→	→	Takeo	107,197		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	109,675	60%	65,805
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	97,548	60%	58,529
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	80,415	60%	48,249
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	87,200	60%	52,320
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	175,731	60%	105,439
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	956,464	60%	573,878
					Total	2,705,322		1,314,883

(12) Energy: Diesel (Import)

The IWT share for Case 0, calculated using Table 5-20, is presented in Table.A 34.

Table.A 34 IWT share for each province (energy: diesel, Case 0)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Diesel by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	190,293		0
	SHV	Truck	→	→	Kep	13,015		0
	SHV	Truck	→	→	Koh Kong	52,377		0
	SHV	Truck	→	→	Preah Sihanouk	226,229		0
2	Cai Mep	Barge	UM2	Truck	Kampong Thom	165,622	10%	16,562
	Cai Mep	Barge	UM2	Truck	Kratie	99,118	10%	9,912
	Cai Mep	Barge	UM2	Truck	Mondul Kiri	36,339	10%	3,634
	Cai Mep	Barge	UM2	Truck	Preah Vihear	64,681	10%	6,468
	Cai Mep	Barge	UM2	Truck	Ratanak Kiri	68,099	10%	6,810
	Cai Mep	Barge	UM2	Truck	Stung Treng	53,850	10%	5,385
3	SHV	Truck	→	→	Banteay Meanchey	218,072		0
	SHV	Truck	→	→	Battambang	262,765		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Oddar Meanchey	62,330	10%	6,233
	SHV	Truck	→	→	Pailin	27,778		0
	SHV	Truck	→	→	Pursat	130,385		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Siem Reap	228,567	10%	22,857
4	Cai Mep	Barge	Kampong Chhnang	Truck	Kampong Chhnang	164,465	10%	16,446
	SHV	Truck	→	→	Kampong Speu	250,208		0
	SHV	Truck	→	→	Takeo	227,363		0
5	Cai Mep	Barge	UM2	Truck	Kampong Cham	232,619	10%	23,262
	Cai Mep	Barge	LM26	Truck	Prey Veng	206,897	10%	20,690
	Cai Mep	Barge	LM26	Truck	Svay Rieng	170,559	10%	17,056
	Cai Mep	Barge	UM2	Truck	Tboung Khmum	184,951	10%	18,495
6	Cai Mep	Barge	PPP	Truck	Kandal	372,723	10%	37,272
	Cai Mep	Barge	PPP	Truck	Phnom Penh	2,028,647	10%	202,865
					Total	5,737,951		413,947

The IWT share for Case 2, calculated using Table 5-21, is presented in Table.A 35.

Table.A 35 IWT share for each province (energy: diesel, Case 2)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Diesel by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	190,293		0
	SHV	Truck	→	→	Kep	13,015		0
	SHV	Truck	→	→	Koh Kong	52,377		0
	SHV	Truck	→	→	Preah Sihanouk	226,229		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	165,622	60%	99,373
	Zone 1 seaport	Barge	UM2	Truck	Kratie	99,118	60%	59,471
	Zone 1 seaport	Barge	UM2	Truck	Mondul Kiri	36,339	60%	21,803
	Zone 1 seaport	Barge	UM2	Truck	Preah Vihear	64,681	60%	38,809
	Zone 1 seaport	Barge	UM2	Truck	Ratanak Kiri	68,099	60%	40,859
	Zone 1 seaport	Barge	UM2	Truck	Stung Treng	53,850	60%	32,310
3	SHV	Truck	→	→	Banteay Meanchey	218,072		0
	SHV	Truck	→	→	Battambang	262,765		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Oddar Meanchey	62,330	60%	37,398
	SHV	Truck	→	→	Pailin	27,778		0
	SHV	Truck	→	→	Pursat	130,385		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Siem Reap	228,567	60%	137,140
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	164,465	60%	98,679
	SHV	Truck	→	→	Kampong Speu	250,208		0
	SHV	Truck	→	→	Takeo	227,363		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	232,619	60%	139,571
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	206,897	60%	124,138
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	170,559	60%	102,335
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	184,951	60%	110,971
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	372,723	60%	223,634
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	2,028,647	60%	1,217,188
					Total	5,737,951		2,483,679

The IWT share for Case 3, calculated using Table 5-22, is presented in Table.A 36.

Table.A 36 IWT share for each province (energy: diesel, Case 3)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Diesel by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	190,293		0
	SHV	Truck	→	→	Kep	13,015		0
	SHV	Truck	→	→	Koh Kong	52,377		0
	SHV	Truck	→	→	Preah Sihanouk	226,229		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	165,622	60%	99,373
	Zone 1 seaport	Barge	Kratie	Truck	Kratie	99,118	60%	59,471
	Zone 1 seaport	Barge	Kratie	Truck	Mondul Kiri	36,339	60%	21,803
	Zone 1 seaport	Barge	Stung Treng	Truck	Preah Vihear	64,681	60%	38,809
	Zone 1 seaport	Barge	Stung Treng	Truck	Ratanak Kiri	68,099	60%	40,859
	Zone 1 seaport	Barge	Stung Treng	Truck	Stung Treng	53,850	60%	32,310
3	Zone 1 seaport	Barge	Chong Khneas	Truck	Banteay Meanchey	218,072	60%	130,843
	Zone 1 seaport	Barge	Chong Khneas	Truck	Battambang	262,765	60%	157,659
	Zone 1 seaport	Barge	Chong Khneas	Truck	Oddar Meanchey	62,330	60%	37,398
	Zone 1 seaport	Barge	Chong Khneas	Truck	Pailin	27,778	60%	16,667
	SHV	Truck	→	→	Pursat	130,385		0
	Zone 1 seaport	Barge	Chong Khneas	Truck	Siem Reap	228,567	60%	137,140
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	164,465	60%	98,679
	SHV	Truck	→	→	Kampong Speu	250,208		0
	SHV	Truck	→	→	Takeo	227,363		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	232,619	60%	139,571
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	206,897	60%	124,138
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	170,559	60%	102,335
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	184,951	60%	110,971
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	372,723	60%	223,634
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	2,028,647	60%	1,217,188
					Total	5,737,951		2,788,848

(13) Energy: LPG (Import)

The IWT share for Case 0, calculated using Table 5-20, is presented in Table.A 37.

Table.A 37 IWT share for each province (energy: LPG, Case 0)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of LPG by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	148,269		0
	SHV	Truck	→	→	Kep	10,141		0
	SHV	Truck	→	→	Koh Kong	40,810		0
	SHV	Truck	→	→	Preah Sihanouk	176,268		0
2	Cai Mep	Barge	UM2	Truck	Kampong Thom	129,046	10%	12,905
	Cai Mep	Barge	UM2	Truck	Kratie	77,229	10%	7,723
	Cai Mep	Barge	UM2	Truck	Mondul Kiri	28,314	10%	2,831
	Cai Mep	Barge	UM2	Truck	Preah Vihear	50,397	10%	5,040
	Cai Mep	Barge	UM2	Truck	Ratanak Kiri	53,060	10%	5,306
	Cai Mep	Barge	UM2	Truck	Stung Treng	41,958	10%	4,196
3	SHV	Truck	→	→	Banteay Meanchey	169,913		0
	SHV	Truck	→	→	Battambang	204,736		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Oddar Meanchey	48,565	10%	4,856
	SHV	Truck	→	→	Pailin	21,644		0
	SHV	Truck	→	→	Pursat	101,590		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Siem Reap	178,090	10%	17,809
4	Cai Mep	Barge	Kampong Chhnang	Truck	Kampong Chhnang	128,144	10%	12,814
	SHV	Truck	→	→	Kampong Speu	194,952		0
	SHV	Truck	→	→	Takeo	177,152		0
5	Cai Mep	Barge	UM2	Truck	Kampong Cham	181,247	10%	18,125
	Cai Mep	Barge	LM26	Truck	Prey Veng	161,206	10%	16,121
	Cai Mep	Barge	LM26	Truck	Svay Rieng	132,892	10%	13,289
	Cai Mep	Barge	UM2	Truck	Tboung Khmum	144,106	10%	14,411
6	Cai Mep	Barge	PPP	Truck	Kandal	290,410	10%	29,041
	Cai Mep	Barge	PPP	Truck	Phnom Penh	1,580,639	10%	158,064
					Total	4,470,776		322,531

The IWT share for Case 2, calculated using Table 5-21, is presented in Table.A 38.

Table.A 38 IWT share for each province (energy: LPG, Case 2)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of LPG by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	148,269		0
	SHV	Truck	→	→	Kep	10,141		0
	SHV	Truck	→	→	Koh Kong	40,810		0
	SHV	Truck	→	→	Preah Sihanouk	176,268		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	129,046	60%	77,427
	Zone 1 seaport	Barge	UM2	Truck	Kratie	77,229	60%	46,337
	Zone 1 seaport	Barge	UM2	Truck	Mondul Kiri	28,314	60%	16,988
	Zone 1 seaport	Barge	UM2	Truck	Preah Vihear	50,397	60%	30,238
	Zone 1 seaport	Barge	UM2	Truck	Ratanak Kiri	53,060	60%	31,836
	Zone 1 seaport	Barge	UM2	Truck	Stung Treng	41,958	60%	25,175
3	SHV	Truck	→	→	Banteay Meanchey	169,913		0
	SHV	Truck	→	→	Battambang	204,736		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Oddar Meanchey	48,565	60%	29,139
	SHV	Truck	→	→	Pailin	21,644		0
	SHV	Truck	→	→	Pursat	101,590		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Siem Reap	178,090	60%	106,854
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	128,144	60%	76,886
	SHV	Truck	→	→	Kampong Speu	194,952		0
	SHV	Truck	→	→	Takeo	177,152		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	181,247	60%	108,748
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	161,206	60%	96,724
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	132,892	60%	79,735
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	144,106	60%	86,464
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	290,410	60%	174,246
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	1,580,639	60%	948,383
					Total	4,470,776		1,935,180

The IWT share for Case 3, calculated using Table 5-22, is presented in Table.A 39.

Table.A 39 IWT share for each province (energy: LPG, Case 3)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of LPG by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	148,269		0
	SHV	Truck	→	→	Kep	10,141		0
	SHV	Truck	→	→	Koh Kong	40,810		0
	SHV	Truck	→	→	Preah Sihanouk	176,268		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	129,046	60%	77,427
	Zone 1 seaport	Barge	Kratie	Truck	Kratie	77,229	60%	46,337
	Zone 1 seaport	Barge	Kratie	Truck	Mondul Kiri	28,314	60%	16,988
	Zone 1 seaport	Barge	Stung Treng	Truck	Preah Vihear	50,397	60%	30,238
	Zone 1 seaport	Barge	Stung Treng	Truck	Ratanak Kiri	53,060	60%	31,836
	Zone 1 seaport	Barge	Stung Treng	Truck	Stung Treng	41,958	60%	25,175
3	Zone 1 seaport	Barge	Chong Khneas	Truck	Banteay Meanchey	169,913	60%	101,948
	Zone 1 seaport	Barge	Chong Khneas	Truck	Battambang	204,736	60%	122,841
	Zone 1 seaport	Barge	Chong Khneas	Truck	Oddar Meanchey	48,565	60%	29,139
	Zone 1 seaport	Barge	Chong Khneas	Truck	Pailin	21,644	60%	12,986
	SHV	Truck	→	→	Pursat	101,590		0
	Zone 1 seaport	Barge	Chong Khneas	Truck	Siem Reap	178,090	60%	106,854
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	128,144	60%	76,886
	SHV	Truck	→	→	Kampong Speu	194,952		0
	SHV	Truck	→	→	Takeo	177,152		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	181,247	60%	108,748
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	161,206	60%	96,724
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	132,892	60%	79,735
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	144,106	60%	86,464
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	290,410	60%	174,246
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	1,580,639	60%	948,383
					Total	4,470,776		2,172,955

(14) Energy: Lubricant (Import)

The IWT share for Case 0, calculated using Table 5-20, is presented in Table.A 40.

Table.A 40 IWT share for each province (energy: lubricant, Case 0)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Lubricant by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	739		0
	SHV	Truck	→	→	Kep	51		0
	SHV	Truck	→	→	Koh Kong	203		0
	SHV	Truck	→	→	Preah Sihanouk	879		0
2	Cai Mep	Barge	UM2	Truck	Kampong Thom	643	10%	64
	Cai Mep	Barge	UM2	Truck	Kratie	385	10%	38
	Cai Mep	Barge	UM2	Truck	Mondul Kiri	141	10%	14
	Cai Mep	Barge	UM2	Truck	Preah Vihear	251	10%	25
	Cai Mep	Barge	UM2	Truck	Ratanak Kiri	264	10%	26
	Cai Mep	Barge	UM2	Truck	Stung Treng	209	10%	21
3	SHV	Truck	→	→	Banteay Meanchey	847		0
	SHV	Truck	→	→	Battambang	1,021		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Oddar Meanchey	242	10%	24
	SHV	Truck	→	→	Pailin	108		0
	SHV	Truck	→	→	Pursat	506		0
	Cai Mep	Barge	Kampong Chhnang	Truck	Siem Reap	888	10%	89
4	Cai Mep	Barge	Kampong Chhnang	Truck	Kampong Chhnang	639	10%	64
	SHV	Truck	→	→	Kampong Speu	972		0
	SHV	Truck	→	→	Takeo	883		0
5	Cai Mep	Barge	UM2	Truck	Kampong Cham	903	10%	90
	Cai Mep	Barge	LM26	Truck	Prey Veng	804	10%	80
	Cai Mep	Barge	LM26	Truck	Svay Rieng	662	10%	66
	Cai Mep	Barge	UM2	Truck	Tboung Khmum	718	10%	72
6	Cai Mep	Barge	PPP	Truck	Kandal	1,448	10%	145
	Cai Mep	Barge	PPP	Truck	Phnom Penh	7,879	10%	788
					Total	22,286		1,606

The IWT share for Case 2, calculated using Table 5-21, is presented in Table.A 41.

Table.A 41 IWT share for each province (energy: lubricant, Case 2)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Lubricant by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	739		0
	SHV	Truck	→	→	Kep	51		0
	SHV	Truck	→	→	Koh Kong	203		0
	SHV	Truck	→	→	Preah Sihanouk	879		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	643	60%	386
	Zone 1 seaport	Barge	UM2	Truck	Kratie	385	60%	231
	Zone 1 seaport	Barge	UM2	Truck	Mondul Kiri	141	60%	85
	Zone 1 seaport	Barge	UM2	Truck	Preah Vihear	251	60%	151
	Zone 1 seaport	Barge	UM2	Truck	Ratanak Kiri	264	60%	159
	Zone 1 seaport	Barge	UM2	Truck	Stung Treng	209	60%	125
3	SHV	Truck	→	→	Banteay Meanchey	847		0
	SHV	Truck	→	→	Battambang	1,021		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Oddar Meanchey	242	60%	145
	SHV	Truck	→	→	Pailin	108		0
	SHV	Truck	→	→	Pursat	506		0
	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Siem Reap	888	60%	533
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	639	60%	383
	SHV	Truck	→	→	Kampong Speu	972		0
	SHV	Truck	→	→	Takeo	883		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	903	60%	542
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	804	60%	482
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	662	60%	397
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	718	60%	431
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	1,448	60%	869
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	7,879	60%	4,727
					Total	22,286		9,646

The IWT share for Case 3, calculated using Table 5-22, is presented in Table.A 42.

Table.A 42 IWT share for each province (energy: lubricant, Case 3)

Zone	First port	Transport mean	Second port	Transport mean	Province	Estimation volume of Lubricant by province in 2050 (ton)	IWT share	IWT volume (ton)
1	SHV	Truck	→	→	Kampot	739		0
	SHV	Truck	→	→	Kep	51		0
	SHV	Truck	→	→	Koh Kong	203		0
	SHV	Truck	→	→	Preah Sihanouk	879		0
2	Zone 1 seaport	Barge	UM2	Truck	Kampong Thom	643	60%	386
	Zone 1 seaport	Barge	Kratie	Truck	Kratie	385	60%	231
	Zone 1 seaport	Barge	Kratie	Truck	Mondul Kiri	141	60%	85
	Zone 1 seaport	Barge	Stung Treng	Truck	Preah Vihear	251	60%	151
	Zone 1 seaport	Barge	Stung Treng	Truck	Ratanak Kiri	264	60%	159
	Zone 1 seaport	Barge	Stung Treng	Truck	Stung Treng	209	60%	125
3	Zone 1 seaport	Barge	Chong Khneas	Truck	Banteay Meanchey	847	60%	508
	Zone 1 seaport	Barge	Chong Khneas	Truck	Battambang	1,021	60%	612
	Zone 1 seaport	Barge	Chong Khneas	Truck	Oddar Meanchey	242	60%	145
	Zone 1 seaport	Barge	Chong Khneas	Truck	Pailin	108	60%	65
	SHV	Truck	→	→	Pursat	506		0
	Zone 1 seaport	Barge	Chong Khneas	Truck	Siem Reap	888	60%	533
4	Zone 1 seaport	Barge	Kampong Chhnang	Truck	Kampong Chhnang	639	60%	383
	SHV	Truck	→	→	Kampong Speu	972		0
	SHV	Truck	→	→	Takeo	883		0
5	Zone 1 seaport	Barge	UM2	Truck	Kampong Cham	903	60%	542
	Zone 1 seaport	Barge	LM26	Truck	Prey Veng	804	60%	482
	Zone 1 seaport	Barge	LM26	Truck	Svay Rieng	662	60%	397
	Zone 1 seaport	Barge	UM2	Truck	Tboung Khmum	718	60%	431
6	Zone 1 seaport	Barge	PPP	Truck	Kandal	1,448	60%	869
	Zone 1 seaport	Barge	PPP	Truck	Phnom Penh	7,879	60%	4,727
					Total	22,286		10,831

Appendix-4 The number of vessels per day navigating (Case 2)

(1) Between UM2 and upper Phnom Penh port

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: UM2 and upper Phnom Penh port

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	230,237	283,309	631	777	3	4	7

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	79,614	0	219	0	1	0	1
Raw rubber	54,597	0	150	0	1	0	1
Cereal&Fertilizer	0	80,258	0	220	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	0	0	0	0	0	0	0
Energey	0	1,224,581	0	3,356	0	2	2
Total	31,838,867	1,304,839	87,232	3,576	31	3	34

Grand total			
	34	7	41

(2) Between Kampong Chhnang and upper Phnom Penh port

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Kampong Chhnang and upper Phnom Penh port

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	135,264	193,345	371	530	2	3	5

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	173,129	0	475	0	1	0	1
Raw rubber	696	0	2	0	1	0	1
Cereal&Fertilizer	0	32,113	0	88	0	1	1
Mineral resources	0	0	0	0	0	0	0
River sand	0	0	0	0	0	0	0
Energey	0	615,973	0	1,688	0	1	1
Total	173,825	648,086	477	1,776	2	2	4

Grand total			
	4	5	9

(3) Upper side of Phnom Penh port

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Upper side of Phnom Penh port

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	365,501	476,384	1,002	1,306	5	6	11

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	252,743	0	693	0	1	0	1
Raw rubber	55,293	0	152	0	1	0	1
Cereal&Fertilizer	0	112,371	0	308	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	0	0	0	0	0	0	0
Energey	0	1,840,554	0	5,043	0	2	2
Total	32,012,692	1,952,925	87,708	5,351	31	3	34

Grand total			
	36	9	45

(4) Between Phnom Penh port and upper mouth of the Funan Techo Canal

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Phnom Penh port and upper mouth of the Funan Techo Canal

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	1,350,768	1,440,289	3,701	3,946	15	16	31

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	319,624	0	876	0	1	0	1
Raw rubber	55,293	0	152	0	1	0	1
Cereal&Fertilizer	0	129,719	0	356	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	45,000,000	0	123,288	0	42	0	42
Energey	0	5,088,918	0	13,943	0	5	5
Total	77,079,573	5,218,637	211,179	14,299	73	6	79

Grand total			
	88	22	110

(5) Between upper mouth of the Funan Techo Canal and LM26

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Upper mouth of the Funan Techo Canal and LM26

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	286,038	110,430	784	303	4	2	6
	144,167	116,934	395	321	2	2	4
Total	430,205	227,364	1,179	624	6	4	10

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	319,624	0	876	0	1	0	1
Raw rubber	811	0	3	0	1	0	1
Cereal&Fertilizer	0	29,623	0	82	0	1	1
Mineral resources	0	0	0	0	0	0	0
River sand	45,000,000	0	123,288	0	42	0	42
Energey	0	510,589	0	1,399	0	1	1
Total	45,320,435	540,212	124,167	1,481	44	2	46

Grand total			
	50	6	56

(6) Between LM26 and the Vietnam border

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: LM26 and the Vietnam border

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	310,421	121,704	851	334	4	2	6

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	395,840	0	1,085	0	1	0	1
Raw rubber	0	0	0	0	0	0	0
Cereal&Fertilizer	0	0	0	0	0	0	0
Mineral resources	0	0	0	0	0	0	0
River sand	45,000,000	0	123,288	0	42	0	42
Energey	0	0	0	0	0	0	0
Total	45,395,840	0	124,373	0	43	0	43

Grand total			
	47	2	49

(7) The Funan Techo Canal

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: The Funan Techo Canal

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	1,181,664	1,474,027	3,238	4,039	13	17	30

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	0	0	0	0	0	0	0
Raw rubber	56,104	0	154	0	1	0	1
Cereal&Fertilizer	0	159,342	0	437	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	0	0	0	0	0	0	0
Energey	0	5,599,507	0	15,342	0	6	6
Total	31,760,760	5,758,849	87,017	15,779	30	7	37

Grand total			43	24	67

Appendix-5 The number of vessels per day navigating (Case 3)

(1) Between Stung Treng and Kratie

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Stung Treng and Kratie

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	45,548	35,083	125	97	1	1	2

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	68,046	0	187	0	1	0	1
Raw rubber	4,694	0	13	0	1	0	1
Cereal&Fertilizer	0	26,381	0	73	0	1	1
Mineral resources	9,540,012	0	26,138	0	9	0	9
River sand	0	0	0	0	0	0	0
Energey	0	252,457	0	692	0	1	1
Total	9,612,752	278,838	26,338	765	11	2	13

Grand total			
	12	3	15

(2) Between Kratie and UM2

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Kratie and UM2

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	154,827	101,312	425	278	2	2	4

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	111,181	0	305	0	1	0	1
Raw rubber	18,410	0	51	0	1	0	1
Cereal&Fertilizer	0	39,941	0	110	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	0	0	0	0	0	0	0
Energey	0	435,691	0	1,194	0	1	1
Total	31,834,247	475,632	87,219	1,304	31	2	33

Grand total			
	33	4	37

(3) Between UM2 and upper Phnom Penh port

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: UM2 and upper Phnom Penh port

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	296,563	307,133	813	842	4	4	8

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	477,686	0	1,309	0	1	0	1
Raw rubber	54,597	0	150	0	1	0	1
Cereal&Fertilizer	0	80,258	0	220	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	0	0	0	0	0	0	0
Energey	0	1,224,581	0	3,356	0	2	2
Total	32,236,939	1,304,839	88,322	3,576	31	3	34

Grand total			
	35	7	42

(4) Between Chong Khneas and Kampong Chhnang

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Chong Khneas and Kampong Chhnang

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	165,701	213,758	454	586	2	3	5

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	744,555	0	2,040	0	1	0	1
Raw rubber	1,075	0	3	0	1	0	1
Cereal&Fertilizer	0	67,453	0	185	0	1	1
Mineral resources	0	0	0	0	0	0	0
River sand	0	0	0	0	0	0	0
Energey	0	1,081,510	0	2,964	0	1	1
Total	745,630	1,148,963	2,043	3,149	2	2	4

Grand total			
	4	5	9

(5) Between Kampong Chhnang and upper Phnom Penh port

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Kampong Chhnang and upper Phnom Penh port

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	255,119	354,569	699	972	3	4	7

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	1,038,776	0	2,846	0	1	0	1
Raw rubber	1,168	0	4	0	1	0	1
Cereal&Fertilizer	0	75,552	0	207	0	1	1
Mineral resources	0	0	0	0	0	0	0
River sand	0	0	0	0	0	0	0
Energey	0	1,303,983	0	3,573	0	2	2
Total	1,039,944	1,379,535	2,850	3,780	2	3	5

Grand total			
	5	7	12

(6) Upper side of Phnom Penh port

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Upper side of Phnom Penh port

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	551,682	661,702	1,512	1,813	7	8	15

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	1,516,462	0	4,155	0	2	0	2
Raw rubber	55,765	0	153	0	1	0	1
Cereal&Fertilizer	0	155,810	0	427	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	0	0	0	0	0	0	0
Energey	0	2,528,564	0	6,928	0	3	3
Total	33,276,883	2,684,374	91,171	7,355	32	4	36

Grand total			
	39	12	51

(7) Between Phnom Penh port and upper mouth of the Funan Techo Canal

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Phnom Penh port and upper mouth of the Funan Techo Canal

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	1,478,957	1,566,466	4,052	4,292	17	18	35

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	1,917,751	0	5,255	0	2	0	2
Raw rubber	55,765	0	153	0	1	0	1
Cereal&Fertilizer	0	173,158	0	475	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	45,000,000	0	123,288	0	42	0	42
Energey	0	5,776,928	0	15,828	0	6	6
Total	78,678,172	5,950,086	215,559	16,303	74	7	81

Grand total			
91	25	116	

(8) Between upper mouth of the Funan Techo Canal and LM26

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: Upper mouth of the Funan Techo Canal and LM26

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	298,429	120,114	818	330	4	2	6
	122,358	92,271	336	253	2	2	4
Total	420,787	212,385	1,154	583	6	4	10

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	1,917,751	0	5,255	0	2	0	2
Raw rubber	811	0	3	0	1	0	1
Cereal&Fertilizer	0	29,623	0	82	0	1	1
Mineral resources	0	0	0	0	0	0	0
River sand	45,000,000	0	123,288	0	42	0	42
Energey	0	510,589	0	1,399	0	1	1
Total	46,918,562	540,212	128,546	1,481	45	2	47

Grand total			
51	6	57	

(9) Between LM26 and the Vietnam border

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: LM26 and the Vietnam border

	TEU base cargo volume (d)		Daily cargo volume (e) = (d) /(a)		The number of daily vessels traffic (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	319,942	129,641	877	356	4	2	6

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	2,375,046	0	6,507	0	3	0	3
Raw rubber	0	0	0	0	0	0	0
Cereal&Fertilizer	0	0	0	0	0	0	0
Mineral resources	0	0	0	0	0	0	0
River sand	45,000,000	0	123,288	0	42	0	42
Energey	0	0	0	0	0	0	0
Total	47,375,046	0	129,795	0	45	0	45

Grand total			
	49	2	51

(10) The Funan Techo Canal

Estimate condition		
Operating days (a)	365	days / year
Load capacity (b)	250	TEU / container vessel
Load capacity (c)	3,000	ton / bulk carrier

Stretch: The Funan Techo Canal

	TEU base traffic volume (d)		Traffic volume per day (e) = (d) / (a)		Number of vessels per day (f) = (e) / (b)		
	Export (TEU)	Import (TEU)	Export (TEU)	Import (TEU)	Export	Import	Total
Container	1,272,800	1,568,710	3,488	4,298	14	18	32

	Weight base cargo volume (g)		Daily cargo volume (h) = (g) / (a)		The number of daily vessels traffic (i) = (h) / (c)		
	Export (ton)	Import (ton)	Export (ton)	Import (ton)	Export	Import	Total
Paddy	0	0	0	0	0	0	0
Raw rubber	56,576	0	156	0	1	0	1
Cereal&Fertilizer	0	202,781	0	556	0	1	1
Mineral resources	31,704,656	0	86,863	0	29	0	29
River sand	0	0	0	0	0	0	0
Energey	0	6,287,517	0	17,227	0	6	6
Total	31,761,232	6,490,298	87,019	17,783	30	7	37

Grand total			
	44	25	69