TRI COUNTRY SCRUTINY OF THE IMPACT OF GREEN CARGO TRANSPORT WITH SPECIAL EMPHASIS ON THE LINKAGE TO ECONOMIC STRAIN

Leonard Christopher Johnstone

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Civil, Transportation and Geo-resources Engineering

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การพิจารณาการขนส่งแบบเป็นมิตรต่อสิ่งแวดล้อมของ 3 ประเทศ ที่ส่งผลต่อความสำคัญของการเชื่อมต่อด้านความเครียดทางเศรษฐกิจ

นายลีโอนาร์ด คริสโตเฟอร์ จอห์นสโตน

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรดุษฎีบัณฑิต
สาขาวิชาวิศวกรรมโยธา ขนส่ง และทรัพยากรธรณี
มหาวิทยาลัยเทคโนโลยีสุรนารี
ปีการศึกษา 2562

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Suranaree University of Technology has approved this thesis submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

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____

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ลีโอนาร์ด คริสโตเฟอร์ จอห์นสโตน : การพิจารณาการขนส่งแบบเป็นมิตรต่อสิ่งแวดล้อมของ 3 ประเทศ ที่ส่งผลต่อความสำคัญของการเชื่อมต่อด้านความเครียดทางเศรษฐกิจ (TRI COUNTRY SCRUTINY OF THE IMPACT OF GREEN CARGO TRANSPORT WITH SPECIAL EMPHASIS ON THE LINKAGE TO ECONOMIC STRAIN) อาจารย์ที่ปรึกษา : ศาสตราจารย์ ดร.วัฒนวงศ์ รัตนวราห, 130 หน้า.

การวิจัยนี้มีวัตถุประสงค์เพื่อระบุแนวโน้มของสมการการเกิดขึ้นของปริมาณการผลิตสินค้าและการวิเคราะห์การเปลี่ยนรูปแบบการขนส่งในระดับกลุ่มของประเภทสินค้าของพื้นที่ทางภูมิศาสตร์ต่าง ๆ ในระดับประเทศของพื้นที่โดยตั้งใจเพื่อระบุแนวโน้มและตั้งสมมติฐานลักษณะร่วมของแต่ละรูปแบบการขนส่ง ซึ่งจะนำไปสู่ความต้องการทางด้านโครงสร้างพื้นฐานที่จะรองรับโดยคำนึงถึงข้อจำกัดทางเศรษฐกิจของแต่ละประเทศในแต่ละพื้นที่ร่วมด้วย

ข้อจำกัดทางด้านเศรษฐกิจจะถูกระบุในแง่ของขนาดและลักษณะของโครงสร้างพื้นฐานที่ต้องการ ในส่วนมูลค่าของโครงสร้างพื้นฐานที่ต้องการดังกล่าวจะไม่รวมอยู่ในขอบเขตของการศึกษาของวิทยานิพนธ์นี้ ดังนั้น จึงได้กำหนดความต้องการโครงสร้างพื้นฐานให้รองรับในลักษณะเส้นทางรถไฟที่ต้องมีเพิ่มขึ้นรองรับเป็นทางเลือกเมื่อเทียบกับการเพิ่มความยาวของถนนที่ต้องการเพื่อให้เป็นการเปลี่ยนรูปแบบการขนส่งที่เป็นมิตรกับสิ่งแวดล้อม

งานวิจัยนี้เริ่มต้นจากการมีข้อมูลเชิงลึกที่มีความสำคัญ หลังจากนั้นจึงทำความเข้าใจที่กว้างขึ้นในด้านของผลกระทบในการที่จะทำให้เกิดการเปลี่ยนแปลงรูปแบบการขนส่งจากทางถนนโดยการศึกษาทบทวนในแต่ละแง่มุมอย่างละเอียด

การศึกษาส่วนแรกมุ่งเน้นไปที่ภาวะที่มีข้อจำกัดของการเคลื่อนย้ายสินค้าจากทางถนนไปยังรูปแบบอื่น ๆ โดยเฉพาะอย่างยิ่งเมื่อการมุ่งเน้นการลงทุนโครงสร้างพื้นฐานและการสนับสนุนจากรัฐบาลที่ให้ความสำคัญค่าใช้จ่ายในภาคถนนที่มากกว่าภาคขนส่งอื่น ๆ ในส่วนนี้พื้นที่ทางภูมิศาสตร์ของอียิปต์ถูกใช้เป็นพื้นที่ศึกษา

ในส่วนที่สองของการศึกษาจะมุ่งเน้นที่ภูมิภาคลุ่มแม่น้ำโขง แม้ว่าประเทศไทยจะเป็นศูนย์กลางของภูมิภาคลุ่มแม่น้ำโขง แต่การเติบโตทางเศรษฐกิจในภูมิภาคนี้นั้นยังขึ้นอยู่กับการขนส่งเคลื่อนย้ายสินค้าข้ามภูมิภาค โดยในตอนนี้ประเทศไทยกำลังสร้างโครงสร้างพื้นฐานทางรถไฟที่สำคัญเพิ่มเติม จึงนำมาสู่ความความจำเป็นที่จะต้องพิจารณาให้ความสำคัญกับรูปแบบการขนส่งอื่น ๆ นอกเหนือจากถนน

ส่วนสุดท้ายการศึกษามุ่งเน้นไปที่การเปรียบเทียบระหว่างเศรษฐกิจของประเทศกำลังพัฒนา ได้แก่อียิปต์และภูมิภาคลุ่มแม่น้ำโขงกับเศรษฐกิจของประเทศที่พัฒนาแล้วของรัฐ

แลนด์ในประเทศออสเตรเลีย ในท้ายที่สุดของการนำเสนอข้อมูลอันจะรวมไปถึงทิศทางการวิจัยต่อในอนาคต

สาขาวิชา วิศวกรรมขนส่ง

ปีการศึกษา 2562

ลายมือชื่อนักศึกษา L.C. Johnstone.

ลายมือชื่ออาจารย์ที่ปรึกษา____________

LEONARD CHRISTOPHER JOHNSTONE : TRI COUNTRY SCRUTINY OF THE IMPACT OF GREEN CARGO TRANSPORT WITH SPECIAL EMPHASIS ON THE LINKAGE TO ECONOMIC STRAIN. THESIS ADVISOR : PROF. VATANAVONGS RATANAVARAHA, Ph.D., 130 PP.

MEKONG/GDP/CARGO/ TRANSPORT MODE/LOGIT MODEL

The purpose of the research is to identify within these commodity groupings common trends in the generation equations and modal shift analysis across different geographical regions. above mentioned localities. The intention is to identify the common trend and hypothesize the general format of a modal whilst at the same time designating the potential requirement in infrastructure which may lead to economic strain within the locality.

The economic strain is identified in the size and nature of the required infrastructure. Costing of said infrastructure is not included within the scope of this thesis. It is, however, possible to identify infrastructure requirements in the form of additional rail track as an alternative to additional kilometers of road space needed in the achievement of green mode shift.

The initial part of this research was to obtain a valuable insight into the broader understanding of the implications in compliance with a modal shift from the road via a thorough literature review.

The first study focused on the dilemma of the shifting of goods movement from the road sector to other sectors especially when the focus on infrastructure investment and government encouragement has an emphasis on the road sector at the

expense of the other transport sectors. In this study, Egypt was used as the geographicalregion.

The focus of the second study was the Mekong region. Whilst Thailand is at the center of the Mekong region, regional economic growth is likely dependent on the movement of freight across the region. Thailand is currently creating significant additional rail infrastructure. It is at this point then there is a need for consideration for the emphasis on transport modes other than the road sector.

The penultimate study focus is on a comparison between the developing economies of Egypt and Mekong with respect to the developed economy in Queensland, a state of Australia. Finally, in the last discussion, information is provided on future research directions.

School of Transportation Engineering   Student's Signature__________

Academic Year 2019   Advisor's Signature__________

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

1.1 Background

In the broader world context, almost all cargo movements are dependent on road transport to some extent. In for example, the European Union as reported (ColliersInternational 2016) cargo movement in 2009 was dominated for example by the road sector. The road modal share for any of the major country members did not fall below sixty percent (ColliersInternational 2016). This was even the case in Germany, even though twelve percent of cargo (ColliersInternational 2016) moves via the mode of inland water. The cargo market is still in Germany dominated by road at sixty five percent. In France, the cargo modal share is eighty percent increasing to eighty five percent in the United Kingdom (ColliersInternational 2016). Whilst the modal share in Italy is just over ninety percent. Thus even in the developed European Union, cargo road transport is the significant mode similar in comparison to developing countries. This dominance of the cargo road sector makes it difficult to realize the objective within the Union to reduce the dependence of cargo movement on road transport.

Thus, the European Union also has a problem with its heavy dependence on road transport. The Agenda 2020 of the European Union (EU) calls for member countries to reduce greenhouse gas emissions and increase renewable energy (Bartocci and Pisani 2013). There is implicit in this agenda within the EU of taxing fuels on road based transport (Bartocci and Pisani 2013), thus encouraging a modal shift away from the dominant road sector. However, in many developing countries, until recently fuel cost for the road sector included subsidy not a fuel tax as is discussed further later.

This research proposal will focus on a hypothesis of cargo transference from the non-green road mode powered directly by hydrocarbons to the friendlier green modes. The hypothesis considers the impact of transference as an example in three localities namely the nation state of Egypt and the Mekong region with a focus on the nation state of Thailand and in the state of Queensland within the nation state of Australia.The three localities stretch across the broad world spectrum as seen in Figure 1.1 Long distance freight as opposes to the urban delivery system is the only freight movement under discussion.

Figure 1.1 The three localities for cargo comparison

The research is to consider in comparison the relative numerical analysis in the determination of cargo generation and modal shift in the above mentioned three localities. The two nation states of Thailand and Egypt with developing economies are considered in detail with reference to the detail of the developed economy of Queensland in Australia. Although cargo generation is different by locality, the intention here is to develop an understanding of the tonnage mode shift to more green efficient modes of transit. Once a tonne of goods has a distribution point, what are the factors that will shift this tonne of cargo towards green friendly transport. There are both network and economic points to consider in this study. Economic impact is considered in the form of additional transport infrastructure resources that are required to facilitate modal shift.

1.2 Purpose of Research

A comparison is problematic across economies because different economies produce different goods. However, if once examines the goods in a grouping fashion, then such an understanding is possible and plausible. A combination of goods via categories is undertaken using the internationally accepted coding of goods.

The Harmonized Commodity Description and Coding Systems (HS) is an international nomenclature for the classification of products. At the international level, and for the purposes of commodity grouping, the Harmonized System (HS) for classifying goods is a six-digit code system. For the purpose of this research, the many combination will be combined together into an overall 5 broad groups roughly that could be considered as agricultural, processed food, chemicals and minerals, agriculturally derived products such as wood and furs and finally a general or miscellaneous grouping as shown in Table 1.1.

The purpose of the research is to identify within these 5 groups common trends in the generation equations and modal shift analysis across the three above mentioned localities. The intention is to identify common trend and hypothesize the general format of a modal whilst at the same time designating the potential requirement in infrastructure which may lead to economic strain within the locality.

The economic strain is identified in the size and nature of required infrastructure. Costing of said infrastructure is not included within the scope of this thesis. It is however possible to identify infrastructure requirements in the form of additional rail track as an alternative to additional kilometers of road space needed in the achievement of green mode shift.

These categorization groupings were a combination of the broader groups developed in earlier work for the analysis of goods movement within Egypt (Johnstone and Ratanavaraha 2017). The original broader 11 groups were agricultural products, foodstuffs and animal fodder, solid mineral fuels, petroleum products, ores and metal waste, metal products, manufactured minerals and building materials, fertilizers, chemicals, machinery, transport equipment and manufactured articles and finally live animals.

Table 1.1 Harmonized code grouping

Overall description	First two digits of HS	Group number
Animal & Animal Products	6-15	1
Vegetable Products	16-24	1
Foodstuffs	25-27	2
Mineral Products	28-38	3
Chemicals & Allied Industries	39-40	3
Plastics / Rubbers	41-43	3
Raw Hides, Skins, Leather, & Furs	44-49	4
Wood & Wood Products	50-63	4
Textiles	64-67	3
Footwear / Headgear	68-71	4
Stone / Glass	72-83	5
Metals	84-85	5
Machinery / Electrical	86-89	5
Transportation	90-97	5
Miscellaneous	6-15	5

1.3 Scope of Research

An example in one of the chosen localities such as the inland container terminal at Lat Krabang adjacent to Bangkok highlights a worrying trend as seen in

Figure 1.2 (Hanaoka and Regmi 2011). In the later part of the previous millennium, actually in 1998, the container share was balanced between road and rail. At the turn of the millennium rail share had reduced to around thirty percent and has not significantly moved higher over the following ten years.

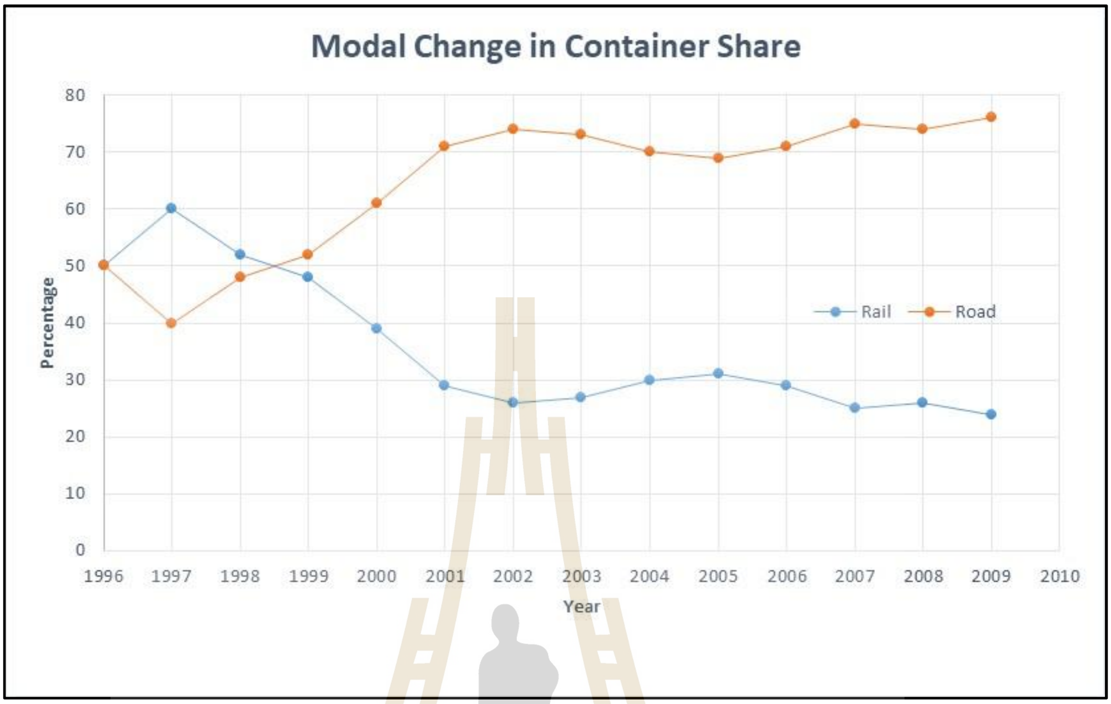

Figure 1.2 A decade of modal shift at Lat krabang Inland container depot

The intention is for the research to identify commonality in estimation of cargo movements by mode in order to understand the structure of modal shift analysis within the localities. One area that will also be considered is the role of institutions in the encouragement of movement of freight by green modes. The most recent Paris Acord of 2016 begins to develop a scientific foundation (Blau 2017) to address the institutional issue of modal shift. The achievement required by the Paris accord is to limit the output of greenhouse emissions. This is unlikely unachievable without the modal shift from non-green cargo transport to green cargo movements.

1.4 Research Question

Although this research will focus on the modal shift aspects, as the focus point of an eventual thesis topic. How is modal shift achieved? It is the likely result of changes in infrastructure or policy such as institutional change. The unique research question is what is needed in the framework environment for achievable mode shift. Is there an identifiable cross locality index that might be identified between localities that may be then applies to other localities? Is such an index dependent on economic parameters such as for example GDP or exchange rates?

1.5 Contribution to knowledge

Previously there is no cross-continental experience in comparison of modal shift and linkage to economic strain including fuel subsidy and the cost of road infrastructure against the opportunity cost for the provision of non- road or greener transport. This research will add to the community knowledge in respect to the awareness on the possibilities of achieving modal shift.

1.6 Organization

This research is divided into 6 chapters as follows:

Chapter I: Introduction mentions the rationale and the importance of the problem objectives and the scope of the study.

Chapter II: The Literature Review: a comprehensive literature review is presented in this chapter.

Chapter III: the Dilemma of the Shifting of Road Freight to Alternatives is the chapter that focuses on the dilemma of the shifting of goods movement from the road sector to other sectors especially when the focus on infrastructure investment and government encouragement has an emphasis towards the road sector at the expense of the other transport sectors. The Model Presented In This discussion That Considered

The Green Shift Away From The Road Sector Was Used In The Preparation Of Future Egyptian Infrastructure Plans. There Is A Detailed Discussion Within This Chapter.

Chapter IV: Green cargo movement, Locality**:** Mekong region across localities is the chapter that considers the process of regional shift. Whilst Thailand is at the center of the Mekong region, regional economic growth likely depends on the movement of freight across the region. it is at this point then there is a need for consideration for the emphasis on transport modes other than the road sector.

Chapter V: Green cargo movement, Multi-jurisdictional commonality is the documentation of comparison in movement patterns of cargo between developed and developing economies using Queensland as an example of a developed economy.

Chapter VI: Conclusion and recommendations. This section concludes the results from chapter III–chapter V and gives suggestions from the findings and discusses future direction of research focus.

Chapters III: through to Chapter V are either published papers or are currently under review for publication.

1.7 References

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CHAPTER II

THE LITERATURE REVIEW

2.1 An overview

An important aspect of transport movement that is somewhat neglected when we think of strategic planning (Kölbl et al. 2008) is the movement of cargo and freight. If not neglected, it is not studied in detail. Strategic planning in transport provides an interlocking linkage within the development of a defined area such as a country or a state. Even in the integrated urban approach of transport planning (May et al. 2006), there is seemingly little treatment of the cargo movement. The focus for the urban area is often only limited to urban development (Hollingsworth et al. 1983) with little understanding of the impact on cargo movement. However, the research in this incidence has a focus on regional or national cargo transport not that which is strictly within the urban boundary.

The future is interwoven with the fabric of the economy, environment and society as illustrated in Figure 2.1. In the development of this research, the intention to examine this in a strategic possibility of how green cargo movement might lead in this direction by examining three different localities in the Middle East, Asia and the Pacific namely Egypt, Thailand and Queensland in Australia within an integrated framework.

The question of the linkage of the three elements of the triangle are also correlated with the environment which brings the association with green transport.

The element of the economy is the linkage to the question of economic stain whereas the society element addresses the question of the appropriate institutions. In the regional sense, integration is important as is highlighted as an example in the air sector. (Tang et al. 2008).

Overall in an analysis of further understanding, transport models are subject to improvement by reference to existing data as long as the original demand flows between localities are robust. If the nature of observed data is not robust, then there are certain issues in using this in the predictive sense. (Johnstone and Prettty 1988).

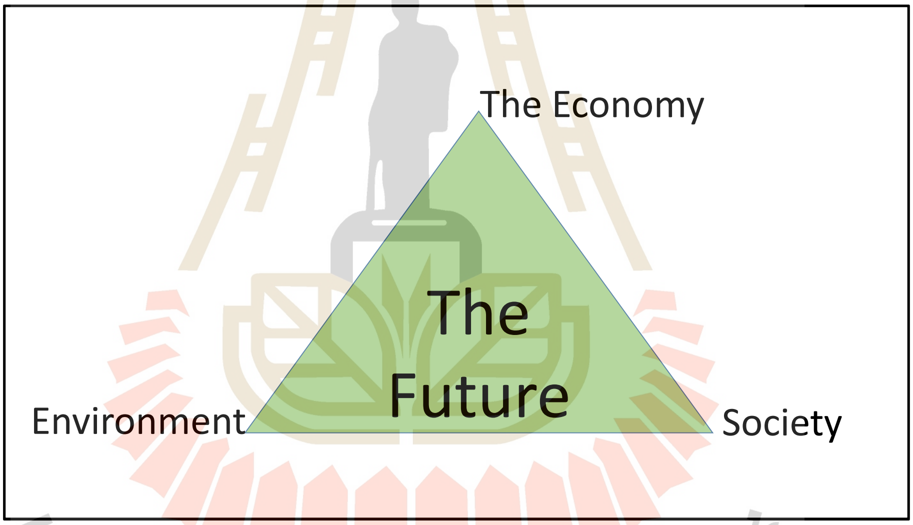

Figure 2.1 The future

Earlier work (Nemoto 2009) within the Mekong region has highlighted the difficulties in the shifting of cargo from the non-road as this is also linked in with logistic chains and in the case of a shipping component of the overall journey with non-national concerns associated with multi-national corporations, the shipping lines.

In the general question of modal shift, there is an issue of reliability linked to the timetabling of both water and rail transport as has already been highlighted by previous work (De Langen and Sharypova 2013). It is possible for the development of a mathematical modelto include consideration including an analysis of an optimum container flow algorithm in modal.The achievement of green transport means that one must achieve good intermodal facilities flows between all three key modes of water, rail and road (Nabais et al. 2015).

2.2 Modal transfer linkage to economic strain

Earlier work (Nemoto 2009) as mentioned earlier within the Mekong region has highlighted the difficulties in the economic stress associated with modal shift. The economic consideration with road freight transport even only that associated with access (Santos et al. 2010) to higher order modes is important. Of particular interest is the work done in India (Donaldson 2010) where the use of principally the nod road corridors has left to both the movement of efficient freight as well as person flows across the sub-continent. The historical development of India is linked with the development of rail. Until recently there has only been growth in the rail sector.

In the case of development of Indian freight movement, rail has been the principal form of movement for cargo. Today however the emphasis for government is in the development of the road sector essentially associated with improving the movement of people across the developing Indian road network. This is of course also encouraging the shift of cargo movement away from rail towards the road sector.

The promotion of intermodal flows (Hanaoka and Regmi 2011) has led to a shifting from the non- road sector. However, the development of a dry port defined as an inland intermodal terminal directly connected by road or rail to a seaport which in fact is really a cargo transfer point often with special reference to the movement of containers as discussed further later. There is some economic strain associate with intermodal flows due to handling cost but the important factor is the possibility in an overall reduction in the movement cost for cargo.

An earlier predictive freight flow model (Bröcker et al. 2011) has led to a better understanding of the global estimations of freight generation. The predictive logic is linked to an estimation of flows within the nation states of Europe via linkage to an analysis of existing flows to incorporate a classical gravity model structure into the predictive nature of freight or cargo flows.

The transference (Regmi and Hanaoka 2012) to the non- road sector has led to consideration of energy pattern change. This paper examines a significant logic behind the shift to the non-road sector namely energy efficiency along a major international corridor linking Korean Peninsula to China, Central Asia and eventually to Europe. However connectivity (De Langen and Sharypova 2013) between modes, that is of cargo movements is paramount to achieving non- economic strain in a green modal shift.

Today, one identifies green products (Gleim et al. 2013) in the market place from the commercial perspective. However, in future, maybe there is an opportunity that a green product should also be identified with its mode of transport to the consumer. For example,if a specified percentage of travel distance to the consumer delivery point is via green modes of transport then the product should be considered as green. This theme of research is further supported in (Murray 2013) providing yet further support for the necessity of research into green transport movements.

Besides mode split and the allocation of cargo movements to different modes, another part of the understanding of modal transfer is the number of Tonne-kilometers of travel by each mode identified in assignment procedures (Maia and do Couto 2013). In some model development, it is within the assignment procedure that the mode of travel is identified whether the movement is associated with green or non- green movement. Sone research has bypassed any understanding of mode split relation to travel patterns and designated instead target mode splits (Monios and Lambert 2013). This is essentially a reverse modal analysis whereby the consequences of transfer to other than the road mode is reviewed with respect to additional infrastructure requirements.

The structured log it model (Rashidi et al. 2012) with respect to the determined explanatory variables development flat or hierarchical approach. These are two different approaches whereby in the flat structure there is a single log it equation to assign cargo movements to a mode of travel. In the hierarchical approach, there are a series of binary log it choice models in the determination of the cargo movement mode. Dynamic cost functions in mode split analysis (Ferrari 2014) and (Ferrari 2015) are a further refinement of the cost variants needed as input into the log it model.

In the paper, (Serag and Al-Tony 2013) there is an analysis of the preparation of the philosophy of cargo mode tests which is to some extent explored in the paper of (Merkert and Hensher 2014) which is a review of where managers of private rail companies see the movement of green cargo movements. The private rail companies in for example Australia also see further understanding of the regulatory framework in line with world practice reviewed in (Laurino et al. 2015).

Further research in inter-modality is presented in (Li et al. 2015). Inter-modality is important because unless there is direct access to non-road at the point of production, there will always need to be road access to a more environmentally friendly mode further downstream from the point of production. A case study of consideration of a new corridor of travel in the USA is given in (Márquez-Ramos 2015). It is important to define a freight corridor which is not necessarily consistent with the alignment of the movement of people (Rodrigue 2006). Otherwise in any corridor analysis, it is likely that the movement of people will receive priority.

In the case of cargo modelling, the issues of modal transfers or inter-modality efficiency is paramount in cargo movements as seen in Figure 2.2 (Nabais et al. 2015). The transfer must be in a logical manner with cargo arriving at one point and leaving at a linked point via a different mode. Time delays associated with hub transfer movements must be in all reality minimized for efficiency.

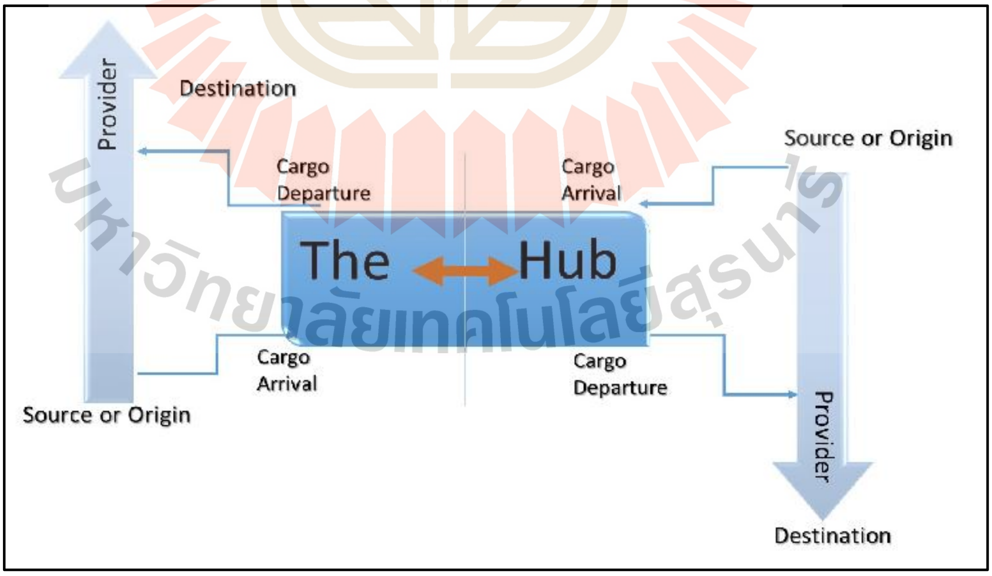

Figure 2.2 The hub transfer

It is necessary to address these issues with the development of a mathematical model framework as seen in a typical analytical structure of Figure 2.3 (Jong et al. 2016). There are clearly issues in the cargo model development that relate to institutional or issues associated with the society element of 2.1. It is also important to develop a confidence in the forecasting procedure associated with modal shift.

The freight transport modelling book (Ben-Akiva et al. 2013) is an important reference source in the understanding of the movement of cargo in relation to the structured numerical equations. As for example in the case of Egypt (Johnstone and Ratanavaraha 2017), one of the localities included within the framework of this research, there is a discussion on the downward movement in cargo movements on other than the road mood and the associated forecasting procedure. The growth of the non-road sector has spurred economic growth in the USA (Donaldson and Hornbeck 2016) and assisted in the growth of ports in Asia (Dang and Yeo 2017).

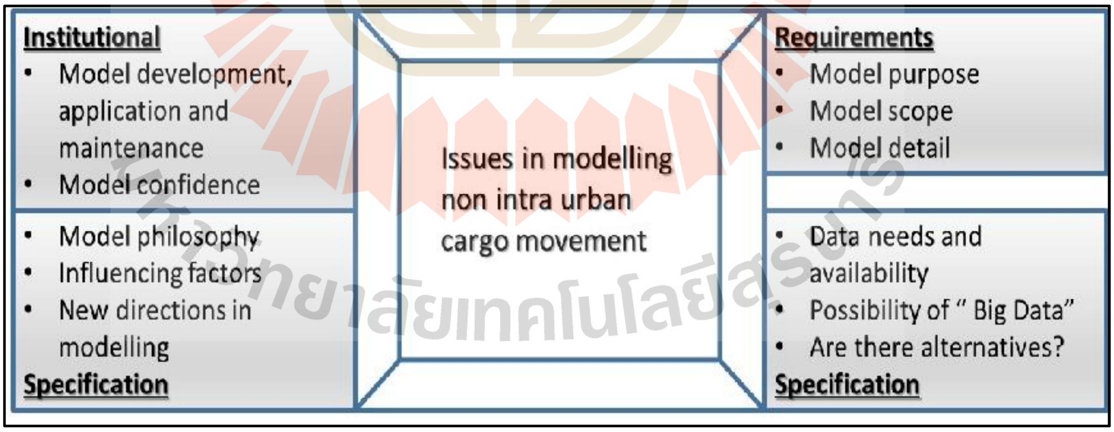

Figure 2.3 The cargo analysis structure

Besides infrastructure improvement, institutional improvement such as trade liberalization (Opasanon and Kitthamkesorn 2016) and privatization of government cargo facilities such as was the case in Australia (Chen et al. 2017). This is also seen in the case of the European experience in an earlier paper (Merkert and Nash 2013) and more recently in the paper (Laroche et al. 2017).

A summary of the key issues addressed in these papers associated with green modal shift is presented in Table 2.1 The research review focuses on all aspects of the cargo transport structure both hardware and software that may sway modal shift. The intention of the research is to determine the commonality in parameters associated with modal shift across three defined localities.

Table 2.1 Green cargo modal shift

Source	Focus of paper
(Rodrigue 2006)	A focus on defining the corridor for freight movement
(Kölbl et al. 2008)	Strategic planning of cargo movements links the complexity of transport with all the technical, socio-economic and environmental facets.
(Tang et al. 2008)	Proposes a mathematical framework for cargo time space flow network.
(Nemoto 2009)	Examines the east to west cargo corridor movement in the Mekong region
(Santos et al. 2010)	Examines the impact of cross border movements linking in particular with road cargo.

Table 2.1 Green cargo modal shift (continued)

Source	Focus of paper
(Donaldson 2010)	Reviews the economic impact in India of creation of extensive railway network.
(Bröcker et al. 2011)	Documentation of global estimation of freight flows with linkage to economic parameters.
(Hanaoka and Regmi 2011)	Presents findings on the changing pattern of operations of ports and Inland container depots towards green technology.
(Ong et al. 2012)	Links the control of emissions and cargo movements.
(Regmi and Hanaoka 2012)	Documents the issue of border crossing bureaucracy within the Asian European corridor
(Merkert and Nash 2013)	This is a review of European rail managers. The paper highlights that good relationships are indicated as the most important contributor to making rail systems work.
(De Langen and Sharypova 2013)	Presents the importance of intermodal connectivity in the understanding of port performance.
(Gleim et al. 2013)	Determination of green transport component of cargo item.
(Maia and do Couto 2013)	Presents a review of the cargo assignment analysis with a particular reference to the importance of inter modality.

Table 2.1 Green cargo modal shift (continued)

Source	Focus of paper
(Monios and Lambert 2013)	An important paper documenting target mode split philosophy and how to achieve said split. In some respects a backwards procedure from traditional modal analysis with an appreciation of the economic and institutional framework.
(Murray 2013)	Proposes a logic for more green consumption. Within this thesis, a proposal to link an element of green consumption to green cargo transport.
(Serag and Al-Tony 2013)	The development of a philosophy set for scenario analysis and testing.
(Merkert and Hensher 2014)	Presents an analysis of interviews with senior rail management in Australia with respect to economic value for money.
(Rashidi et al. 2012)	Behavioral approach to logit model development
(Ferrari 2014)	Dynamic mode split cost model
(Ferrari 2015)	Dynamic mode split freight model
(Laurino et al. 2015)	A worldwide evaluation of economic regulatory environment.
(Li et al. 2015)	Addresses the importance of inter modality in the importance of transport alternatives to road.

Table 2.1 Green cargo modal shift (continued)

Source	Focus of paper
(Márquez-Ramos 2015)	This is a review of a newly opened inland transport corridor in the USA.
(Nabais et al. 2015)	An examination of an intermodal hub with an understanding of transfers between water , rail and road to ensure enhanced efficiency of movement
(Donaldson and Hornbeck 2016)	Linkage of railroads with economic growth in the USA.
(Jong et al. 2016)	Addresses issues associate with freight modelling at the national level.
(Opasanon and Kitthamkesorn 2016)	This paper addresses the issue of the linkage between trade liberalization and the increase in imports and exports.
(Chen et al. 2017)	An examination of port privatization in Australia.
(Johnstone and Ratanavaraha 2017)	Addressees the issue of green modal shift in Egypt.
(Dang and Yeo 2017)	An examination of the strategic and economic position of ports in Asia.
(Laroche et al. 2017)	Presents the case for cargo movement by rail in Europe.

2.2.1 Consideration in Egypt

Many issues discussed in this section with respect to Egypt are in fact also relevant to the other three localities. In this incidence, Egypt is used essentially as the template for the examination of research into modal shift especially with reference to fuel.

Within Egypt, Modal shift opportunities are apparent as reported in a recent publication. (Johnstone and Ratanavaraha 2017). There is an opportunity for an improved efficiency in regional transport within Egypt via a modal shift. Significant energy subsidies that favor the road sector have in the past made this difficult.

In Egypt, transport of cargo by road has been aided by the fuel subsidy which was a little over fifty percent, (Fattouh and El-Katiri 2013). This implies that when the cost of fuel to the government was one hundred Egyptian pounds, the government was then forward selling to the general public at fifty Egyptian pounds.

Such a subsidy is of course in stark contrast to the status in for example the European Union which imposes a fuel tax. The fuel subsidy in Egypt however is not dissimilar to the rest of the Middle East region. In the case of the major oil exporting companies such as Kuwait or Saudi Arabia this subsidy approaches ninety percent. In the case of the European Union, taxes on fuel sold within the European Union generally represent between forty and sixty percent of the cost of each liter of fuel, (Klier and Linn 2013).

In the United States, prices for regular gasoline in 2011 averaged $3.56 per gallon. The unit cost breakdown was crude oil sixty-eight percent; refining thirteen percent, distribution and marketing seven percent and taxes twelve percent. In this context, there was even an impact on even new vehicle acquisition (Choi et al.

2014). In many developed countries now there is even consideration being given to an introduction of a Carbon tax following the Paris accord of 2016 that would further add to the cost of cargo movement on the road and add encouragement to modal transfer.

Fuel subsidies are less transparent and more difficult to calculate the impact on modal shift. They typically occur in oil and gas exporting countries, where mostly state-owned oil and gas companies produce, refine and market petroleum products. For instance, the national oil company can be mandated to sell petroleum products for the domestic market at below international prices but above production costs. In this case, the national oil company does not incur financial losses, and hence the government does not need to make an explicit transfer to compensate the national oil company for losses. The implicit subsidy represents the opportunity cost, i.e. the economic rent or revenue wasted by failing to sell oil at higher market prices.

This then involves a transfer from the government to the final consumers without such a transfer appearing explicitly on state oil companies' records or in the government budget. If this foregone revenue had been collected, it could have been used by the government in a variety of ways such as to reduce the budget deficit and the size of the public debt or to increase spending in more productive areas such as infrastructure, education, and health. Alternatively this money could have been distributed directly to its people in the form of tax reduction, (Fattouh and El-Katiri 2013). Historically fuel subsidies have been high in some countries as seen in Figure 2.4 Many developing and emerging market countries have subsidies on fuel products. This is not necessarily efficient on the overall macro economy of the state, aggregate welfare is reduced by these fuel subsidies (Plante 2014).

In future, in the case of Egypt, the state may besides removing subsidy need to consider an “at the pump” tax on fuel. Fuel taxes are typically collected “at the pump” from motorists. Other forms of fuel, such as cooking and heating fuel[1], tend to have different tax structures and collection mechanism. It is therefore of interest that the application of fuel tax, levied “at the pump” in the form of increased fuel price, be considered within an Egyptian context as a valuable mechanism for sourcing transport revenues as well as a deterrent to the continued growth in cargo road transport.

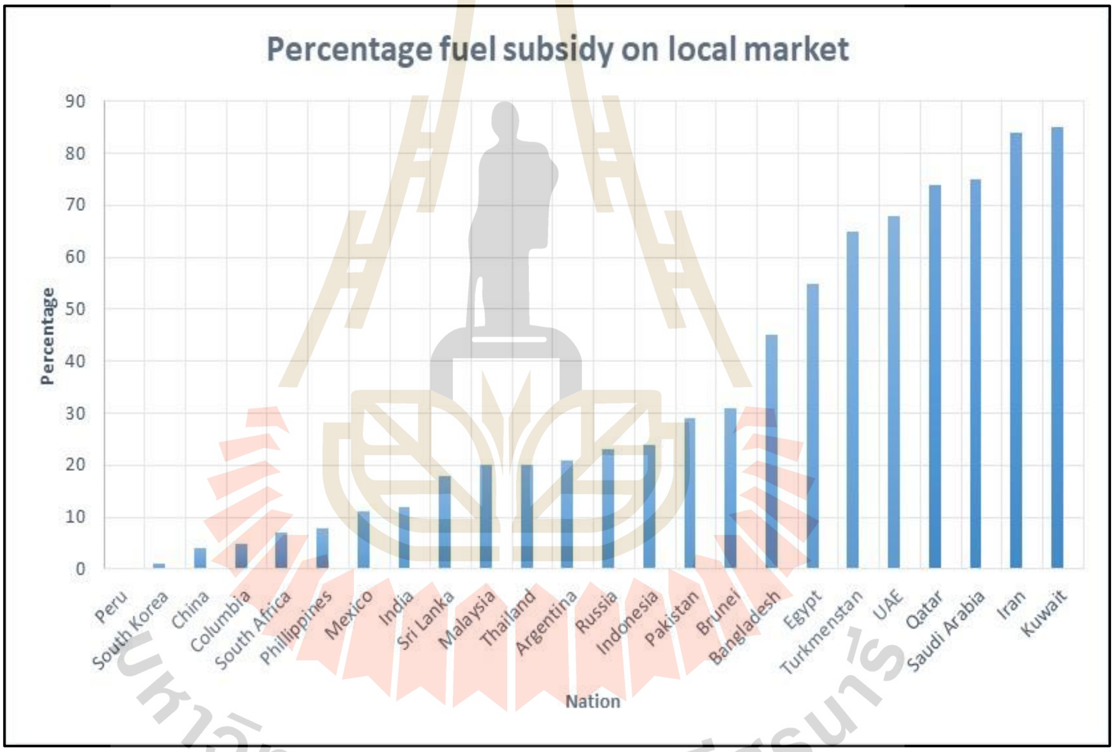

Figure 2.4 Historical fuel subsidy

[1]The removal of any subsidy on these fuels would likely have direct social consequences.

Fuel is generally priced in dollars, thus the exchange rate mechanism comparison across the three localities is important. (see Figure 2.5) (World Bank.) Egypt has experienced a long period of relative stability over the last decade until recently. Whilst shows a range that peaked at 100 percent during the Asian financial crisis. Australia meanwhile over the long term has shown a period of stabilization.

In the research associated with common parameters that will define modal shift, it is likely that consideration of inclusion of economic parameters is probably paramount.

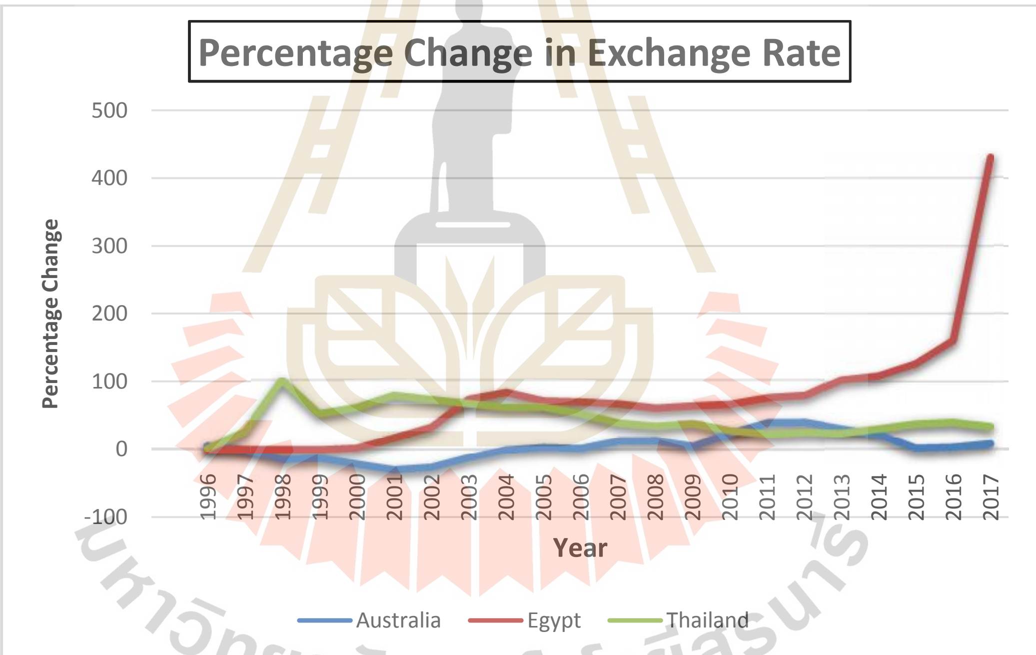

Figure 2.5 Cross country comparison of exchange rate against US dollar

2.2.2 Cargo consideration for the Mekong and Thailand

Thailand, the logistic center of the Mekong is facing major infrastructure change that has the potential to encourage regional modal shift. Within

Thailand, there is an expansive railway development program underway at present with significant border linkage with other countries. There are current proposals to encourage significant rail linkage to the countries of the Eastern Mekong region. A collaborative border administration approach (Opasanon and Kitthamkesorn 2016) would improve green transport movement as it improves overall efficiency of transport movement.

2.2.3 Cargo generation in Australia

As stated earlier, the freight modal shift in this locality will be given consideration in the final comparison after developing the analytical procedures. The issue of inter-modality transfer is of paramount importance in Australia (Ghaderi et al. 2016).

2.2.4 Cargo generation in Summary

Apart from Europe which in any case is single market, current research has a focus on a single locality. There is apparently little research on the exploration of commonality across locality to develop the impact with an emphasis on economic strain in the understanding of the consequences of modal shift towards the movement of cargo using green modes of transport. This is the focus of the research via the analysis of key data sources mentioned in the next section.

2.2.5 Key data sources

The key data sources that will provide the foundation for the analysis of modal shift are documented in Table 2.2

Table 2.2 Key data sources

Locality	Source of movement data
Egypt	Comprehensive Study on The Master Plan for Nationwide Transport System in the Arab Republic of Egypt. ((JICA) 2012)
The Mekong and Thailand	The regional Mekong transport model prepared by the Asian Development Bank and the transport database available as part of the Thailand national transport model.
Australia, Queensland	Queensland Transport Facts, 2016

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CHAPTER III

THE DILEMMA OF THE SHIFTING OF ROAD FREIGHT TO ALTERNATIVES

3.1 Abstract

Today, there is a real issue of an alternative to road freight transport. This discussion presents experience from Egypt during which time a mathematical procedure was developed to analyze the impact of shifting cargo movement from the road transport sector to the alternatives of water and rail. Currently in Egypt more than 90% of national cargo is carried via the road transport sector. In fact, Egypt has a distinctive advantage in comparison to many other countries with respect to modal shift from the road sector. A proportion of national Cargo movements are along the alignment of the Nile River which for the most part is navigable. There is an existing parallel rail alignment. During this analysis, there were several issues for consideration in the transfer of Cargo to an environmentally friendly or a green freight alternative. Not least of these issues was the fact that fuel was heavily subsidized at that time in the country. So road cargo transport providers did not pay for the use of road infrastructure but in addition also had the usage of cheap fuel. Whereas cargo providers on the alternatives within the water and rail sector had to fund fuel and infrastructure maintenance costs.

The mathematical model described hence is used to consider freight modal shifts under various infrastructure development scenarios. It was the intention during

this analysis to emphasize the change from the fact that road infrastructure currently receives the highest investment priority but the utilization of this capacity is weak due to less-than-optimum management as well as poor transport equipment (outdated and badly maintained). The outcome from the analysis results in a recommendation for the future development of national cargo transport to shift from the road sector to the non-road sector. This shows that within the framework of mathematical analysis that it is possible to evaluate the impact of the shift of the movement of cargo away from the road sector.

3.2 An overview

The road mode is an essential factor in economic activity and has historically played a strong role in the development of many countries across the world. The road mode is an essential factor in economic activity and has historically played a strong role in the development for many countries across the world. Within d. Within the context of Egypt, the use of the road-based transport mode has increased exponentially in the last few years. Whilst this phenomenon has fulfilled a variety of social goals and expectations, unfettered growth is increasingly contributing to various negative social, economic and environmental impacts. This high level of usage is a historic consequence of growing vehicle ownership, pricing policies (such as the fuel subsidy), and “road focused” capital works programs. There is a beginning of an understanding of the notion that a more balanced approach to providing mobility is desirable especially in respect to the transportation of cargo within the borders of Egypt.

The increasing movement of cargo via the road mode will also lead to an increase in emission gases. Whilst to some degree, such emissions from within cities for personal mobility have been contained. This is not the case for the movement of cargo especially over long distances. These phenomena are not limited to Egypt but are common elsewhere especially in large geographical countries. For example, in another large country such as Australia, over the period 1990 to 2006, overall transport emissions grew by 27.4 per cent, however emissions from freight grew by 40 per cent. Freight transport emissions now contribute around four per cent of the national emissions total in that country and are forecast to more than treble to thirteen per cent by 2020 as reported in a freight transport paper, Total Environment Centre Inc (2008).

Likewise, the European Union also has a problem with its heavy dependence on road transport. The Agenda 2020 of the European Union calls for member countries to reduce greenhouse gas emissions and increase renewable energy. There is implicit in this agenda within the EU of taxing fuels on road-based transport, Bartocci et al. (2013) thus encouraging a modal shift away from the dominant road sector.

3.3 The context

In this documentation, the Egyptian situation for the movement of cargo is presented both today and in the form of a twenty year projection with alternative scenarios investigated to control the growth in the Cargo road mode share thus moving Egypt towards a greener movement of freight with consequently fewer greenhouse emissions. In *consideration, one must first present the existing situation of* *network infrastructure and* cargo modal movement. The future projection was estimated via the development of a mathematical computer model, JICA (2012).

3.3.1 The existing network structure

The existing transport infrastructure within Egypt is dominated by a road system that extends over approximately 100,000 kilometers, nearly 23,500 kilometers of which is managed and maintained centrally. The major road network is densest within the Nile Delta, coastal areas, the Sinai Peninsula and flanking the Nile River which traverses Egypt from north to south. Cairo tends to serve as the “hub” of the national “spoke” of roadways. The road network is varied comprising expressways, toll roads, primary inter-city roads and other road types. Responsibility for higher-order roads lies mainly with the General Authority for Roads, Bridges and Land Transport, part of central government. The remainder of Egypt’s 59,500 kilometers of paved roadway network is administrated by the country’s local administrations.

The rail network, extends over some 5,100 kilometers, or about 9,600 track kilometers. Almost thirty percent thereof is double tracked, the remaining network is single tracked. The entire system is standard gauge and not electrified. There exist some 700 stations, and almost 1,300 level crossings.The Inland Water Transport (IWT) network encompasses 2,635 kilometers consisting of 1,696 kilometers within the Nile Valley and 936 kilometers within the Nile Delta. Navigable waterways classified as 1st class require specified vertical clearance, fairway width, maximum draft and minimum water depth. The 1st class network includes 980 kilometers between Cairo and Aswan, 205 kilometers between Cairo and Alexandria as well as 241 kilometers between Cairo and Damietta. These three waterways feature

3 locks and 24 bridges, 7 locks and 27 bridges, as well as 3 locks and 16 bridges, respectively. Approximate 320 cargo vessels (comprised mainly of barges and tugboats) as well as 2,200 passenger vessels (including tourist boats, ferries and other light boats) are currently registered to operate on the IWT network. About thirty percent of the cargo vessels and ninety percent of the passenger vessels are owned by the private sector, the remainder being under public sector ownership as seen in Table 3.1

In addition, Egypt has 15 commercial ports facing the Mediterranean Sea and the Red Sea. The Maritime Transport Sector is responsible for the administration of those ports, delegated according to four regional Port Authorities. Apart from the commercial ports, roughly fifty ports are in operation for a variety of specialized purposes to include petroleum ports, mining ports, tourist ports, and fishing ports.

3.3.2 National cargo movements

In Egypt as stated earlier, the movement of cargo is dominated by the road sector[1]. Each day in Egypt as reported in JICA, (2012), a total of 1.5 million tonnes are moved throughout Egypt. Of this approximately twenty percent is carried in the extensive Egyptian pipeline system. Of the remainder, the majority of cargo movement is on the road sector at more than ninety five percent as depicted in Table 3.2. In the case of the movement in form of tonne-kilometre, around thirty percent is shifted via the pipeline system. . Of the remainder, the majority of cargo movement is moved on the road sector with a modal share of more than ninety five percent.

[1] Of course, there is a substantial movement of international cargo movement through Egypt via the Suez Canal. This is not considered in this discussion. Much of this traffic is container in containers.

Table 3.1 The national road system

Category	Road Length (kilometers)
Expressway	395
Primary Road	15,002
Secondary Road	8,189
Total	23,586

These estimates of cargo movements were developed from both primary and secondary data sources. In the case of the primary data source, this was a significant source of data available from a multitude of surveys as seen in Table 3.3. The analysis of these surveys was also instrumental in the development of a mathematical model for future projections. The structure of this model is briefly discussed in the following section.

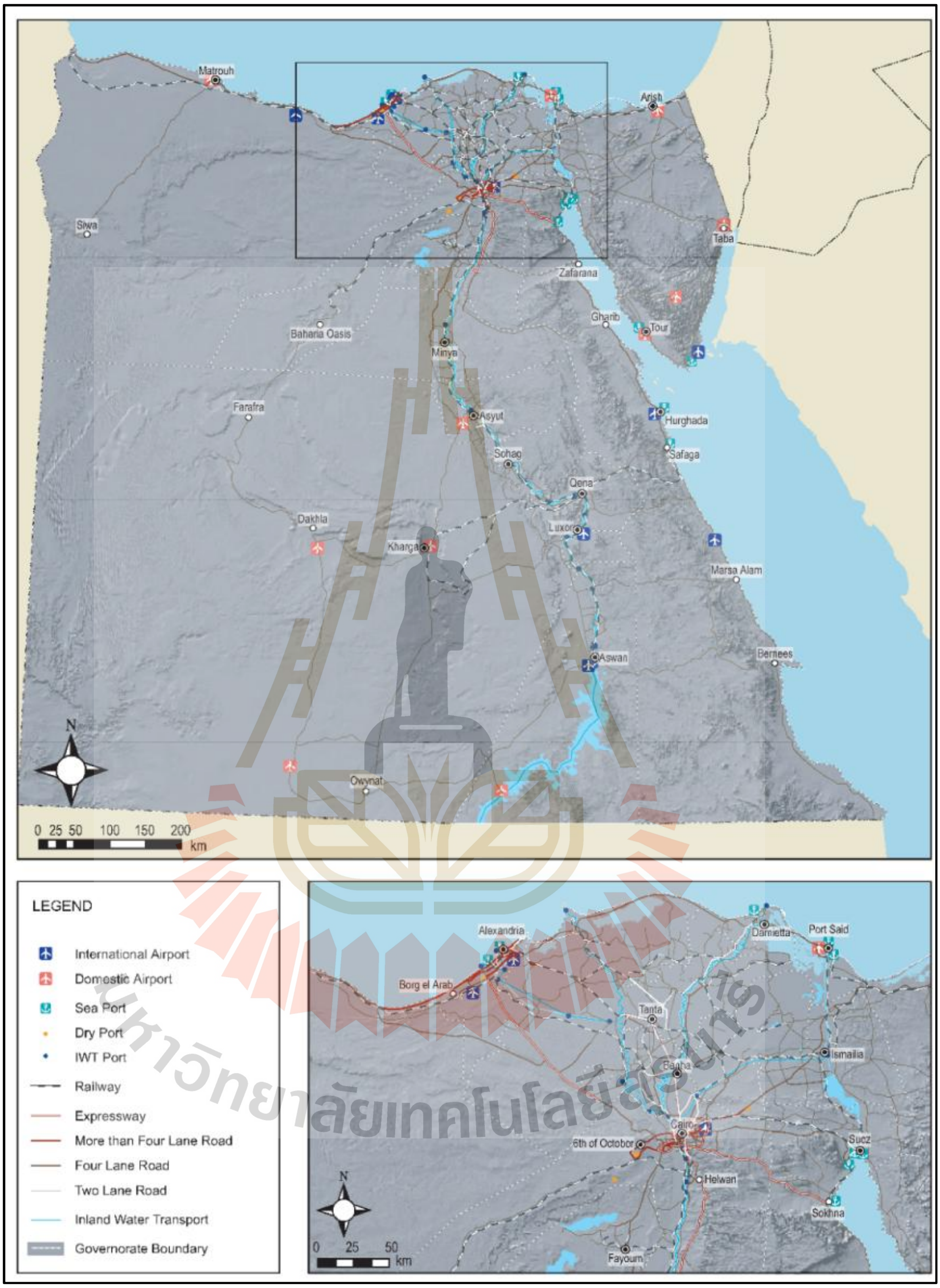

Figure 3.1 The national transport network

In the case of Egypt, these estimates are as a result of an extensive survey program undertaken during the development of a national transport development plan for Egypt, JICA (2012). Historically, the proportion of Cargo carried on the road sector has grown from eighty nine percent in 1979 to ninety three percent in 1992, sourced from JICA (1997) and JICA (2003). As seen from the extensive survey program, whilst a large number of the surveys was developed to understand the movement of people, a significant proportion of the surveys was focused on the movement of cargo. In particular in the case from the roadside interview surveys at some 185 location, it was possible to develop an understanding of cargo movements throughout the nation.

Up until the end of the first decade of the second millennium, the proportion of cargo shifted by rail remained steady at five percent. The rail proportion has since declined as road cargo movement has approached one hundred percent. One interesting observations from the extensive survey program conducted by JICA, (2012) was that around ninety percent trucks had no back load. Many trucks were observed as empty. For example, one company would have a contract to bring cargo to a port whilst a different company would have a contract deliver cargo from the same location. This thus enabled a policy proposal in the future to increase trucking efficiency which may lead to a decrease in truck fleet size.

Table 3.2 National percentage distribution of cargo (excluding pipeline)

Mode	Tonne	Tonne-Kilometers
Road	97.4	96.5
Rail	0.8	1.9
Inland Water Transport	1.8	1.6
Total	100.0	100.0

Table 3.3 Extent of national transport surveys

Survey Group	Location	Number of Locations	Sample Size
Roadside Interview Survey	Roadside	185	297,725
	Railway Station	26	43,144
	Bus Terminal		15,666
Passenger Transport Terminal Survey	Shared Taxi Terminal	110	101,550
	Airport	11	4,072
	Seaport	8	873
	Railway Terminal	27	315
	River Port	15	81
Freight Transport Terminal Survey	Dry Port	4	307
	Free Zone	7	321
	Airport	1	275
Sea Port Survey	Sea Port	10	16,970
	Freight Forwarder	58	58
Freight Company Survey	Trucking Company	63	63
	Manufacturing	242	242

3.3.3 The world context

In a broader world context, almost all cargo movements are dependent on road transport. In for example, the European Union as reported by Colliers International (2016), cargo movement in 2009 was dominated by the road sector. The road modal share for any of the major country members did not fall below sixty percent. This was even the case in Germany, even though twelve percent of cargo moves via the mode of inland water. The cargo market is still in Germany dominated by road at sixty five percent. In France, the cargo modal share is eighty percent increasing to eighty five percent in the United Kingdom. Whilst the modal share in Italy is just over ninety percent. Thus in the developed European Union cargo road transport is the significant mode similar in comparison to Egypt. This dominance of the road sector makes it difficult to realize the objective of the Union to reduce the dependence on road transport.

3.3.4 Fuel pricing

In Egypt, transport of cargo by road is aided by the fuel subsidy which is a little over fifty percent, Fattouh et al. (2013). This is of course in stark contrast to the status in the European Union which imposes a fuel tax. The fuel subsidy in Egypt is not dissimilar to the rest of the Middle East region. In the case of the major oil exporting companies such as Kuwait or Saudi Arabia this subsidy approaches ninety percent. This is in contrast to both the European Union and the United states. In the case of the European Union, taxes on fuel sold within the European Union generally represent between forty and sixty percent of the cost of each liter of fuel, Klier et al.(2013). In the United States, prices for regular gasoline in 2011 averaged $3.56 per gallon. The unit cost breakdown was crude oil sixty-eight percent; refining thirteen percent, distribution and marketing seven percent and taxes twelve percent. In this context, there was even an impact on even new vehicle acquisition, Choi et al. (2014).

Fuel subsidies are less transparent and more difficult to calculate. They typically occur in oil and gas exporting countries, where mostly state-owned oil and gas companies produce, refine and market petroleum products. For instance, the national oil company can be mandated to sell petroleum products for the domestic market at below international prices but above production costs. In this case, the national oil company does not incur financial losses, and hence the government does not need to make an explicit transfer to compensate the national oil company for losses. The implicit subsidy represents the opportunity cost, i.e. the economic rent or revenue wasted by failing to sell oil at higher market prices. This then involves a transfer from the government to the final consumers without such a transfer appearing explicitly on state oil companies' records or in the government budget. If this foregone revenue had been collected, it could have been used by the government in a variety of ways such as to reduce the budget deficit and the size of the public debt or to increase spending in more productive areas such as infrastructure, education, and health. Alternatively this money could have been distributed directly to its people in the form of tax reduction, Fattouh et al. (2013). Many developing and emerging market countries have subsidies on fuel products. This is not necessarily efficient. Across the overall macro economy of the state, aggregate welfare is reduced by these fuel subsidies, Plante (2014).

In future, Egypt may besides removing subsidy need to consider an “at the pump” tax on fuel. Fuel taxes are typically collected “at the pump” from motorists. Other forms of fuel, such as cooking and heating fuel[2], tend to have different tax structures and collection mechanism. It is therefore of interest that the application of fuel tax, levied “at the pump” in the form of increased fuel price, be considered within an Egyptian context as a valuable mechanism for sourcing transport revenues as well as a deterrent to the continued growth in cargo road transport.

3.4 The future modal analysis

The structure for understanding of cargo movement within Egypt was to first reproduce the cargo movements mentioned above within the framework of a national transport modeling structure. In the development of analytical structure for Egypt, the nation was geographically divided into different sub areas. At the lowest level of detail the nation was divided into some 385 small areas or traffic zones, the next level being 61 large zones to analyze the movement of commodities. Whilst at the highest level there are eight internal regions.

The internal small zone boundaries, the most detailed building block for the entire zoning system, are patterned after Markaz 3boundaries. A Markaz is sometimes divided geographically by, for instance, the Nile River. For the transport analysis, such sub-divided Markaz areas are considered as separate entities and uniquely defined as small zones. There are 385 internal Small Zones and 19 external zones, a total of 394 Small Zones.

Most summary reports will be prepared at the level of the 9 regions. The regions become important in the understanding of the cargo movement pattern in

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2 The removal of any subsidy on these fuels would likely have direct social consequences.

3 The Markaz level is the boundary defined by the national census bureau, CAPMAS.

Egypt. The regional patterns are easier for people to visualize rather than the movement of cargo across 394 small zones.

3.4.1 Analytical procedure for forecasting cargo movement in Egypt

A national transport model was developed in Egypt with two distinct streams of development namely, for person or passenger transport and freight or cargo transport. In this documentation only the structure of the cargo model is discussed and is developed from the extensive survey program mentioned earlier. There exists two primary data sources for cargo flows: the survey program and the production and consumption analysis. Hence the stipulation that cargo trip modelling is focused on large zone cargo trips as this is the geographical region of data collection for the production consumption analysis. In the final assignment step of vehicles, train and ships to the network, outputs of the person trip model, in terms of people or vehicles, is also include but the framework of the person model is not presented here. In this context, the output results of the analysis are a matrix of commodity type tonne

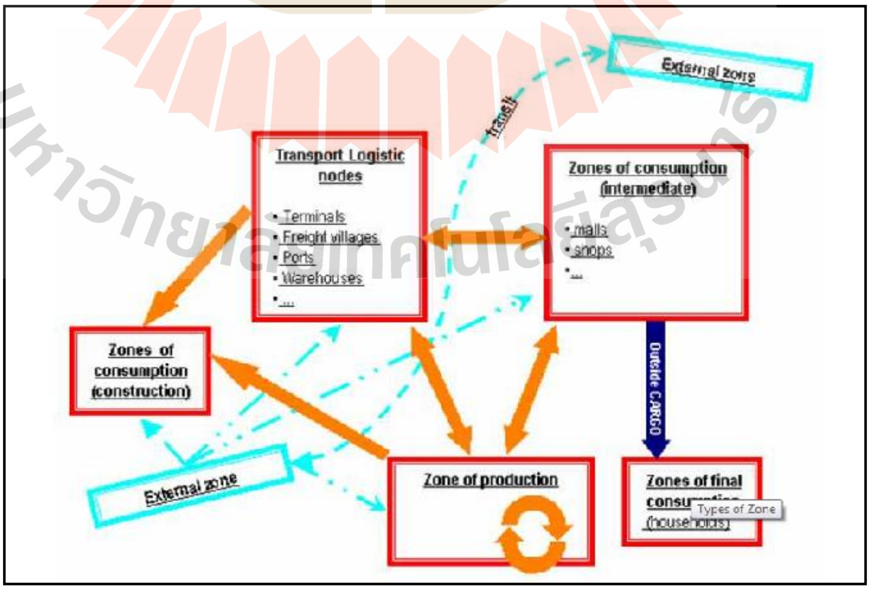

Figure 3.2 The Cargo Trip Chain Topology

movements (Figure 3.2). This is followed by additional analysis to determine how those tonnes are moved and by what means, the modal calculus. The large zones and their respective regions discussed here are presented in Figure 3.3.

There are eleven commodity groupings that represent the "building " of the cargo model. In that context movement (tonne) matrixes are built initially at the individual commodity level, then aggregated to commodity group prior to further analysis and, ultimately, assigned to a network in combination with the flow of people. The some forty different commodities used in this analysis and their overall commodity groupings are shown in Table 3.4.

This procedure using the software platform of CUBE, Cargo3F[4] was first proposed to understand cargo movements throughout the United States originating or terminating at the port of Los Angeles, Kumayak (2008).There are four key steps to estimate freight movement as shown in Figure 3.4 namely:

- Generation;
- Distribution;
- Haulage Classification;
- Fine Distribution; and
    - Short Haul; and
    - Long Haul.
        - Mode Split; and
        - Transport Logistic Node.
- Vehicle Assignment.

4 This software is a module of the CUBE software platform, proprietary software of Citilabs Inc. This software was used extensively in the development of the national transport model for Egypt.

These steps are not so different to the traditional Four Step person trip analysis of Generation, Distribution, Mode Split and Assignment. Similarities are seen in generation, distribution and mode split. In Distribution, there is distinguishing between the long and short haul freight movement.

The generation model forecasts the trip ends as well as the number of tonnes of each commodity group produced and consumed in each internal large zone. The productions are divided into internal productions, which are to be transported to an internal zone, or exports, which are sent to external zones. Similarly, the attractions are classified as internal, that is, from internal zones, or as imports, which come from external zones. This procedure was devised for the estimation of production and consumption for the forty two commodities identified in the aforementioned table. The commodity produced is linked to the elasticity associated with that commodity and the changes in the associated socio economic parameter either population or Gross Domestic Product (GDP).

The first step in the distribution model is to partition the internal trips into “short-haul” and “long-haul” trips. The proportion of short haul trips varies by commodity. It is approximately in the range of between five and ten percent of each commodity category flow. These short haul trips are assumed to use the road network. The distinction between long- and short-haul trips is as much about journey purpose as about trip length. The “short” trips are distributed using a gravity model with a negative exponential deterrence function. The function is applied to the square of the distance.

A generalized cost function for the long haul trips is next calculated. This cost is a linear combination of time and distance, estimated from the digitized network. The coefficients of these generalized cost components are estimated separately by mode for inclusion in the development of a logit mode split as seen in the step of the model structure for mode split. The internal, import, and export long trips are distributed using a gravity model with a negative exponential deterrence function. In this case, the function is the generalized cost.

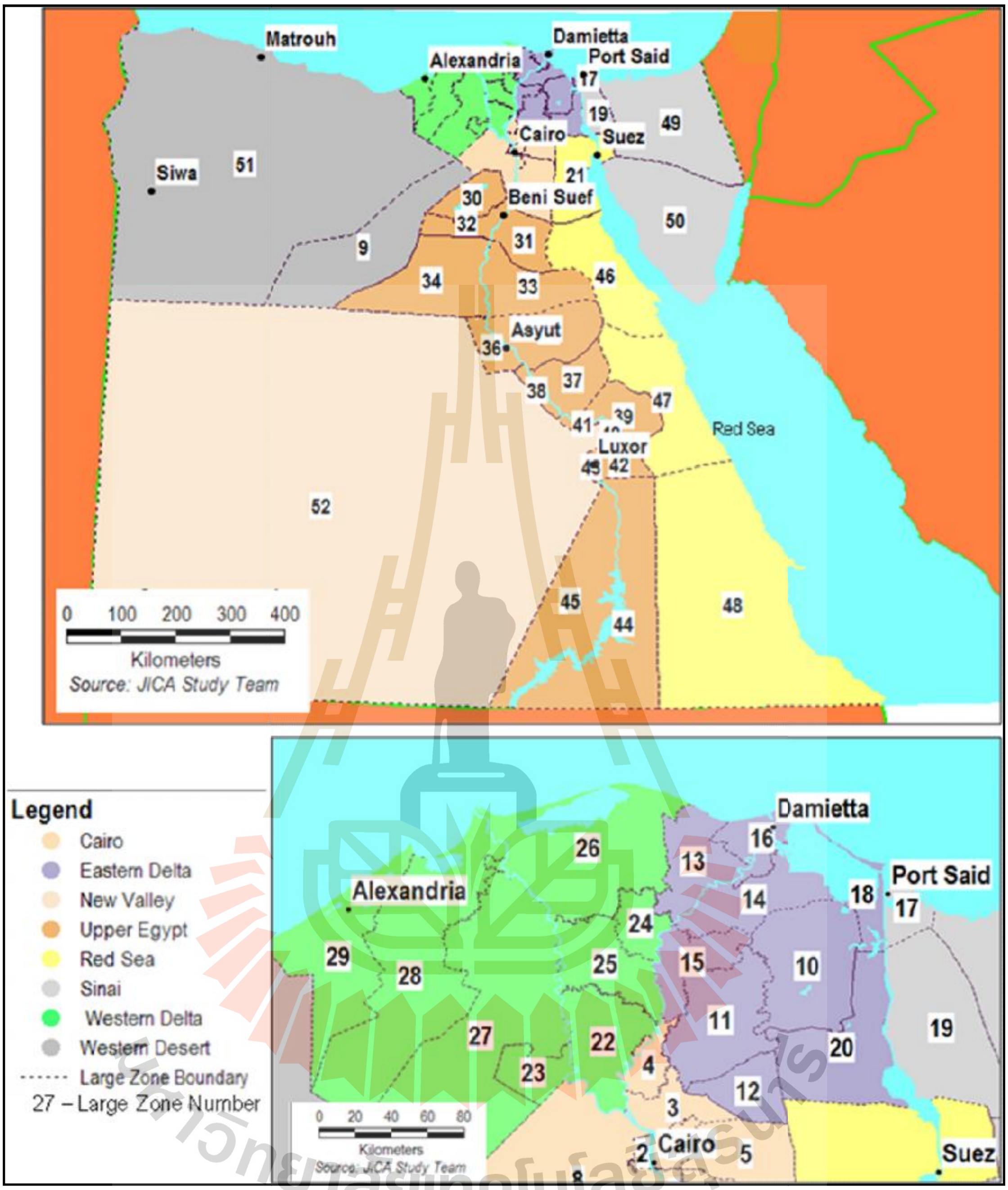

Figure 3.2 Structural Map for Large Zones and Regions

Table 3.4 Commodity code classifications

Commodity Group	Group Name	Commodity Name
1	Agricultural Products	Lumber and Timber
		Barley
		Corn
		Maize
		Rice
		Broad Bean
		Sorghum
		Fruits
		Vegetable
		Greenhouse Vegetable
		Onion
		Garlic
		Potato
		Sugar Cane
		Sugar Beet
		Fiber Crop
		Animal Fodder
		Poultry Fodder
		Oil Crops
		Wheat
2	Food Stuffs and Animal Fodder	Dairy Products
		Fishery
		Edible Oil
		Refined Sugar
		Beverage

Table 3.4 Commodity code classifications (Continued)

Commodity Group	Group Name	Commodity Name
3	Solid Mineral Fuels	Coal and Coke
		Crude Oil
		Natural Gas
4	Petroleum Products	Petroleum Products
5	Iron Ore and Metal Waste	Iron ore
6	Metal Products	Metal
7	Manufactured Minerals and Construction Material	Cement
		Construction Material
8	Fertilizers	Fertilizer
9	Chemicals	Chemical Product
		Paper
10	Machinery, Transport Equipment, Manufactured Articles and Miscellaneous Articles	Textile
		Soap
		Industrial Product
		Animal Meat
11	Live Animal	Poultry Meat
		Egg

In summary, the outputs from distribution model are total large zone to large zone movements for all modes. The modal split model is run on only the long-

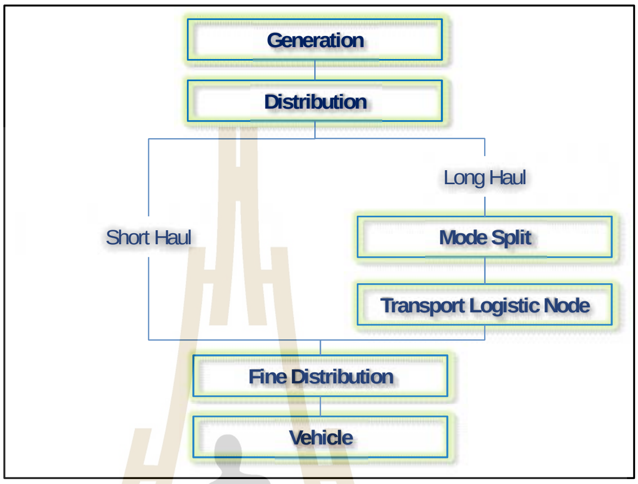

Figure 3.4 Freight Movement Model Structure

haul trips. All short-haul trips are assumed to travel by road. The generalized cost function is defined for each combination of commodity group and mode. There are three independent variables, time, distance and cost. For each commodity group, the modal split is a simple multinomial logit model.

The outputs from modal split are large zone to large zone freight movement in tonnes for each mode of transport. Following the mode split analysis, consideration is given to the Transport Logistic Nodes (TLNs). These are places such as major goods yards, multimodal terminals, railway stations, and ports, where trip chaining occurs.

The logistic nodes model examines the matrices created by the long-haul modal split model and partitions them into "direct transport" and "transport chain matrices." The goods in the direct transport matrices will be transported directly from their initial origins to their final destinations. The goods in the “transport chain matrices” will travel via TLNs. These trips must be divided into two sections: from origin to TLN and from TLN to destination. Of these two sections, one will be classified as long-haul and the other will be classified as short-haul. This prompts a modified interpretation of “direction” of the distribution trips. In the case the trips to the TLN is long-haul (and the trip from the TLN is short-haul), these are considered as “production” and collection trips, whereas when the trip to the TLN is short-haul (and the trip from the TLN is long-haul), these are considered as “consumption.”

At the end of this process, there are four matrices per mode per commodity group. These are short-haul direct, long-haul direct, long-haul to or from TLN, and short-haul to or from a TLN. Logistic nodes model outputs are the matrices generated by the logistic nodes module that contain the direct flows between the production zones and the final destination zones and the trips going through the logistic nodes.

For each combination of mode and commodity group, the movement is estimated in tonne, for direct long- and short-haul trips, relative to the large zone system. The final step is to uses all this flow information to produce matrices of flows, in tonnes, in the small zone system, the fine distribution analysis. The distribution from the large zone to the small zone is based on calculating a weight for each small Zone. The weights are based on the small zone socio-economic data relative to the large zone.

The demand analysis has been estimated in tonnes. At the last step, in preparation for assignment to the infrastructure networks, an estimation is made of vehicle trips per day for that proportion of cargo on the road sector. These vehicles are then divided into heavy trucks and light trucks. In the case of long-haul trip, these are made by heavy trucks by using the average loading per truck as developed from the extensive survey program mentioned earlier. All movement matrices for a given mode and commodity group are combined to give a single vehicle from small zone to small zone movement matrix, relative to the small zone system. Hence these cargo vehicle movements can be combined with person vehicle movements for the overall network assignment.

The cargo mode share as a result of the analysis is provided in Table 3.5. Of the cargo moved by road at the time of this investigation, it was estimated that nearly eighty percent of all cargo moved by road if pipeline mode was included. Without pipeline which is only suitable for limited commodities, the proportion was closer to ninety five percent. Overall nearly two thirds of all cargo excluding pipeline is carried by heavy commercial truck.

Apart from petroleum and mineral fuel products, all other commodity groups exhibit a more than ninety percent mode share to the road sector as depicted in Table 3.6. This indicates that the preferred mode of transport for cargo in the nation is by road. The largest commodity group moved in Egypt is the Manufactured Minerals and Building Materials commodity group.

Table 3.5 Cargo mode percentage share in 2010

Major Mode	Mode	Tonnes	Tonne-km
Road	Light Truck	14.1	7.3
	Medium Truck	14.3	9.7
	Heavy Truck	48.6	49.7
	Subtotal	77.1	66.7
Non Road	Rail	0.6	1.3
	IWT	1.4	1.1
	Pipeline	20.9	30.9
	Subtotal	22.9	33.3
Total		100.0	100.0

Table 3.6 Cargo commodity by mode in 2010 (percentage of tonne movements)

Commodity Group	Description	Percentage Mode of Transport					Overall Commodity Percentage
		Road	Rail	IWT	Pipeline	Total	
1	Agricultural Products	98.0	1.8	0.2	0.0	100.0	10.5
2	Foodstuffs and Animal Fodder	99.3	0.0	0.7	0.0	100.0	5.2
3	Solid Mineral Fuels	84.9	14.7	0.4	0.0	100.0	0.8
4	Petroleum Products	16.8	0.4	0.4	82.5	100.0	25.3
5	Ores and Metal Waste	97.0	2.8	0.2	0.0	100.0	3.3
6	Metal Products	94.6	5.4	0.0	0.0	100.0	0.6
7	Manufactured Minerals and Building Materials	99.2	0.2	0.6	0.0	100.0	34.1

Table 3.6 Cargo commodity by mode in 2010 (percentage of tonne movements) (Continued)

Commodity Group	Description	Percentage Mode of Transport					Overall Commodity Percentage
		Road	Rail	IWT	Pipeline	Total	
8	Fertilizers	97.3	0.2	2.5	0.0	100.0	2.4
9	Chemicals	100.0	0.0	0.0	0.0	100.0	3.2
10	Machinery, Transport Equipment and Manufactured Articles	92.6	0.1	7.3	0.0	100.0	13.7
11	Live Animals	99.4	0.4	0.2	0.0	100.0	0.8
	Total	100.0	100.0	100.0	100.0	-	100.0

3.4.2 The national forecast

In Egypt, several future strategies were considered that focused on the combination of the development aspects of the Egyptian national development strategy with a combination of different infrastructure development initiatives. However, prior to consideration of national infrastructure strategy or initiatives, there must be a socio-economic development plan as a basis for such a strategy. In 2013, the population of Egypt was just above seventy-eight million people with a Gross Domestic Product (GDP) of nearly one thousand billion Egyptian Pounds[5]. The number of employed people in Egypt was around eleven million people thus

[5]The GDP in Egypt is measured in constant year base of 2009. In 2013, one US dollar was equivalent to nearly seven Egyptian pounds.

indicating an employment participation rate of only fourteen per cent. The twenty year projection of population will bring the national population to an estimated one hundred and seven million people5F[6] together with a GDP forecast of around two and a half thousand billion Egyptian Pounds.

Initially this forecast was significantly higher at around an overall growth rate of seven percent per annum. However as a result of the Arab Spring and the consequent Egyptian revolution, this was downgraded to five percent for the initial years following the Arab Spring, JICA (2012) 6F[7].In Table 3.7, it is seen that the population and GDP growth by region vary nationwide with the lower growth in the significantly developed regions of the nation namely Cairo and the Delta. In the established regions, there is already significant development whereas the other regions are starting from a lower base thus these regions exhibit higher growth rates. Within the framework of the National Vision, there was an implicit goal of decentralization.

[6] This population forecast is in alignment with the Egypt Vision 2052, prepared by the GOPP, Ministry of Housing, Utilities and Urban Communities, 2010 (with updates). This document represents the only long-term plan for Egypt. The Vision is understood to have been approved by the Prime Minister and the Supreme Council for Urban Development and Planning.

[7] In fact, there were several iterations of the GDP forecast consequent on the impact of the Arab Spring.

Table 3.7 The twenty year forecast percentage growth per annum

Region	Population	Regional GDP
Cairo	1.3	4.3
Eastern Delta	1.1	4.6
New Valley	8.9	12.6
Upper Egypt	2.3	6.4
Red Sea	5.3	9.2
Sinai	7.3	12.9
Western Delta	1.6	5.2
Western Desert	9.5	11.9
National	1.9	5.3

3.4.3 Egyptian Scenarios

Four scenarios were initially considered in the development of infrastructure in Egypt. Each scenario was analyzed with the mathematical model. The framework structure of said model was described earlier. The scenarios were:

- Scenario A: "Do Minimum" scenario, embodies future demand on the existing network in addition to the on-going and committed projects. That is, the transport networks include the year 2010 facilities plus those committed for implementation by the road, rail and inland waterway sectors. The network assignment reflects modal split under current transport costing conditions to include fuel prices. The findings of Scenario A represent the case against which evaluations of more elaborate future scenarios are compared.

- Scenario B: “Do nothing” scenario is driven by future demand on the existing network. The assignment operates under identical conditions as Scenario A, with the major difference being that committed transport projects are excluded from consideration. This provides a more direct comparison to observed year 2010 conditions; that is, an understanding of how existing networks cope with future demand.

Scenario C contains three variants of future scenarios namely:

- Scenario C-1: “Maximum infrastructure” scenario. The “existing plus committed” transport network is enhanced by the inclusion of (a) some elements of the dedicated strategic corridors, JICA(2012); (b) additional projects proposed (but not committed) by transport service providers, and (c) transport linkages contained in the Egypt Vision 2052 document. The rail network thus includes provision for “high speed” (TGV/Shinkansen-class) services in some corridors. The analysis reflects a more market oriented approach (“user pays principle) with the adoption of market fuel cost effectively removing the current fuel subsidy whilst forcing an emphasis on the non- road modes.
- Scenario C-2: “Reduced infrastructure” scenario evolves towards a less complex and expensive network vis-à-vis that of Scenario C-1. For example, high speed rail is replaced by “higher speed rail” with an operating speed between 160-200 kilometers per hour (kph). Fuel price increases are less severe than Scenario C-1.
- Scenario C-3: “Revenue generation” scenario builds upon previous scenarios by utilizing reduced infrastructure (as per Scenario C-2). In

addition, the Scenario C-1 fuel pricing structure is increased by some twenty percent of per-liter costs via the application of an "at the pump" fuel tax. The intent is to simulate possible revenues which can be derived from levying a simple fuel tax "at the pump" as in many other countries or an environmental tax as that is under consideration currently in some countries. In this scenario there is a significant shift towards the non-road modes of transport.

The scenarios that were initially considered in the investigation in the development of an infrastructure plan are summarized in Table 3.8. The modal shift associated with each scenario is seen in Table 3.9. The increased diversion of cargo from road to non-road modes also carries considerable implications in terms of required infrastructure. In case of road, being the dominant carrier of cargo, demand over base year increases, across all scenarios, by a factor of 2.2 to 2.4.

It may be stated that, for rail and inland waterway, tonnage is expected to increase in the twenty year projection by factors of 1.7 and 1.4, respectively, assuming the current modal split is largely maintained and given the projected expansion of the Egyptian economy. This situation is represented by Scenarios A and B. Thus, enhancements are required which permit these modes to almost double their present tonnage.

Rail cargo carriage is shown as increasing by factors of 6.7, 2.3 and 14.6 for Scenarios C-1, C-2 and C-3, respectively as seen in Table 3.10. Based on existing annual carriage of 4.04 million tonnes, the twenty year projection demand would be 27.1, 9.3 and 58.9 million tonnes, respectively. The highest totals carried by rail over the past decade is on the order of 12 million tonnes; thus, Scenario C-2 can be seen as "regaining past capabilities". That is, under the assumption that having carried such volumes before, rail upgrading can focus on rehabilitation of existing resources with minimal network expansion. However, this is unlikely to be the case for other scenarios, in particular C-3. The notion of carrying near 60 million tonnes is daunting. Under this scenario rail network infrastructure would require massive investment at significant cost.

Inland waterway carriage is shown as increasing by factors of 2.9, 1.4 and 5.3 for Scenarios C-1, C-2 and C-3, respectively as seen in Table 3.10. Based on existing annual carriage of 2.23 million tonnes, the twenty year projection demand would be 6.5, 3.1 and 11.8 million tonnes, respectively. The highest recent totals carried by IWT is on the order of three million tonnes; thus, Scenario C-2 can be seen as "regaining past capabilities". However, this is unlikely to be the case for other scenarios, in particular Scenario C-3 (11.8 million tonnes) which is likely to require considerable system upgrades at significant cost. Thus, road systems are less sensitive to cargo activity in terms of underlying infrastructure required. However, the situation is very different for the rail and IWT modes.

Table 3.8 Scenario strategy consideration

Scenario	Scenario Reference	Fuel Price	Infrastructure	Modal Focus
A	Do Minimum	Current	Existing plus Committed	Road
B	Do Nothing	Current	Existing	Road
C-1	Maximum Infrastructure	Market Price	Existing plus Committed plus All New	Non Road
C-2	Reduced Infrastructure	Less than Market Price but higher than Existing Price	Existing plus Committed plus Most New	Non Road-Passenger Road-Cargo
C-3	Revenue Generation	Market Price plus "at the pump" tax	Existing plus Committed plus Most New	Maximum Non Road

Table 3.9 The Twenty Year Projection – Cargo Mode Split

Scenario	Road	Rail	Inland Waterway	Total
Tonne				
A	98.3	0.6	1.1	100.0
B	98.3	0.6	1.1	100.0
C-1	95.5	2.3	2.2	100.0
C-2	98.1	0.8	1.1	100.0
C-3	90.9	5.0	4.1	100.0
Tonne-Kilometers				
A	98.5	1.0	0.5	100.0
B	98.6	0.9	0.5	100.0
C-1	90.3	5.9	3.7	100.0
C-2	98.8	0.8	0.4	100.0
C-3	80.7	11.8	7.5	100.0

Table 3.10 The Twenty Year Projection – Cargo Growth Factor in Tonnes

Scenario	Road	Rail	Inland Waterway	Total
Base Year	1.0	1.0	1.0	1.0
A	2.4	1.7	1.4	2.4
B	2.4	1.7	1.4	2.4
C-1	2.3	6.7	2.9	2.4
C-2	2.4	2.3	1.4	2.4
C-3	2.2	14.6	5.3	2.4

3.4.4 The European Experience

Even within the European Union, European Union (2009), the trend towards increasing road based cargo transport is difficult to change as per the projection of Table 3.11. The European Union has the intention to encourage a green cargo transport philosophy but in reality the Union is barely maintaining the status quo. From a public and national policy perspective, environmental sustainability in logistics is focused on reduction of negative externalities from transport such as emissions, contamination and noise as well as reducing the energy use of the sector. The European Union has set an ambitious goal of reducing transport-related emissions by at least sixty percent of the 1990 levels by 2050. Total carbon footprint estimation for cargo trips is encouraged through the adoption of greenhouse fact-finding studies in support of the development of an EU strategy for cargo transport logistics that reduces the dependence on road based transport.

With regards to energy use, the use of less and cleaner energy is the most important goal of European transport policy. This can be achieved through modal shift (shift of fifty percent of long-haul road freight to rail and waterborne transport), green freight corridors, use of alternative energy and cleaner sources, eco-driving and fuel-saving techniques as well as more efficient technologies and supporting administrative measures (e.g., fuel taxes, speed limitations of freight vehicles etc.). However, current trends in European cargo movements as seen in Table 3.11 will not make this an easy achievement.

Table 3.11 European Trends in Cargo Movement

Year	Modal Share (% by tonne km)			
	Road	Rail	IWT	Total
2010	73.1	14.1	12.8	100.0
2020	75.4	12.6	12.0	100.0
2030	77.5	11.2	11.3	100.0

3.5 The Desire and Consequence of Modal Shift

The road mode remains under the preferred scenario an essential factor in economic activity as this sector has historically played a strong role in modal choice for Egypt. While these phenomena have fulfilled a variety of social goals and expectations, unfettered growth is also contributing to various negative social, economic and environmental impacts. However there is now a modal focus away from the road sector in the case of cargo and away from the private car in the case of passenger transport.

3.5.1 The Hybrid Scenario or Scenario D

The recommended preferred scenario for Egyptian infrastructure is in fact a hybrid of scenarios C1 and C2 hereafter referred to as Scenario D and is structured on the following:

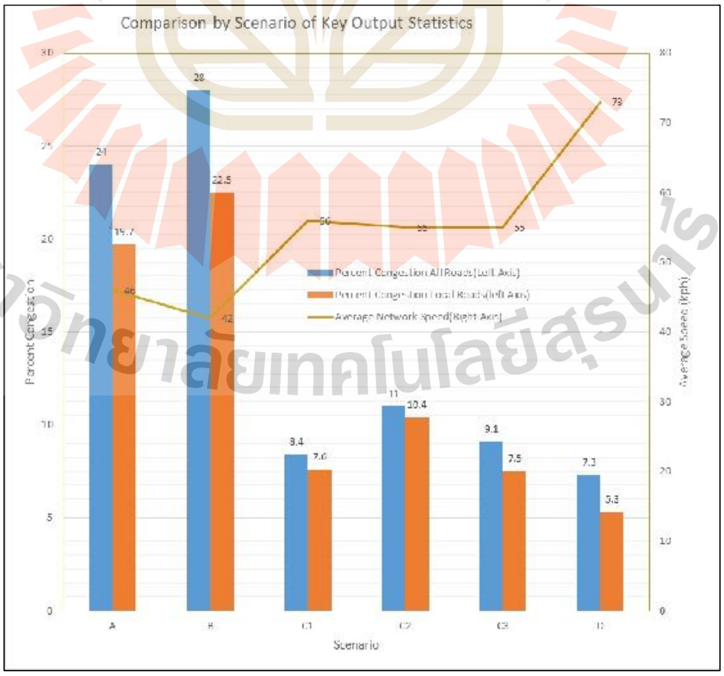

Figure 3.5 Key Statistical Scenario Output

- The preferred scenario includes the adoption of a "user pay principle" vis-à-vis the market cost of fuel. That is, operating cost calculations reflect the adoption of market fuel price (as per Scenario C-1), in constant year 2010 terms, over the 20 year projection but the scenario does not include any allowance for an "at the pump" fuel tax;
- The Networks proposed across all modes for the preferred scenario are derived recognizing both quantitative plus qualitative (vision, policy and strategy) parameters; and
- The road transport networks will tend towards improvements consisting of ongoing plus planned projects, as proposed in Scenario C-1.

The high level of road usage is a historic consequence of vehicle ownership characteristics, pricing policies (such as the non- adoption of market fuel price), supported by "road focused" capital works programs and limitations to public transport services in the case of passenger movements. Increasing car usage and truck movements within urban and rural areas is beginning to impact the quality of life. A more balanced approach to providing mobility is desirable as seen in Figure 3.5. A key focus in Egypt, is therefore the creation and promotion of high quality, multi-modal (and intermodal) transport system for both persons and cargo. The performance of the preferred scenarios therefore focuses on two aspects: diversion of cargoes to non-road (rail and inland waterway) modes of transport, and refocusing the role of passenger transport onto those public means of conveyance seen as being compatible with longer trips.

The simulations suggest that, in case of cargo as stated earlier:

- The road mode is expected to retain its vital role; however, the dominance is reduced.(Table 3.12)
- The impact of adoption of market fuel price (for example, for trucks) is confirmed in Scenario D.

The increased diversion of cargo from road to non-road modes also carries considerable implications in terms of required infrastructure funding. In case of road, being the dominant carrier, demand over base year 2010 increases, across all scenarios, by a factor of 2.3 in terms of tonnes. Table 3.13 tabulates this using the unity factor for the base year. Thus, road systems are less sensitive to cargo activity in terms of underlying infrastructure required. However, the situation is very different for the rail and IWT modes.

It may be stated that, for rail and inland waterway, tonnage is expected to increase in the framework of the twenty year projection by factors of 5.8 and 2.6, respectively, in the preferred scenario. This is in contrast to Scenario A where the existing mode split is essentially maintained even given the expected expansion of the Egyptian economy. Thus, enhancements are required which permit these modes to almost double their present tonnage.

Table 3.12 Twenty Year Projection- percentage mode split

Scenario	Road	Rail	Inland Waterway	Total
Tonne				
A	98.3	0.6	1.1	100.0
C-1	95.5	2.3	2.2	100.0
D	96.0	2.0	2.0	100.0
Tonne-Kilometers				
A	98.5	1.0	0.5	100.0
C-1	90.3	5.9	3.7	100.0
D	90.3	6.1	3.6	100.0

Table 3.13 Twenty year projection -Cargo growth factor for Scenario D

Scenario	Road	Rail	Inland Waterway	Total
Base Year	1.0	1.0	1.0	1.0
A	2.4	1.7	1.4	2.3
C-1	2.3	6.7	2.9	2.3
D	2.3	5.8	2.6	2.3

3.6 Conclusion

When considering the development of new infrastructure in Egypt to assist in the transfer to Green freight movement, the desired modal split should be pursued in a realistic manner taking the growth trend in road cargo into account. Large increases in the sector capability of the non-road sector are implied in Table 3.13. but difficult from a practical and economic point of view.

The twenty year forecast for the nation demographically in accordance with the national vision demonstrates via infrastructure development Scenario D that it is possible to halt the fact that the road sector for cargo movements was continuing to approach the one hundred percent mark. (Armstrong-Wright and Transport and Road Research Laboratory. 1993)

Of course, this cannot achievable overnight so that the mathematical model considers a twenty-year time frame which is also in line with the Egyptian National Vision of 2052. The dilemma is the establishment of Green Freight Movement and the shifting of cargo movements from the dominant road mode to alternative modes. The development of the mathematical model for cargo movement has enabled the transport planner practitioner to advance the understanding of cargo movements and provide a numerical framework for the understanding the impact of a green cargo modal shift.

3.7 Acknowledgements

All ideas and views expressed in this discussion are those of the authors. They do not necessarily reflect any of the sponsoring authorities of projects discussed in this documentation or the organizations employing the respective authors.

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CHAPTER IV

GREEN CARGO MOVEMENT, LOCALITY: MEKONG REGION ACROSS LOCALITIES

4.1 Abstract

There is an issue in the identification of commonality across several localities associated with the problem of cargo movement via modes of transport other than the road. The approach in this chapter considers movement from the locality of the multi-jurisdiction of the Mekong Region, an agglomeration of Myanmar, Thailand, Laos, Vietnam, Cambodia, and southern China. A mathematical approach was developed to analyze the impact of cargo movement away from the road transport sector to greener alternative rail mode. The analytical appreciation is considered from the review of large-scale cargo movement across the region. Results from the data analysis are indicative of an environmentally friendly or a green freight alternative. The mathematical model described in this chapter is used to consider freight modal shifts under various infrastructure development scenarios. The outcome from the analysis results is the input into ongoing research to identify common mathematical functions across other jurisdictions. The conclusion is that there is a likelihood that common mathematical procedures are applicable in several localities.

4.2 Introduction

The Mekong region in this context is defined to include seven localities namely the nation states of Myanmar, Thailand, Lao People's Democratic Republic (PDR), Cambodia, Vietnam and the two southern provinces of Guangxi and Yunnan within the People's Republic of China (PRC). The extent of the major infrastructure network is presented in Figure 4.1. The focus of this chapter is the modal analysis of cargo or freight movement throughout the Mekong.

Within any region, the transport mode of cargo transport by road is an essential factor in economic activity and has historically played a strong role in the development of many areas across the globe. In many regions and countries with a single jurisdiction, there is a growing trend to develop strategies that move away from the dominance of cargo transport by road toward alternative environmental friendlier modes.

In a broader world context, almost all cargo movements are dependent on road transport. In for example, even in the European Union as reported in an earlier report (ColliersInternational 2016), cargo movement in 2009 was dominated by the road sector. The road modal share for any of the major country members did not fall below sixty percent. This was true even in the case of Germany where twelve percent of cargo moves via the mode of inland water.

In France, the road cargo modal share is eighty percent increasing to eighty-five percent in the United Kingdom. Whilst the modal share by road in Italy is just over ninety percent. Thus, even in the context of the developed European Union cargo movement, road transport is the most significant mode. This dominance of the road sector makes it difficult to realize the objective of the European Union to reduce the dependence on road transport.

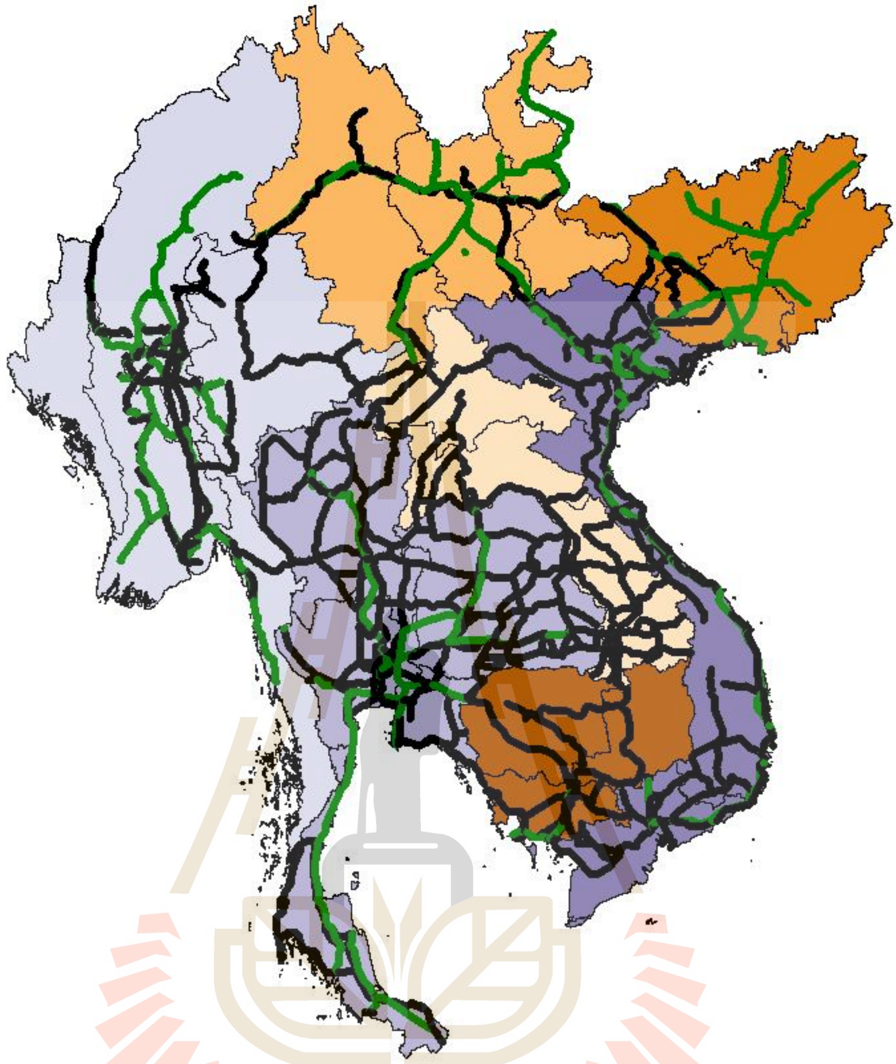

Figure 4.1 The Mekong Region.

The Agenda 2020 of the European Union calls for member countries to reduce greenhouse gas emissions. There is implicit in this agenda within the Union the desirability of taxing fuels on road-based transport, (Bartocci and Pisani 2013) thus encouraging by financial incentives a modal shift away from the dominant road sector. The Union is providing incentives towards a greener movement of freight with consequently fewer greenhouse emissions which in essence is to reduce the road component of cargo movement following the Paris Agreement on Climate Change (Hossain et al.). This, of course, leads to the need for improving the alternatives to cargo movements by road.

4.3 The Regional Situation

There are two parts in the understanding of regional cargo movement namely the movement infrastructure, the transport supply and the actual amount and nature of cargo movement on the network, the demand side.

Within the framework of the regional transport network for the Mekong assembled as part of this research in the development of an analytical transport modeling tool, the primary regional road network identified as depicted in the earlier Figure 4. 1 is some 37,000 kilometers in length. The identified rail network is of some 17,000 kilometers in length. The length of the rail network is thus some 34% of the major transport corridor by comparison in length. There is a significant regional rail network although there are some missing connections between the earlier defined seven localities within the Mekong.

In addition to the land transport network, there are a further 10,000 kilometers each of Inland Waterway Transport (IWT) and Coastal Shipping or Sea Mode included in the transport network. For the movement of people an extensive air transport network is incorporated into the overall network framework.

The cargo road mode of transport is often driven by the lack of high-quality alternatives. In the understanding of the cargo transport demand today and that of the future, the key inputs are the macro economic indicators. These indicators reflect the overall development of each of the seven localities and the propensity for cargo movement.

4.3.1 Historical Activity Levels

Between 1998 and 2014, the Gross Domestic Product (GDP), as measured in constant US dollars in the base year of 2010 at market prices has grown at an overall of 8.6% per annum. The regional population has grown at 0.8% per annum. As depicted in Table 4.1, there is differential growth by locality with Myanmar registering the highest growth in GDP closely following by the two Chinese provinces. Thailand which is starting at a higher level of GDP also registers significant economic growth over this period.

Population growth is seen as the higher in the two larger population localities of Cambodia and Vietnam. The Lao PDR has the highest historical population growth albeit from a lower base.

The noted differential growth rates in the future are likely to lead to in the distribution of GDP Use at most three levels of headings that correspond to chapters, sections, and subsections.

Table 4.1 Locality growth per annum 1998 - 2014

Locality	GDP	Population
Cambodia	10.1%	1.4%
Guangxi, PRC	12.4%	0.1%
Yunnan, PRC	11.3%	0.9%

Table 4.1 Locality growth per annum 1998 – 2014 (Continued)

Locality	GDP	Population
Lao PDR	9.7%	2.1%
Myanmar	13.4%	0.8%
Thailand	6.3%	0.7%
Viet Nam	8.6%	1.1%

4.3.2 Associated environmental concerns

The continued movement of cargo via the road mode especially over long distances will also lead to a continued increase in emission gases. This is not in alignment with the overall Paris environmental agreement. Whilst to some degree, such emissions from within cities for personal mobility have been contained. This is not the case for the movement of cargo, especially over long distances. Within the context of another large jurisdiction namely Egypt (Johnstone and Ratanavaraha 2017), the use of the road-based transport mode has increased exponentially in the last few years.

Whilst this phenomenon has fulfilled a variety of economic goals and expectations, unfettered growth is increasingly contributing to various negative environmental impacts. This high level of usage in Egypt is a historical consequence of pricing policies (such as the fuel subsidy), and “road focused” capital works programs. There is a beginning of an understanding of the notion that a more balanced approach to providing cargo mobility is desirable especially in respect to the transportation of cargo within the borders of Egypt.

For example, in another large country jurisdiction such as Australia, over the period 1990 to 2006, overall transport emissions grew by 27.4 percent, however, emissions from the movement of freight grew by 40 percent. Freight transport emissions now contribute around four percent of the national emissions total throughout the country and are forecast to more than treble to thirteen percent by 2020 as reported in a recent freight transport review chapter (Eren 2008).

4.4 Methodology

The most commonly used tool for understanding the movement of people or cargo throughout a defined geographical space is in the form of a transport model (Johnstone and Chancharoen 2010), (Johnstone and Chancharoen 2010). A classic four-step transport model is developed as the analytical tool for the examination of cargo movement through the region. The structure for understanding movement within the Mekong is built initially from the understanding the existing regional movement.

Of course, cargo movement does not happen in isolation. The four-step procedure is followed both for the movement of cargo and people as depicted in Figure 4. 2. In the final step, the network assignment combines all movement across all transport network infrastructure. In fact, the performance of the road network is defined by both the movement of people and cargo.

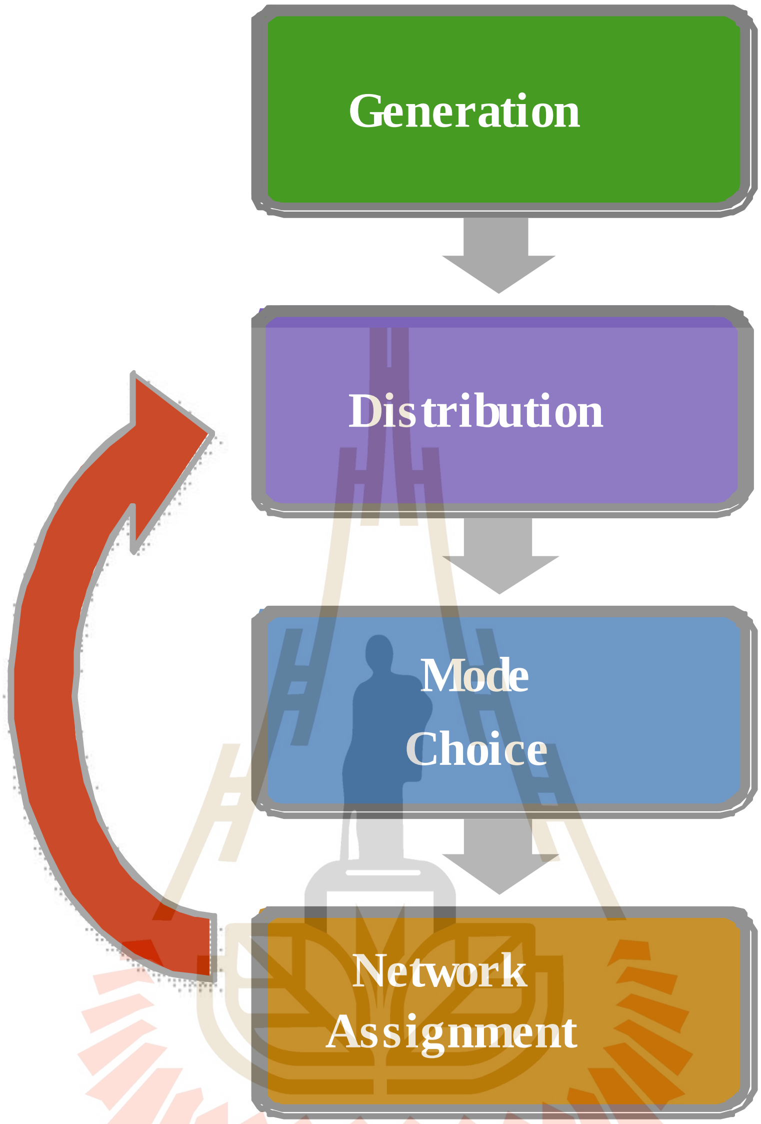

Figure 4.2 The regional model structure.

4.4.1 Data Preparation

The base input data are a collation of databases available by locality held by the various responsible agencies throughout the region. The master transport network includes all known transport projects at present, both existing and proposed, that are incorporated into a master network with the potential opening year of any new project provided as a network parameter. At the same time, the economic and population datasets are prepared for the base time horizon of 2015 and a future time horizon of 2050.

The data is prepared in detail at the level of traffic analytical zone that corresponds to administrative boundaries with the amalgamation of smaller administrative areas into a single traffic zone.

The zone system adopted for the model is the same as that for the earlier 2006 GMS Transport Sector Strategy Study (Asian Development 2006). Within the two provinces of China, there are 30 zones. In Myanmar, there are 40 zones whilst Thailand has a total of 56 zones. There are 17 zones and 24 zones in Lao PDR and Cambodia respectively. Finally, Viet Nam has 49 zones. Thus, the model has a total of 216 internal zones. The total number of zones is 254 including 38 external zones of which 30 of the externals represent seaports.

4.4.2 The key Inputs – Drivers of future demand

The two planning inputs, drivers of future cargo movements are the regional GDP and the population. The future economic and population projections are based on trend data except for Thailand (OTP 2014), Myanmar ((JICA) 2014) and Vietnam ((JICA) 2009). In these three localities, the economic and population projections were derived from the national transport databases.

The Mekong wide GDP is projected to increase at 6.2% per annum until the year 2025 and estimated to grow at 5% per annum thereafter until 2050. These overall projected growth rates are in line with earlier detailed historical growth rates [13] as well as those available from national transport databases. The key important change in the future is the forecast distribution balance of GDP. As earlier noted, the differential locality growth rates predict a change in regional economic distribution.

In 2015, as depicted in Figure 4.3., Thailand has nearly 40% of regional GDP. This is projected to decrease to under 20% by 2050. This share of GDP is transferred to the two Chinese provinces and Myanmar by 2050. By 2050, the two Chinese provinces are projected to increase their share of overall GDP by 15% from an initial 39% to 54% whereas Myanmar will increase its share of regional GDP from 7% to 10%. The remaining localities of Lao People's Democratic Republic (PDR), Cambodia, Vietnam are expected to maintain approximately their existing share of GDP.

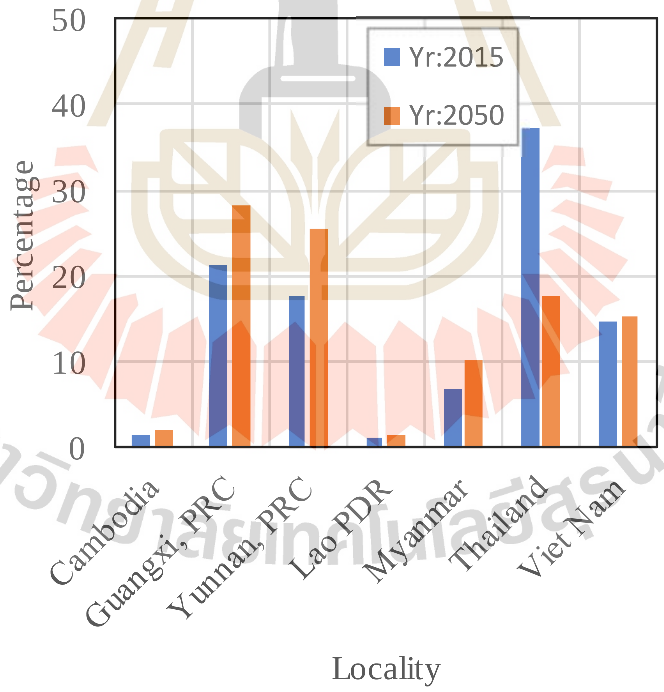

Figure 4.3 Distribution of GDP by locality.

The regional population is projected to increase at 0.8% over the overall time horizon between 2015and 2050. Between 2015 and 2050, the regional population is anticipated to grow from 340 million to some 453 million people thus forming a potentially significant trading block. The regional population distribution is depicted in Figure 4.4.

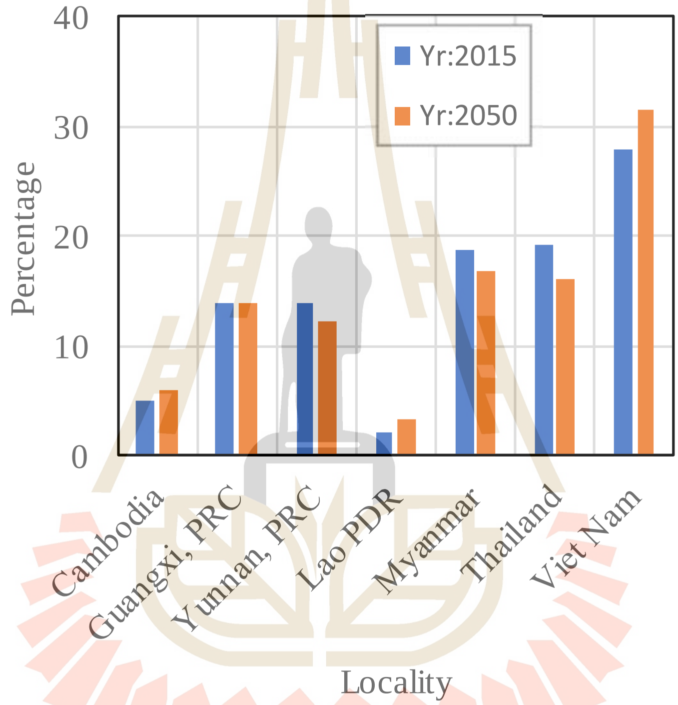

Figure 4.4 Distribution of Population by locality.

Unlike GDP, the population distribution is unlikely to change significantly. The regional population share of Viet Nam increases from 28% to 32%. The regional population share of Thailand decreases by approximately three percent. The change in distribution in all other localities is less than 2%. The change in distribution between localities is important because such change will impact the likely future pattern exchange of cargo movement between the localities.

4.4.3 The Structure of Cargo Movement

For the analysis of cargo movements, the key modes represented within the model are a road, rail, inland waterways transport, and coastal shipping. The model developed is known as the Mekong Regional Transport Model henceforth referred to simply as the MRTM.

Cargo movement is divided into 5 commodity classifications. The MRTM was developed to produce forecasts of passenger and 5 categories of cargo movement by mode for the time horizons of the base year of 2015 and two future horizons of 2025. and 2050

The parameters in the equations vary by locality and commodity group. The five commodity groups were summarized based on the international Harmonized System codes also referred to as simply the HS codes. These codes are an internationally standardized system of names and numbers to identify an individual product. The code is an 8-digit number but broad classifications are developed using the first two digits of the code.

Broadly the five commodity categories in numerical order one through to five are agriculture, processed food, wood products, chemicals, and miscellaneous goods. The link of the five commodity categories to the Harmonized System of coding is presented in Table 4.2 which tabulates the first two-digits of the HS code against the commodity category.

Table 4.2 Cargo commodity category

Category	Description	HS Code	
		Start	End
1	Agricultural	1	15
2	Processed Food	16	24
3	Chemical/Mineral	25	40
4	Wood/Skins	41	49
3	Chemical/Mineral	50	63
4	Wood/Skins	64	67
5	Miscellaneous	68	97

4.5 The Analysis

The focus of this research as stated earlier is on the modal allocation and the key input parameters namely the population and GDP. However, prior to the modal allocation step, there are the two earlier steps associated with the trip generation and distribution of cargo movement. Cargo movement generations are estimated by traffic zone via a relationship linking population and GDP per capita in a series of linear regression equations derived for each locality separately.

Cargo trip distribution used the Fratar growth factor distribution method (Horowitz 2009) that takes as a base an existing distribution patterns sourced from an earlier Mekong study (Bank 2016). The trip distribution is across all localities so that there are not separate trip distribution procedures via locality.

For the mode split step, the commodity movement cost and travel times are the key inputs into the freight mode split model. The mode split structure for freight is a hierarchical three-level mode split logit model as depicted in Figure 4.5. The total cargo trips were distributed across four modes. At the first level, coastal trips are separated while at the second level, inland water transport trips are separated, with the final level being the allocation of movement between road and rail. In many cases, the mode choices were limited to road and rail since there was no logical route via other modes.

The master transport network of MRTM includes all known transport projects at present, both existing and proposed, that are incorporated into a master network with the potential opening year of any new project provided as a network parameter. In this manner, there is inbuilt flexibility as it is actually possible to develop the network other than for the two future time horizons of 2025 and 2050.

The structure of the binary logit equations is shown in Eq. 1.

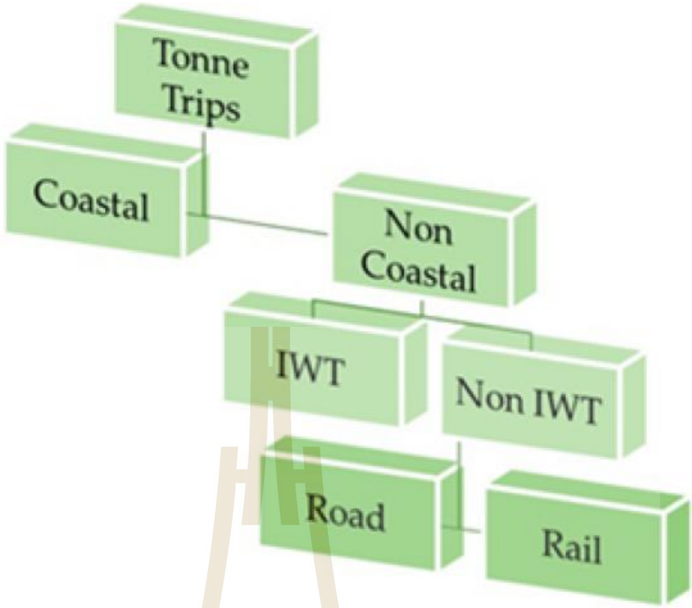

Figure 4.5 Modal Allocation Structure

The cost of travel on alternative modes is referred to as the generalized cost of travel and is a function of time and cost.

$$P_1 = \frac{\exp^{V_1}}{\exp^{V_1} + \exp^{V_2}} \quad (4.1)$$

Equation (1) defines the probability of using mode 1 as opposed to mode 2 whereas V_1 and V_2 are the generalized travel costs associated with modes 1 and 2 respectively.

The variables in the determination of generalized travel cost are namely the travel time and the travel cost weighted by scale factors. These scale factors are presented in Table 4.3 by commodity category for each level of the modal analysis. The cost of travel by the various modes of travel was determined by locality.

The final step was the assignment or the allocation of the flow of people and freight to air, road, rail, inland waterway and coastal shipping networks. The final network travel times across the road network were estimated following a capacity restrained assignment.

In the case of the road network, the movement of persons by car and bus were converted into equivalent passenger car units together with the cargo-carrying trucks on the network. The impact of person and cargo trips were combined in consideration of the impact on the shared road network.

It was necessary to convert cargo movements allocated to road network into vehicles via load factors. The remaining freight trips do not use the road network except for access to the non-road network (e.g. truck to rail).

In the case of truck trips, there was also an implied back loading factor to allow for trucks returning from their destination without any load. The non-road trips are then assigned to their respective networks such as rail. This results in a final network that represented travel across all modes.

Table 4.3 Scale factors by commodity category

Category	Equation Level	Time	Cost
1	1	-0.2244	-0.0001
2	1	-0.0004	-0.0004
3	1	-0.0858	-0.0004
4	1	-0.0355	-0.0004
5	1	-0.0355	-0.0004
1	2	-0.0194	-0.0001

Table 4.3 Scale factors by commodity category (Continued)

Category	Equation Level	Time	Cost
2	2	-0.0387	-0.0004
3	2	-0.0732	-0.0006
4	2	-0.0169	-0.0004
5	2	-0.0173	-0.0001
1	3	-0.3892	-0.0008
2	3	-0.2078	-0.0003
3	3	-0.176	-0.0008
4	3	-0.5941	-0.0034
5	3	-0.5891	-0.0006

Passenger vehicles and trucks share the road networks. For the traffic movements assigned to the road network, there is a feedback loop to adjust the road traffic speed until there is equilibrium across the network (i.e. that assumed input speeds match the actual output speeds after the traffic assignment). The travel time on the road network impacts the mode split of both person and cargo movement. All the assigned trips across all networks are combined into a single output network following the equilibrium procedure.

One potential bottleneck for the movement of cargo between the different localities is both the formality and physical barriers at international border crossing points. This is currently being addressed by various cross-regional organizations such as The Greater Mekong Rail Association. In the distant future scenario, these are resolved to facilitate economic prosperity.

4.5.1 The model validation

The validation of the model was undertaken from data sources not currently used as input data in the model development. Two such comparisons are discussed here. The base output from combined road vehicle movement in 2015 was validated against screen line traffic counts in Thailand in the north-west and south-east where such traffic has the potential to betraveling to locality crossing points. The screenline comparison of vehicle traffic was within 10%.

A Big Data comparison was made between the model estimation of the overall trade between Thailand and the two localities of Yunnan and Guangxi in China via a comparison of the two custom databases. The estimation of trade between the two Chinese localities and Thailand is 1,409 tonnes on average per day in 2015 compared to an observed volume of 1,400 tonnes per day. The comparison is good.

4.6. Results and Conclusions

In the current situation incorporating all infrastructure proposals, there is a small modal shift in terms of tonne-kilometers of travel. However, this implies that significantly more effort is required to ensure a modal shift away from the road sector

In the current situation incorporating all infrastructure proposals, there is a small modal shift in terms of tonne-kilometers of travel. However, this implies that significantly more effort is required to ensure a modal shift away from the road sector.

4.6.1 The future result

Cargo movement as measured in terms of tonne-kilometers of travel is estimated to grow at 4.9 % per annum between 2015 and 2025. However, as a result of the changing interaction between the economic parameters, the differential distribution of cargo across localities changes as depicted in Figure 4.6.

In 2015, Thailand has nearly 50% of regional cargo movements. This is projected to decrease to under 40% by 2050. This share of cargo is transferred across all localities by 2050. By 2050, the two Chinese provinces are projected to increase their share of overall cargo movements by 40% from an initial 14% to 20% whereas Myanmar will decrease its share of regional movement from 12% to 9%. The localities of Lao People's Democratic Republic (PDR) and Vietnam are expected to increase approximately their share of cargo movement.

In the current proposal incorporating all new rail infrastructure proposals of the seven localities, there is a small modal shift in the movement of cargo as reported in Table 4.4. The truck remains the dominant mode of transport across the region. The modal share of the alternative non-road modes in combination increases nearly four times. The modal share increases in rail alone increase by nearly 150%. There is in this case also an estimated shift to IWT as a direct result of increased road congestion.

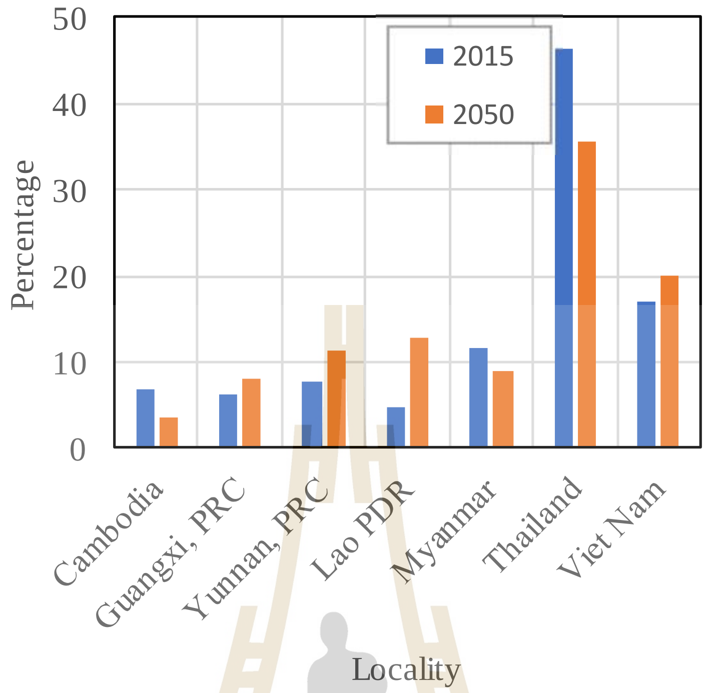

Figure 4.6 Distribution of cargo travel by locality

Table 4.4 Modal shift between 2015 and 2050

Mode	2015	2050
Truck	98.43%	96.29%
Rail	0.78%	1.30%
IWT	0.18%	0.24%
Sea	0.62%	2.17%

Another issue that arises from the continual maintenance of the high cargo modal split towards road movement is that by 2050, there is an estimated

Significant change in the distribution of road traffic across the region. As depicted in Figure 4. 7, by 2050, that there is a dramatic shift in the sharing of regional road space in terms of road movement as measured in terms of passenger car units.

Today, trucks account for 23% of all movements across the regional road network, the model developed in this research suggests that this will rise to 45% in a future scenario. This is a significant change and is likely to have an impact on traffic accidents.

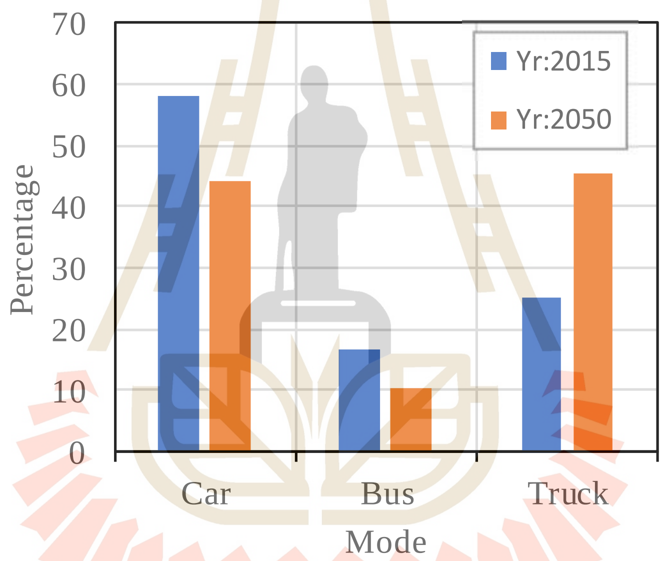

Figure 4.7 Road Usage (pcu-km of travel)

4.6.2 The future result-Ultimate Scenario

In the case of an ultimate rail scenario such as the double tracking of the complete existing region rail together with improved border crossings, there is, in this case, an ultimate shift in cargo movement. The truck remains the dominant mode of transport across the region. The modal share of the alternative modes in combination increases nearly seven times.

The modal share increase in rail alone is of the order of five times higher depicted in Table 4.5. The transport model prepared as part of this research is an analytical tool that is an initial starting point for researchers to understand the mobility of cargo throughout the Mekong.

Table 4.5 Modal comparison – increase infrastructure

Mode	2015	2050
Truck	98.43%	92.62%
Rail	0.78%	5.09%
IWT	0.18%	0.46%
Sea	0.62%	1.83%

If the localities of the Mekong are to consider a modal shift away from the road there will likely need to be a change in the pricing structure of the movement of cargo by road and rail. Such a change in cost is reported in a test case in Table 4.6.

Table 4.6 Modal comparison – cost differential

Mode	2015	2050
Truck	98.43%	89.48%
Rail	0.78%	7.90%
IWT	0.18%	0.45%
Sea	0.62%	2.15%

In this test case, the cost differential is changed with an increase in the cost of cargo movement by truck whilst at the same decreasing the cost of cargo movement by rail. This suggests that there is a potential for the truck modal share of the movement of cargo across the Mekong to fall below the 90% level.

4.6.3 Feasibility of green cargo shift

When considering the development of new infrastructure in the Mekong Region to assist in the transfer to Green freight movement, the desired modal split should be pursued in a realistic manner taking the growth trend in road cargo into account. Large increases in the sector capability of the non-road sector are implementable but difficult from a practical and economic point of view.

The long-term forecast for the region demographically in accordance with the various locality economic forecasts demonstrates via infrastructure development that it is possible to halt the fact that the road sector for cargo movements was continuing to approach the one hundred percent mark. Of course, such movement away from the road sector is not achievable overnight so that the mathematical model considers a thirty-five year time frame for intermodal shift (Li et al. 2015).

The dilemma is the establishment of Green Cargo Movement and the shifting of cargo movements from the dominant road mode to alternative modes. The development of the mathematical model for cargo movement has enabled the transport planner practitioner to advance the understanding of cargo movements and provide a numerical framework for understanding the impact of a green cargo modal shift.

4.7 Acknowledgments

The authors acknowledge the support of the government agencies within the Mekong and the Asian Development Bank in the preparation of existing datasets and the development of the analytical tools. All ideas and views expressed in this chapter are those of the authors. They do not necessarily reflect any of the sponsoring authorities of projects discussed in this chapter or any organizations associated with the respective authors.

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CHAPTER V

GREEN CARGO MOVEMENT, MULTI JURISDICTIONAL COMMONALITY

5.1 Abstract

There is an issue in the identification of commonality across different localities associated with the understanding of cargo movement via different modes of transport other than via road. Today even in Europe, the road sector is dominant. The approach here considers movement within three different jurisdictions of Egypt, the Mekong with a focus on Thailand and Queensland in Australia. A mathematical approach considers the impact of cargo movement shift away from the road transport sector to the greener alternatives of water and rail. The analytical appreciation is considered from the review of large-scale cargo movement across the nominated jurisdictions. Results from the data analysis are indicative of the impact of an environmentally friendly or a green cargo alternative. The mathematical models described here are used to consider the impact of the potential modal shift of cargo movement and potential economic consequences. It was the intention during this research to understand the factual situation that road infrastructure currently is dominant in the movement of cargo. The outcome from the analysis results is an understanding of the consequence of cargo modal shift.

5.2 Introduction

In The implementation of the Paris Agreement (UnitedNations 2015) requires a reduction in greenhouse emissions. Achievement of this implementation requires the development of an efficient movement of cargo whilst simultaneously maintaining economic growth. Currently, cargo movement is closely linked to the road sector even when alternative modes are available. The European Union reported (ColliersInternational 2016) cargo movement in 2009 was dominated by the road sector. The road modal share for any of the major country members did not fall below sixty percent. In Germany where there are extensive alternative networks, there was for example only twelve percent of cargo movement via the alternative mode of inland water. The cargo market is still in Germany dominated by road at sixty five percent. In France, the road cargo modal share is eighty percent increasing to eighty five percent in the United Kingdom. Whilst the road sector modal share in Italy is just over ninety percent. Thus, even in the developed European Union, cargo movement by road transport is the significant mode. This is similar in comparison to developing countries. This dominance of the cargo movement via the road sector makes it difficult to realize the objective even within the European Union to reduce the dependence on road transport.

The Agenda 2020 of the European Union calls for member countries to reduce greenhouse gas emissions and increase renewable energy (Bartocci and Pisani 2013). There is implicit in this agenda within the EU of taxing fuels on road based transport (Bartocci and Pisani 2013), thus encouraging a modal shift away from the dominant road sector. The contrast is that in many developing countries, until recently fuel for the road sector included a subsidy, not a fuel tax. This research considers as a comparison of the relative numerical analysis in the determination of cargo generation and modal shift across three different jurisdictions. There are both network and economic points to consider in the under.

A comparison is problematic across economies of different jurisdictions because different economies produce different goods. In this paper, there is consideration given to the understanding of cargo movement in Egypt, the Mekong with a focus on Thailand and Queensland in Australia. However, if cargo movements are considered in broad groups then such an understanding is both possible and plausible. The Mekong jurisdiction besides Thailand includes the countries of Myanmar, Cambodia, Laos, and Vietnam as well as the two southern provinces of Guangxi and Yunnan in the People's Republic of China (PRC). These three jurisdictions are illustrated below in Figure 5.1.

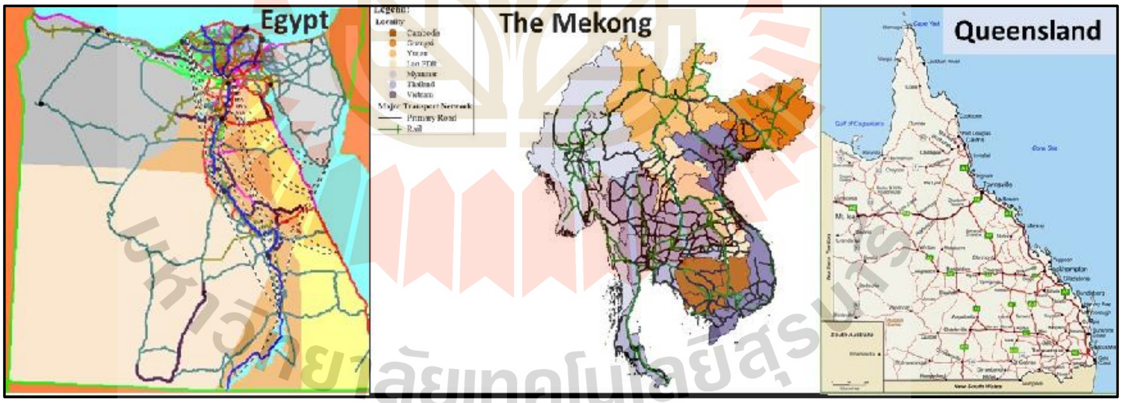

Figure 5.1 The three jurisdictions

An agglomeration of goods across various categories is undertaken using the internationally accepted coding classification of cargo. The Harmonized Commodity Description and Coding Systems (HS) is an international nomenclature for the classification of products. At the international level, and for the purposes of commodity grouping, the Harmonized System (HS) for classifying goods is a six-digit code system. For the purpose of this research, the many cargo classifications identified are combined into an overall five broad groupings roughly these groupings could be considered as agricultural, processed food, chemicals, and minerals, agriculturally derived products such as wood and furs and finally a general or miscellaneous grouping.

The five groups are further detailed via their HS numerical system as depicted in Table 5.1. These categorization groupings were a combination of the broader groups developed in an earlier effort for the analysis of goods movement within Egypt. (Johnstone and Ratanavaraha 2017b).

The purpose of the research is to identify within these five groups common trends in the modal shift analysis. The intention is to then identify common trends and hypothesize the general format of a modal shift first in the incidence of the jurisdictions under consideration whilst at the same time identifying the potential impacts on infrastructure requirements which may lead to economic strain within the jurisdiction.

Table 5.1 Group number relationship to Harmonized Code

Overall Description	First Two Digits of HS Code	Group Number
Animal & Animal Products	01-15	1
Vegetable Products	16-24	1
Foodstuffs	25-27	2
Mineral Products	28-38	3

Table 5.1 Group number relationship to Harmonized Code (Continued)

Overall Description	First Two Digits of HS Code	Group Number
Chemicals & Allied Industries	39-40	3
Plastics / Rubbers	41-43	3
Raw Hides, Skins, Leather, & Furs	44-49	4
Wood & Wood Products	50-63	4
Textiles	64-67	3
Footwear / Headgear	68-71	4
Stone / Glass	72-83	5
Metals	84-85	5
Machinery / Electrical	86-89	5
Transportation	90-97	5
Miscellaneous	98-99	5

The economic strain is identified in the size and nature of the required infrastructure. It is, however, possible to identify infrastructure requirements in the form of additional rail track as an alternative to additional kilometers of road space needed in the achievement of green mode shift away from the road sector.

5.2.1 Literature review

An important aspect of transport movement that is somewhat neglected when we think of strategic planning (Kölbl et al. 2008) is the movement of cargo. Cargo movement is interwoven within the fabric of the economy, environment, and society, as shown in the future circle (Figure 5.2). It is intimately linked with the future economic growth of any jurisdiction. Even in integrated urban transport planning, (May et al. 2006), the emphasis is often on the movement of people rather than cargo movement. The focus for the urban area is regularly only limited to urban development (Hollingsworth et al. 1983) and the movement of people between and within urban areas. However, the focus of this paper is regional or national cargo transport movement, not that which is strictly within the boundary of the urban environment. It must be understood that in any inter urban travel pattern, the cargo road movements are a significant portion of the road traffic.

The intention here is to examine the proposition that there is a strategic possibility for green cargo movement. Simply stated this modal shift is achievable and leads in this direction of the movement of cargo away from the dominant road sector. The question of the linkage of the elements of the circle as depicted in Figure 5.2 is also correlated with the environment which brings into consideration the association with green transport.

The element of the economy is the linkage to the question of economic strain whereas the society element addresses the question of the cost of achieving a significant green cargo movement. In the regional sense, integration is important as is highlighted as the example of the air sector (Tang et al. 2008). Integration of the road and non-road sector are important as access to the non-road sector is via the road sector.

Overall in the development of any analytical tool for the analysis of the further understanding of movement, transport models are subject to improvement by reference to existing data provided the observed demand flows between localities are robust. Even when cargo is moved mostly by rail, access to and from the rail is often provided by road. If the nature of observed data is not robust, then there are certain issues in using this in the predictive sense (Johnstone and Prettty 1988). Earlier work

(Nemoto 2009) within a different locality namely the Mekong region has highlighted the difficulties in the shifting of cargo from the non-road sector as this is also linked in with logistic chains. In the case of a shipping component within the overall cargo journey, a key is the movement linkage associated with multi-national corporations namely the shipping lines.

In the general question of modal shift, there is an issue of reliability linked to the timetabling of both alternatives such as water and rail transport. This has already been highlighted by previous work (De Langen and Sharypova 2013). It is possible for the development of a mathematical model to include consideration of delays at transshipment points including an analysis of an optimum container flow algorithm in modal. The achievement of green transport means that one must realize good intermodal facilities flows between all three key modes of water, rail, and road (Nabais et al. 2015).

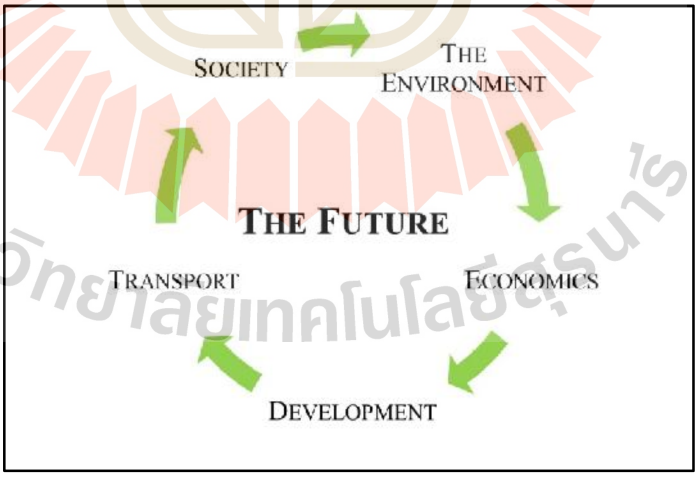

Figure 5.2 The future circle

5.2.2 The importance of this research

An important aspect of transport movement that is somewhat neglected as stated previously when we think of strategic planning (Kölbl et al. 2008) is the movement of cargo and freight. If not neglected, it is not studied in detail. Previously there is limited knowledge in comparison of modal shift and linkage to economic strain including fuel subsidy and the cost of road infrastructure against the opportunity cost for the provision of non- road or greener transport. This research will add to the community knowledge with respect to the awareness of the possibilities of achieving modal shift. Modal shift is important in the light of recent convention that encourages the limitation in the production of greenhouse gas.

5.2.3 The Existing modal infrastructure[1]

It is important first to have an appreciation of the existing situation within the three jurisdictions. The existing transport infrastructure firstly within Egypt is dominated by a road system that extends over approximately 100,000 kilometers, nearly 23,500 kilometers of which is managed and maintained centrally. This major road network is densest within the Nile Delta, coastal areas, the Sinai Peninsula and flanking the Nile River which traverses Egypt from north to south. Cairo tends to serve as the "hub" of the national "spoke" of roadways. The rail network extends over some 5,100 kilometers. Almost thirty percent thereof is double tracked, the remaining network is single tracked. The system is standard gauge and not electrified. The Inland Water Transport (IWT) network encompasses 2,635 kilometers consisting of 1,696 kilometers within the Nile Valley and 936 kilometers within the Nile Delta. As

[1] Pipelines and the air network infrastructure are not included in this analysis.

reported in Table 5, almost all cargo movement is carried by road (Johnstone and Ratanavaraha 2017b).

The Mekong Region covers five member countries and two provinces of the PRC. Currently, the network consists of 37,000 kilometers of primary road, 17,000 kilometers of railways and 10,000 kilometers of waterways, each of which is used for both the movement of people and freight (Johnstone and Ratanavaraha 2017a). The Queensland network consists of kilometers of 13,600 km of road, 9,550 km of rail and 15 coastal ports (Main Roads 2013).

Both within Egypt and the Mekong, cargo movement is dominated by the road sector as reported in Table 5. Overall in Australia, there is a better balance with nearly sixty percent (Irranezhad and Hine 2019) of cargo movements in terms of tonne-kilometers carried via the rail network and only around thirty percent carried on the road network[2]. In Queensland, the road mode split to the road is 65 percent (Main Roads 2019).

Table 5.2 Mode distribution of cargo movement across jurisdiction in 2017

Mode	Jurisdiction		
	Egypt	Mekong	Queensland
Road	97.8	97.2	65.0
Rail	0.8	2.4	32.5
Water	1.4	0.4	2.5
Total	100.0	100.0	100.0

[2] Within Australia, there are significant rail links devoted to the carrying of various metal ores especially within the states of Queensland and western Australia.

The key movement of cargo within Egypt is the north to south movement corridor from Aswan to the Mediterranean coast. There are three parallel modes available for cargo movement within this corridor namely road, rail, and IWT. The road is currently the dominant transport mode in this corridor. Within the Mekong, there are three significant transport infrastructure routes focused on the major road river catchments roughly running north to the south together with north and north eastern connection to the PRC. Whilst in Queensland, the focus of transport infrastructure is also north to south connecting the major urban centers with western links to the minor inland towns.

A summary of infrastructure is presented within each jurisdiction is presented in Table 5.. Of the three jurisdictions, Queensland has the highest percentage of rail infrastructure at forty percent of non-waterway infrastructure followed by the Mekong region at thirty percent and lastly Egypt at less than ten percent.

Table 5.3 Lengths of network infrastructure

Mode	Infrastructure Length (km)		
	Egypt	Mekong	Queensland
Road	80,000	37,000	13,600
Rail	5,100	17,000	9,550
Water	2,635	10,000	Not applicable

5.3 An Economic Perspective

The most commonly used tool for understanding the movement of people or cargo throughout a defined geographical region is the economic and population datasets. In these jurisdictions, they are prepared for the base time horizon and a future twenty-year time horizon.

In economic terms, Egypt and the Mekong region have a similar GDP per capita in 2017 with 2,720 and 3,540 United States Dollars3 (USD) per capita. (Bank 2017). Whilst in Queensland, the GDP per capita is some 40,000(Treasury 2018). The population of Egypt, the Mekong, and Queensland in 2017 was ninety, three hundred and fifty and five million people respectively. If a single member country of the Mekong is considered such as Thailand, then in 2017 the GDP per capita was 6,500 USD with a population of some sixty-five million people.

5.3.1 Economic difference

It is important to understand the economic differences in detail between the three jurisdictions in terms of the change in economic comparison activity. Three comparisons were chosen namely GDP, GDP per capita and the exchange rate between local currencies and the USD. The annual change in GDP over a twenty-year time horizon with 1995 as a base is presented in Figure 5.3. For the case of the Mekong jurisdiction, Thailand is chosen as the representative member country for the Mekong as stated earlier. Although the base is different, there is a not dissimilar trend in the overall growth over the twenty-year time frame.

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[3] The USD currency is fixed 2010 USD.

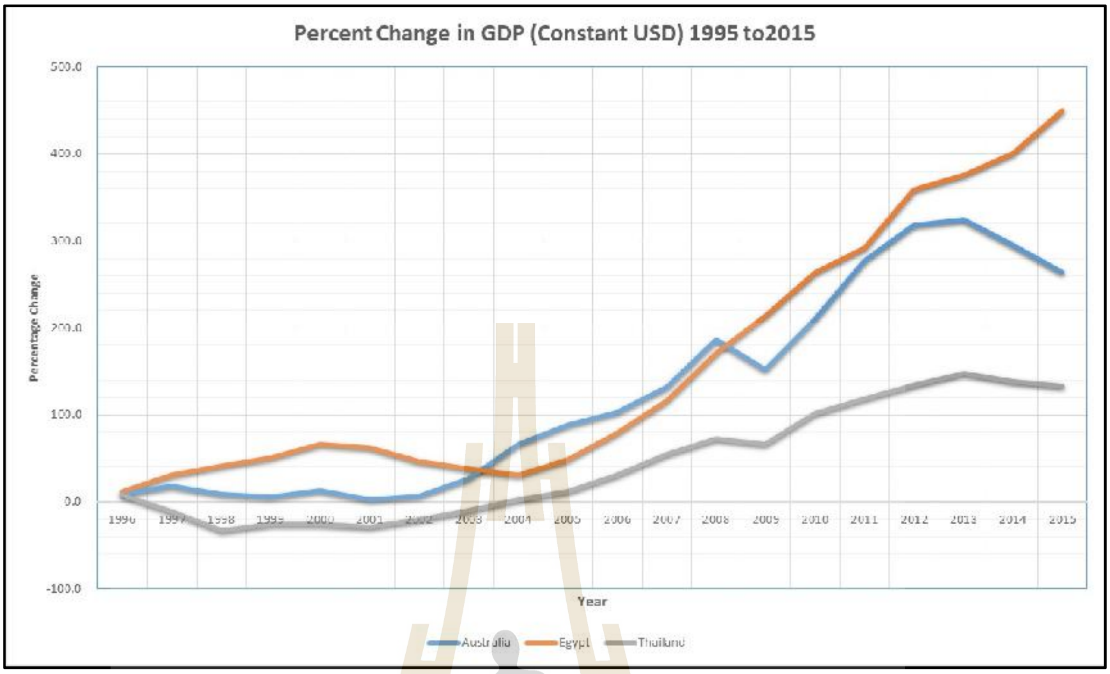

Figure 5.3 Historical change in GDP with 1995 base

In the situation with reference to GDP per capita as reported in Figure 5.4

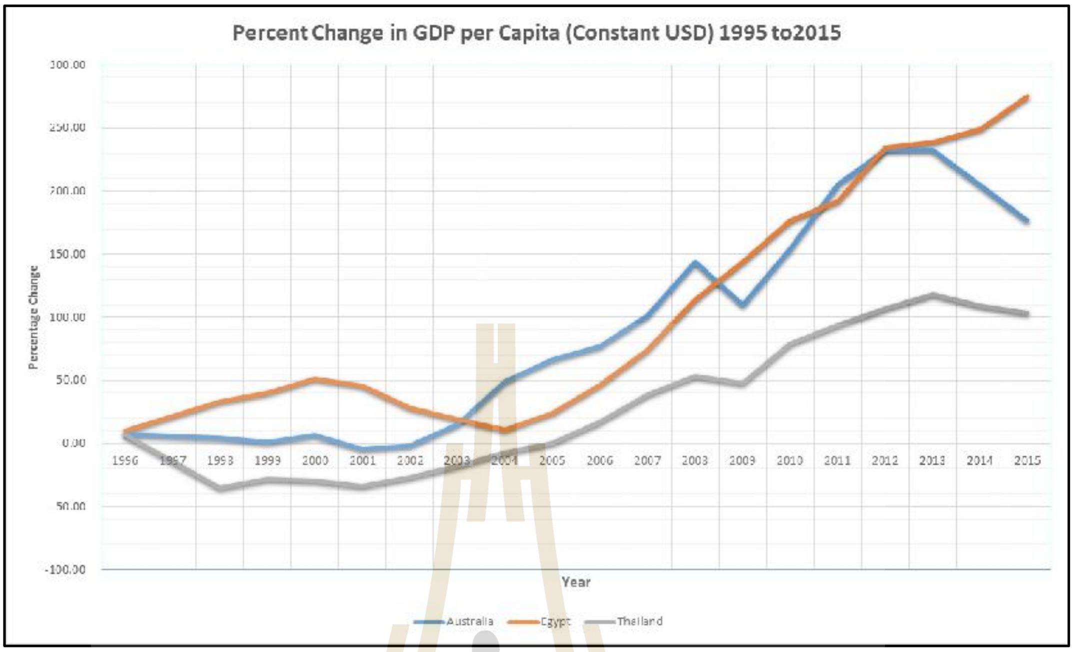

Figure 5.4 Historical change in GDP per capita with 1995 base

there are significant different trends with the growth decreasing in both Egypt and Thailand towards the end of the similarly selected time frame. This is probably a better reflection on the performance of the economic activity then GDP alone.

For an overall reference and for completeness, the percentage in changing currency exchange rates is depicted in Figure 5.5. All three shown in this Figure 5.5 suggest strong fluctuations making a comparison between the three economies difficult.

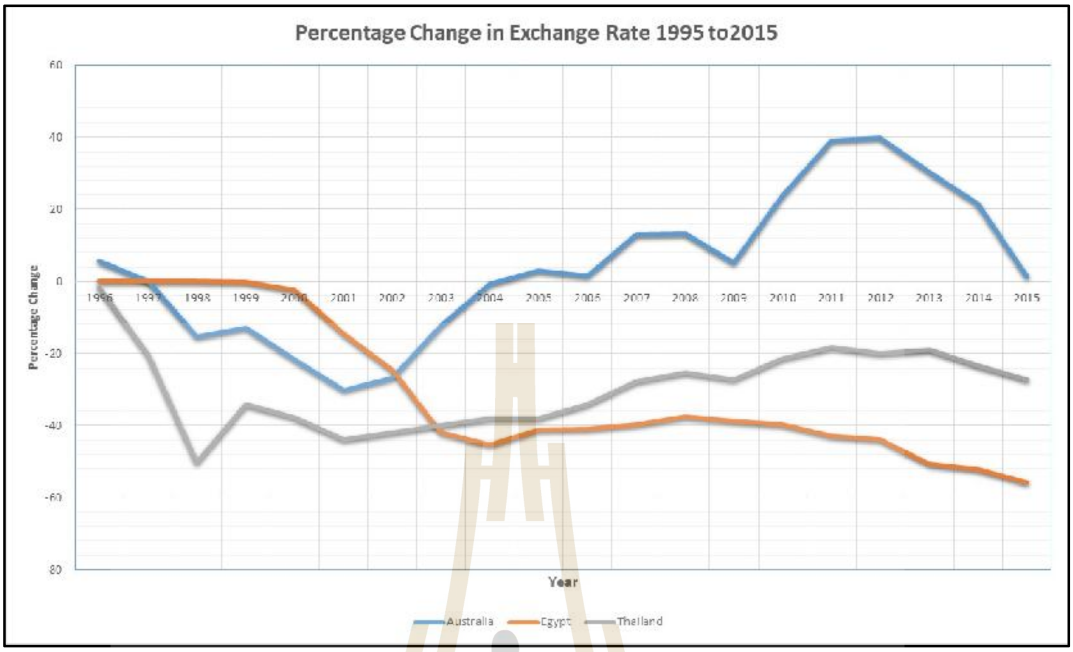

Figure 5.5 Historical change in exchange rate of local currencies against USD

5.4 Methodology

The most commonly used tool for understanding the movement of people or cargo throughout a defined geographical space is a transport model, (Johnstone and Chancharoen 2010). A classic four step transport model is developed as the analytical tool for the examination of cargo movement throughout the Egyptian region. The structure for understanding movement within the region is built initially from the understanding of the existing observed regional movement from the analysis of an extensive survey program.

Of course, cargo movement does not happen in isolation. However, as depicted in Figure 5.6, the movement of cargo is different.

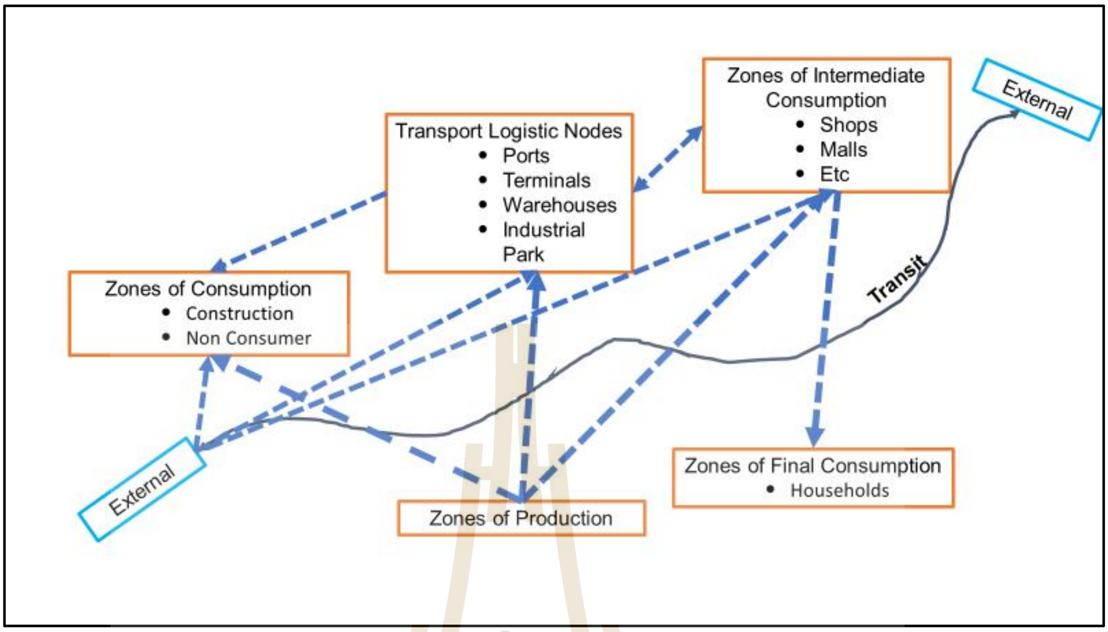

Figure 5.6 Analytical structure

The movement of people and cargo, for the most part, share the same infrastructure. Cargo movement goes through several intermediate or exchange points as an item of cargo moves along a supply chain. The first step determines the size of the movement or the production at each location. The second step proposes the path of movement between the production and the consumption locations whilst step three which is the focus of this research determines the mode of movement. In the final step, the network assignment combines all movement across all transport network infrastructure. In this paper, there are three different approaches to modal allocation

5.4.1 Data analysis

The base input data are a collation of databases available by locality held by the various responsible agencies throughout the three jurisdictions. In the case of infrastructure, the master transport network developed in this incidence includes all known transport projects at present, both existing and proposed, within the tree jurisdictions that are incorporated into the network.

The Egypt database source is tabulated here as an example of a recent significant survey database behind the development of the structured equations with respect to the modal allocation or mode split. The database was built from a survey across the country including nearly 300,000 interviews at some 185 roadside survey stations as depicted in Table 5.. This was discussed in detail earlier in this treatise.

Table 5.4 Cargo surveys

Survey type	Number of locations	Number of samples
Roadside Interview Survey	185	297,725
Railway Station	26	43,144
Dry Port	4	307
Sea Port	10	16,970
Freight Forwarder	58	58
Trucking Company	63	63
Manufacturing	242	242

5.4.2 The analytical structure

The national transport model has, as noted earlier, two distinct streams of development; namely, for person or passenger transport and freight or cargo transport. The primary purpose of the development of the transport model was the need to understand the requirements for future national transport infrastructure in Egypt. This paper concentrates only on the development of the cargo model stream development. The primary data sources for cargo model development were the survey program briefly described earlier.

The outputs of a person trip model are in terms of people movement by different economic classes. In the cargo modeling context, likewise, the analogy is that the results are a matrix of commodity movements in terms of tonnes instead of people.

5.4.3 The modal calculus

In the estimation of the movement of cargo, there are four basic steps of generation, distribution, modal choice, and network assignment. The estimation of production and consumption for the five commodity groups previously identified is linked to the elasticity associated with that commodity and the changes in the associated socio-economic parameter either population or regional GDP. The distribution module calculates the association between trip ends thus identifying the origin and destination of a cargo movement. The next step is the mode split which allocates the cargo movements to individual mode. These procedures are estimated for each of the five commodity groups.

The first step in the mode split or allocation model is to partition the trips into “short-haul” and “long-haul” trips. The proportion of short haul trips in the overall national cargo movement is less than ten percent for each commodity group. The modal split model is run on the “long-haul trips”. All short-haul trips are assumed to travel by road. The generalized cost function is defined for each combination of commodity group and mode for each travel zone pair. There are two independent variables associated with the determination of the travel mode between any origin and destination namely time and generalized cost. Each modal cost function includes two coefficients: one for each of the independent variables. In the case of Egypt, for each commodity group, the modal split is a multinomial logit model.

The generalized cost of travel between any origin and destination, $\Gamma_{m,c}$ is calculated for each commodity of a group, c moved across mode, m in terms of travel time, cost of travel. The generalized cost of travel for commodity type c in terms of travel time, $T_{m,c}$ and monetary units, $M_{m,c}$ is as defined in Equation (5.1). The terms, α and β referenced in the equation are the calibration scale factors for travel time and cost respectively. The scale factors for time and cost are tabulated in Table 5..

$$\Gamma_{m,c} = \alpha T_{m,c} + \beta M_{m,c} \tag{5.1}$$

The mode split by commodity is defined as $\zeta_{m,c}$ for the commodity group, c transported by mode, m in a logit function as detailed in Equation (5.2). equations are then programmed into the structure of the transport model.

$$\zeta_{m,c} = \frac{e^{\Gamma_{m,c}}}{\sum_m e^{\Gamma_{m,c}}} \tag{5.2}$$

This modal split procedure essentially links travel times and modal costs to the proportion of one of five commodity groups carried via the available mode. At the end of the procedure, there are four matrices per commodity group. The “short haul” trip representing as stated earlier less than ten percent of the tonne movements. Some cargo movements are via intermediate points or logistic nodes.

Table 5.5 Modal split scale factors for Egypt

Commodity Group	Time Scale Factor			Monetary Scale Factor		
	Road	Rail	Inland Water	Road	Rail	Inland Water
1	-0.0298	-0.0326	-0.0298	-0.1007	-0.0490	-0.1007
2	-0.0281	-0.0290	-0.0281	-0.0563	-0.0392	-0.0563
3	-0.0452	-0.0452	-0.0452	-0.0530	-0.0528	-0.0530
4	-0.0489	-0.0497	-0.0489	-0.0901	-0.0767	-0.0901
5	-0.0497	-0.0498	-0.0497	-0.0775	-0.0758	-0.0775

The Mekong modal allocation is different. In this model, there is a series of binary choices. The choice structure is presented in Figure 5.7. There are three different curves in this structure. In reality, there is even in this structure only a single modal choice between road and rail. The other modes are simply often not available

The cost of travel on alternative modes is referred to as the generalized cost of travel and is a function of time and cost as is with the case of Egypt.

$$\zeta_{1,c} = \frac{e^{\Gamma_{1,c}}}{e^{\Gamma_{1,c}} + e^{\Gamma_{2,c}}} \tag{5.3}$$

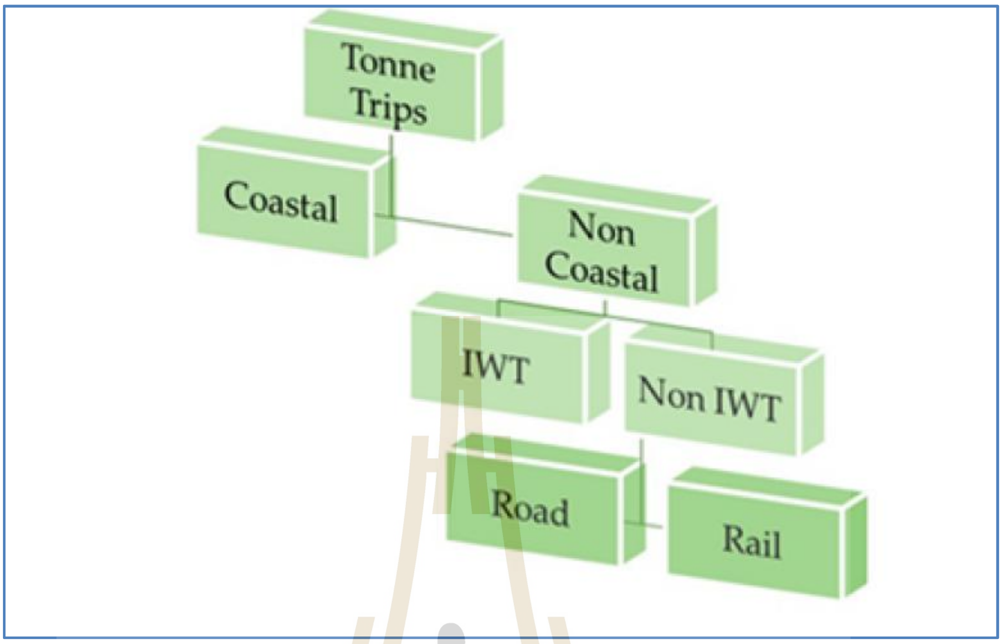

Figure 5.7 Modal allocation structure - Mekong

Equation (5.3) defines the probability of using mode 1 as opposed to mode 2 whereas $\Gamma_{1,c}$ and $\Gamma_{2,c}$ are the generalized travel costs associated with modes 1 and 2 respectively. The variables in the determination of generalized travel cost namely travel time and the cost is weighted by scale factors. These scale factors are presented in Table 5.4 by commodity category for each level of the modal analysis. The cost of travel by the various modes of travel was determined by locality with different cost values associate with different member countries.

In the case of the Queensland mode split, the approach is even further simplified via the application of trend analysis rather than a logit model approach. The next and final step is the assignment of movement to the network. The cargo movements in the form of tonnes are allocated to the mode vehicle whether it be a truck, a train or a barge. The allocation of the truck is particularly inefficient. Truck inefficiency is noted from the survey data that ninety percent of trucks have no back load.

Table 5.6 Modal split scale factors for the Mekong

Commodity Group	Level 1- Coastal		Level 2- IWT		Level 3- Road	
	Time	Cost	Time	Cost	Time	Cost
1	-0.2244	-0.0001	-0.0194	-0.0001	-0.3892	-0.0008
2	-0.0004	-0.0004	-0.0387	-0.0004	-0.2078	-0.0003
3	-0.0858	-0.0004	-0.0732	-0.0006	-0.176	-0.0008
4	-0.0355	-0.0004	-0.0169	-0.0004	-0.5941	-0.0034
5	-0.0355	-0.0004	-0.0173	-0.0001	-0.5891	-0.0006

5.5 The results

This results from the analytical procedure allow for estimation in the base year and for future time horizons. The input into the future time horizon forecast is the improved network infrastructure and the changing socio-economic parameters. The overall mode split is presented below (Table 5.) excluding movements via an extensive national pipeline network. The future is a twenty-year time forecast.

The twenty-year forecast referred to as the maximum leverage scenario included not only the removal of any existing fuel subsidy but in addition an imposition of fuel tax where none previously existed already. Under this second scenario, there is a significant change in the operational cost of the road sector. Thailand decrease from nearly 100% to 91% maximum leverage includes completion of the double track rail program in Thailand.

Such a significant change with its associated change in government policy does not occur overnight but would come to fruition within the timeframe of the twenty-year forecast horizon. The total road proportion of tonne movement in the base time horizon is 98%, 97% and 65% within the three jurisdictions of Egypt, Mekong, and Queensland respectively. With the future time horizon, in the case without maximum leverage, the road mode sector decreases to 80.8%, 86% and 65% across the three jurisdictions respectively.

Table 5.7 Percentage road mode split

Jurisdiction	Existing	Twenty Year Forecast with Maximum Leverage
Egypt	98.1%	92.81%
Mekong	97.0%	86.0%
Queensland	65.0%	59.0%

The implication is that in the case of maximum leverage, the total road mode split share falls by less than an overall 10% in all three jurisdictions. However, the result of the impact of this moderate decrease in the road sector is an approaching corresponding increase in the non-road sector of between four and five-fold in the developing jurisdiction. The non-road sector share of tonne movement has a significant increase. In achieving such a modal shift, this requires a serious evaluation of the existing carrying capability of the non- road sector. There are thus significant costs in achieving the twenty year decrease in the road sector modal share.

5.5.1 Detail of Discussion

Consideration must be given also to such suggested change by commodity group. In the case of commodity group one, there is a projected 18% decrease in the road sector with a nearly ten-fold increase in tonne movements by the non-road sector. For commodity group two, there is a projected 8% decrease in the road sector with a nearly nine-fold increase in tonne movements by the non-road sector. It is important to appreciate that these two commodity groups relate to the movement of bulk agricultural goods and as such is amenable to the movement by rail and IWT.

In the case of commodity group three, there is a projected 4% decrease in the road sector with a nearly four-fold increase in tonne movements by the non-road sector. In the case of commodity group four, there is a projected 9% decrease in the road sector with a nearly four- fold increase in- tonne movements by the non-road sector. For commodity group five, there is a projected 7% decrease in the road sector with a nearly three-fold increase in tonne movements by the non-road sector.

The non-road sector needs improved infrastructure to incorporate the modal shift. There are thus costs associated with the movement of cargo towards a greener future.

When considering the development of new infrastructure in Egypt to assist in the transfer to a green freight movement, the desired modal split should be pursued in a realistic manner taking the growth trend in road cargo into account. Large increases in the sector capability of the non-road sector are implementable but difficult from a practical and economic point of view.

The twenty-year forecast for the nation (Johnstone and Ratanavaraha 2017a) demographically in accordance with the national vision demonstrates via infrastructure development that it is possible to halt the fact that the road sector for cargo movements was continuing to approach the one hundred percent mark. This is not a good environmental practice (Armstrong-Wright and Transport and Road Research Laboratory. 1993).

Of course, this is not achievable in the short term. The development of the mathematical model for cargo movement has enabled the transport planner practitioner to advance the understanding of cargo movements and provide a numerical framework for the understanding of the impact.

5.6 Discussion and conclusion

When considering the development of new infrastructure in Egypt to assist in the transfer to a green freight movement, the desired modal split should be pursued in a realistic manner taking the growth trend in road cargo into account. Large increases in the sector capability of the non-road sector are implement Table 5. but difficult from a practical and economic point of view.

Of course, this is not achievable in the short term. The development of the mathematical model for cargo movement has enabled the transport planner practitioner to advance the understanding of cargo movements and provide a numerical framework for the understanding of the impact.

5.6.1 Discussion

Many issues discussed are relevant to cargo movement essentially elsewhere on our planet. Within the three jurisdictions discussed, modal shift opportunities are apparent and achievable as also reported in earlier publications. (Johnstone and Ratanavaraha 2017b). There is an opportunity for improved efficiency in regional transport via a modal shift. Significant energy subsidies that favor the road sector have in the past made this difficult. Again as in Egypt for example, transport of cargo by road has been aided by the fuel subsidy which was a little over fifty percent, (Fattouh and El-Katiri 2013). This implies that when the cost of fuel to the government was one hundred Egyptian pounds, the government was then forward selling to the general public at fifty Egyptian pounds. No longer should carbon based fuels be subsidized but as a resource that should be phased into alternative fuels. In the case of the European Union, taxes on fuel sold within the European Union generally represent between forty and sixty percent of the cost of each liter of fuel, (Klier and Linn 2013).

5.6.2 Conclusion

There is a reasonable opportunity of modal shift to move forward with a green transport agenda. There is a cost as it needs non-road transport infrastructure upgrades. This then is the community choice for upgrading of the non-road transport infrastructure rather than continuous support of the road sector. It is essential in this task that deterrents be put in the path of the continuous monopolistic road cargo transport sector.

5.7 Acknowledgements

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CHAPTER VI

RECOMMENDATIONS AND CONCLUSIONS

Today, there is a need to address the issues of carbon emissions, especially from transport via the road sector. Cargo transport on the extensive road networks available road wide does not address carbon emissions. Thus, for example, as stated earlier, the European Union also has a problem with its heavy dependence on road transport. The Agenda 2020 of the European Union (EU) calls for member countries to reduce greenhouse gas emissions and increase renewable energy(Bartocci and Pisani 2013). Renewable energy can be used to produce electricity which makes the rail mode of cargo transport superior as worldwide rail networks are electrified.

This treatise proposes an understanding of cargo movements in consideration under different jurisdictions. Previously there was little cross-continental experience in comparison of modal shift and linkage to economic strain including consideration of fuel subsidy and the cost of road infrastructure against the opportunity cost for the provision of non- road or greener transport. This research will add to the transport community knowledge with respect to the awareness of the possibilities of achieving a modal shift. The research is unique in the fact that there is a comparison across there continents including both developing and developed economies. This has not been undertaken previously in such a format.

This treatise started with identifying the research need. This was followed by an extensive literature search in the identification of other parameters that might prove relevant in the research. The modal shift desire was further illustrated in the following three chapters of this treatise. There were three examples woven together to produce an understanding and the need for modal shift in cargo movement.

In the first incidence, there was an extensive evaluation of the phycology of the modal shift of the occurrence in Egypt(Johnstone and Ratanavaraha 2017b) where for this to occur there is a need for a priority change in infrastructure spending but also in the taxation situation with respect to carbon based fuel.

In the second incidence, there was an examination of the propensity for modal shift in the Mekong region(Johnstone and Ratanavaraha 2017a). Again, it was seen that there are infrastructure consequences. In this case, Thailand which is at the center of the Mekong is moving forward with an extensive rail upgrade program thus providing an alternative to the road sector movement of cargo. In the third incidence, there is a comparison between the two developing economies a developed economy.

6.1 Factors influencing Green transport

In this treatise, there is a clear link in modal distribution between population, employment distribution and economic parameters. The percentage of cargo that moves between two destinations on a nominated transport mode is related to the cost of the movement on that the mode. These costs are directly related to economic performance and economic investment in modal infrastructure. In the case of Egypt, for example, modal shift will occur if there is a change in infrastructure provision towards the rail sector but this may result in economic strain.

6.2 The role of non-road transport

The road mode is an essential factor in economic activity and has historically played a strong role in the development of many countries across the world. Within for example the context of Egypt, the use of the road-based transport mode has increased exponentially in the last few years. Whilst this phenomenon has fulfilled a variety of social goals and expectations, unfettered growth is increasingly contributing to various negative social, economic and environmental impacts. This high level of usage is a historic consequence of growing vehicle ownership, pricing policies (such as the fuel subsidy), and "road focused" capital works programs. Now there is a need to consider global priorities. There is a beginning of an understanding of the notion that a more balanced approach to providing cargo mobility is desirable.

Egypt is a good example because along the main north-south corridor of the country, two alternative modes are available within a few kilometers of the road corridor namely rail and water cargo movement along the Nile river. The increasing movement of cargo via the road mode will only lead to an increase in emission gases. It is understood that the road sector will invariably be the last leg of the journey. It thus provides access to alternative modes. These alternative modes must begin to play an important role in the long haul of cargo.

Short cargo trips under current technology will use road transport. Even long haul trips will remain relevant to the road sector for some time as their modal share is high but there is a need for consideration of modal shift to confirm with climate goals defined in Paris (Cadman et al. 2017).

6.3 Future research

In this treatise, there is the identification of a regional transport model developed for the Mekong. This model addresses the "how and where" modal shift which is also linked to trade growth (ADB 2016). Currently, the ADB is funding a program to consider the improvement of the railways within the Central Asian Region Economic Cooperation (CAREC). This is basically to improve the ease of cargo movement between the Northern Pacific Ocean and the Black Sea and also within that defined region. Within the framework of the consideration of the improvement, the ADB is funding the development of a transport modelling tool similar to that discussed within Chapter 4 of this treatise.

ADB has three significant regions namely Mekong, CAREC and the South Asia Sub regional Economic Cooperation (SASEC). At the beginning of next year, the ADB will fund research in the development of an Asian transport model that will incorporate all three regions based on the premise of the Mekong transport model discussed within this treatise. The focus of the research in the development of such a tool is the movement of cargo across Asia.

6.4 References

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APPENDIX A

LIST OF PUBLICATIONS

List of Publications

Johnstone L, and Ratanavaraha V. 2016. Viability of high speed rail alternatives in southern India Proceedings of 2016 Australian Transport Research Forum Conference.

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Johnstone L, and Ratanavaraha V. 2019. Green cargo movement, Multi jurisdictional commonality.Under review for publication.

BIOGRAPHY

Mr. Leonard Christopher Johnstone was born on the seventh of November, 1954 at Brisbane, Queensland, Australia. He started his primary education at Mater Dei, Ash grove School, secondary education at Marist Brothers College, Ash grove. Then, he further studied for a Bachelor's degree in Civil Engineering at the University of Queensland receiving a Second Class Honors Degree, Division A in 1975. After his graduation for the next decade, he worked for the Government of Queensland concluding that portion of his career as a Transport planner. He then joined a private consultant company in Australia which initially led to his deployment to Asia. From 1990 to now, he has worked extensively throughout Asia on transport projects with much of that time spent in the development of projects in Bangkok. Several of these projects were at the forefront of the planning of the extensive mass transit system now under construction in Bangkok. He has now worked on all major continents with the exception of South America. For many projects, he joined collaborative development teams with Japanese companies.

At present, he is an independent consultant whose main projects at present are engagements in central Asia with the Asian Development Bank based in Manilla. He is interested in researches on transportation in many perspectives such as using the impact of driverless vehicles on the revenue stream of commercial transport infrastructure, procedures for the encouragement of mass transit either urban or long distance and the impact of economic development on transportation planning.