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INFRASTRUCTURE, TRADE AND GROWTH IN SELECTED ASEAN COUNTRIES

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By

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INFRASTRUCTURE, TRADE AND GROWTH IN SELECTED ASEAN COUNTRIES

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Infrastructure is widely recognized as an important ingredient for development and economic growth. However, the significance of infrastructure goes far beyond its impact on growth. Infrastructure and its related services also play a crucial role in international trade flows, particularly after substantial tariff reductions. This study's main objective is to examine the influence of infrastructure on economic growth and trade flows in ASEAN countries. Specifically, we examine the effects of infrastructure quality and quantity on economic growth by applying the pooled mean group (PMG) estimator. Disentangling the effects of quantity and quality of infrastructure allows policy makers to evaluate the mechanism of transmission from infrastructure investment to economic growth and identify the potential growth benefits they can contribute. After differentiating infrastructure into quantity and quality of infrastructure, we assess the impact of infrastructure quantity in three sectors: transportation, ICT, and energy. Transport infrastructure, as captured by four indicators, is found to be significant in terms of economic growth, and railway lines and road networks appear to be the most influential. To measure ICT infrastructure, we use proxies such as number of fixed lines, mobile phone subscriptions, and internet users. The results provide empirical evidence of the positive effects of telecommunications on growth. Energy infrastructure is also found to have a significant impact on growth when tested with indicators such as electric power consumption per capita, energy use per capita, and energy production. Regarding quality-related measures, we use such variables as percentage of the road network that is paved and electric power transmission and distribution losses as a percentage of GDP. The results show that both quality-related infrastructure variables are important in influencing economic growth in ASEAN countries. In response to a growing interest in the role of infrastructure in facilitating trade, this study investigates the impact of hard and soft infrastructure on trade flows using a gravity model extended with infrastructure variables. We focus not only on the influence of physical infrastructure on trade but also address the role of soft infrastructure. Various indicators from different types of infrastructure, such as those in the transport, energy, and telecommunication sectors, are used and estimated using static models. The model is estimated by using the fixed effects model (FEM) and the

random effects model (REM). We find that trade flows increase with improvement in hard infrastructures in all three sectors. In relation to soft infrastructure, we estimate the effects on trade flows of the number of documents and days taken to export by using Fixed Effect Vector Decomposition (FEVD). The results show that soft infrastructure reforms can improve trade flows. This study also analyses the effects of transport infrastructure on sectoral trade flows based on the Standard International Trade Classification (SITC) Rev.3. We include three types of transportation: land transport, sea transport, and air transport. The findings show that different types of transport infrastructure affect sectoral trade flows differently. The study's empirical results suggest that both quantity and quality of infrastructure contribute positively to ASEAN economic growth. Our findings also confirm the contribution of hard and soft infrastructure in increasing trade flows in the absence of tariff barriers.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

INFRASTRUKTUR, PERDAGANGAN DAN PERTUMBUHAN EKONOMI BAGI NEGARA ASEAN TERPILIH

Oleh

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Infrastruktur telah dikenalpasti sebagai penyumbang penting di dalam pembangunan dan pertumbuhan ekonomi. Walaubagaimanapun, sumbangan infrastruktur bukan sahaja ke atas pertumbuhan ekonomi tetapi juga memainkan peranan yang penting terhadap aliran perdagangan antarabangsa terutamanya selepas penurunan tarif. Tujuan utama kajian ini adalah untuk mengkaji secara mendalam peranan dan impak pembangunan infrastruktur terhadap pertumbuhan ekonomi dan juga aliran perdagangan bagi negara-negara ASEAN terpilih. Secara khususnya, kajian ini dijalankan bagi mengkaji impak infrastruktur ke atas pertumbuhan ekonomi negara ASEAN dan kajian dibuat bukan sahaja dari aspek kuantiti tetapi juga dari aspek kualiti infrastruktur. Kajian ini menggunakan kaedah PMG (pooled mean group) untuk mengenalpasti kesan kuantiti dan kualiti infrastruktur kepada pertumbuhan ekonomi. Pengasingan kedua dua aspek infrastruktur ini akan membolehkan penggubal dasar menilai keberkesanan dan sumbangan ke atas pelaburan pembangunan infrastruktur kepada pertumbuhan ekonomi. Untuk objektif kajian yang pertama, infrastruktur dibahagikan kepada dua jenis iaitu kuantiti infrastruktur dan kualiti infrastruktur. Untuk mengkaji impak kuantiti infrastruktur terhadap pertumbuhan ekonomi, kajian adalah tertumpu kepada tiga (3) sektor iaitu infrastruktur pengangkutan, telekomunikasi dan tenaga. Empat pembolehubah telah digunakan bagi mewakili infrastruktur pengangkutan darat dan penemuan kajian mendapati pembinaan pengangkutan rel keretapi dan jalan raya memberikan impak yang positif kepada pertumbuhan ekonomi. Infrastruktur telekomunikasi juga didapati memberi kesan positif ke atas pertumbuhan ekonomi setelah pembolehubah seperti bilangan langganan untuk talian tetap dan bergerak dan penggunaan internet diuji. Selain infrastruktur pengangkutan dan telekomunikasi, infrastruktur tenaga juga didapati memberi kesan ke atas pertumbuhan ekonomi apabila tiga pembolehubah diuji. Seterusnya, kajian dijalankan bagi mengkaji impak kualiti infrastruktur terhadap pertumbuhan ekonomi dengan menggunakan dua pembolehubah iaitu peratus jalan raya yang bertar dan transmisi dan agihan kuasa elektrik yang rugi dari peratusan Keluaran Dalam Negara Kasar (KDNK). Keputusan berdasarkan ujikaji keatas kedua dua pembolehubah ini menunjukkan kualiti infrastruktur sememangnya memberi impak positif kepada

pertumbuhan ekonomi . Selari dengan peningkatan peranan infrastruktur di dalam fasilitasi perdagangan, kajian telah dijalankan dengan menjuruskan kepada pengasingan di antara kesan infrastruktur fizikal dan bukan fizikal dengan berdasarkan model graviti. Pelbagai pembolehubah yang mewakili pelbagai sektor seperti infrastruktur pengangkutan, telekomunikasi dan tenaga telah diuji berdasarkan pendekatan statik. Hasil ujian kajian menggunakan kaedah FEM (fixed effect model) dan REM (random effect model) menunjukkan infrastruktur fizikal mempengaruhi pertambahan dalam aliran perdagangan. Bagi mengkaji impak infrastruktur bukan fizikal, dua pembolehubah telah digunakan iaitu bilangan dokumen dan bilangan hari diambil untuk mengekspot dengan menggunakan kaedah FEVD (fixed effect vector decomposition). Hasil kajian mendapati infrastruktur bukan fizikal memainkan peranan yang penting untuk meningkatkan aliran perdagangan. Selain daripada itu, kajian lebih mendalam terhadap impak infrastruktur pengangkutan ke atas prestasi dagangan peringkat sektoral telah dijalankan berdasarkan kepada klasifikasi SITC Rev 3 untuk tiga jenis infrastruktur pengangkutan iaitu pengangkutan darat, udara dan laut. Rumusan hasil kajian mendapati kesan yang berbeza bergantung kepada kaedah pengangkutan dan sektoral. Sebagai penutup, hasil kajian secara empirikal ini menunjukkan bahawa kedua dua aspek infrastruktur iaitu kuantiti dan kualiti menyumbang secara positif terhadap pertumbuhan ekonomi negara ASEAN. Hasil kajian juga menyokong dapatan akan kepentingan kedua dua infrastruktur fizikal dan bukan fizikal di dalam mempengaruhi aliran perdagangan.

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TABLE OF CONTENTS

		Page
ABSTRACT		i
ABSTRAK		iii
ACKNOWLEDGEMENTS		v
APPROVAL		vi
DECLARATION		viii
LIST OF TABLES		xiii
LIST OF FIGURES		xiv
LIST OF ABBREVIATIONS		xv
CHAPTER		
1	**INTRODUCTION**	1
1.1	Study Background	2
1.1.1	Definition of Infrastructure	6
1.1.2	The Quantity and Quality of Infrastructure	7
1.1.3	Hard and Soft Infrastructure	8
1.2	An Overview of Current Infrastructure Development in ASEAN Countries	9
1.2.1	Quality of Overall Infrastructure	11
1.2.2	Trading Across Border	14
1.2.3	Logistic Performance Index	16
1.3	Problem Statements	17
1.4	Objectives of the Study	19
1.5	Significance and Contribution of the Study	20
1.6	Scope of the Study	21
2	**LITERATURE REVIEW**	22
2.1	Introduction	22
2.2	Infrastructure and Growth	22
2.2.1	Channels of Transmission	23
2.2.2	Review of Infrastructure Issues	24
2.2.3	Empirical Evidence	25
2.3	Infrastructure and Trade	30
2.3.1	Gravity Model of International Trade	33
2.3.2	Empirical Evidence	33
3	**METHODOLOGY**	39
3.1	Introduction	39
3.2	Theoretical Framework	39
3.2.1	Introduction	39
3.2.2	Infrastructure and Growth: An Augmented Solow Model with Infrastructure	40
3.2.3	Infrastructure and Trade	42
3.3	The Impacts of the Quantity and Quality of Infrastructure on Economic Growth	44
3.3.1	Model Specification	44

3.3.2 Method: Pooled Mean Group Estimator 46
3.3.3 Econometric Issues 48
3.3.4 Multicollinearity 49
3.3.5 Data Source 50
3.4 The Impacts of the Hard and Soft Infrastructure on Trade Flows 51
3.4.1 Model Specification 51
3.4.2 Method 53
3.4.2.1 Fixed Effect Model and Random Effect Model 53
3.4.2.2 Fixed Effect Vector Decomposition 53
3.4.3 Econometric Issues 55
3.4.4 Data Source 56
3.5 The Impacts Transport Infrastructure on Trade at Sectoral Level 58
3.5.1 Model Specification 58
3.5.2 Data Source 58

4 RESULTS AND DISCUSSION 60
4.1 Introduction 60
4.2 Descriptive Statistics 60
4.3 Estimating the Effects of Quantity and Quality of Infrastructure on Economic Growth 62
4.3.1 The Impact of Quantity and Quality of Infrastructure on Economic Growth (Full Model) 62
4.3.2 The Impact of Quantity Infrastructure on Economic Growth 66
4.3.2.1 Transport Infrastructure 66
4.3.2.2 ICT Infrastructure 67
4.3.2.3 Energy Infrastructure 69
4.3.3 The Impact of Quality Infrastructure on Economic Growth 72
4.4 Estimating the Effects of Hard and Soft Infrastructure on Trade Flows 74
4.4.1 The Impact of Hard and Soft Infrastructure on Trade Flows (Full Model) 75
4.4.2 The Impact of Hard Infrastructure on Trade Flows 78
4.4.2.1 Transport Infrastructure and Trade Flows 78
4.4.2.2 ICT Infrastructure and Trade Flows 79
4.4.2.3 Energy Infrastructure and Trade Flows 81
4.4.3 The Impact of Soft Infrastructure on Trade Flows 84
4.5 Estimating the Effects of Transport Infrastructure on Trade Flows: Disaggregated Level 87
4.5.1 The Impact of Transport Infrastructure on Trade Flows by Product Group: Agriculture Related Products. 88
4.5.2 The Impact of Transport Infrastructure on Trade Flows by Product Group: Manufacturing Sector 89
4.5.3 The Impact of Transport Infrastructure on Trade 95

Flows by Product Group: Chemicals and Non-Manufacturing Sector
4.6 Conclusion 100

5 CONCLUSION AND POLICY RECOMMENDATIONS 101
5.1 Introduction 101
5.2 An Overview of the Study 101
5.3 The Major Findings 102
5.3.1 Quantity and Quality of Infrastructure on Growth 102
5.3.2 Hard and Soft Infrastructure and Trade Flows at Aggregated Level 103
5.3.3 Transport Infrastructure and Trade Flows at Disaggregated Level 104
5.4 Policy Implications 105
5.5 Limitations and Suggestions for Future Studies 106
5.6 Conclusion 107

REFERENCES 108
BIODATA OF STUDENT 128
LIST OF PUBLICATIONS 129

LIST OF TABLES

Table		Page
1.1	Export, Performance against Selected MDGs and Selected Monitoring Indicators, Latest Year	4
1.2	Infrastructure in ASEAN Member Economies, Latest Year	10
1.3	Ranking of ASEAN Countries According to the Level of Infrastructure Development for the year 1991 and 2005	11
1.4	Overall Infrastructure Quality in ASEAN Member Economies.	12
1.5	Selected Infrastructure Quality Indicators, 2013-2014	13
1.6	Trading Across Border, 2014	15
1.7	Logistic Performance Index by ASEAN Countries	16
3.1	Description of the Variables, Infrastructure Indicators and Data Source	50
3.2	Data Sources and Definitions of the Variable	57
3.3	Data Sources and Definitions of the Variable	59
4.1	Descriptive Statistics	61
4.2	Pearson Correlation Matrix of the Growth Explanatory Variables and Infrastructure Variables	63
4.3	The Effects of Quantity and Quality of Infrastructure on Economic Growth	65
4.4	The Effects of Transport Infrastructure on Economic Growth	68
4.5	The Effects of ICT Infrastructure on Economic Growth	70
4.6	The Effects of Energy Infrastructure on Economic Growth	71
4.7	The Effects of Infrastructure Quality on Economic Growth	73
4.8	Pearson Correlation Matrix of the Trade Flow Explanatory Variables and Infrastructure Variables	76
4.9	The Impact of Hard and Soft Infrastructure on Trade Flows (Full Model)	79
4.10	The Impact of Transport Infrastructure on Trade Flows	80
4.11	The Impact of ICT Infrastructure on Trade Flows	82
4.12	The Impact of Energy Infrastructure on Trade Flows	83
4.13	The Impact of Soft Infrastructure on Trade Flows	85
4.14	The Impact of Soft Infrastructure on Trade Flows Using Fixed Effect Vector Decomposition	86
4.15	The Impact of Transport Infrastructure on Trade Flows by Product Group: Agriculture Related Products.	90
4.16	The Impact of Transport Infrastructure on Trade Flows in Different Sectors: Manufacturing Sector	93
4.17	The Impact of Transport Infrastructure on Trade Flows in Different Sectors: Chemicals and Non-Manufacturing Sector	96

LIST OF FIGURES

Table		Page
1.1	Contribution of Infrastructure towards Achievement of MDGs	5
3.1	Estimated Trade Cost in Industrialized Countries	43
3.2	Sources of Trade Costs	44
4.1	Subcategories and Proxies for Infrastructure Quantity	66
4.2	Subcategories and Proxies for Hard Infrastructure	75
4.3	Subcategories and Proxies for Transport Infrastructure	88

LIST OF ABBREVIATIONS

AEC	ASEAN Economic Community
ADB	Asian Development Bank
APEC	Asia-Pacific Economic Cooperation
ARDL	Autoregressive Distributed Lag
ASEAN	Association of South East Asian Nations
CES	Constant Elasticity Substitution
DFE	Dynamic Fixed Effect
FEM	Fixed Effect Model
FEVD	Fixed Effect Vector Decomposition
GDP	Gross Domestic Product
GLS	Generalized Least Square
GMM	Generalized Method of Moment
H-O	Heckscher-Ohlin
ICT	Information and communication technology
IV	Instrumental Variable
IFS	International Financial Statistics
MDGs	Millennium Development Goals
MLE	Maximum Likelihood Estimation
MENA	Middle East and North Africa
MG	Mean Group
NEPAD	New Partnership for Africa's Development
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
PMG	Pooled Mean Group
PRC	People Republic of China
PPP	Purchasing Power Parity
REM	Random Effect Model
RGDP	Real Gross Domestic Product
SBC	Schwarz Bayesian Criterion
SIDs	Small Island Developing States
SITC	Standard International Trade Classification
SSA	Sub Saharan Africa
SYS-GMM	System Generalized Method of Moment
T&D	Transmission and Distribution
TFP	Total Factor Productivity
UN	United Nation
WDI	World Development Indicators
WEF	World Economic Forum
WTO	World Trade Organization
UNESCAP	United Nations Economic and Social Commission for Asia and
UNICEF	United Nations Children's Fund

CHAPTER 1

INTRODUCTION

Infrastructure has long been well recognised for the role it plays in a country's development. Consequently, the relationship between infrastructure and economic growth has been extensively investigated (Aschaeur, 1989a, 1989b; Munnel, 1992; Canning, 1999; Canning, Fay & Perotti, 1994; Calderon & Serven, 2003; Estache, 2006; Bogetic & Fedderke, 2006; Calderón, 2009; World Bank, 1994). Researchers have identified two general channels through which infrastructure can affect growth: direct and indirect channels.

More recently, the study of economic development has highlighted the role of infrastructure in poverty reduction and its contribution to the attainment of Millennium Development Goals (MDGs).[1] Among the issues addressed in the MDGs are the issues of poverty reduction, gender equality, education, health, the environment and global partnerships for development.

The MDGs are to be achieved by the year 2015. The achievement of the MDGs depends on the availability and expansion of basic infrastructure. Basic infrastructure is an essential requirement in improving the delivery of basic services. Many studies have provided evidence of the importance of infrastructure in terms of growth and other MDGs.[2] Despite the country's various efforts to meet the MDGs, Haruhiko Kuroda, President of the Asian Development Bank (ADB), in his speech at the MDG Summit in 2010 in New York, stated that he believes that the issue of infrastructure constraints remain key in achieving the MDG goals by 2015.

Numerous empirical studies have used quantity-related measures of infrastructure to examine the impact of infrastructure on growth. These studies, however, do not consider how quality-related measures of infrastructure affect economic growth. Instead, the studies tend to define infrastructure indicators in narrow terms (i.e., only from the quantity aspects).

There is an emerging issue of infrastructure indicators, in broader terms, to look at the quality indicators of infrastructure when investigating the effect of infrastructure on economic growth (Hulten, 1996; Calderon and Serven, 2004a). The need to distinguish between the impact of the quantity and quality of infrastructure on economic growth arises in order to evaluate how the expansion and improvement of infrastructure affects economic growth.

[1] The Millennium Development Goals are solid targets backed by 189 countries at the September 2000 UN Millennium General Assembly. The primary aim of the Millennium Development Goals are to cut the proportion of people living in extreme poverty worldwide by 2015 in half, as well as to provide education, improve health, and sustain the environment.

[2] de la Fuente, A., & Estache, A. (2004), for an insightful review.

Another strand of the infrastructure literature is related to trade flows. Trade facilitation is a significant part of the economic and trade policy, particularly after tariffs come down. It is believed that trade facilitation does not only reduce transaction costs and the intricacy of international trade, it can also enhance the trading environment.

In the context of the World Trade Organization (WTO), the definition of trade facilitation is "the simplification and harmonization of international trade procedures, including the activities, practices, and formalities involved in collecting, presenting, communicating, and processing data and other information required for the movement of goods in international trade" (WTO, 1998)[3]. Dee, Findlay and Pomfret (2008, p.30) argued for a wider definition of trade facilitation, which included all factors affecting the time and costs of moving goods across borders. Thus, an improvement or increase in infrastructure is one form of trade facilitation which may encompass both hard and soft infrastructure.

Many studies have explicitly emphasized the hard aspect of infrastructure. Little attention has been given to the role of soft infrastructure in affecting trade flows. Soft infrastructure is more about the institutions (e.g., law enforcement, procedures, institutions and policy reforms) that lead to more trade flows. Therefore, assessing the relative impacts of soft infrastructural improvements in reducing trade costs allows for the comparison of the benefits and costs of infrastructure investment or policy reform.

In light of recent, increased interest in the role of infrastructure, this study aimed to explain the various stages and current developments of infrastructure in the Association of Southeast Asian Nations (ASEAN) countries. More specifically, the role of infrastructure in helping the economy to achieve MDGs will be investigated. The impact on economic growth and the role in affecting trade flows will also be examined.

This chapter provides an overview of the proposed study. In the next section, the study background will be presented. This will be followed by an overview of current infrastructure development in the ASEAN countries (Section 1.2). In Section 1.3, we discuss the issues and problem statements that need to be addressed. Section 1.4 presents the objectives of this research and Section 1.5 provides the significance of, and contributions to, the study. The scope of the study is presented in Section 1.6.There may be a preamble at the beginning of a chapter. The purpose may be to introduce the themes of the main headings.

1.1 Study Background

Infrastructure is a popular theme covered in the economic literature. More specifically, infrastructure is recognised as an important element in sustaining and promoting growth. The World Bank, in its World Development Report (1994), concluded that East Asia grew faster than sub-Saharan Africa because of its infrastructure investment. The development and maintenance of

[3] Taken from ADB (2009).

infrastructure is expected to contribute to future economic growth, especially in developing countries, where infrastructure is still insufficient.

Despite the widely recognised importance of infrastructure, many ASEAN countries are still lagging behind in terms of their stocks. Infrastructure gaps among ASEAN countries are huge and continue to grow, especially for the newly emerging countries of Cambodia, Lao PDR, Myanmar and Vietnam (CLMVs).

There is a need for ASEAN countries to increase the quantity of their infrastructure and have quality and advanced types of infrastructure to support the higher level of economic activities. The quantity of infrastructure refers to the size of the infrastructure stock, while the quality of infrastructure refers to improving the performance of the existing infrastructure stock (e.g., road conditions, sanitation services and electricity distribution).

Besides being crucial for fostering economic growth, reliable and efficient infrastructure is also important for supporting the realisation of the MDGs.[4] In adopting the United Nations Declaration Millennium at the Millennium Summit in 2000, world leaders have pledged their commitments towards achieving MDGs and meeting a deadline of 2015. In its 2005 report, *Connecting East Asia: A New Framework for Infrastructure* (ADB, 2005), the ADB emphasized the importance of infrastructure's contribution to the MDGs.

ASEAN has made a joint declaration and commitment on the attainment of MDGs, which was signed and adopted at the 14th ASEAN summit in Thailand. However, in order to fully achieve the agreed goals, some of the ASEAN countries have to address and overcome a number of significant challenges, like providing access to safe drinking, road access to schools, basic sanitation facilities, improving maternal health, increasing the quality of education and reducing the child mortality rate. In this regard, infrastructure can play a direct role by providing and supporting the delivery of key services, such as communication networks, water and sanitation facilities, power and transportation.

[4] The eight Millennium Development Goals include: 1) eradicate extreme poverty and hunger; 2) achieve universal primary education; 3) promote gender equality and empower woman; 4) reduce child mortality; 5) improve maternal health; 6) combat HIV/AIDS, malaria and other diseases; 7) ensure environmental sustainability; and 8) develop a global partnership for development.

Table 1.1. Performance against Selected MDGs and Selected Monitoring Indicators, Latest Year

Selected MDGs	Goal 1: Eradicate Extreme Poverty and Hunger	Goal 2: Achieve Universal Primary Education	Goal 3: Promote Gender Equality and Empower Women	Goal 4: Reduce Child Mortality	Goal 5: Improve Maternal Health
Selected Monitoring Indicators	Prevalence of Under-weight Children Under 5years of Age (%)	Total Net Enrolment Ratio in Primary Education (2012) (%)	Ratio of Girls to Boys in Tertiary Education (2012)	Infant Mortality (per 1,000 live births) (2012)	Maternal Mortality Ratio (per 100,000 live births) (2013)
Brunei	…	95.7	1.74	7	27
Cambodia	29 (2010)	98.4	0.61 (2011)	34	170
Indonesia	18.6 (2010)	95.3	1.03	26	190
Lao PDR	31.6 (2006)	95.9	0.82	54	220
Malaysia	12.9 (2006)	96.1 (2007)	1.20 (2011)	7	29
Myanmar	22.6 (2009)	...	1.34 (2011)	41	200
Philippines	20.2 (2011)	88.6 (2009)	1.24 (2009)	24	120
Singapore	3.3 (2000)	...	...	2	6
Thailand	7 (2006)	95.6 (2009)	1.34 (2013)	11	26
Vietnam	12 (2011)	98.2	1.02 (2011)	18	49

(Source: ADB Key Indicators (2014), MDG refers to Millennium Development Goals)

Table 1.1 illustrates the selected MDGs and monitoring indicators used to assess ASEAN progress towards achieving MDGs. In relation to achieving MDG1, one of the indicators for hunger is the percentage of children under 5 years old who are underweight; this is based on the criteria identified by the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO). A majority of the children below 5 years old in ASEAN countries have poor nutrition, as is indicated by about half of the ASEAN countries, with more than 20% of children being underweight.

As for the total net enrolment ratio in primary education, about two-thirds of ASEAN countries had a ratio higher than 95%. With regard to the indicator for the child mortality rate, Cambodia, Lao PDR and Myanmar have high child death rates per 1,000 live births. Lao PDR recorded the highest child death rate (54); this was followed by Myanmar (41) and Cambodia (34). This rate is not similar to that of developed countries, where the child mortality rate is about 3 per 1000 live births; the average is 24 for the ASEAN countries.

Cambodia, Lao PDR and Myanmar do not only have a high ratio of infant mortality, they also have high maternal mortality. Lao PDR had the highest ratio of 220, while the rate in Singapore was less than 10 per 100,000 live births. The numbers are 139 and 6 for the ASEAN and developed countries, respectively. Hence, many ASEAN countries still have a lot of catching up to do.

The progress that has been achieved by the ASEAN countries signifies the need to call for immediate infrastructure improvements. For example, in order to achieve MDG1, which is to eradicate extreme poverty and hunger, there is no doubt that economic growth plays a significant role as the best course to eliminating poverty. Electricity infrastructure is becoming an increasingly essential input for growth, and thus, the adequacy and quality of the electricity supply is very important. However, the percentage of households with access to electricity in Cambodia and Laos is less than 50% of its population (ADB Key Indicator, 2010).

A few ASEAN countries, like the CLMVs, are experiencing a power crisis with frequent supply disruptions. As reported in the *Global Competitiveness Report 2009-2010*, the quality indexes of the electricity supply in these countries are far below the global mean.

With respect to the other agreed MDGs, such as education and health (MDG2, MDG4, MDG5 and MDG6), they rely on services that require supportive infrastructure and access to infrastructure. For instance, a better transportation system and safer road network will increase school attendance, while greater access to clean water and sanitation will improve health and prevent disease.

In relation to MDGs, Leipziger *et al.* (2003), in their study on the factors affecting child health outcomes, found that having good fundamental infrastructure services is vital in improving child health development, along with conventional variables, such as the income variable. The role of infrastructure in contributing towards the achievement of MDGs is summarized in Figure 1.1.

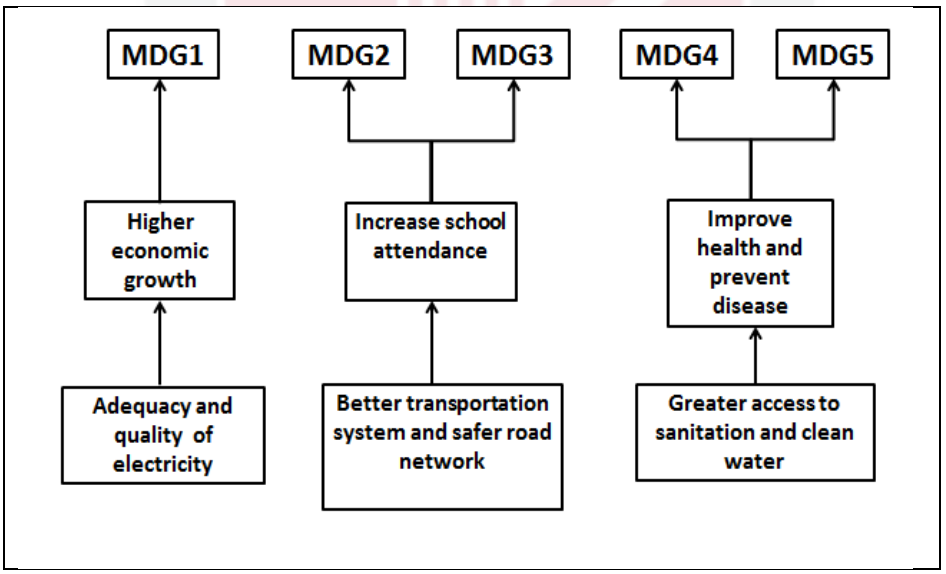

Figure 1.1. Contribution of Infrastructure towards the Achievement of MDGs
(Source: Author's own simplified framework)

The success of ASEAN countries in meeting MDGs also depends on its trade performance, as ASEAN economic growth is indebted to the growth of its international trade. Throughout the past twenty years, the globalisation of world trade has increased due to the liberalisation of trade policies in many countries and from progress in transportation, communications and storage technologies (World Bank, 1994). Thus, today's trade strategy has to go beyond the traditional trade policy barriers of tariffs and quotas if ASEAN wants to remain a highly competitive region.

Trade liberalisation, through a combination of multilateral, regional and unilateral efforts, has significantly reduced tariffs in most countries. For example, ASEAN cut its average tariff rate to just 0.05% and 2.61% in 2010 for the ASEAN-6 and the other four newest members, respectively.

An elimination of a tariff, as a result of tariff liberalisation, has forced ASEAN countries to focus on trade facilitation. Trade facilitation refers to the set of policies that ease trade flows. The ADB and United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP, 2009) defines trade facilitation as "the systemic rationalization of customs procedures and documents", and that "it covers all the measures that affect the movement of goods between buyers and sellers, along the entire international supply chain". Therefore, trade facilitation embodies both hard and soft infrastructure.

Hard infrastructure refers to physical infrastructures that underpin the economy, such as power lines, roads, ports, railways and satellites. Soft infrastructure refers to non-physical infrastructure, such as transparency, institution quality, financial systems, customs management and the business environment. Soft infrastructure supports the function of hard infrastructure.

It is increasingly being realized that barriers to trade, such as tariffs, are only one component of the overall trade costs. This is because trade costs are incurred at all stages of the export or import process (e.g., freight costs, governance transparency, time costs, legal and regulatory costs, information costs, contract enforcement costs, delays in custom clearance and other costs associated with trade transactions). Consequently, trade costs can be lowered by further improving trade facilitation through providing quality physical infrastructure and the efficiency of border services or making policy reforms in areas like the business environment and transparency.

Recent studies suggest that trade facilitation measures have a greater impact on trade costs than trade policy barriers. For example, the World Bank (2005) found that attempts to improve customs procedures and documents and to reduce transportation costs may produce better results than common reductions in trade policy barriers.

1.1.1 Definition of Infrastructure

The role of infrastructure in economic development has long been recognised and debated in the literature. Although infrastructure is generally recognized as a key ingredient that is crucial to a country's economic development, it is not

easy to find a commonly agreed upon definition of infrastructure. This is because the definitions of infrastructure used in the literature vary widely.

Hirschman (1958) defines infrastructure as “capital that provides public services”. The World Bank (1994) views infrastructure as public services (e.g., power and gas, water and sanitation, public works (roads), other transportation (harbours and airports)). In the meanwhile, Gramlich (1994) defines infrastructure as “the tangible capital stock owned by the public sector” and Prud’homme (2005) defines infrastructure as being comprised of capital goods which are not consumed directly.

Despite these various definitions, economists and urban planners do differentiate between economic infrastructure and social infrastructure. Economic infrastructure is defined as infrastructure that supports economic activity (e.g., roads, railroads, seaports, airports, water supply and sanitation, electricity and telecommunications), while social infrastructure is defined as infrastructure that improves the quality of life (e.g., schools and hospitals) (Fourie, 2006). The definition of infrastructure used in this study refers to infrastructure associated with the transportation, energy and telecommunications sectors.

As development has progressed, so has the measurement of infrastructure. Early studies measured infrastructure in terms of public investments (e.g., public capital). However, there is a shift in the use of public investments as a proxy for infrastructure, due to some limitations that arise. This is coupled with the availability of an alternative infrastructure proxy (e.g., physical indicators). More discussion on this measurement is presented in Chapter 2, Section 2.2.2.

In this study, infrastructure is measured by using two physical indicators: quantity and quality. In relation to trade, we examine infrastructure according to its two dimensions: hard and soft infrastructure. Further elaboration on these concepts is provided in the following sections.

1.1.2 The Quantity and Quality of Infrastructure

Growing evidence exists on the impact of infrastructure on economic growth. A number empirical studies have demonstrated the impact of infrastructure on economic performance (Munnell, 1992; Easterly & Rebelo, 1993; Garcia-Mila et al., 1996; Sturm et al., 1998; Demetriades & Mamuneas, 2000; Roller & Waverman, 2001). As mentioned previously, the empirical literature uses a variety of infrastructure definitions (e.g., public investment and physical indicators).

Lau and Sin (1997), Blanca Sanchez-Robles (1998) and Sturm et al. (1999) used public capital as a proxy for infrastructure, while Canning and Pedroni (2004), Égert et al. (2009), Um et al. (2009), Seethepalli (2008) and Calderón and Servén (2008), among others, used physical indicators. However, their focus is more on the quantity aspect of infrastructure.

Infrastructure quantity refers to increasing the size of the infrastructure stock, such as more roads and railways, a larger electricity grid and more telephone lines. Although the quantity, rather than quality of the infrastructure, has been the focus in past studies, evidence suggests that the quality of the infrastructure is also important (Calderón & Chong, 2004; Calderón & Serven, 2008; Calderón, 2009). Infrastructure quality is defined as enhancing the performance of the current infrastructure stock, for instance, improving road conditions by paving and patching roads, upgrading electricity transmission and distribution networks or improving sanitation services.

Following this recent literature of the need to focus on the quantity and quality aspects of infrastructure, this study includes these two measurements of infrastructure. With regards to quantity-related infrastructure, we have selected some indicators to represent the transportation, ICT and energy sectors. Details about these indicators are discussed in Chapter 3. To represent the quality-related infrastructure measures, the selected variables include the percentage of the road network that is paved and the electric power transmission and distribution losses, as a percentage of output.

1.1.3 Hard and Soft Infrastructure

It is no doubt that infrastructure and its related services play a critical role in the international trade flows in ASEAN countries. Many of the previous studies have explored the relationship between trade and infrastructure and have found a positive and significant impact of the quality of infrastructure on trade (Limão and Venables, 2001; Wilson et al., 2003; Clark et al., 2004). However, most of the indicators applied in these studies focused on the hard aspects of infrastructure, such as roads, railways, airports and seaports. The use of non-physical infrastructure, as an indicator in quantifying the impact of infrastructure, is very scarce.

In terms of non-physical infrastructure, Nordås and Piermartini (2004) included a time variable that was required for customs clearance. Hoekman and Nicita (2008) included customs and regulatory capacity. Hernandez and Taningco (2010) used time delays in the trade and depth of credit information as proxies for behind the border.

Along with hard infrastructure, matters related to behind the border policies have also started to gain attention. This was particularly the case after tariff reductions forced ASEAN countries to focus on non-tariff barriers, where behind the border policies are an example of the non-tariff barriers.

In a more recent study by Perez and Wilson (2012), infrastructure was measured in terms of two dimensions: hard infrastructure and soft infrastructure. Hard infrastructure, or physical infrastructure, measured the level of development and the quality of the transportation infrastructure. It was comprised of roads, airports, ports and rail infrastructure. The telecommunications sector was also regarded as a physical infrastructure that encompasses indicators on the use, availability, absorption and government prioritization of ICT.

Perez and Wilson (2012) defined soft infrastructure as matters related to border and transportation efficiency. It measures the level of custom efficiency and domestic transportation that is signified in the time, cost, and number of documents necessary for export and import procedures. It also includes the business and regulatory environment, which measures the regulations and the transparency level. Indicators employed to represent soft infrastructure include irregular payments, favoritism, government transparency, and measures to combat corruption.

In quantifying the impact of infrastructure on trade flows, this study follows Perez and Wilson (2012) by employing both hard and soft infrastructure. Our study differs from Perez and Wilson (2012) as we include more sectors and variables. More specifically, hard infrastructure is measured by three sectors: the transportation, ICT and energy sectors. Transportation infrastructure covers land, sea and air transportation. The four indicators that are used include air traffic freight, container port traffic, rail networks and paved roads. The ICT sector represents the telecommunications sector; it includes four indicators that act as proxies for ICT infrastructure, namely telephone lines, fixed mobiles, mobile cellular subscription numbers and the number of internet users. The two variables selected as indicators to measure the energy sector include electric power consumption (kWh per capita) and energy use (kg of oil equivalent per capita).

To measure the soft infrastructure, this study makes use of four different aspects of soft infrastructure: costs to export, documents to export, number of procedures and time to export. Though there already exists a vast amount of literature on infrastructure issues in relation to trade, by focusing on the wider coverage of hard and soft infrastructure, this study will provide a bigger scope to analyze the impact of infrastructure on the trade level in a more comprehensive way.

1.2 An Overview of the Current ASEAN Infrastructure Development

Table 1.2 shows the present infrastructure development in ASEAN by the selected indicators. Table 1.2 illustrates that a huge infrastructure development gap exists among the ASEAN countries. For instance, 100% of roads in Singapore are paved, while in Cambodia, only 6.3% of roads are paved. In terms of access to improve water sources, in Cambodia and Laos, the accessibility rate is about 70% of its population, as compared to almost 100% in Malaysia, Thailand and Singapore. With regard to internet access, there is a marked difference among the ASEAN countries. Internet access is very low in Cambodia, Myanmar, Laos and Indonesia. Singapore and Malaysia have the highest number of internet users per 100 people in 2007, at 73 and 67, respectively; this is followed by Brunei with 64.5.

Table 1.2. Infrastructure in ASEAN Member Economies, 2014

Country	Paved Roads (percent of total roads)	Mobile cellular subscrip-tions (per 100 people) (2013)	Internet users (per 100 people) (2013)	Improved water source (% of populatio n with access) (2012)	Electric power consump-tion (kWh per capita) (2011)	Energy use (kg of oil equivalent per capita) (2011)
Brunei	81.1 (08)	112	64.5	NA	8507	9427
Singapore	100 (07)	156	73.0	100	8404	6452
Malaysia	79.8 (06)	145	67.0	100	4246	2639
Thailand	99.9 (07)	140	28.9	96	2316	1790
Indonesia	59.1 (08)	125	15.8	85	680	857
Philippines	22.2 (05)	105	37.0	92	647	426
Cambodia	6.3 (04)	134	6.0	71	164	365
Laos	13.6 (09)	68	12.5	72	NA	NA
Myanmar	11.9 (05)	13	1.2	86	110	268
Vietnam	47.6 (07)	131	43.9	95	1073	697

(Source: World Development Indicators Online, 2015)
Note: (year) = Year of most recently available data.

Kumar and De (2008) developed the infrastructure index to examine the rankings of regions and countries according to the infrastructure development level. Despite improvements in the world ranking throughout the years, ASEAN countries still suffer from infrastructure inadequacy. Excluding Myanmar, all ASEAN countries successfully increased their global ranking between 1991 and 2005. Vietnam, which was ranked 92 in the year 1991, made a big jump to settle at 62nd place in 2005. Singapore occupies the top ASEAN position and was ranked 3rd in the world, while Cambodia was ranked 98. However, as noted earlier, a disturbing trend here is that although, in general, ASEAN countries have improved their infrastructure, the gap among countries is still huge, as is illustrated in Table 1.3. In general, the infrastructure index reveals a very wide gap in terms of infrastructure availability across the ASEAN region. Thus, infrastructure development in the lagging countries needs to be paid due attention if the gap is not to be widened further.

Table 1.3. Ranking of ASEAN Countries According to the Level of Infrastructure Development for the Years of 1991 and 2005

COUNTRY	RANK*	
	1991	2005
Singapore	6	3
Malaysia	37	29
Thailand	43	42
Viet Nam	92	61
Indonesia	69	62
Philippines	76	63
Lao PDR	99	92
Myanmar	90	95
Cambodia	100	98

(Source: Kumar and De (2008) and RIS (2008))
Note: Rank out of 144 economies
.

1.2.1 Quality of Overall Infrastructure

Table 1.4 displays the quality of the overall infrastructure for ASEAN countries, as reported in the *Global Competitiveness Report (2014-2015)* for the year 2013-2014. The overall quality of infrastructure in almost half of the ASEAN countries falls below the world mean of 4.2. The average of the overall infrastructure quality indexes of the ASEAN, as a region, is lower than that of the corresponding world mean and OECD countries.

Among the ASEAN countries, Singapore stood out as having the best overall infrastructure quality in the region. This was followed by Malaysia, Lao PDR and Indonesia. Except for the previously mentioned four countries, the quality indexes for the rest of the ASEAN countries are below the regional average. In particular, the overall infrastructure quality index of Thailand (4.1), Philippines (3.7), Vietnam (3.3) and Myanmar (2.3) are quite low, as compared to the world mean (4.2) and the OECD average (5.5).

Table 1.4. Overall Infrastructure Quality in the ASEAN Member Economies

Country	Rank*	2013-2014
Singapore	5	6.3
Malaysia	20	5.6
Lao PDR	66	4.3
Indonesia	72	4.2
Thailand	76	4.1
Philippines	95	3.7
Cambodia	109	3.4
Vietnam	112	3.3
Myanmar	138	2.3
ASEAN		4.13
World		4.2
OECD		5.4

Notes:
(i) Data for Brunei was not available
(ii) Quality of infrastructure is coded as: 1=extremely underdeveloped; 7 = extensive and efficient by international standards
(iii) ASEAN and OECD data are calculated by the author
(iv) 2014-2015 Rank out of 144 economies
(Source: World Economic Forum's Global Competitiveness Report 2014-2015)

Table 1.5 shows the index of the quality of the four indicators, as reported in the *Global Competitiveness Report (2014-2015)*. The quality of road infrastructure in three ASEAN countries, namely Singapore, Malaysia and Thailand, is better than the global mean. Except for Malaysia and Indonesia, the quality of railroads in the rest of the ASEAN countries is below the global mean; it is also well below that of the OECD countries. Furthermore, Cambodia and Myanmar have very low railroad quality indexes, at 1.6 and 1.8, respectively. In terms of the quality of port infrastructure, air transportation infrastructure and the electricity supply, the same three countries mentioned previously have recorded a higher index than the world average.

Thus, the challenges for ASEAN countries includes both quantity and quality gaps. In this respect, it is worth noting that Singapore is the highest ranked country, not only in the region, but also in the world, in terms of the quality of road, port and air transportation infrastructure. On the other hand, Vietnam and Myanmar are ranked 104th and 134th in the world for road infrastructure, respectively. Hence, the quality gap among the countries in the region remains quite large, especially for the new ASEAN members. This is due to the imbalance level of development and the nature of their economies. The gap is even wider when compared with the OECD countries. In general, the infrastructure quality in ASEAN countries is still very low in comparison to the OECD countries.

Table 1.5. Selected Infrastructure Quality Indicators, 2013-2014

Country	Quality of road infrastructure		Quality of railroad infrastructure		Quality of port infrastructure		Quality of air transportation infrastructure		Quality of electricity supply	
	Rank	Score (mean: 4.0)	Rank	Score (mean: 3.3)	Rank	Score (mean: 4.1)	Rank	Score (mean: 4.4)	Rank	Score (mean: 4.5)
Singapore	6	6.1	n/a	N/Appl	2	6.7	1	6.8	6	6.7
Malaysia	19	5.6	12	5.0	19	5.6	19	5.7	39	5.7
Thailand	50	4.5	74	2.4	54	4.5	37	5.3	58	5.1
Cambodia	93	3.4	98	1.6	97	3.6	106	3.6	110	3.0
Indonesia	72	3.9	41	3.7	77	4	64	4.5	84	4.3
Philippines	87	3.6	80	2.3	101	3.5	108	3.6	87	4.2
Vietnam	104	3.2	52	3.0	88	3.7	87	4.0	88	4.2
Lao PDR	68	4.0	n/a	N/Appl	129	2.6	82	4.1	64	5
Myanmar	134	2.4	94	1.8	125	2.6	137	2.5	117	2.8
ASEAN		4.1		2.8		4.1		4.1		4.6
WORLD		4.0		3.3		4.1		4.4		4.5
OECD		5.3		4.7		5.0		5.3		6.0

Notes:
(i) Data for Brunei was not available
(ii) N/Appl. is used for economies where there is no regular train service or where the network covers only a negligible portion of the territory. Assessment of the existence of a network was conducted by the World Economic Forum based on various sources.
(iii) Quality of infrastructure is coded as: 1 = extremely underdeveloped; 7 = extensive and efficient by international standards.
(iv) ASEAN and OECD data are calculated by the author.
(Source: World Economic Forum's Global Competitiveness Report 2014 – 2015)

1.2.2 Trading Across Border

The relative performance of each country and region in trading across borders is illustrated in Table 1.6, as reported in *Doing Business Report* [5]*(2009-2010).* The cost to import and export a standard container to and from East Asia, and specifically, ASEAN, is lower than it is for any other region. However, in terms of delivery time for the goods, it takes an average of 26 days to export goods from the East Asia Pacific. This is 16 days more than that of the OECD average. Time delivery affects trade through time costs. Delays in delivery will increase trading costs in terms of opportunity costs. It also leads to additional expenditures, such as storage and wage charges. Consequently, this results in an ASEAN trade reduction. The longer the delivery time, the higher the transportation costs. Increased transportation costs, as a result of delays in the transportation of goods, have partly contributed to the inadequate and inefficient transportation infrastructure.

The longer time delivery affects the competitiveness of ASEAN in the international market in terms of the responsiveness ability and trade costs. A study by Hummels (2007) found that the cost of import delays exceeds that of tariff costs in every region, while the cost of export delays exceeds tariff costs in every region except for East Asia and Western Europe. In another study, Djankov, Freund and Pham (2010) discovered that each day of delay at customs is equal to a country distancing itself from its trading partners by an additional 85 km. Keeping custom procedures as simple and transparent as possible contributes to reducing the time needed to clear customs, and thereby, reducing this dimension of trade costs.

[5] The Doing Business Report provides an indication of the extent of the problem in trading across borders. A dataset on the procedural requirements for importing and exporting is based on a standardized cargo of goods by ocean transport.

Table 1.6. Trading Across Borders, 2014

	Trading Across Borders					
Region/ Country	Document to export (number)	Time to export (days)	Cost to export (US$ per container)	Document to import (number)	Time to import (days)	Cost to import (US$ per container)
East Asia & the Pacific	6.1	20.2	864.0	6.7	21.6	895.6
Eastern Europe & Central Asia	6.9	23.6	2154.5	8.0	25.9	2435.9
Latin America & the Caribbean	5.7	16.8	1299.1	6.8	18.7	1691.1
Middle East & North Africa	6.0	19.4	1166.3	7.8	23.8	1307.0
OECD High Income	3.8	10.5	1080.3	4.3	9.6	1100.4
South Asia	8.1	33.4	1922.9	9.4	34.4	2117.8
Sub-Saharan Africa	7.6	30.5	2200.7	8.9	37.6	2930.9
ASEAN	6.8	21.0	799.9	7.1	21.8	876.9
Brunei Darussalam	5	19	705	5	15	770
Cambodia	8	22	795	9	24	930
Indonesia	4	17	571.8	8	26	660
Lao PDR	10	23	1950	10	26	1910
Malaysia	4	11	525	4	8	560
Philippines	6	15	755	7	15	915
Singapore	3	6	460	3	4	440
Thailand	5	14	595	5	13	760
Vietnam	5	21	610	8	21	600

Note: Data for ASEAN was calculated by the author
(Source: World Bank Doing Business Report 2015)

1.2.3 Logistic Performance Index

In a global economy, all countries, especially developing countries, are competing with each other to improve their competitiveness. Therefore, for ASEAN countries not to be marginalised, one of the important factors that needs to be addressed is to have an efficient logistic that enhances competitiveness and promotes economic growth.

Logistics now plays an increasingly important role, as reported in the Logistic Performance Index (LPI) by the World Bank. This report stresses the importance of logistics to trade expansion and overall economic growth. A recent publication by the World Bank (2014) titled *Connecting to Compete: Trade Logistics in the Global Economy,* offers a valuable assessment of the logistic performance for 166 countries based on some selected indicators[6]. Out of the 166 countries that participated in the survey, ASEAN countries were ranked poorly, with the exception of Singapore. Myanmar ranked the lowest. These rankings should be treated seriously by policymakers in terms of making ASEAN a competitive region.

In an era where speed to market is key, recognition by the government to reduce time for the clearance of goods, transparency and increased communications between the private and public sectors is important. Carruthers et al. (2003) suggests that manufacturers in Asia require low-cost services and services with precision. In other words, more logistic services with higher quality are needed to support the demands of international trade and business in this region.

Table 1.7. Logistic Performance Index by the ASEAN Countries

LPI Rank	Country	LPI	Customs	Infrastructure	International shipments	Logistic competence	Tracking & tracing	Timelines
2	Singapore	4.06	4.03	4.24	3.82	4.03	4.00	4.30
26	Malaysia	3.54	3.31	3.50	3.54	3.44	3.53	3.90
35	Thailand	3.34	3.10	3.27	3.27	3.19	3.36	3.83
53	Vietnam	3.07	2.76	2.88	3.16	2.94	3.15	3.51
58	Philippines	3.01	2.83	2.63	3.21	2.97	3.10	3.24
59	Indonesia	3.00	2.71	2.76	2.90	2.99	3.08	3.53
96	Cambodia	2.63	2.48	2.40	2.66	2.56	2.80	2.83
129	Lao PDR	2.42	2.37	2.21	2.50	2.33	2.29	2.79
151	Myanmar	2.27	2.04	2.07	2.23	2.15	2.30	2.78

(Source: World Bank Logistics Performance Index 2014)

Note: As a new feature in the 2014 Report, the scores of the six components across the four LPI surveys were used to generate a "big picture" to better indicate a country's logistic performance, and thus, reduce random variation from one LPI survey to another. Each year's scores in each component were given weights: 6.7 percent for 2007, 13.3 percent for 2010, 26.7 percent for 2012, and 53.3 percent for 2014. In this way, the most recent data carried the highest weight.

[6] Logistic performances of the countries are ranked based on indicators such as the efficiency of customs operations, infrastructure, logistical competence, tracking and tracing and timeliness.

1.3 Problem Statement

Infrastructure plays a significant role in the process of economic growth through the provision of final consumption services directly to households and as key intermediate inputs for production in other sectors. It further raises the productivity of other production factors through various channels, such as the betterment of health and education. Conversely, shortfalls in infrastructure will result in losses in productive efficiency. Thus, the availability of infrastructure is vital for providing access to markets and interactions with prospective customers, thereby leading to the creation of market opportunities. For instance, reliable transportation will reduce logistical costs while telecommunication networks allow for more information to be acquired.

Likewise, the efficiency of electricity networks often determines the investment and technological choices given that frequent power losses increase the maintenance costs and risks of machinery breakdowns of capital-intensive technologies. Thus, having a functioning and critical level of quality infrastructure consistent with a country's level of development may be a crucial precondition for further growth.

The relationship between the quantity and quality of infrastructure and economic growth is apparent. For a transportation infrastructure, a high density transportation infrastructure and highly connected networks are commonly associated with high levels of development. When transportation systems are efficient, they provide economic and social opportunities and benefits that result in positive multiplier effects, such as better accessibility to markets, employment, and additional investments. However, when transportation systems are deficient in terms of capacity or reliability, they can result in an economic cost, such as reduced or missed opportunities and lower quality of life. Although quality infrastructure may initially appear costly, it is indeed cost-effective in the long run as it is easy to use and durable. Therefore, the question becomes whether the focus should be on the expansion of its infrastructure or the improvement of the quality of the existing infrastructure to promote economic growth. As ASEAN needs an immense amount of infrastructure investment, it is vital to segregate the impact of quantity and quality of infrastructure on growth so that the government can prioritize its investment on either new investments or the maintenance or replacement of existing infrastructure.

The lack of quantity and quality of infrastructure not only impedes economic growth, it also constrains the attainment of the MDGs. The core of the MDGs is poverty reduction and enhanced human development. Consequently, the chances of ASEAN reaching the MDGs in most areas will be influenced by an individual region's ability to address critical infrastructure challenges. For instance, roads significantly contribute to lowering transaction costs (MDG 1), raising school attendance (MDG 2/3), improving access to hospitals and medications (MDG 4/5/6), and fostering international connectivity (MDG 8).

The fundamental components of infrastructure (e.g., transportation, electricity, water and sanitation, and information and communication technology), are essential for creating economic opportunities and supporting social

development. However, ASEAN data for the year 2008 shows that 160.3 million, or 28%, of its population were without electricity. In other words, ASEAN only has a 72% access to electricity rate, which falls short of the global rate (i.e., 78%). In the meanwhile, 69% and 86% of the population in South-Eastern Asia have access to basic sanitation and improved water sources, respectively (The MDG Report, 2010). With this current progress, many ASEAN countries are struggling to meet the MDG targets and require appropriate attention focused on basic infrastructure such as roads, water and sanitation, electricity, and information and communication technology.

Although infrastructure stocks in most ASEAN countries have been increasing at a substantial pace, their levels remain at lower levels than in some other developing countries in terms of both quantity and quality. A recent survey by the Global Competitiveness Report (2010) noted that only four ASEAN countries' overall infrastructure quality index was above the global mean. Improvement in infrastructure could lessen the production cost. It also normally increases the productivity of other inputs in the production process.

The productivity of capital depends on the reliability of power supplies, while the productivity of labour will be far higher if good education and healthcare infrastructure produces a well-educated and healthy workforce. Therefore, having a good and efficient infrastructure allows for greater output stemming from a given level of input and thus lowers the cost of production. Conversely, an inadequate supply or unreliability in services may restrain the investment of productive capital or reduce output.

Having adequate and efficient infrastructure services are necessary for the attainment of economic growth and for trade. According to a study by the World Bank (1994), an inadequate and unreliable infrastructure cripples countries' ability to engage in international trade. NEPAD[7] (2003, p. 7) added that: "There can be no meaningful development without trade — and there can be no trade without adequate and reliable infrastructure."

With tariff barriers significantly reduced, the focus is now on non-tariff barriers and trade facilitation. The failure to address these non-tariff barriers will impede ASEAN's trade expansion and competitiveness. In the absence of direct policy barriers, other components of trade cost, such as transportation costs and border-related trade costs, must be reduced. According to Anderson and Van Wincoop (2004), the 170% of "representative" trade costs in industrialised countries breaks down into 21% transportation costs, 44% border-related trade barriers, and 55% retail and wholesale distribution costs. In other words, transportation costs have become a key factor in determining a country's trade competitiveness and currently represent a considerably larger barrier to trade than before.

In a trade environment of declining tariffs, trade facilitation has been in the policy spotlight as the next key option for reducing trade costs in developing

[7] NEPAD stands for the New Partnership for Africa's Development; it is designed to address the current challenges facing the African continent.

countries. The relevance of trade facilitation has increased as liberalization continues to reduce artificial barriers to trade. Infrastructure is a form of trade facilitation; therefore, improving both hard and soft infrastructure can contribute to enhancing trade competitiveness. The impact of both hard and soft infrastructure on trade flows must be addressed to provide information on whether hard infrastructure, complemented by institutional reform, can increase trade flows for ASEAN countries.

In examining the impact of infrastructure on trade flows, it is vital to assess the role and efficiency of the transportation infrastructure, a key element in the logistics chain that has a considerable influence on facilitating trade internally and externally. The transport infrastructure itself is influenced by the types of product groups within the system. This is because some sectors or product groups require different modes of transport infrastructure, depending on the nature of the industry. Some products may be time sensitive, information sensitive, or distance sensitive. Supply chains for time-sensitive products, and, in particular, for perishable products such as fresh fruit, pose specific and unique challenges as these products have a limited lifetime, and failure to use them in time means they will have to be discarded. Therefore, speed is important. On the other hand, sensitive goods that require a high level of security may require air transport. Similarly, sea transport is linked to heavy industries, such as steel and petrochemical products. For this reason, transportation infrastructure plays a significant role in trade, making it necessary to study its impact on trade at the sectoral level.

The development of a trade-related infrastructure, including both hard and soft infrastructure, is therefore critical for enabling ASEAN to capitalize on the benefits of international trade. The development of infrastructure has been found to be a major factor in lowering trade costs in Asia, thereby facilitating trade expansion (Brooks & Hummels, 2009). Furthermore, infrastructure has become relatively more significant than direct policy barriers as potential sources of further cost savings (Brooks, Roland-Holst & Zhai, 2005).

Given this background, the current study investigates the relationship among infrastructure, trade, and growth for the ASEAN-5 countries. Our further interest includes a number of research questions considered important in the context of the roles of infrastructure in promoting growth and supporting international trade. Consequently, this study focusses on answering five research questions: First, does infrastructure affect growth in ASEAN-5? Second, is economic growth affected by a higher volume and a better quality of infrastructure? Third, does infrastructure affect trade flows? Fourth, can trade flows be increased by increasing hard infrastructure and improving soft infrastructure? Finally, how are sectoral performances affected by different modes of transportation?

1.4 Objectives of the Study

The general objective of the present study is to examine the roles of infrastructure on economic growth and trade in ASEAN countries. The specific objectives of this study are:

1) to examine the effects of both the quantity and quality of infrastructure on economic growth.
2) to investigate the impact of hard and soft infrastructure on trade flows.
3) to analyse the impact of transportation infrastructure on trade flows at the sectoral level.

1.5 Significance and Contribution of the Study

This study provides an overall picture of the level of infrastructure development in ASEAN countries, not only in terms of its quantity, but also in terms of its quality. The development of infrastructure is vital to achieving the MDGs. As infrastructure can contribute to the achievement of MDGs, addressing the issue of infrastructure is critical, especially for ASEAN new members, whose infrastructure development lags far behind.

However, increasing the quantity of infrastructure should not be the exclusive focus of policy. Instead, improving the quality of the infrastructure services is also vital. An increase in the quantity of the infrastructure alone may not be sufficient. Having good and efficient/quality infrastructure must complement the effort of building new infrastructure. Therefore, this study will provide information on the magnitude of the effects of the quantity and quality of the infrastructure.

By examining the impact of infrastructure, from the aspects of quantity and quality, policymakers can evaluate the transmission mechanism from the infrastructure investment to economic growth. This study will also identify some areas of opportunity across the different types of infrastructure in terms of the potential growth benefits that they can contribute.

In the trade literature, many studies have examined the role of infrastructure in affecting trade performance. However, most studies have only focussed on the role of physical infrastructure on trade. Few studies have adequately addressed the role of soft infrastructure. In addition to hard infrastructure, soft infrastructure has also been acknowledged as one of the key elements for facilitating trade. Facilitating trade not only requires good and efficient hard infrastructure, it also requires soft infrastructure, such as the business and regulatory environment, transparency and custom management. Therefore, this study will quantify the impacts of both hard and soft infrastructure on trade volume. Improvements in hard and soft infrastructure need to be pursued simultaneously to enhance trade competitiveness. Examining the relative impacts of soft infrastructure can provide information for policymakers to compare the benefits and costs of infrastructure investment or policy reform.

In addition, this study analyses the effects of infrastructure on trade flows, at both the aggregate and disaggregated level, such as at the sectoral level. Trade facilitation, through infrastructure services, may affect sectoral performances differently. The need to analyse differences among the sectors as far, as the importance of infrastructure is concerned, arises due to the fact that some sectors require different types of infrastructure, depending on the nature of the industries. This is because the potential impacts of addressing

different types of infrastructure may vary across sectors or product groups. For example, some sectors may be time-sensitive, information-sensitive or distance sensitive. Therefore, this study may provide additional insight into the importance of the transportation infrastructure for different sectors.

Furthermore, this study also provides information for policymakers to recognize the type of transportation infrastructure that is important to each sector, so as to reduce trade costs and improve trade volume. Analysing the role and impact of the transportation infrastructure, using disaggregated sectors, allows us to identify the magnitude of the effect, and thus, enhance the comparative advantage. With analysis done at the sectoral level, it can help policymakers in developing and formulating strategies for infrastructure investment according to the sectoral needs.

The remainder of the paper is organised as follows. Chapter 2 reviews the empirical evidence on the infrastructure-growth and infrastructure-trade nexus. Chapter 3 presents the theoretical framework and describes the data and methodology used in the study. Chapter 4 presents the results and discussion on the findings. Chapter 5 concludes the study with a discussion on policy implications and suggestions for future research.

1.6 Scope of the Study

The ASEAN countries that we considered in this study include Indonesia, Malaysia, the Philippines, Thailand and Vietnam. Other ASEAN countries, namely, Brunei Darussalam, Cambodia, Lao PDR and Myanmar, were not included, due to incomplete data. The time periods covered include 1970-2010 (to analyse the effect of infrastructure on growth) and 1995-2010 (to analyse the effect of infrastructure on trade flows).

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