THE UNIVERSITY OF HULL

Regional Logistics Capability and Economic Development of the Regions in Great Britain

being a Thesis submitted for the Degree of

PhD Management

in the University of Hull

by

Jiashi Song

MSc (Hull University)

BSc (Jilin University)

Feb 2011

Acknowledgements

This thesis could not be completed without the kind help from many people, yet only few can be mentioned here. I would like to extend my appreciation to all of them.

First of all, my special thanks should be given to my supervisors Prof. Chandra Lalwani, Prof. John Mangan and Dr Tim Butcher who have been supporting my work with insightful comments and guidance. I also owe many appreciations to the Hull University Business School for sponsoring my PhD study.

I offer my special gratitude to all the participants involved in this study for giving me valuable information needed to complete this research.

I own great appreciations to Mr Rob Bell for his continuous encouragement and support. I am also grateful to his wife Alyson Lloyd and their daughters Catherine, Lucy and Marianne for treating my wife and I as family with love. I will always remember the warm home of Green Wickets during my study in the UK.

Finally, I would like to express my deep love and appreciation to all my family for their encouragement, support and sacrifices. Their love is always my source of motivation.

Dedications

To the two women I love the most,

my wife Vivian Liu Wan and my mother Jixian Qu

List of Abbreviations

RLC	Regional Logistics Capabilities
GVA	Gross Value Added
SCM	Supply Chain Management
LM	Logistics Management
CSCMP	Council of Supply Chain Management Professionals
CLM	Council of Logistics Management
LPI	Logistics Performance Index
ONS	Office of National Statistics
DfT	Department for Transport
HMRC	Her Majesty's Revenue and Customs
APS	Annual Population Survey
DECC	Department of Energy and Climate Change
CAA	Civil Aviation Authority
SIC	Classification of Economic Activities
NUTS	Nomenclature of Units for Territorial Statistics
GOR	Government Office Region
MAUT	Multi-Attribute Utility Theory
AHP	Analytic Hierarchy Process
SMART	Simple Multi-attribute Rating Technique
ROC	Rank Order Centroid
ROD	Rank Order Distribution
SMARTER	SMART Exploiting Ranks
SMARTS	SMART using Swings
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
EA	East of England
EM	East Midlands
Ldn	London
NE	North East
NW	North West
Sco	Scotland
SE	South East
SW	South West
Wal	Wales
WM	West Midlands
Yks	Yorkshire and Humber

Abstract

Logistics and Supply Chain Management, as the “last frontier” for firm’s cost reduction potential, have been heatedly discussed since half a century ago (Drucker, 1962). In recent years, logistics and supply chain management have emerged as key business concerns and moved much higher up the agenda in organisations in every industry and sector (Christopher, 2005). Adequate and reliable supply is the key to success of not only battles in war, but also equally intense battles in the business arena.

In the era of escalating globalisation and international trade, the crucial role of logistics is gaining more and more focus for enhancing competitive advantage for not only firms, but also on a larger scale - economies. The World Bank’s Logistics Performance Index reports (Arvis *et al*., 2007; Arvis *et al*., 2010) provide clear evidence of the positive correlation between logistics performance and economic growth at the national level. The best logistics performers could gain better access to more distant markets and consumers, and achieve more benefits from globalisation. This close logistics-economy relationship is found at the regional level too. Huggins (1997) suggested that the physical flow of goods is an essential element of the trade and linkages among different regions across the world. Vickerman *et al.* (1999) added that improved access to input materials and to markets will cause firms in a region to be more productive, more competitive and hence more successful than those in regions with inferior accessibility. A capacity to network, which ties a region to relevant external partners, has become a stronger determinant for regional development. Those regions which are successful in forging these links are likely to witness a

significant increase in competitiveness and rapid economic growth. Logistics capacity therefore has a crucial role in regional economic development.

Conventional logistics research, however, seems to focus on activities within organisations and businesses, and lack a regional focus. On the other hand, it is also a missing link in the field of Economic Geography not to consider the role of logistics capability. This thesis attempts to fill this gap by discussing the logistics – economy relationship among the regions in GB.

Firstly, the previous literature on Logistics, Supply Chain Management and Economic Geography are to highlight the importance of logistics in regional economic development. Then after defining the Regional Logistics Capability (RLC), this thesis develops a measurement framework which aggregates an overall numerical evaluation (RLC score) of the logistics performances of the regions in GB. 40 logistics experts from the 11 GB regions are interviewed to evaluate the importance weights of the RLC indicators. In addition, the regions' actual performance data on the 17 indicators are elicited from statistics published by official sources in order to produce the RLC scores. This RLC score is then used to confirm a close relationship between the logistics capability and economic development at the regional level in GB. More in-depth analysis also identifies the key factors determining a region's logistics capabilities to be Infrastructure, Location and Workforce, which has significant implications in developing the RLC in GB. After discussing the specific strengths and weaknesses in logistics capabilities of each GB region, this thesis proposes specific guidelines for RLC improvement in light of the key RLC factors and the actual GB regional conditions.

Table of Contents

List of Tables

List of Figures

CHAPTER 1. INTRODUCTION

This study concerns the regional logistics capabilities of the various regions in Great Britain[1] and their relation to economic development.

History has always seen the close correlation between the growth in demand for freight logistics capabilities and economic growth. Logistics is especially important to economic development in the era of escalating globalisation and international trade. Firstly, logistics bears substantial costs in any economy. Today, according to the "UK Labour Market Factsheets" published by the Skill for Logistics website, the UK logistics sector is essential to the economy with a worth of £75bn and employment of 2.3 million people – 8 percent of the total employment in the UK (Skill for Logistics, 2009). Secondly, logistics also positively contributes to national wealth by increased connectivity and accessibility. The best logistics performers could gain better access to more distant markets and consumers, so they could benefit more from globalisation. In contrast, those countries that are landlocked and logistically constrained typically suffer not only from geographical disadvantages resulting in high transport costs and delays, but also from limited access to competitive markets, as shown in the case of some land locked countries in Africa.

The World Bank Logistics Performance Index reports (Arvis *et al*., 2007; Arvis *et al*., 2010) provide further evidence of the positive correlation between

---

[1] Great Britain (GB) is made up of England, Scotland and Wales. The United Kingdom (UK) is made up of

logistics performance and economic growth at the national level. This close logistics-economy relationship is found at the regional level too. Huggins (1997) suggested that the physical flow of products is an obvious essential of the trade and linkages among different regions across the world. Vickerman *et al.* (1999) added that improved access to input materials and to target markets will cause firms in a region to be more productive, more competitive and hence more successful than those in regions with inferior accessibility. A capacity to network, which ties a region to relevant external partners, has become a stronger determinant for development. Those regions which are successful in forging these links are likely to witness a significant increase in competitiveness and rapid economic development. Logistics capacity therefore plays a crucial role in regional economic development.

Conventional research in logistics, however, lacks a regional focus. Since the emergence of the logistics concept, the definitions of logistics mostly focus on activities within organisations and businesses, or among different partners within the supply chain (Ballou, 2007). Little logistics research attempts to address the role of logistics in regional economic development. Similarly, the traditional logistics performance measurement literature also emphasises measuring the logistics efficiency and effectiveness of a company or a supply chain, rather than reflecting the logistics capacities of a region (Caplice and Sheffi, 1994; Chow *et al.*, 1994; Forslund, 2007; Griffis *et al.*, 2007; Gunasekaran *et al.*, 2001; Neely *et al.*, 1995).

Economic Geography research also fails to highlight the role of logistics capability in promoting a region’s economic development. Economic geography is a study of the location, distribution and spatial organisation of economic activities across the world. It acknowledges the important role of regions in considering economic development (Krugman, 1991). Several models of Economic Geography study the complex bonds between economic development, transport costs, and spatial inequalities, such as the Gravity Model of Trade (Tinbergen, 1962); the Monopolistic Competition Model (Dixit and Stiglitz, 1977); the Dixit-Stiglitz-Krugman Model of Trade (Helpman and Krugman, 1985), and the highly influential Cluster Theory (Porter, 1998). Although some of these models do have transportation cost as a component, most of them seem to ignore the contribution of logistics capability to the competitive advantage of regions.

The main objective of this research is to examine the relationship between a region's logistics capability and its economic development in GB. The research seeks to answer the following research question:

Research Question 1: What is the relationship between a region's Regional Logistics Capability and its economic development in GB?

The interest of this research is to study the logistics capabilities of a region rather than an organisation or a supply chain or a nation. There is a need to first define and measure the Regional Logistics Capabilities (RLC) of the regions in GB.

This research differentiates regional logistics capability from national logistics capability. The Logistics Performance Index report from the World Bank (Arvis *et al.*, 2007; 2010) shed light on the logistics "friendliness" performance of 150 countries which indicates good logistics performance facilitates trade and stimulates economic development. To measure the logistics performance of a country, the LPI report considered four main groups of factors which tend to be a strong determinant of overall national logistics performance: infrastructure, services, border procedures and time, and supply chain reliability. As regional scientists and economic geographers have long understood, there are substantial differences in economic performance across regions in virtually every nation (Scott, 2002; Porter, 2003). Some of the LPI factors are country-level indicators, such as "Customs and border efficiency" which does not vary significantly across sub-national regions. However, the other indicators needs to be reconsidered at the regional level, such as "Geographical characteristics", "Demography of regional logistics workforce" etc. Therefore, there is a need to investigate the issue of logistics capability further on the regional level.

Based on the above argument, this research first attempts to quantify the RLC of the 11 GB government regions, so that the relationships between logistics and an economy on a regional level can be explored. Next, the relationship among RLC indicators is studied in order to propose suggestions for building stronger RLC in the regions in GB to support economic development. This is to answer the second research question:

Research Question 2: How to efficiently develop Regional Logistics Capability in the regions in GB?

This thesis is structured in eight chapters.

Chapter One is the introduction chapter which sets the context of the study.

Chapter Two reviews relevant literature to firstly illustrate the important role of logistics in regional economic development and then gives a definition of RLC. Next, this chapter reviews the logistics performance literature to identify 24 indicators which affect the logistics performance of a region.

Chapter Three presents the definition and a brief description of the research focus of this thesis – the 11 regions in GB.

Chapter Four explains how the research has been designed and why the SMART-ROD method has been chosen.

Chapter Five is the first of two data analysis chapters which reports the data sources and how the data were processed to produce RLC scores for the regions in GB. This chapter also gives a discussion of the issues of data used including omitted indicators, missing data and outliers.

Chapter Six is the second data analysis chapter which digs deeper into the data to explore the relationship between RLC and economy indicators, as well as the relationship between RLC and its indicators. The processes and results of the statistical techniques used are reported in this chapter, including Correlation analysis and Stepwise multiple regression. Finally, the issue of research reliability and validity is discussed towards the end of this chapter.

Chapter Seven discusses the findings of this study and explores in detail regional logistics performance in the context of the 11 regions in GB. Each region's strengths and weaknesses in logistics capabilities are discussed, thereafter proposing specific suggestions for improvement in light of the findings of the previous data analysis chapter and specific regional conditions.

Chapter Eight finally gives conclusion to this study by summarising the contributions and limitations, as well as pointing out future studies needed.

In addition, the questionnaire used to collect RLC weights data from the logistics experts is attached in Appendix One.

CHAPTER 2. REGIONAL LOGISTICS CAPABILITY AND ECONOMIC DEVELOPMENT

2.1 Introduction

Logistics is a concept that was first used in the military to efficiently supply the troops with food, water and ammo. Later logistics principles were introduced into the business world to reduce the costs of goods movement during production, distribution and consumption. However, logistics has been a missing link in the regional development and Economic Geography literature.

Today we are living in a world where distances are no longer prohibitive. However, the significance of the spatial separation of nations and regions in economic life is not lessened (Combes *et al.*, 2008). In the era of globalisation, logistics is increasingly viewed as an essential factor in determining the economic success of a country or a region, which is also the interest of this research.

This chapter reviews relevant literature to firstly illustrate the important role of logistics in regional economic development, and then gives a definition of RLC from an efficiency and effectiveness perspective (Mentzer and Konrad, 1991): "**The effectiveness and efficiency of a region in facilitating logistics activities both within the region and across regional borders**." Next, this chapter reviews the logistics performance literature to identify 24 indicators which affect the logistics performance of a region. These indicators are categorised into five dimensions in preparation to develop a RLC measurement framework: location features, quality of infrastructure, local logistics services availability, local government policies and support, and finally the size and quality of logistics workforce.

2.2 Logistics and Regional Economic Development

2.2.1 Evolution of Logistics and Supply Chain Management

The concept of Logistics was first used in the military. It was defined in the Oxford English dictionary (Simpson and Weiner, 1989) as: “The branch of military science having to do with procuring, maintaining and transporting material, personnel and facilities.”

Logistics as a business concept only developed in the 1950s and has had significant impact through the functions of production, distribution and consumption (Hesse and Rodrigue, 2004). This was mainly due to the increasing complexity of supplying businesses with materials and shipping out products in an increasingly globalised supply chain. Logistics was first taught as a course in the university around 1960 (Ballou, 2007). It mainly discussed activities such as transportation, inventory control, warehousing, and facility location. The emphasis was on a firm’s outbound movement of goods and dealt little with inbound movements.

Initially, logistics was an activity divided around the supplying, warehousing, production and distribution functions, most of them being fairly independent from the other in the 1960s. The study and practice of physical distribution and logistics emerged in the 1960s and 1970s when logistics costs were very high at the national level across the world. According to previous studies, logistics cost accounted for 15 percent of the gross national product (GNP) in the USA, as of 16 percent of sales in the UK, 26.5 percent of sales in Japan and 14.1 percent of sales in Australia (Heskett *et al.*,1973; Murphy, 1972; Kobayashi, 1973; Stephenson, 1975). During the 1980s, the emergence of lean manufacturing was another milestone in the development of logistics and supply chain management, which encouraged supply chain partners to work closer to eliminate costs in the supply chain.

Later on, with the new organization and management principles, firms were following a more integrated approach to deal with the increasingly turbulent market demand. In the 1990s, with the convergence of logistics and information technologies, this principle was increasingly applied to the whole supply chain, hence the development of the concept of supply chain management (SCM) (Hesse and Rodrigue, 2004).

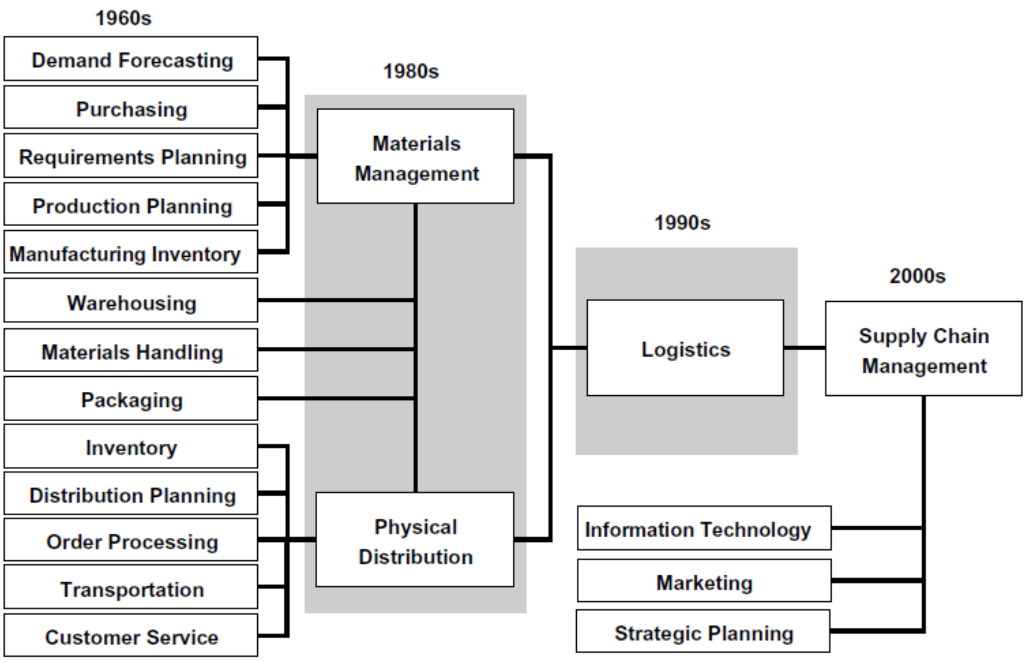


Figure 2-1. The evolution of logistics and supply chain management.
Source: Hesse and Rodrigue (2004)

The above Figure 2-1 shows the evolution of the logistics development from the 1960s to 2000s.

In general, logistics is the function responsible for the flow of materials from suppliers into an organisation, through operations within the organisation and then out to customers (Panayides, 2006). This equates to having the right item in the right quantity at the right time at the right place for the right price.

The logistics and SCM relationship, however, is not agreed among researchers. An international survey conducted by Larson and Halldorsson (2002) revealed four unique perspectives on the relationship between logistics and SCM:

- The traditionalist perspective, which sees SCM as one small part of logistics.
- The re-labelling perspective, which simply renames logistics to SCM.
- The unionist perspective, which treats logistics as a part of SCM.
- The inter-sectionist perspective, which sees SCM as a broad strategy that cuts across many if not all business areas.

The boundaries of logistics management (LM) activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfilment, logistics network design, inventory management, supply/demand planning, and management of third-party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. CSCMP[2] (Council of Supply Chain Management Professionals) defined logistics as

"The process of planning, implementing, and controlling procedures for the efficient and effective transportation and storage of goods including services, and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. This definition includes inbound, outbound, internal, and external movements."

SCM, on the other hand is an integrating function, which coordinates and optimises all logistics activities, as well as integrates logistics activities with other functions including marketing, sales manufacturing, finance, and information technology. CSCMP (2004) gives a definition of SCM:

"Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies."

---

[2] Formally named CLM (Council of Logistics Management, is the pre-eminent association for individuals involved in logistics management. It was founded in 1963 as the National Council of Physical Distribution Management (NCPDM). In 1985, recognizing the growing field of logistics, the association's focus broadened as it changed its name to the Council of Logistics Management. In 2005, CLM changed its name again to CSCMP (Council of Supply Chain Management Professionals).

In this definition, SCM is viewed as managing product flows across multiple enterprises whereas logistics is seen as managing the product flow activities just within the firm (Ballou, 2007). In fact, CSCMP specifies that SCM “includes all of the logistics management activities…, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology."

This thesis tilts to the unionist view which sees logistics as a subset of SCM, and adopts the CSCMP definitions of logistics and supply chains. However, it is interested in exploring the importance of logistics from a regional perspective, which will be discussed later.

2.2.2 Regional economy and Economic Geography

How an economy grows in a particular region is an area that academics continue to explore. Economic geography is such a discipline which studies “what” is “where” (Thisse, 2008). “What” could be any particular economic activities and “Where” refers to areas such as cities, regions, or custom unions. The Economic Geography theories focus on spatial competition between firms and consumers’ residential choices, and try to explore why particular economic activities establish themselves in particular places.

Paul Krugman is one of the leading economists who have discovered the important role of regions in stimulating the growth of national economies. In Krugman’s view (1991), the regional industrial specialisation and concentration is so important that Economic Geography should be a major sub-discipline within economics.

Krugman (1986) believes that regions matter. He argues that international trade and competitiveness is closely linked with the sub-national level economic performance. Therefore large-scale regions are more significant economic units than nation-states. The best and simplest evidence is a satellite image of the world at night which will show regional agglomerations rather than national concentrations. In his words, “One of the best ways to understand how the international economy works is to start by looking at what happens inside nations. If we want to understand differences in national growth rates, a good place to start is by examining differences in regional growth; if we want to understand international specialisation, a good place to start is with local specialisation” (Krugman, 1991). He even goes further to say that it is meaningless to apply the word “competitiveness” to national economies, and the obsession with competitiveness is both “wrong” and “dangerous” (Krugman, 1995). He mainly argues that regional industrial agglomerations firstly evolve for accidental historical reasons, and once these regions are established, they become locked in by cumulative processes and are sustained by the external scale economies (Krugman, 1991).

Regional inequality in economic development is another reason why we need to take regions as the unit of study. The studies in Economic Geography suggest that the development of regional economies have never been geographically even in GB or Europe. The estimation of the GDP per capita of the period from 1800 to 1913 shows that although the Industrial Revolution produced a rise in the level of well-being of European countries on average, the process of development was quite unbalanced (Combes *et al*, 2008). In fact, the regional development grew more uneven with the declining costs of communication and transportation.

This trend might seem surprising, but is well explained by Economic Geography studies. Several models of Economic Geography study the complex bonds between economic development, transport costs, and spatial inequalities, such as the Gravity Model of Trade (Tinbergen, 1962); the Monopolistic Competition Model (Dixit and Stiglitz, 1977); the Dixit-Stiglitz-Krugman Model of Trade (Helpman and Krugman, 1985). These models suggest the following: Trade costs which include all costs generated by distance and border are positive for space to matter. However, it would be wrong to infer regions matter less even when trade costs decline. On the contrary, according to Krugman (1991) high transport costs act to prohibit the geographical concentration of production. However, with some reduction on transport costs, firms will want to concentrate in one site to realise economies of scale both in production and in transport. If transport costs continue to fall, the model suggests that the need to locate near to markets will disappear and production may disperse. In other words, lower transportation and other trade costs would lead footloose firms to changes, and therefore make them more sensitive to minor differences between regions. Minor difference might results in major impact on the spatial distribution of economic activity. This explains the rise of the manufacturing belt in the North-eastern United States during the nineteenth century (Krugman, 1991). In general, Krugman's models combine the models of imperfect competition and scale economies used in new trade theory with location theory's emphasis on the significance of transport costs. Martin and Sunley (1996), however, point out that Krugman’s models lack adequate sense of geographical and historical context.

Another highly influential framework to explore a region's economic development is Porter's Cluster Theory (Porter, 1998), which states that a region's competitiveness is improved by the well-established geographic concentrations of interconnected companies and institutions in a particular field.

Porter (1998) defines clusters as "critical masses in one place of linked industries and institutions - from suppliers to universities to government agencies - that enjoy unusual competitive success in a particular field." As an alternative way of organising the value chain, clusters represent a kind of new spatial organisational form which provides unique advantages for cluster members (Porter, 1998). Upstream suppliers and downstream customers are often included in the same cluster. The former provide raw materials, components and services while the latter may be the final consumer of the product or an intermediary channel to the final consumer. Moreover, clusters often extend horizontally to manufacturers of similar and complementary products that require the same basic skills, common inputs, and similar technologies. Many clusters also include universities, vocational training providers, trade associations, and governmental institutions. Examples include the entertainment cluster in Hollywood, the computing cluster in Silicon Valley, the finance cluster on Wall Street, and the consumer electronics cluster in Japan.

Clusters affect competition by increasing the productivity of companies based within it; driving the direction and pace of innovation, and stimulating the formation of new businesses within the cluster (Patti, 2006). Additional less quantifiable economic advantages of clusters include the increased power that clusters have to influence legislation, regulation, local educational institutions, industrial trade organisations and local infrastructure development (Patti, 2006). In essence, the advantages of clusters are based on a superior local business environment produced by local proximities. Coe *et al.* (2007) suggest there are different economic-geographical interpretations of proximity in the Cluster Theory. In addition to the most obvious spatial proximity (physical distance) there are also:

- Institutional proximity: a closeness of a region derived from operating within the same legal and institutional frameworks as other regions.
- Cultural proximity: a closeness created through a shared cultural background and linguistic heritage.
- Organisational proximity: a closeness engendered through both written rules and unwritten ways of doing things within a particular firm of institution.
- Relational proximity: a nearness derived from informal inter-personal relations.

The Cluster Theory, however, is not accepted by all. Martin and Sunley (2003) criticise the cluster concept as “a chaotic concept”, which lack of clear boundaries, both industrial and geographical, is that such a concept cannot provide a universal and deterministic model of how agglomeration is related to regional and local economic growth.

Moreover, there has not been enough empirical support for Cluster Theory.

McDonald *et al*. (2006) developed and tested a conceptual model of the relationship between public policies and the development of industrial clusters, using data from 43 European industrial clusters. The results indicate that there is limited evidence that packages of government policies that are specifically geared towards improving the local asset base are effective in overcoming obstacles to growth of industrial clusters. McDonald *et al.* (2007) also assessed the relationship between key cluster characteristics (depth, stage of development and industrial sector) and performance (employment growth and international significance), using data from a Department of Trade and Industry (DTI) study on clusters in the UK. Their analysis finds no strong support for the current thrust of cluster policies. This further indicates that Porter-type cluster policies that focus on developing local supply chains and locally based collaborative networks are unlikely to be sufficient. And in some cases it may not be necessary to create and develop such Porter-type clusters in order to promote regional development objectives. Therefore it is necessary to question whether current Cluster Theory is missing an important element.

It is clear that the majority of the cluster literature emphasises the geography of innovation and global flows of information, knowledge and innovation. However, there is very little research on the advantages a regional cluster gains from efficient and effective logistical linkages.

The general argument about innovation network systems is that geographical proximity facilitates knowledge sharing and, thus, interactive learning and innovation in a region (Cooke, 2001). And between different regional clusters there are global linkages - national or global networks of innovation – which are often even more important than local ones in terms of facilitating knowledge flow, despite the distance (Cooke, 2007).

While recognising the importance of the innovation flow to the development of regional clusters, it is a significant deficit to ignore the contribution of logistics capability to the competitive advantage of regions.

This section summaries previous literature on Economic Geography, which points out that large-scale regions are more significant economic units than nation-states. This is the main reason why sub-national regions are chosen to be the focus of this thesis in exploring logistics and economy relationship. Furthermore, the Economic Geography studies such as the cluster theory tend to be around the innovation, information, and knowledge link and flow among global regions rather than physical freight movement. Although some Economic Geography models touch upon the transportation costs, such as the Gravity Model of Trade (Tinbergen, 1962); the Monopolistic Competition Model (Dixit and Stiglitz, 1977); the Dixit-Stiglitz-Krugman Model of Trade (Helpman and Krugman, 1985), they fail to address the complete role of logistics and supply chain capability in the regional economies.

As a link to external partners, logistics activity is important to both companies and regional clusters, especially in today's perpetually globalised economy, which will be discussed in detail in the next section.

2.2.3 Logistics for regions in a globalised world

Globalisation is a phenomenon that has received much attention and has been extensively debated (Dicken, 2007). As the era of globalisation unfolds, geographic distance seems to become much less significant. Transformations in transportation and communications technologies have shrunk the world. As a major determinant of spatial interactions such as trade, the costs for transport have decreased considerably over the years, which seem to have reduced the issue of space in the modern economy (Rietveld, and Vickerman, 2003). Improvements in information technology and transportation have enabled companies to expand their markets and supply bases worldwide (Zeng and Rossetti, 2003). The relative ease and speed of air travel allow for frequent face-to-face interaction when necessary. Moreover, rapid IT development provides us with high speed and easily accessible communications technologies and makes it possible to communicate to suppliers and customers around the world almost as easily as with suppliers and customers next door. An efficient and more secure global financial network has developed that allows multinational enterprises to expand their operations with (Grant *et al.*, 2006).

These conditions have fuelled the trend toward multinational supply chains by encouraging outsourcing to overseas destinations. Apple Computer offers a good example of this point. Not only does Apple not own a shipping fleet, it does not even have a manufacturing plant (Chanda, 2007). A music player is designed by Apple's engineers in Cupertino, California, integrating the innovations of many others from Taiwan, South Korea, and India, and then assembled in China, sold on the Internet, and finally delivered to customer's home by a Dutch logistics company.

Therefore, the expansion of global trade in manufactured goods became one of the most remarkable economic trends of the last 40 years, which shows no sign of abating. As Burnson (1999) describes, “The most successful companies often develop their products in Europe and the USA, manufacture in Asia and Latin America, and sell worldwide.” The growth of global trade in manufactured goods has been further reinforced by the reduction in tariff barriers and the expansion of low-cost international logistics in the form of container freight (Braithwaite, 2007). One way to picture the global economy, therefore, is as a geographically uneven, highly complex and dynamic web of production networks in the form of localised economies. Regions and their economic activities are connected together through threads of flows (Scott and Storper, 1992). Figure 2-2 below shows the global trade network in the clothing industry which illustrates the point.

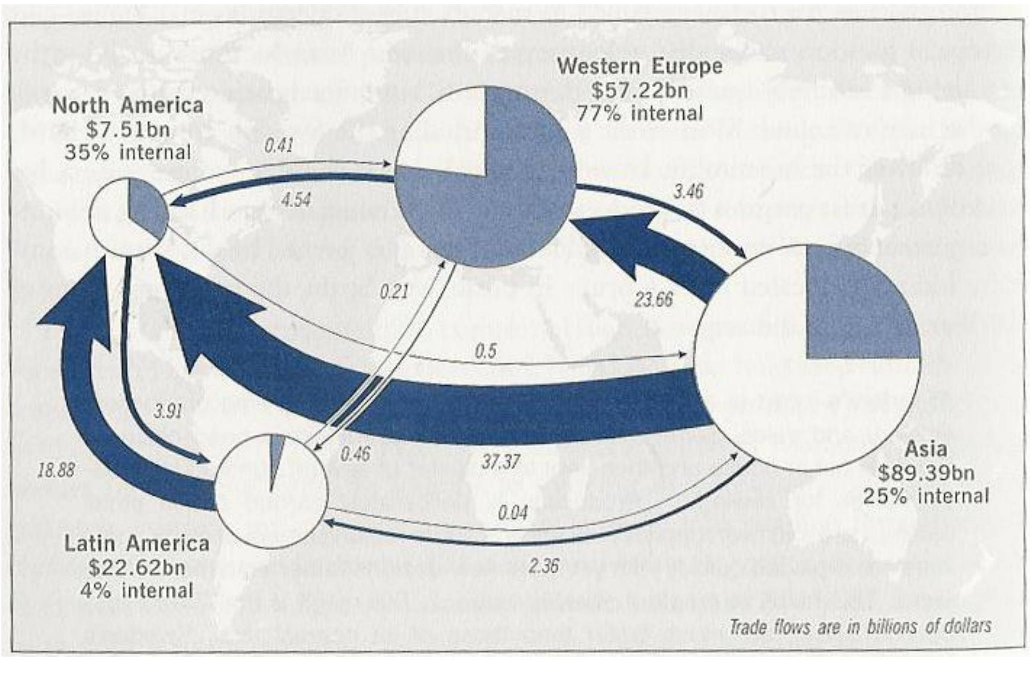


Figure 2-2. Global trade network in clothing.

Source: Global Shift (Dicken, 2007)

These fundamental changes seem to have diminished the traditional significance of transport. Researchers such as Cairncross (2001) even go further to claim “the end of geography” or “the death of distance”. Porter (2002), however, argued that the process of globalisation seemingly should make location and regions less important, but it “appears to be doing just the opposite.” Scott (2002) pointed out that the world is not “a borderless space of flows” and that “a new regionalism” is on the rise, which is rooted in a series of dense nodes of human labour and communal life scattered across the world. Rietveld and Vickerman (2003) added that the talk of the “death of distance” is unmistakably premature, because the issue of transport and logistics still has significant implications to regional science in the globalised world today. They pointed out that travel and movement of goods are not an inconvenience to be minimised but necessary service activities that has been rapidly growing in both variety and volume due to the increase of customers’ incomes and demand.

It is therefore necessary for regional science to deal with changing patterns of transport and logistics which affect the measurement of basic accessibility of a region.

We are living in times characterised by escalating speed, complexity, risk and uncertainty (Bender, 2007). Nevertheless, businesses have been driven to seek cheaper resources and new markets overseas by ever-increasing pressure from customers’ demands for cheaper, better, faster products and services. If a business fails to meet the level of responsiveness of today’s more and more turbulent market, it will almost definitely be forced out of the market

(Christopher, 2005). As a fundamental role in international trade growth, logistics is going to have even more significant impacts, to the success of not only businesses but also nations and regions.

The challenge faced by contemporary business leaders is to improve their logistics operations to increase responsiveness to customer demand whilst lowering cost, while the challenge faced by regions is to provide sufficient capabilities and proper conditions to facilitate the logistical needs within the region as well as across regional border and sustain economic development. This has led to the need to explore the role of logistics in facilitating regional economic activities.

2.2.4 Logistics and economic development

Without any doubt, logistics is important to the economic development of countries and regions around world. Logistics has always been a central and essential feature of all economic activity (Christopher, 1981). In any economy, the logistics industry bears substantial direct and indirect costs, and by improving logistics and encouraging a more efficient supply chain it provides an excellent opportunity for economic growth (Nikolar *et al.*, 2005). Thirty years ago, Childerley (1980) pointed out the overall importance of logistics to the UK economy: it is estimated that in 1976 approximately 29 percent of the UK working population or nearly 31 percent of those in paid employment were concerned with logistics, which was about 1.6 million people (ONS, 2009). In terms of cost logistics activities account for a massive part of the national expenditure: 28.4 percent of GDP in 1976 – almost £36bn at current prices. Today the UK logistics sector is worth £75bn to the economy and currently employs approximately 2.3 million people (SfL, 2009). Christopher (1981) also argued that any productivity improvement in any part of the logistics system would release resources for use elsewhere in the economy, thus can influence economic health not only of individual companies but also, in the aggregate, the national economy.

In addition to the financial argument, logistics is a positive contributor to national wealth through delivery performance in export markets (Christopher, 1981). As trade barriers are reduced and as new markets are opened up, it is essential to have high levels of accessibility. All countries need a well-developed transport infrastructure to compete internationally in new global markets (Banister and Berechman, 2001). The best logistics performers could gain better access to more distant markets and consumers to benefit more from globalisation. For example, Chile has the potential be a major player in the high-end world food market, supplying fresh fish and perishable fruits to consumers in Asia, Europe, and North America (Arvis *et al.*, 2007).

In contrast, those countries that are landlocked and logistically constrained typically suffer not only from geographical disadvantages resulting in high transport costs and delays but also from limited access to competitive markets. This is also one of the reasons for Africa's underdeveloped economy. These countries are trapped in a "vicious circle" of underinvestment in logistics infrastructure, leading to stagnant trade (Arvis *et al.*, 2007).

Africa is the most geographically stable continental land mass on Earth, and yet it is also the most divided continent on Earth. Today, Africa is divided into 46 states, which is more than three times the number in Asia (whose land surface area is almost 50 percent larger). The implication of such fragmentation is a nightmare in logistics. Until today, few railways and roads in Africa cross international frontiers; most do not even approach them (Reader, 1998).

In addition, fifteen African states are entirely landlocked, whose access to seaborne trade are cuts off. Paul Collier (2007) points out that it is one of the major development traps that hold a country back to be geographically landlocked in a poor neighbourhood: "If you are coastal, you serve the world; if you are landlocked, you serve your neighbours." Many landlocked countries in Africa have to depend on their neighbours' stability for transportation and trade.

The boundary between Senegal and the Gambia is a classic example (See Figure 2-3). The Gambia, 500 kilometres long but in places only twenty kilometres wide, lies astride the navigable section of the Gambia River – "a worm-like intrusion into the State of Senegal" (Reader, 1998).

Because the Gambia River is one of the easiest and most extensively navigable rivers in Africa, the boundary would undoubtedly have become the principal artery of trade for Senegal and land-locked Mali as well as the Gambia. But in fact, because the national border separation, the other countries have to transport their produce to the coast by road or rail. The Gambia River – which could have served the entire hinterland at a fraction of the cost of other transportation means – carries only produce from the Gambia itself.

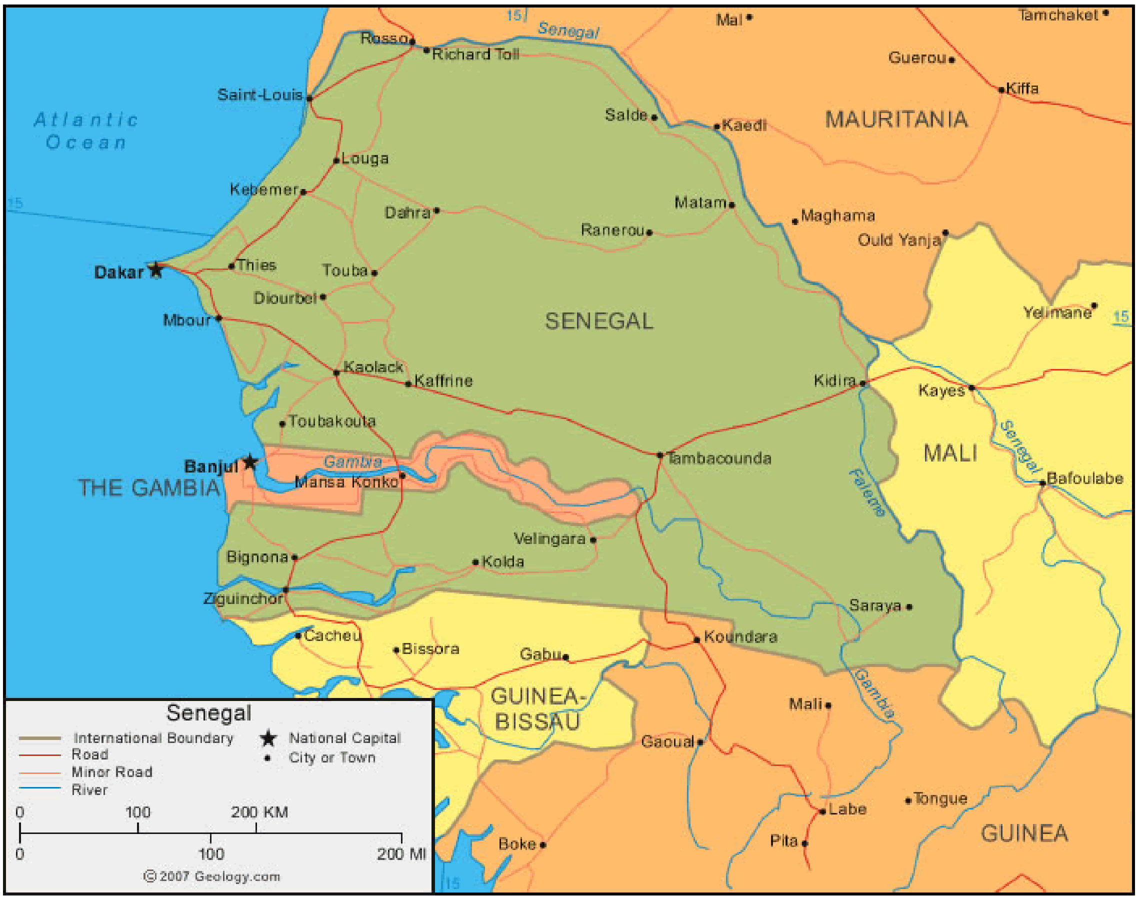


Figure 2-3. Map of Gambia and Senegal.

Source: geology.com

Logistics also has a positive role in promoting domestic economic development and revolution. If not for the various development in logistics conditions in the UK, such as the road building and canal transportation in the 18th century and the coming of railways in the 19th century, none of the dramatic and rapid changes in the industrial revolution could have happened to change a largely agrarian and cottage industry UK to a highly industrialised and trade-oriented nation (Christopher, 1981).

History has always seen the close correlation between the growth in demand for freight logistics capabilities and economic growth in a country (Banister and

Berechman, 2001; Vickerman *et al.*, 1999). The World Bank Logistics Performance Index reports (Arvis *et al*., 2007; Arvis *et al*., 2010) provide further evidence of such clear positive correlation between logistics performance and economic growth (see Figure 2-4).

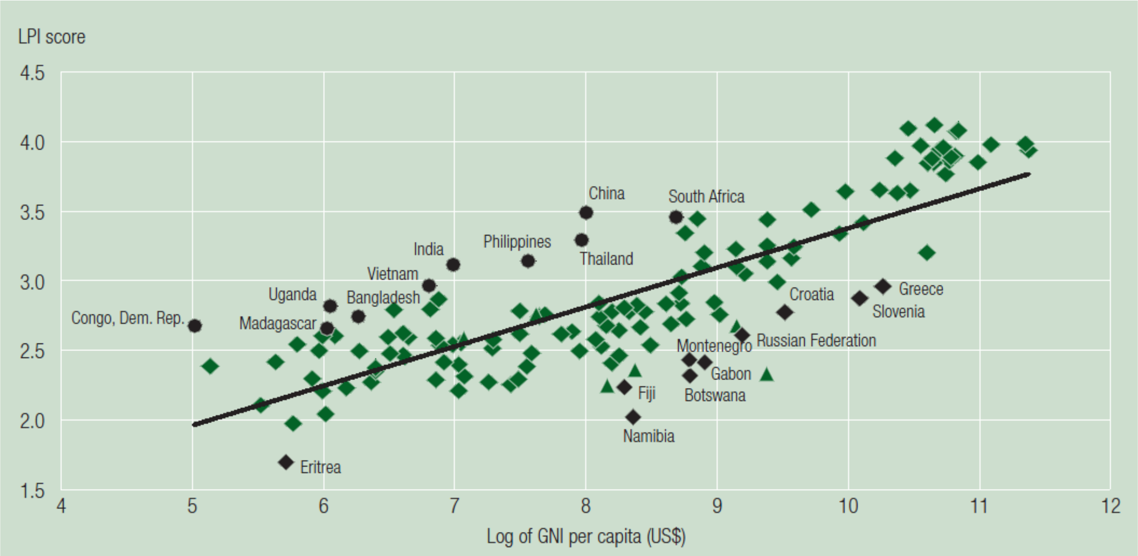


Figure 2-4. LPI scores in relative to income per capita.

Source: World Bank LPI report (Arvis *et al.*, 2010)

Analysis based on the 2007 LPI or similar information has shown that better logistics performance is strongly associated with trade expansion, export diversification, ability to attract foreign direct investments, and economic growth. Moreover evidence from the 2007 and 2010 LPIs indicates that, for countries at the same level of per capita income, those with the best logistics performance experience additional growth: 1 percent in gross domestic product and 2 percent in trade.

Using a 5-point scale, the LPI aggregates logistics performance comparison across 155 countries. The LPI scores of advanced economies and some emerging economies are relatively high due to their well-developed infrastructure and trade facilitation programs.

As Figure 2-4 shows, LPI scores suggest that all developed countries in economy are also top logistics performers. In the 2010 LPI, the top ratings go to Germany and Singapore with scores over 4.08. At the other extreme of the index are the low-income countries, often landlocked and geographically isolated, or countries undergoing conflicts or severe governance problems. Those landlocked developing countries, especially in Africa and Central Asia (such as Chad and Afghanistan), are the most logistically constrained, who typically suffer high transport costs and delays due to geographical disadvantages. Moreover, their international market accessibility is also seriously limited and therefore has to depend upon the performance of other transit countries. These countries are often poorly served by an overregulated and fragmented logistics services industry

In the middle range, sit the rest of developing countries at similar incomes. However, a number of countries stand out for their logistics performance ranking comparing with their economic conditions. China, for example, is a middle income country. However its logistics performance ranks 30th of 150, far higher than would be expected based solely on its economic development level. The same applies for other emerging economies where export-oriented manufacturing has been a major factor in economy such as South Africa.

In contrast, some other countries in higher income groups have a relatively low level of logistics performance, which is a feature of many oil exporting countries, such as Algeria (140), Qatar (46), Kuwait (44), Saudi Arabia (41), and Bahrain

(36). One reason for the underperformance in logistics for the oil exporting countries reflects the dominance of oil in their exports economy – resulting in the relative absence in these countries of incentives and pressure from the private sector to implement institutional reforms for trade and transport.

LPI report is of significant importance as a milestone study to shed light on relationship between logistics and economy at the national level. At the same time, LPI report (2010) also points out that a high LPI score does not necessarily indicate uniformly strong economic performance within a country, especially for those large and geographically diverse countries.

Logistics is less studied at the regional level comparing with the national studies. However, one could expect to find a similar positive logistics – economy relationship. Huggins (1997) suggested that the physical flow of products is an obvious essential of the trade and linkages among different regions across the world. Vickerman *et al.* (1999) added that improved access to input materials and to markets will cause firms in a region to be more productive, more competitive and hence more successful than those in regions with inferior accessibility. A capacity to network, which ties a region to relevant external partners, has become a stronger determinant for development. Those regions which are successful in forging these links are likely to witness a significant increase in competitiveness and rapid economic development. Logistics capacity therefore stands a crucial role in regional economic development.

It is clear from the previous literature in logistics that the logistics performance and economic status of a country are positively linked. But this relationship at the regional level is less studied. If we had better understanding of the relationship between the regional logistics capability and regional economic performance, effort could be made to improve the economy of a region through growing of its logistics capability. This research therefore aims to fill this gap.

The important role of logistics leads to the questions of how to define and measure regional logistics capability, which will be discussed in the next section.

2.3 RLC Definition and Measurement

2.3.1 Defining Regional Logistics Capability

The definitions of logistics mostly focus on activities within organisations and businesses, or among different partners within the supply chain (Ballou, 2007). Little logistics research attempts to address the role of logistics in regional economic development. The interest of this research, nevertheless, is to measure the logistics capabilities of a region rather than an organisation or a supply chain. Therefore a new definition of Regional Logistics Capability (RLC) is needed to illustrate the ability of a region to connect to the external trade partners via physical and informational linkages.

Mentzer and Konrad (1991) reviewed logistic performance measurement practices and pointed out that the essence of performance measurement is an analysis of both effectiveness and efficiency in accomplishing a given task. “Effectiveness” is the extent to which goals are accomplished, whereas “efficiency” is the measure of how well the resources expended are utilised. Thus performance is a function of both resources utilised and results compared to a standard. The “task” for a region’s logistics services is to satisfy the need of its residences and businesses for “the right item in the right quantity at the right time at the right place for the right price” (Panayides, 2006), through “effective” and “efficient” plan, implement and control of the flow and storage of goods coming in as well as going out the region (CLM, 2004). In other words, a region has to be able to facilitate the logistics activities within the region to better connect to its trade partners. The stronger a region’s ability to accomplish this task, the better regional logistics capability it has.

From this efficiency and effectiveness perspective, this study uses the concept of Regional Logistics Capacity to refer to the “**The effectiveness and efficiency of a region in facilitating logistics activities both within the region and across regional borders.**”

Here “logistics activities” refers to all the operation of the goods during the flow from point of origin to point of consumption, including transportation, warehousing, packaging, handling, and information integration *etc*. Finally, “both within the region and across regional borders” means RLC covers both domestic and foreign flow of goods of a region.

2.3.2 Measuring Regional Logistics Capability

The objective of this research is to establish a measurement framework for evaluating the logistics capability of regions, and thereafter explore the relationship between logistics and regional economy in Great Britain. As Rafele

(2004) pointed out, it is very difficult to deploy of an effective performance measurement system in logistic because of the interdependence of all activities in the supply chain in a region. Jiang and Peng (2008) suggested that a synthetic evaluation system which takes factors as much as possible is needed for the comprehensive evaluation of the regional “Logistics Infrastructure Capability” - a similar concept of Regional Logistics Capability. Therefore, this study first reviews the relevant literature on regional logistics performance measurement to identify possible indicators that have influence over the RLC before setting up a measurement framework for RLC.

Similar to the traditional logistics definitions, the performance measurement literature also lacks a focus at the regional level logistics performance. Traditionally, logistics performance is viewed as a subset of the larger notion of firm or organizational performance (Chow *et al.*, 1994). It invests how to evaluate and improve supply chain efficiency and effectiveness in different levels of planning and execution - strategic, operational and tactical. Forslund (2007) also confirms this trend by pointing out that “most of the literature on performance measurement frameworks and systems is concerned with intra-organisational performance measurement”. The main challenge was to identify the key performance measures for value-adding areas of an organisation for business and then the factors that will affect the core business processes that create value to customers (Gunasekaran *et al.*, 2001).

The available literature identifies several important performance measures in the evaluation of supply chain efficiency and effectiveness which have been categorised in many different ways: Neely *et al.* (1995) consider four main categories: quality, time, flexibility, and cost; According to Caplice and Sheffi (1994), a good metric has to capture the critical elements of the logistic process: time, distance, and money. There are several existing assessment tools such as the SCOR model or the Enkawa Supply Chain Logistics Scorecard which quantify the performance of a firm's key logistics activities and thereafter give suggestions on improving the operational effectiveness and efficiency (Griffis *et al.*, 2007).

The interest of this research, however, is from a different perspective - to measure the logistics capabilities of a region rather than an organisation or a supply chain. Therefore a new set of indicators are needed which reflect more at the regional feature of logistics performance.

The Logistics Performance Index report from the World Bank (Arvis *et al.*, 2007; 2010) shed light on the logistics "friendliness" performance of 150 countries which indicates good logistics performance facilitates trade and stimulates economic development. To measure the logistics performance of a country, the LPI report considered four main groups of factors which tend to be a strong determinant of overall national logistics performance: infrastructure, services, border procedures and time, and supply chain reliability.

According to Banomyong (2007), a "regional logistics system" is composed of shippers, traders, and consignees; public, private sector logistics and transport service providers; provincial and national institutions, policies, and rules; transport and communications infrastructure.

Tongzon (2007) also identified several factors that determine international competitiveness in a region's logistics capability, including strategic location (on main shipping and air routes), well connected seaports and airports, capabilities in warehousing and related services, skilled workforce (language and logistics skills), political and economic stability, and strong and supportive government policies.

Banister and Berechman (2001) argues that at the regional level, transport accessibility must be seen as part of a much wider concept of accessibility that includes availability of skilled labour, good-quality locations, the necessary supporting infrastructure, and local road and rail networks.

Concisely, a good performance measurement system is necessary to determine the efficiency and the effectiveness of a region's logistics capabilities or to compare with competing alternative regions. The logistics performance of a region is often affected by several local business environment factors such as location features, quality of infrastructure, local logistics services, size and quality of workforce, and local administration policies and efficiency. Therefore a set of indicators that affect regional logistics performance are categorised under these five dimensions to serve as a basic RLC measurement framework in this research as posted in Figure 2-13 and Table 2-3 towards the end of the section. Each dimension of indicators is introduced in more detail next.

2.3.3 RLC and Location indicators

The location of a region is obviously crucial to its connectivity and economic development. Adam Smith in the Wealth of Nations put great stress on geography as a determinant of economic development. In Smith's analysis, development depends on specialisation, which in turn depends on the scope of the market (Smith, 1776). The scope of the market in turn is limited by transport costs, so development and specialisation is expected to be most advanced in regions benefitting from low transport costs. One could argue that the better a region's logistics capability is the better accessibility to international markets a region enjoys. Therefore, the UK Regional Trade in Goods Statistics "value of regional trade of goods outside the EU published by HM Revenue and Customs is selected to show the international market scope of a region.

By examining the global economy one would easily find that virtually all landlocked countries outside of Europe are poor, especially in Africa (Gallup *et al.*, 1999). Landlocked countries and regions are at a disadvantage because firstly, they cannot control shipping conditions outside their borders and have to depend on their neighbours' stability for transportation and trade. Secondly, the extra land legs to and from sea ports for export and import means extended lead time and higher transport costs than for its coastal neighbours. In Smith's day, and ours, those regions accessible to sea transport generally benefit from lower transport costs and wider market access in international trade. Therefore, the accessibility of a region to waterborne freight transportation is a crucial locational factor in determining a region's logistics capability, which could be shown by the total length of navigable coastline and waterway.

Apart from the access to sea-based trade, the same considerations about the scope of the market favour economic development in regions that are proximate to major markets such as major population centres. That is to say, it is not only the physical distance between regions that is important, but also the volume of trade a trade route carries. A region could only be called strategically well located when it is relatively close to its main trade partners. Therefore, the distances of each region to other region city centres weighted by trading volume percentage (distance*freight flow) could be used as an indicator in this research to illustrate the relative location of each GB regions.

Another important locational factor is political stability. LPI report (2010) suggests that logistics performance depends on the predictability and reliability of the supply chain even more than time and cost. As a result of extra import and export costs due to the need to mitigate the effects of unreliable supply chains, the best performing countries have almost doubled level of logistics service available than the lowest performing countries.

Since the terrorist attacks on the September 11th 2001, more strict supply chain security rules have been introduced to secure international trade. The potential large scale terrorist acts have become an important factor for supply chain risk, which leads to transportation difficulties and change of inventory management strategies (Sheffi, 2001). Apart from terrorism, other political risk such as civil wars, and political uprisings recently witnessed in the Middle East and North Africa are likely to continue to be a major influencer for businesses transactions around the world.

Such political instability often leads to economic volatilities that are also essential challenges in logistics and supply chain performance. For example, the unsteady political situation in Middle East and North Africa threats the global oil supply, therefore affect the freight transportation in all modes. In addition, as governments around the world are making effort cutting back on spending due to the negative effects of the global financial crisis, increasing strikes and demonstrations often serious hinder the free flow of goods in the region.

Therefore, it is important to note that the political and economic stability of a region also contributes to the logistics capability of the region as it leads to fewer breaks of the supply chain such as strikes and risks to damage the goods (Tongzon, 2007). However, these points might be less significant in regional comparisons within the same country due to the proximate conditions among sub-regions of a country. To show the regional difference in economic stability, unemployment rate is chosen as an indicator, because often the political turbulences root from people's unsatisfactory with the local economic conditions, Moreover, "all aged 16 and over unemployed as a percentage of total economically active" is the unemployment rate indicator published by the UK Office of National Statistics. It should be noted that using unemployment as a proxy for economic stability may not be accurate from every perspective. However, as a "latent variable", economic stability is not directly measureable, and no "manifest variable" is likely to be completely representative. For the purpose of this study, it could be argued that the unemployment rate to an extend correlates with the economic stability of a region and provides a measurable indicator to the requirement of the overall RLC measurement.

In addition, environmental issues also need to be included when considering regional logistics in the UK. Carbon dioxide (CO_2) is the most widely known

Greenhouse gases contributing to global warming, which accounts for 85 percent of all greenhouse gas emissions in the UK (DECC, 2010). In today's urging situation of global climate changing, the UK has a legally binding target under the Kyoto Protocol to reduce emissions of greenhouse gases by 12.5 percent below 1990 levels by 2012. Through the Climate Change Act 2008 it has also set itself a more ambitious target to reduce greenhouse gas emissions by 80 percent below 1990 levels by 2050, with an aim of achieving a 26 percent reduction in carbon dioxide emissions by 2020 (DECC, 2010).

If these government's obligations under the Climate Change Act and international agreements are to be made, the UK regions must not overlook the logistics industry. According to the ONS website, the total UK greenhouse gas emissions fell 8.1 percent between 1990 and 2003, however, greenhouse gas emissions from the transport and communication industries rose by 48.4 percent since 1990 (see Figure 2-5).

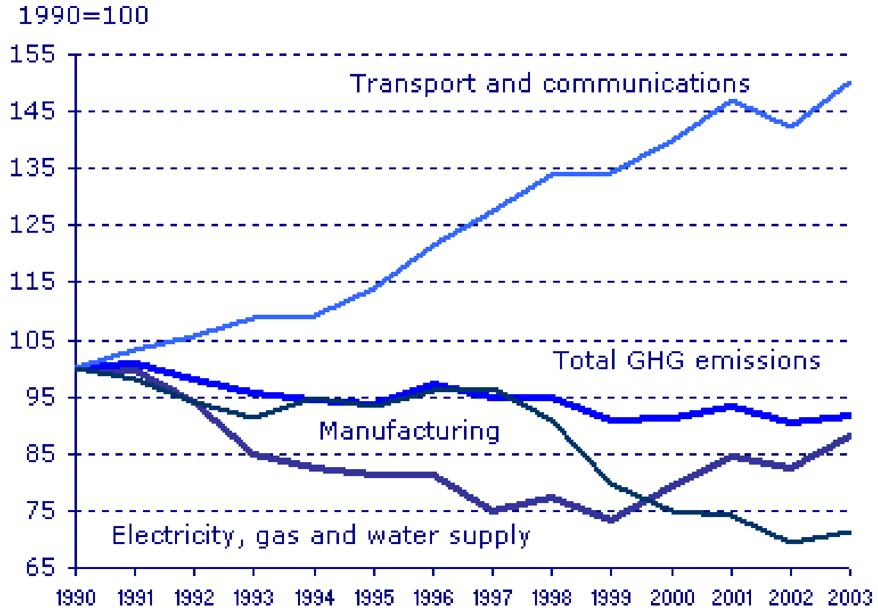


Figure 2-5. Greenhouse gas emissions in the UK, 1990 – 2003.

Source: ONS website (2010)

Therefore, the environmental status of the regions in GB will inevitably affect its logistics capability. In reporting greenhouse gas emissions, the emission units are presented as “carbon dioxide equivalent”. This is in line with international reporting and carbon trading protocols. Again, this is not a direct measurement of the environment status of a region. The high volume of greenhouse gas emissions may not (yet) lead to regulations that limit the efficiency of freight operation. But it reflects the pressure of the regional logistics industry for its freight operations, and serves the purpose of this study.

In summary, five indicators are identified to illustrate how well a region is located for its logistics capability:

- **Strategic location** – the aggregated distance to other regions weighted by the trade volume. This will show how proximate a region is to its main trading regions.
- **Geographical characteristics** – the total length of navigable coastline and waterway. This will show the accessibility of a region to waterborne freight transportation.
- **Market accessibility** – Value of regional trade of goods outside the EU. This shows the international market scope of a region.
- **Economic stability** – The employment rate for all adult residents aged 16 and over. This shows how stable a region is.
- **Environment status** – Total regional CO_2 Emissions. This shows the current environment status and thus the pressure on logistics capability.

2.3.4 RLC and Infrastructure indicators

A clear positive correlation exists between transport infrastructure quality of interregional accessibility and economic development represented by indicators such as GDP per capita, although this may not necessarily represent a causal relationship (Vickerman *et al.*, 1999). LPI survey shows the satisfaction with infrastructure quality is much higher among respondents from the top-performing countries than in the other groups.

Infrastructure is the fixed installations that allow a vehicle to operate. For transport modes such as rail, pipeline, road, the entire way the vehicle travels must be built up, whereas for air and water transport, fixed infrastructure are needed at terminals. Banerjee *et al.* (2009) gave three main reasons why good transportation infrastructure is advantageous for economic development of a region. First, it reduces trade costs and extends the market access. Secondly, it promotes access to better living facilities such as hospitals. Therefore, it is easier for the region to attract human capital. In addition, and more intangibly, the free movement of people and goods may bring with it new aspirations, new ideas, and information about new technologies.

The UK's transport infrastructure is highly developed, with significant road, rail, water, air and pipeline facilities (BMI, 2010). The following Figure 2-6 gives an illustration of the composition of the domestic freight transport modes.

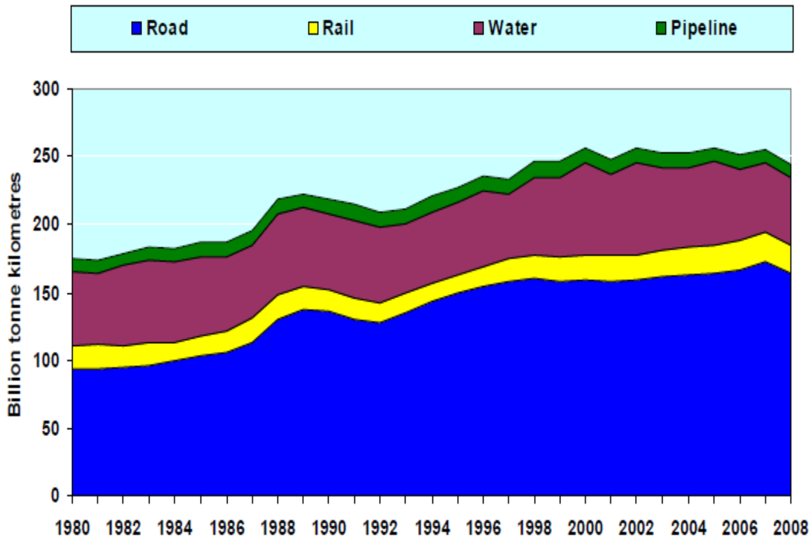


Figure 2-6. Domestic freight moved by mode in GB: 1980 to 2008.

Source: DfT, 2009a

Road freight the dominate mode of domestic movement of goods. The UK has nearly 390,000km of paved roadways, and road widening programmes are being undertaken in different parts of the country (BMI, 2010). In 2005, road accounted for 64 percent of tonnes moved and 82 percent of tonnes lifted in Great Britain. These numbers has grown to 67 percent and 83 percent by 2008 respectively (DfT, 2009a).

One of the reasons for road's high freight market share is the relatively short distances that much freight travels. DfT (2008) shows around 70 percent of road freight on average is within the same region of the UK (see Figure 2-7). The DfT (2008)'s report "Delivering a sustainable transport system" also shows the regions with the most goods lifted by origin are the North West (233 million tonnes), Yorkshire and Humber (216 million tonnes), East Midlands (203 million tonnes), East of England (200 million tonnes) and the West Midlands (194 million tonnes).

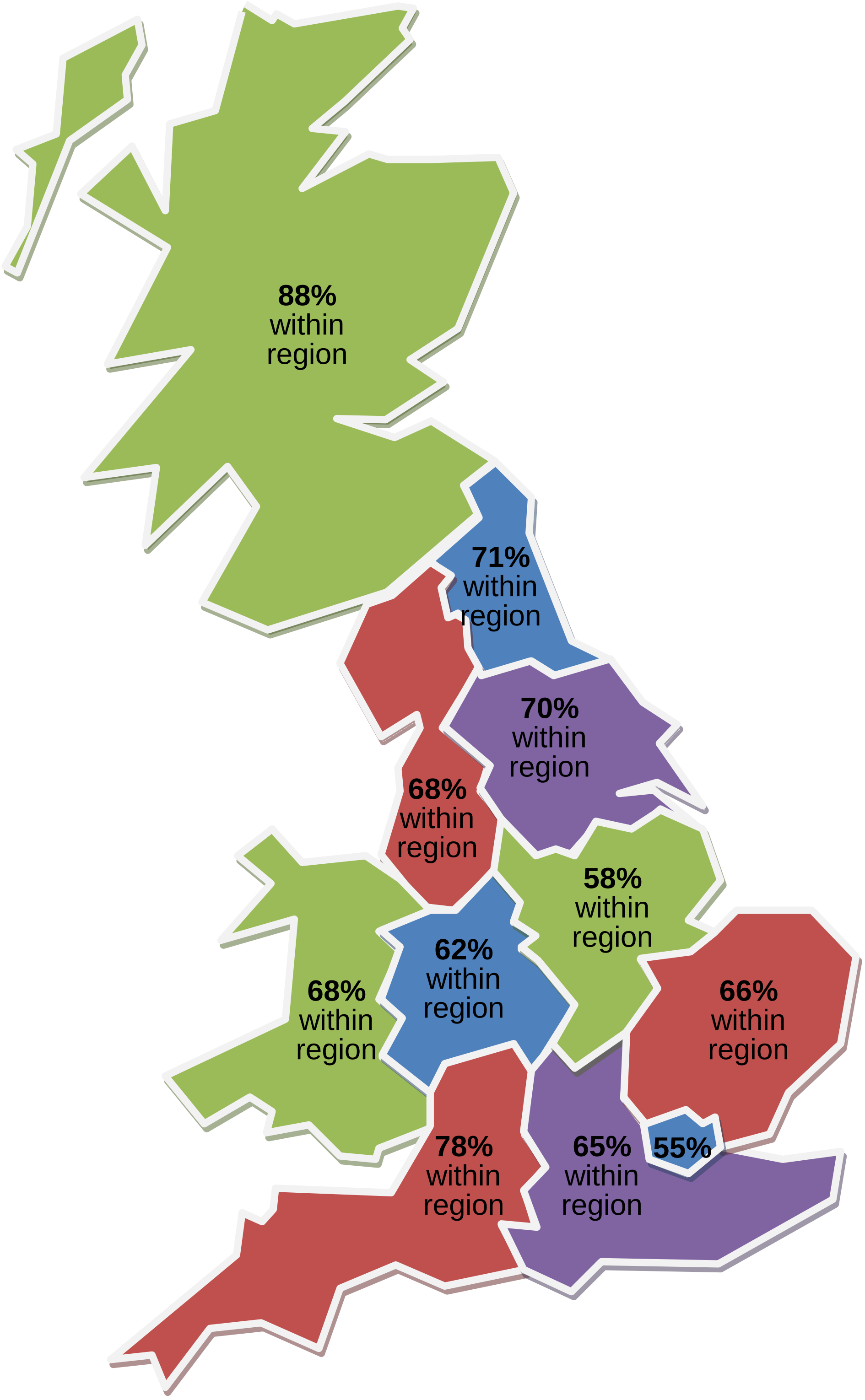


Figure 2-7. Road freight lifted by origin and destination in GB regions.

Source: DfT (2008)

The regions with the most goods lifted by destination are the North West (240 million tonnes), South East (208 million tonnes), Yorkshire and Humber (204 million tonnes) and East of England (194 million tonnes).

The East and West Midlands are significant destinations for freight (given their agglomeration of national distribution centres). This is partly due to the Midlands' closeness to population centres, well connected infrastructure and traditionally cheaper land and labour costs. It is also obvious that those regions with international gateways, such as the South East with Dover, the channel tunnel and Southampton, have high levels of freight lifted. The manufacturing of goods also has a significant impact on where freight is being moved to and from. For example, the East Midlands, is a footwear, clothing and manufacture centre, while the West Midlands contains car and tyre manufacturing. The processing and distribution of food is also a major generator of freight demand.

Therefore the "total regional freight moved by road of the 11 regions in GB" could be used as a useful measure of road infrastructure in the GB regions in this study.

Rail freight has also increased its share of goods moved in recent years, and is still the major mode for the movement of coal and coke. However, the data availability at the regional level in the UK is rather limited apart from the "Route Utilisation Strategy Report" by Network Rail (2007). The following Figure 2-8 shows the freight tonnage moved on the UK railway network in the year 2004/2005.

Figure 2-8. Gross freight tonnage on the UK rail network, 2004/2005.

Source: Network Rail (2007)

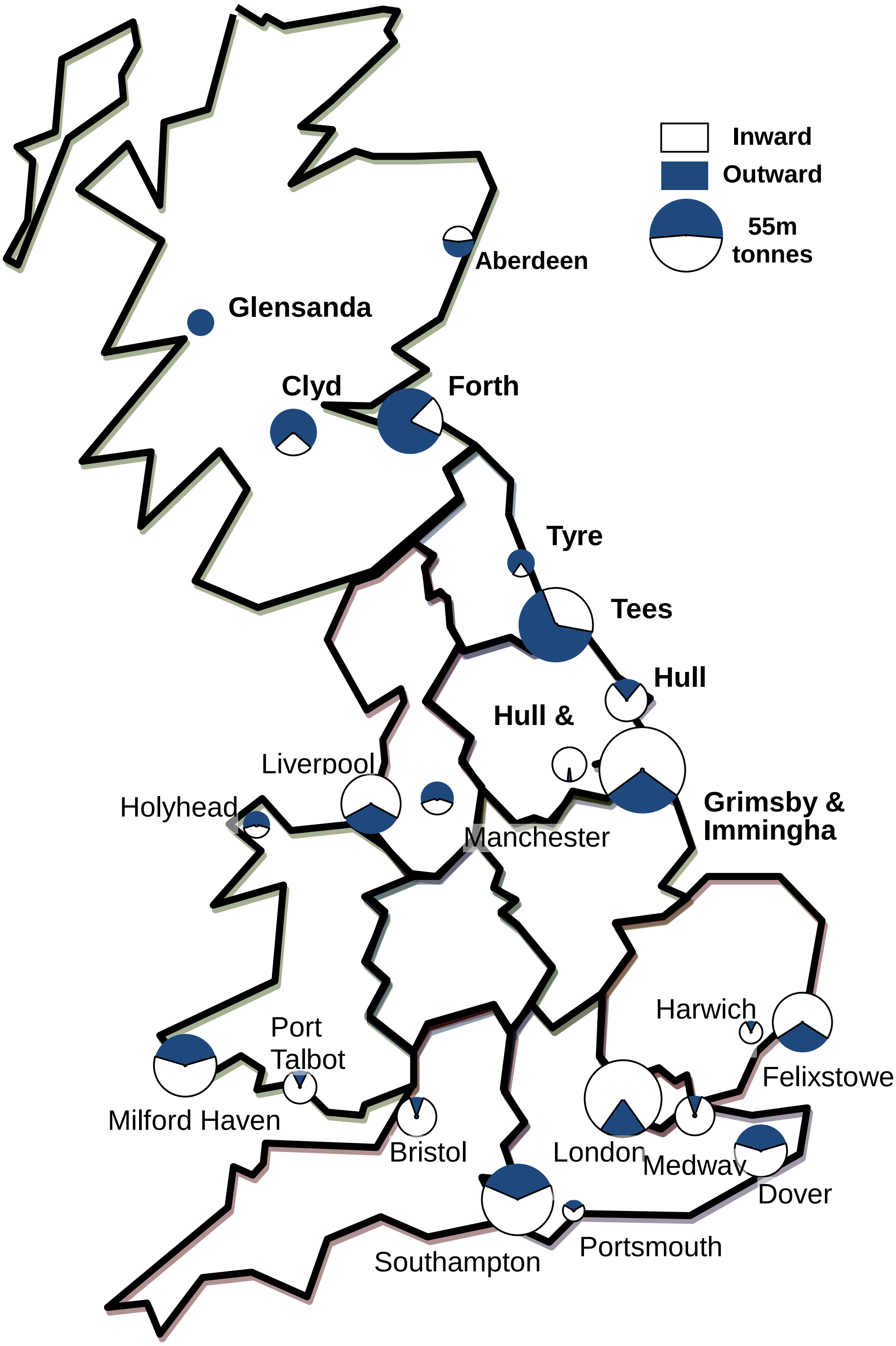


Figure 2-9. Freight traffic through UK Ports.

Source: DfT (2009c)

Water freight including Channel tunnel continues to be the dominant mode for UK international trade and petroleum products movement. UK ports handled 562 million tonnes of freight traffic in 2008, which is more than any other European country, which was 19 million tonnes (3 percent less than in 2007). Ports in Scotland handled the most freight (96.3 million tonnes), followed by Yorkshire and Humberside, and the South East (91.2 and 89.8 million tonnes respectively). Grimsby and Immingham was the UK's largest port by tonnage in 2008, followed by London, and Tees and Hartlepool. 5.2 million container units (8.7 million TEU (twenty-foot equivalent)) were handled by UK ports. This is an increase of 21 percent since 2000, 37 percent of these were at Felixstowe and 18 percent at Southampton. The freight volume of the major UK ports is indicated in Figure 2-9. Freight traffic through the Channel Tunnel has expanded rapidly as well since it opened in May 1994 as shown in Figure 2-10.

Therefore the port infrastructure in GB regions could be illustrated by the foreign and domestic sea freight traffic at the ports in each region.

Air freight is an important factor in supporting the UK's international trade. UK air freight grew very rapidly from 1970 through the 1980's and doubled in the 1990's. It grew from 580,000 tonnes in 1970 to 2.2 million tonnes in 2002. In 2003, the Department for Transport forecast that freight growth would grow even more quickly over the next decade. In reality, UK air freight has stabilised in the last ten years. The volume of freight handled at UK airports is relatively small compared to goods transported by sea, although increasing by 40 percent since 1995. It does however have a high value - a third of UK visible trade by value goes by air (DfT, 2008).

In this study, “freight lifted at airports in each GB region” is the indicator selected to show the comparison of regional capability in air freight infrastructure (See Figure 2-10).

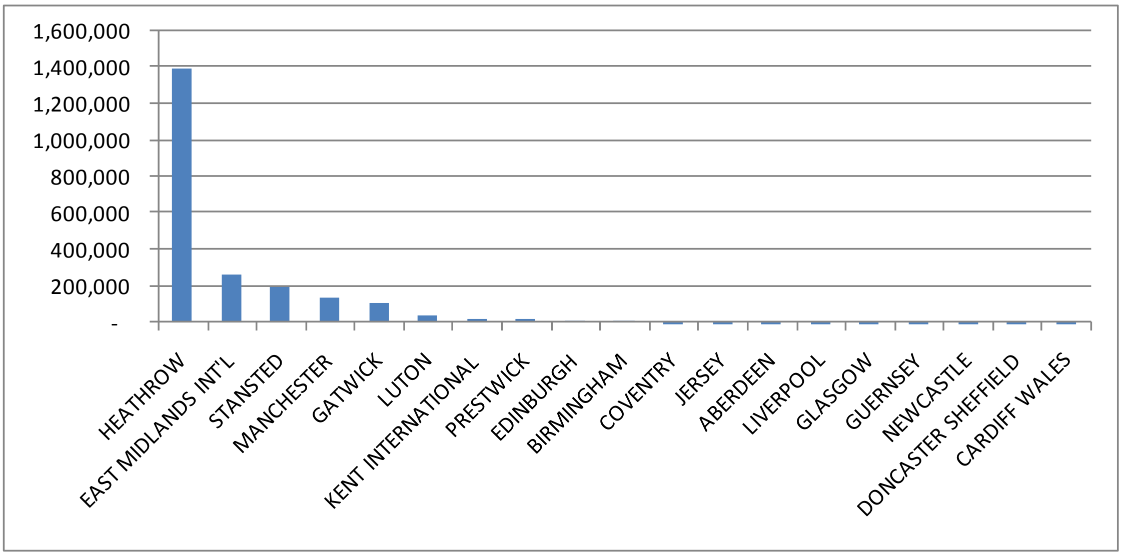


Figure 2-10. Total tonnage of freight handled by major GB airports (over 1,000 tons) in 2008

Source: DfT, 2009a

Pipeline infrastructure. In 2008, there was a total length of pipelines in operation in the UK of 22,312 kilometres. Major products transported by pipelines are Natural Gas (Dry), Ethylene and Crude Oil (UKOPA website, 2009). The statistics of pipeline transportation however, is not broken down into regions. A map of the pipeline networks is published by Greenergy Ltd as in Figure 2-11.

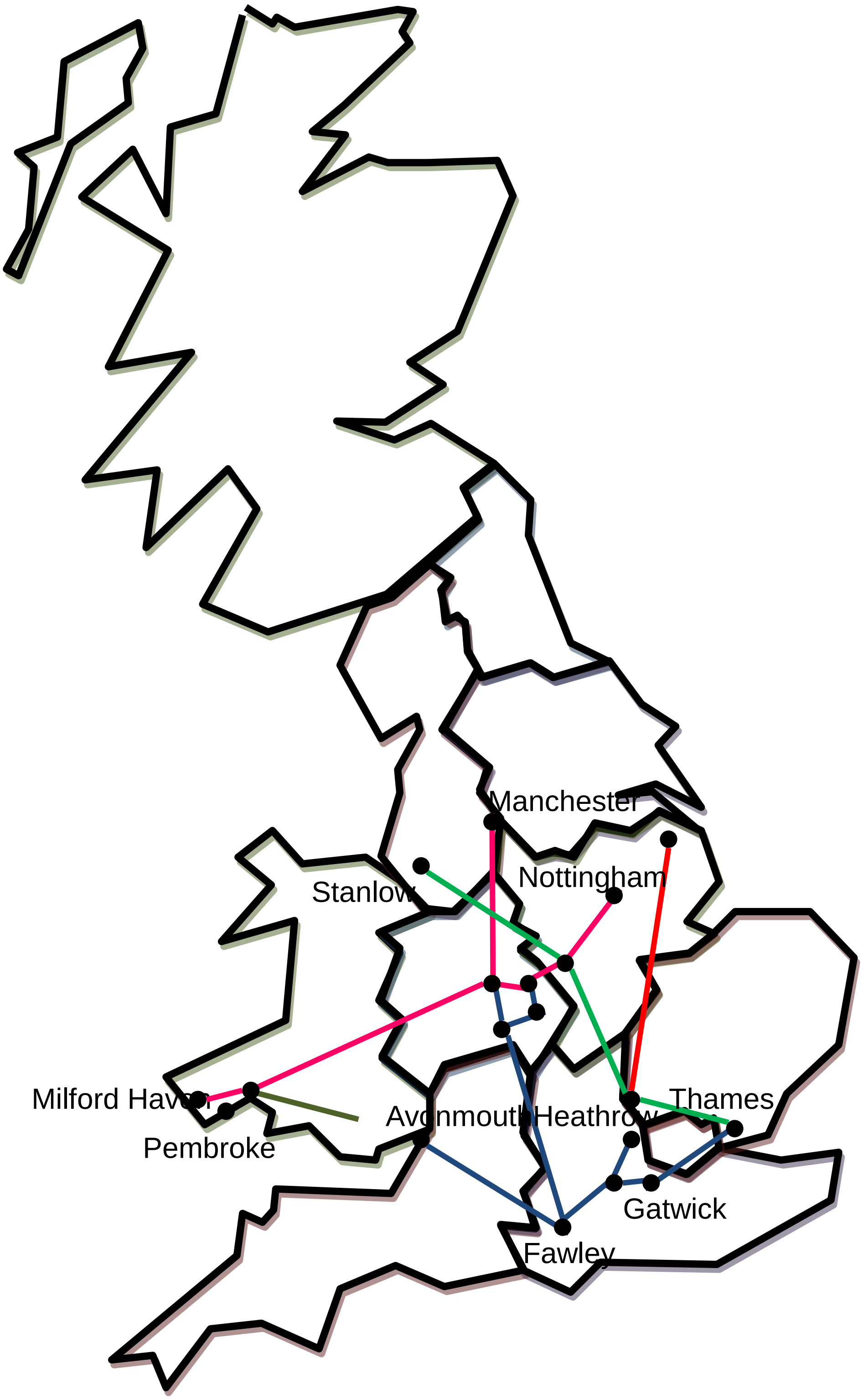


Figure 2-11. UK pipeline system.

Source: Greenergy background paper

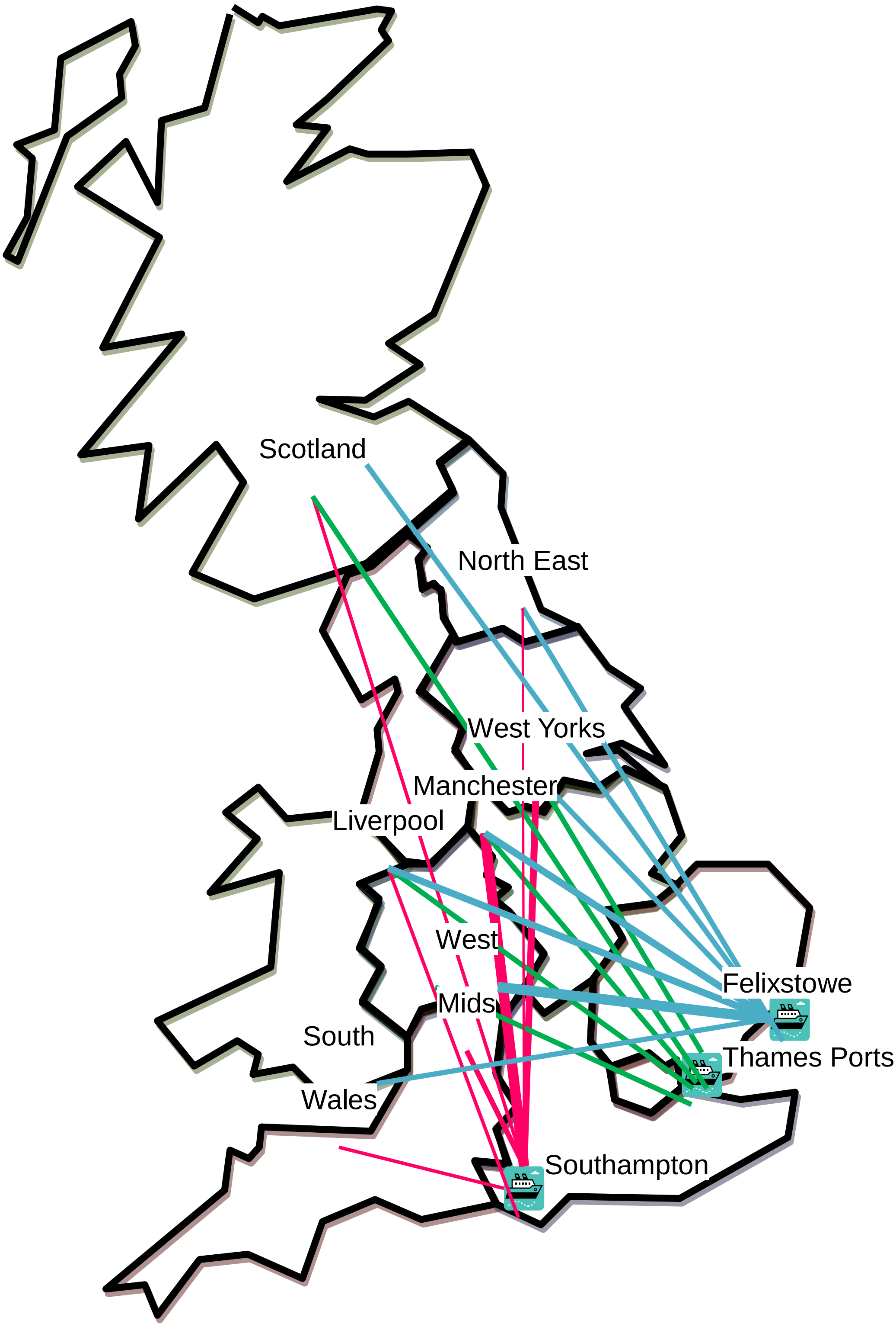


Figure 2-12. Main UK intermodal traffic flows.

Source: DfT, 2009b

Intermodal freight transport is another important element of the freight transportation in the UK. Adequate and suitably located facilities for inter-modal freight interchanges are vital to fulfilling national and regional policy objectives in relation to freight transport (DfT 2009). Intermodal freight involves the transportation of freight in an intermodal container or vehicle, using multiple modes of transportation (rail, ship, and truck), without any handling of the freight itself when changing modes. As the regional data of GB intermodal terminals is not available yet, the intermodal infrastructure capacity could be indirectly illustrated by the inwards container movements from UK container ports (see Figure 2-12).

IT Infrastructure. Telecommunications and IT infrastructure are a vital component of modern trade processes (LPI, 2010). The physical movement of goods largely depends on the efficient and timely exchange of information. To measure the information connectivity of a region, a useful measurement is the "Teledensity" (United Nations 2005). Teledensity is a metric that has been used to provide international comparisons and to contrast regions within a specific country, with the basic core infrastructure and access metrics of connectivity such as fixed telephone lines/mobile/broadband subscribers per 100 inhabitants.

Therefore, seven indicators are identified to illustrate how good a region is in its basic infrastructures for supporting logistics activities:

- **Road freight infrastructure** – represented by the total regional freight moved by road of the 11 regions in GB.

- **Railway freight infrastructure** – represented by regional gross freight tonnage on the network.
- **Water freight infrastructure** – represented by the foreign and domestic sea freight traffic at UK ports.
- **Air freight infrastructure** – represented by the freight lifted at airports in each GB region.
- **Intermodal freight infrastructure** – represented by the regional distribution of inwards container movements by road from UK container ports.
- **Teledensity** – represented by the fixed telephone lines/mobile/broadband subscribers per 100 inhabitants in each GB region.

2.3.5 RLC and Workforce indicators

Human capital is another important resource for logistics performance (Visser, 2007). Like any other industry, logistics industry depends on a sufficient workforce base to operate, especially in those labour-intensive areas such as cargo handling in warehouses (Brewer, *et al.*, 2001).

The UK logistics sector is worth £75bn to the economy and currently employs approximately 2.3 million people spanning some 196,000 companies (SfL, 2009), which is a significant growth from 1.6 million logistics related employees in 1976 (ONS, 2009). Logistics employers are engaged in all modes of transport: road, rail, air and sea. 41 percent of the workforce is employed within the wholesale sub-sector, 14 percent in national post activities, 13 percent within freight transport by road, and a further 11 percent in storage and warehousing (SfL, 2009). Table 2-1 shows the number of employees in the main logistics related occupations in the UK.

Occupation	Number Employed	Occupation	Number Employed
Other goods handling & storage occupations	381,200	**Transport & distribution managers**	86,800
Large (Heavy) Goods Vehicle drivers	309,100	**Storage & warehouse managers**	77,300
Post workers, mail sorter, messenger or couriers	211,600	**Transport & distribution clerks**	64,150
Van drivers	199,500	**Other occupations**	989,900

Table 2-1. Logistic occupations across the UK.

Source: SfL (2010)

As for the regional differences in workforce in GB, the South East, an area that serves a number of major airports (Heathrow and Gatwick) as well as ports (Dover and Southampton), has the largest absolute number of logistics workers in the region (341,000) followed by the North West (268,000) and East of England (252,600). The North East has the least workers (81,400) (SfL, 2010). Therefore, the "total number of logistics related employees in the regions" becomes an important factor to the regional logistics capability in GB.

In addition to the workforce sufficiency, labour costs also need to be considered as labour costs account a substantial portion of total logistics costs. The most straight forward indicator for labour cost comparison with in GB is the gross weekly pay in the logistics industry in each region.

The quality of human resources is also among the factors affecting innovation in logistics technologies for logistics service providers, thus influencing logistics capability of an organisation or a region (Lin, 2007). It should be noted that employment in the logistics sector is heavily concentrated in the lower skilled occupations. Operatives and elementary positions account for 47 percent compared to 19 percent in other sectors. In terms of formal certification, the sector is poorly qualified. 46 percent of the workers do not have a level 2 qualification, compared to 30 percent of the national workforce. Other characters of the UK logistics workforce include gender unbalance, lower level of self and part-time employed and older age of the employees (see Table 2-2). To show the professional skill levels of the logistics workforce in each region in GB, the "total regional employees with NVQ Level 2 or above in GB" is compared.

Workforce Characteristics		Logistics	All Sectors
Gender	Female	27 percent	46 percent
Employment	Self employed	8 percent	15 percent
	Part Time	14 percent	25 percent
Age	16 -24	10 percent	14 percent
	25 -44	49 percent	47 percent
	45 +	41 percent	39 percent
Qualifications	Below Level 2	46 percent	30 percent
	Level 2	18 percent	15 percent
	Above Level 2	36 percent	55 percent

Table 2-2. Characteristics of the logistics workforce in the UK.

Source: SfL (2010)

In addition to the logistics skills, Tongzon (2007) identified language skills to be important in logistics operations, especially in international trade. In the face of increasing globalisation and business pressure, more and more businesses are operating in an international environment. The efficient and effective communication therefore becomes essential for the international coordination to ensure the smooth flow of information, products, and other resources from the origin to the end customers, often thousands of miles away. Being able to speak and write in international languages of the trade partners develops into an invaluable skill for all levels of management working within the Logistics and Supply Chain industry. However, as English is currently the language used as the tool of communication between different nationalities, it is an advantage for English speaking countries in the international trade. Also, this makes language skills less important in comparing GB regions in logistics capability.

In summary, a qualified, sufficiently available and reasonably affordable pool of workforce is crucial for any industry especially logistics (Gammelgaard and Larson, 2001). Therefore, four indicators are identified to illustrate how effective the logistics workforce is in a region for supporting logistics activities:

- **Demography** – represented by the total number of logistics related employees in the regions in GB.
- **Professional skills** – represented by total regional employees with NVQ Level 2 or above in GB.
- **Cost of workforce** – represented by the gross weekly pay in the logistics industry in each GB region.
- **Language skills** – represented by the international language skills of the regional logistics workforce in GB.

2.3.6 RLC and Service indicators

The quality and competence of core logistics service providers is also a useful outcome measure of logistics performance. Lai (2004) pointed out that the trend of many manufacturers and retailers seeking to outsource their logistics activities to logistics service providers to satisfy their increasing need for logistics services. Logistics service provider would then perform all or part of a client company's logistics function, as well as additional materials management services (e.g. inventory management), information-related services (e.g. tracking and tracing), and value-added services (e.g. secondary assembly) (Coyle *et al.*, 1996; Berglund *et al.*, 1999). Therefore, to some extent, regional logistics capabilities have to rely on the capacity and performance of the regional service providers.

As Tongzon (2007) argues, the capabilities in warehousing and related services are crucial for regional logistics competitiveness. Transportation and warehousing are directly related to the moving and distributing goods from sources to customers, therefore would qualify as the most important aspects for the measurement of the service dimension. Therefore the "Total light and heavy goods vehicles licensed in the UK regions" statistics from Department for Transport (DfT) and the "Warehouses floorspace of the GB regions" statistics from the Communities and Local Government analysis of Valuation Office fit the purpose of this research and serve as two main indicators of regional logistics service capacity in the following analysis.

According to DfT (2008), the turnover of the UK companies operating in the freight and distribution sector totalled £86.54bn in 2008, having increased by 1.8 percent compared with the previous year. Over the previous 5 years, turnover in the sector had increased by 32.7 percent. However, the sector has experienced a downturn in 2009 as a result of the recession in the UK and world economies. Therefore the main issue facing the sector over the next few years is the recovery. There are many uncertainties regarding the future, but it seems likely that the recovery will be slow, with a return to trend growth rates expected in 2011. Overall growth of 23.1 percent is expected between 2009 and 2013. From 2011 growth year on year is expected to be around 7 percent (DfT, 2008).

Lai (2004) identifies value-added service capacity as another important factor in determining the service capability and performance of logistics service providers. Value-added logistics services are services that add value to the products such as order processing, assembling/re-assembling, repackaging/relabeling, purchasing/procurement, cross-docking, customer-specific label printing, *etc*. The Annual Business Inquiry (ABI) database, an integrated survey of employment and accounting information from businesses and other establishments in most industry sectors of the economy, contains the statistics of “approximate gross value added” in the “Cargo handling and storage” industry (SIC 2003: 63.1) which gives good illustration of this factor. The ABI has been managed by the Office for National Statistics (ONS) in close consultation with other government departments, including the Department of Trade and Industry (DTI), the Department for Education and Employment (DfEE), the H.M. Treasury, the Scottish Executive, the National Assembly for Wales and the Northern Ireland Office.

Various researchers have suggested that knowledge creation in the supply chain leading to innovation and long-term competitive advantage (Hardy, *et al.*, 2003; Lee and Choi, 2003; Kahn, *et al.*, 2006). Therefore a factor indicating the knowledge created in each region should be considered in the RLC measurement, such as the number of logistics-related research/graduates in the region. However, such factor is difficult to measure in reality.

Finally, the quality and cost of the financial services is provided by the finance industry also considered in the preliminary RLC factor evaluation as an indicator of the regional business environment. The finance industry includes a broad range of organisations that deal with the management of money, such as banks, credit card companies, insurance companies, stock brokerages, investment funds and some government sponsored enterprises. These organisations provide crucial services to ensure the financial efficiency of the supply chain and logistics operations. This is an increasingly central business area for companies and their international suppliers under contradictory pressures to reduce prices and improve payment terms and cash flow efficiencies. However, the financial service capacity becomes a less major factor at the sub-national level as the financial services are less constraint with physical distances, therefore the variation of the regional financial service capacities within the same country is unlikely to be large.

In summary, five indicators are identified to illustrate the capacity and performance of GB regional service providers in supporting logistics activities:

- **Transportation** – represented by the total regional employees in the transport industry (including Transport Associate Professionals and Transport Drivers and Operatives).
- **Warehousing** – represented by the warehouses floorspace of the regions in GB.
- **Value added service** – represented by the approximate gross value added of regional cargo handling and storage service.
- **Knowledge** – represented by the number of logistics-related research in each region.
- **Financial service** – represented by the quality and cost of the financial services in each region.

2.3.7 RLC and Administration indicators

Various researchers have pointed out the important role of effective and efficient government administration in facilitating logistics activities. Tongzon (2007) noted that one of the important factors determining the international competitiveness in a region's logistics capability is the strong and supportive government policies. Banomyong (2007) also considered policies and rules to be crucial element of the regional logistics system.

The first function of government in eliminating logistical barriers and creating a more favourable logistics environment is the financing of transportation infrastructure (Li and Velenga, 1993). Often the development of logistics capabilities requires large scale strategic investment in basic infrastructures such as road, rail, port and airport networks, which is beyond the capability of individual companies and organisations. Government therefore plays a crucial role. Through investments and funding, government facilitates the development of a competitive transportation infrastructure system that would not be otherwise possible. In this research, to give evidence for the regional differences in the support received from government to develop logistics capability, the indicator of “Government regional expenditure on transport in the regions in GB” is chosen.

Simplifying customs administration procedures and improving customs services is another of the government’s efforts to facilitate and promote logistics services (Li and Velenga, 1993). Customs release times and documentation requirements for clearance directly influence companies’ inventory levels, transportation arrangements, logistics costs, and customer service levels. Inconvenient customs services often mean late deliveries, high costs, and longer cycle times. The LPI reports (Arvis *et al.*, 2007; 2010) also considered efficiency of the customs clearance process to be one of the most important aspects of the current logistics environment of nations, especially in the post-911 environment. Cargo security has become an important border management issue which attracts much attention. This inevitably imposes extra costs in money and time to the private sector and potentially inhibits trade with other countries. The LPI survey shows that lead time for port or airport supply chains is nearly twice as long in low performance countries than high performance ones. The contrast is even more extreme for land supply chains: low performance countries could be more than five times slower.

In the LPI report, the “Efficiency of the customs clearance process” is one of the most important aspects to capture in the current logistics environment internationally. However, it should be noted that the time taken to clear goods through customs is a relatively small fraction of total import time, and the differences in custom service efficiency among regions within a country are not as great due to the standardised procedures.

In addition to the physical inspection, proliferation of procedures and red tape also illustrate a lack of coordination at the border and imposes burden on logistics operators (Arvis *et al.*, 2007; 2010). Operators in the highest performing countries typically deal with around half the number of government agencies as operators in low performance countries. The same is true for document requirements: two or three documents are typically required in the countries with the highest LPI scores, versus five or six in those with the lowest scores. Again, due to the fact that UK Customs procedures are based on the common "Community Customs Code" which defines the legislation applicable to the import and export of goods between the European Community and non-member countries, therefore the custom clearance practice and procedure should be the same across the UK regions and even the EU, this factor is likely to be relevant for a regional perspective.

In summary, three indicators are identified to illustrate the government administrative capacity and performance in supporting logistics activities:

- **Policy and funding** – represented by the government regional expenditure on transport in the regions in GB.
- **Customs and border efficiency** – represented by the average time taken to clear customs in each region.

- **Red tape** – represented by the number and speed of document processing in each region.

2.3.8 Indicator summary

To sum up, a definition for RLC and in total 24 indicators grouped in five dimensions are preliminarily identified to cover all the aspects of regional logistics capability and give a full picture of regional logistics performance in GB (see Table 2-3 and Figure 2-13). The indicators were developed by referring to previous research on logistics performance evaluation (Vickerman *et al.*, 1999; Banomyong, 2007; Tongzon, 2007; Arvis *et al*., 2007; Arvis *et al*., 2010) and from discussions with academics and practitioners in logistics in the UK. However, these indicators may not necessarily all be fit for the purpose of this study within the context of the regions in GB. Based on the relative weightings, data availability and more in-depth discussion, some of these indicators will be eliminated from the study (See section 5.3.1 Omitted indicators).

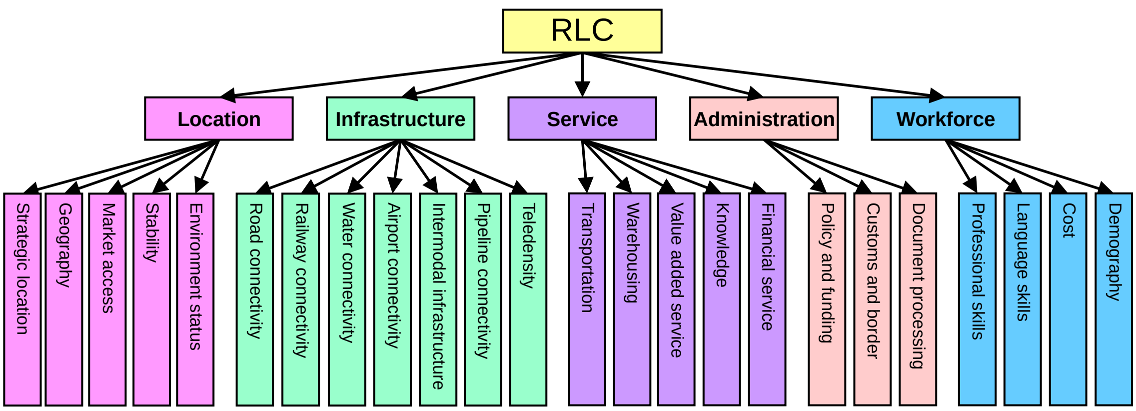


Figure 2-13. Preliminary indicators of Regional Logistics Capability.

Dimensions	Indicators
Location	Strategic location Geographical characteristics Market accessibility Economic stability Environment status
Infrastructure	Road freight infrastructure Railway freight infrastructure Water freight infrastructure Air freight infrastructure Intermodal freight infrastructure Pipeline infrastructure Teledensity
Service	Transportation Warehousing Value added service Knowledge Financial service
Administration	Policy and funding Customs and border efficiency Document processing speed
Workforce	Professional skills of regional logistics workforce Language skills of regional logistics workforce Cost of regional logistics workforce Demography of regional logistics workforce

Table 2-3. List of preliminary indicators of RLC.

Based on these indicators which determine the performance and capacities of the regional logistics system, a logistics system scorecard will be established for evaluation and benchmarking of the logistical performance of different regions in GB and to provide a reference for future improvement.

2.4 Conclusion

This chapter firstly reviews relevant literature in Economic Geography to discuss why sub-national regions economic units are more suitable for this thesis in exploring logistics and economy relationship. Although Economic

Geography emphasises on the importance of regions in locational economic activities, it mainly focuses on the innovation, information, and knowledge links among global regions and fails to address the role of logistics apart from touching upon the transportation costs. Conventional studies such as the LPI report do illustrate the critical role of logistics to economies, however, mainly at the national level. Therefore it is this thesis's objective to fill the gap of Logistics-economy relationship studies at the regional level.

This chapter also defines the RLC and prepares the measurement of RLC identifying RLC indicators. These preliminary stages are necessary for the following data collection and analysis.

This chapter gives a definition of RLC from an efficiency and effectiveness perspective (Mentzer and Konrad, 1991): "**The effectiveness and efficiency of a region in facilitating logistics activities both within the region and across regional borders**." Then this chapter reviews the logistics performance literature to identify 24 indicators which affect the logistics performance of a region (see page 61 for the full list). These indicators are categorised into five dimensions in preparation to develop a RLC measurement framework: location features, quality of infrastructure, local logistics services availability, local government policies and support, and finally the size and quality of logistics workforce.

CHAPTER 3. GB REGIONAL PROFILES

3.1 Introduction

Having introduced the concept of regional logistics, this chapter gives a brief description of the research focus of this thesis – the 11 regions in GB.

Since the 1960s and 1970s, governments across the world have been putting regional development at an increasingly significant position. The process of globalisation is one of the most important drivers of this trend after the Second World War. Globalisation increases the mobility of capital, workers, goods and services, and therefore forces firms and regions to react and adjust to the new economic challenges. Some firms and regions across the world have grasped such changes as an opportunity and have established conditions whereby they currently reap the benefits. On the other hand, the opening of national economies also reveals some regional economic structures with low capacity to compete in the globalised arena (Pick *et al*, 2006).

Most studies of logistics competitiveness and economic development tended to focus at the national level, taking countries as the unit of analysis such as the LPI study of the World Bank. However, Charles Kindleberger (1969) prognosticates “The nation state is just about through as an economic unit.” Scott (2002) also argued that “country” is no longer a unit of prosperity. As regional scientists and economic geographers have long understood, there are substantial differences in economic performance across regions in virtually every nation (Scott, 2002; Porter, 2003). Krugman (1991) as an economic geographer also acknowledge the importance of focusing on regions when study economics.

The UK economy has changed rapidly and fundamentally in the last two decades with profound consequences for regional economic development. BMI (2010) forecasts the annual GDP growth in the UK will be 2.6 percent for the 2010-2014 period. As for the freight sector, the average annual growth in 2010-2014 will be 1.5 percent, expressed in million tonnes per kilometre. The developments in the national economy reflect the average economic performance of UK regions. However, large divergences exist at the regional level in the UK from geographic location, infrastructure development and transport policies to economic development.

According to Matthews and Gardiner (1999), the combined effects of changing economic fortunes, economic restructuring and the decline as an imperial power have created the so-called North-South divide of the UK, in which decaying industrial areas of the north of England and Scotland contrast with the wealthy, finance-and-technology led southern economy. This has led successive governments to develop regional policies to try and rectify the imbalance.

There has been an increasing emphasis on the regions within public policy making in the UK (ERN *et al.*, 2005). Over the last two decade, a regional governance structure for the English regions have emerged, including the “Government offices for the regions (formed in 1994)”, “Regional development agencies (formed in 1999)”, “Regional Chambers (designated in 1999)”, and in

Wales the “Welsh Development Agency (absorbed into the Welsh Assembly Government's Department of Economy and Transport in 2006)” and the “Scottish Enterprise” and “Highlands and Islands Enterprise” in Scotland.

3.2 Regional Definition

In order to get a more detailed picture of the logistics and economy relationship, this study takes Nomenclature of Units for Territorial Statistics (NUTS) regions in GB as the unit of study.

According to the UK Directgov website, the United Kingdom of Great Britain and Northern Ireland (the UK or United Kingdom for short) is made up of England, Scotland, Wales and Northern Ireland. The term “Great Britain” (GB or just Britain) refers to the area covered by England, Scotland and Wales. It is useful to point out here that this thesis excludes Northern Ireland and takes the Great Britain as the focus of study instead of the UK. This is due to the fact that the data is not available from Northern Ireland for many indicators involved in the study. Within those available many are not comparable with the data from other regions.

NUTS was created by the European Office for Statistics (Eurostat) as a single hierarchical classification of spatial units used for statistical production across the European Union. NUTS is the most widely used regional classification in the UK and most of the regional data on the indicator involved in this study are compatible with NUTS.

Figure 3-1. UK NUS-1 & 2 Map.

Source: Dunnell (2009)

As any other EU member country, UK has established a hierarchy of three NUTS levels (see Table 2-3 and Figure 2-13). This study uses “regions” when referring to the 11 NUTS-1 regions in GB (Northern Ireland not included) and “sub-regions” when referring to NUTS-2 and 3 areas.

NUTS level	England	Scotland	Wales	Northern Ireland	Total in UK
1	Government Office Regions (GORs)	Scotland	Wales	Northern Ireland	12
2	Counties/groups of counties	Combinations of council areas, LECs and parts thereof	Groups of unitary authorities	Northern Ireland	37
3	Counties / groups of unitary authorities	Combinations of council areas, LECs and parts thereof	Groups of unitary authorities	Groups of district council areas	133

Table 3-1. NUTS levels definition in the UK.

Source: National Statistics. http://www.statistics.gov.uk/geography/nuts.asp

3.3 GB Regional Profiles

To set the context of this study, this section takes each GB region in turn to introduce briefly their regional profiles. The physical locations and important facts of the economical and logistical will be reviewed.

East of England

The East of England region covers around 19,100 km^2 with a population of 5.5 million (working age population is 3.4 million). It shares its borders with London, the South East and the East Midlands. It is one of the flattest regions in the UK and also has an extensive coastline. Large towns and cities in the region include Norwich, Cambridge, Peterborough, Stevenage, Ipswich, Colchester, Southend-on-Sea and Luton.

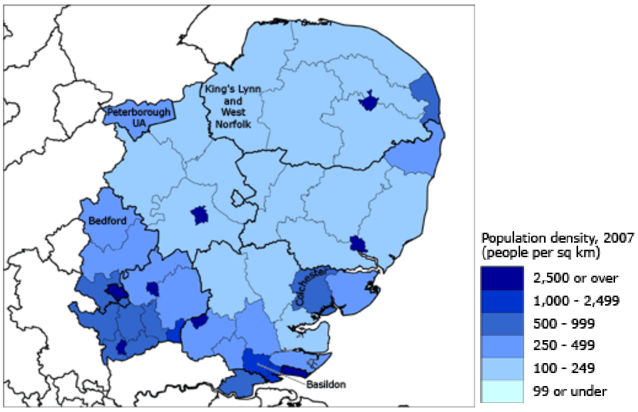


Figure 3-2. Population density in East of England.
Source: ONS website

The East of England benefits from its location close to London and well-constructed infrastructure to forge good inter-regional and international linkages. Freight is vitally central to the East of England regional economy, significantly contributing to the East of England's GVA and jobs. With several important international ports and airports located in the region, East of England has an important 'gateway' role, handling large volumes of traffic with origins and destinations throughout the UK.

Over 400 million tonnes of goods were moved by road in the region in 2003 (East of England Plan, 2008). In addition, more than 29 million tonnes were moved from the region's ports to the neighbouring regions. The major concentrations of logistics facilities are in the south of the region, HGVs account for over 20% of traffic on the M25, M1, A1 and M11 corridors. The A14 also provides a crucial east/west route between Felixstowe/Harwich ports and the Midlands, and act as a strategic transport link for the East of England together with the M1, the Midland Mainline and East Coast Mainline.

Rail freight is also key to the distribution of containers traffic to/from the major ports. Approximately 3.5 million tonnes of goods was transported from the region and around 5.2 million tonnes to the region in 2003 by rail. Due to the current bottlenecked rail freight infrastructure, there is likely to be considerable suppressed demand for rail freight services.

Felixstowe is one of the four major deep sea container ports in Britain, with capacity for container ships of 500,000 TEU or above, for ro-ro ships, 250,000 units and above and for cargo ships of more than 5 million tonnes. Harwich and Ipswich also handle significant levels of roll on-roll off traffic. Nearly 30 million tonnes of freight were handled through these ports in 2007 (Corke and Wood, 2009). Other smaller ports handle important flows of goods to and from the region by short sea shipping. Important new port developments are planned for the region that will generate significant levels of regional and interregional traffic.

Two of the five international London airports are in East of England, at Luton and Stansted, handling at least 10,000 air transport movements of cargo aircraft per year. Many towns have a direct train link to Central London and large numbers of workers commute to the city on a daily basis. As large portion of the containers to the UK land in the East of England, the region is better equipped with intermodal infrastructures to handle such traffic.

The Workforce in the East of England, however, lags behind its overall logistics performance. At an average salary rate, the availability and quality of the logistics workforce are much worse than the other regions. Moreover, the government spending on the transportation is slightly under average too.

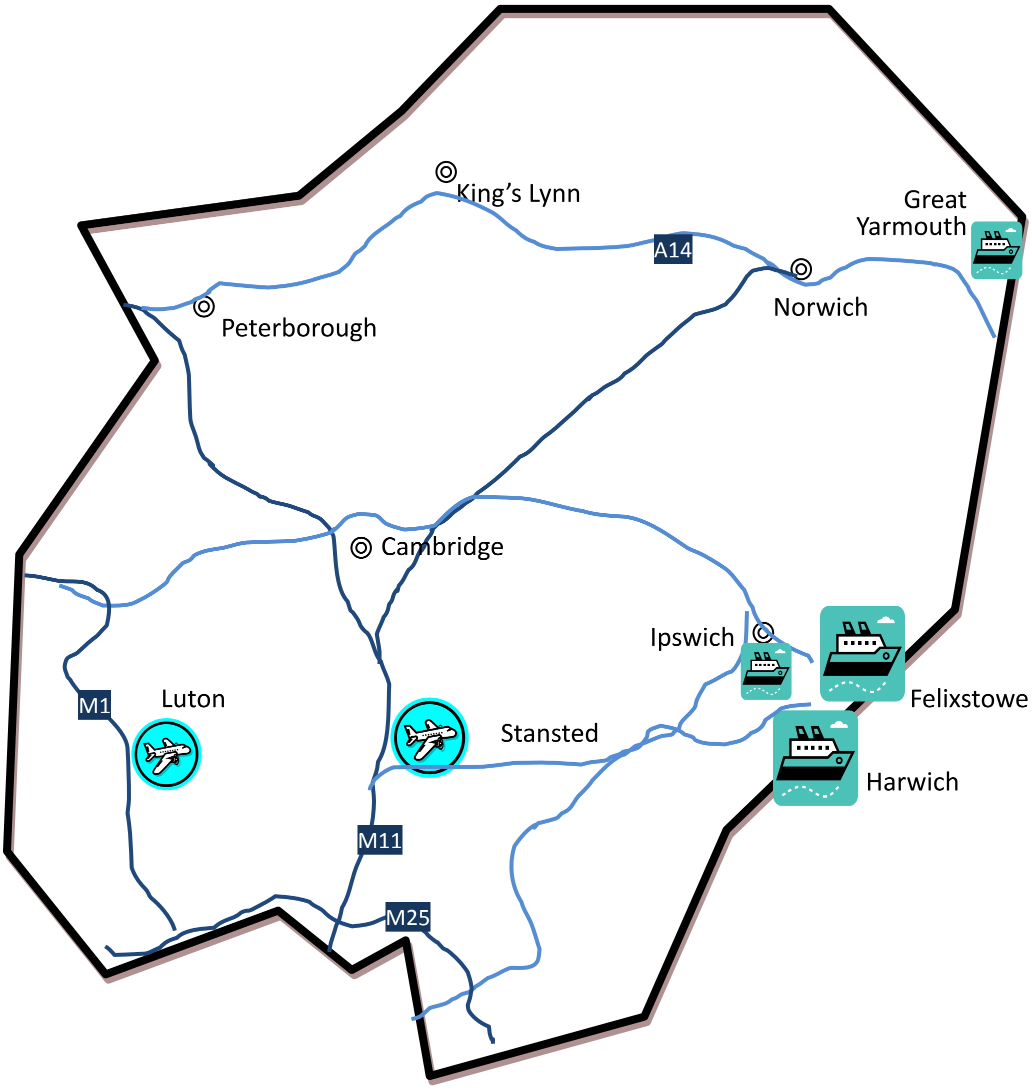


Figure 3-3. Key infrastructures in East of England.

Source: East of England Plan (2008)

According to Government Office for the East of England, the region has one of the fastest growing economies in the country. The East of England is responsible for 9 percent of the UK's gross value added (GVA) Productivity, as measured by GVA per hour worked, was one percentage point higher than the UK rate in 2007.

The East of England had the second highest employment rate among the English regions and its businesses invested more in research and development than those in any other region (ONS, 2010).

East Midlands

The East Midlands covers an area of 15,607 km² with a population of 4.3 million (working age population is 2.6 million). It is the fourth largest English Region, covering 12 percent of the total area of England and 6 percent of the UK. The region is bordered by Yorkshire and The Humber to the north, the North West, the West Midlands, the South East and East of England and by the North Sea coastline to the east.

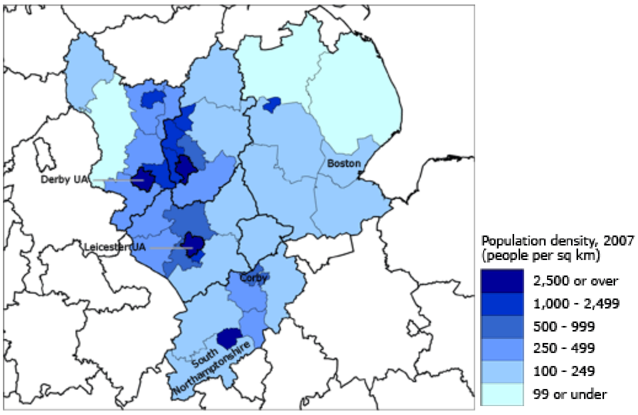


Figure 3-4. Population density in East Midlands

Source: ONS website

As transportation demand increases in recent years, pressure is growing on

East Midlands' infrastructure. There are about 140,000 heavy goods vehicle movements from, through or within the Region every day. 31% of these movements complete their entire journey within the Region, 22% represent transit traffic. The region, particularly the north and west, is well served by good road and rail transport links such as strategic links to Yorkshire and Humber including M1, A1, East Coast Main Line and trend navigation, and strategic links with West Midlands via M6/M45, West Coast and London-Birmingham Main Lines. Rail carries 10% of the tonnage of land freight in the East Midlands. This equates to 12% of tonne kilometres. Rail also carries 16% of all freight that passes through the Region (East Midlands Regional Plan, 2009). However, the main north-south road routes are increasingly congested, whilst additional investment is required in rail and other forms of transport. Poor east to west links remain a key issue for the region.

The East Midlands is served well by its East Midlands International Airport 15 miles from Nottingham and Derby which is the second largest freight airport in the UK (Beaumont, 2009). The air freight through EMA has grown dramatically in recent years to reach over 300,000 tonnes in 2007, therefore EMA is recognised as a national freight hub.

The access to sea, however, is only better than land-locked West Midlands. The region major ports, Boston and Sutton Bridge, carry relatively small volumes of freight. In terms of tonnage throughput, they account for only 0.1% of the sea freight volume in the UK in 2007 (DfT Maritime statistics). However their 2 million tonnes of bulk products, grain and steel make an important contribution to the local economy by providing a cost effective and sustainable alternative to road haulage.

The River Trent carries approximately 250,000 tonnes per year, mainly gravel and similar products. The River Nene carries about 60,000 tonnes per annum upstream from Sutton Bridge – mainly to Wisbech.

It is worth pointing out that a higher proportion of the workforce in the East Midlands is in lower skilled occupations as the economy of the region is more dependent on manufacturing than other regions (ONS, 2010). This has resulted in the lowest scores on logistics workforce qualification and base number for the East Midlands.

The strong manufacture base has also resulted in the good value add service capacity in the East Midlands, although the transport and warehousing capacities are only median comparing with other regions in GB.

Finally, the government support in the East Midlands is below national level.

The manufacturing sector, despite being in decline, still makes the highest contribution to the East Midlands economic output. In fact, as a proportion of total regional output, manufacturing is greater in the East Midlands than in any other region or country of the UK. As the economy of the region is more dependent on manufacturing than other regions, a higher proportion of the workforce are in lower skilled occupations.

The working-age employment rate in the East Midlands was fourth highest among the English regions at 74.9 percent in May to July 2009. According to ONS (2010), the employment rates in the East Midlands during the economic downturn have not declined as rapidly as the national average.

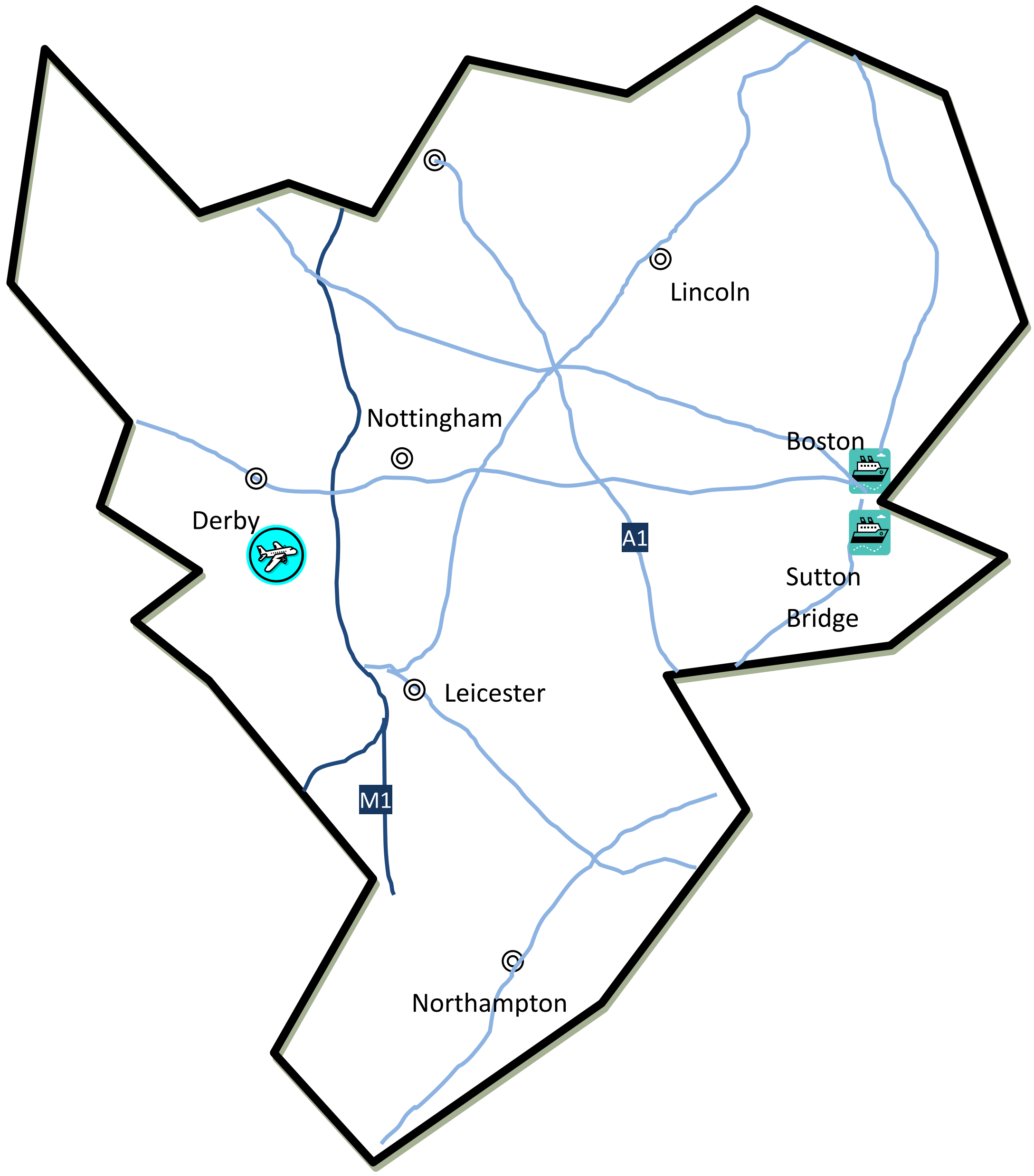


Figure 3-5. Key infrastructures in East Midlands.

Source: East Midlands Regional Plan (2009)

London

"London" in this study refers to the Greater London region which covers the City of London, including Middle Temple and Inner Temple, and 32 London boroughs. It is bounded by Essex and Hertfordshire in the East of England region and Buckinghamshire, Berkshire, Surrey and Kent in South East England.

Greater London is the UK's only world city with 7.51 million inhabitants which is almost 15 percent of England's population, although by size it is the smallest of the English regions at 1,572 km².

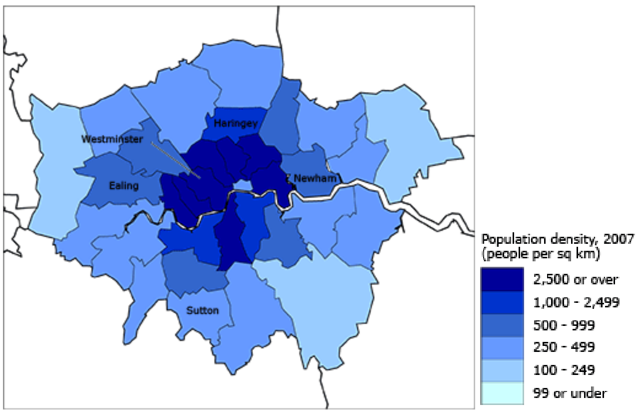


Figure 3-6. Population density in London

Source: ONS website

London enjoys its centre location where most of the international trade in GB happens between London and other regions especially those around London. London also has the best international market accessibility among all the regions in GB. Principal UK ports are also within easy reach of London, such as Southampton and Felixstowe.

International and national freight movement has an important role in the success of the economy of London and the busy transportation network has large environmental impact. Therefore the Mayor of London is seeking to deliver enhanced rail freight capacity through supporting new terminals to facilitate efficient movement of goods; and encourage transfer of freight from road to rail wherever possible (The London Plan, 2009).

Motorways and national rail networks also provide London with essential connectivity to and from the rest of the UK and Europe. Some 70 percent of all national rail journeys either start or finish in London (The London Plan, 2009). Also, all the international freight trains from UK pass through London's rail system to mainland Europe. However, due the competition over rail paths with passenger transport, rail freight trains through London are avoided. The London Plan therefore seeks to remove unnecessary movement of freight by rail through London by supporting enhancements, to the rail network outside London, to allow more use to be made of alternative routes where there are fewer conflicts. A rail connected freight transhipment facility at Howbury Park opened in 2010, providing extra capacity to transfer freight from road to rail. In addition a new rail freight hub at Brent Cross/Cricklewood is also proposed.

Water freight is a more environmental friendly freight transportation modal, which is particularly suitable to bulk movements of relatively low value cargoes for which speed is less critical, such as aggregates and waste. In the Olympic Park at Stratford, waterways have been upgraded so construction material can be transported by water rather than road The new Three Mills Lock in Bromley by Bow can accommodate barges weighing up to 350 tonnes (equivalent to 17 average HGV loads).

The London ports (Tilbury and Thames ports) account for 9.8 percent of all the sea freight traffic at UK ports in tonnage. In 2011, the new £15bn container port near Tilbury will provide considerable additional port capacity opens, which will generate new rail freight flows passing through London.

In terms of air freight, London is in the domination position - the three airports in London (Heathrow, London City and Metro London Heliport) together account for 62 percent of all the freight lifted in the UK in the year 2008 (Aviation Statistics 2009).

London is unique among the British regions also in that a significant proportion of the workforce resides in neighbouring regions which is not picked up by the region employee indicator. Therefore, although the labour cost is higher in London than any other region, the logistics workforce indicator in London would actually be better than the RLC indicates.

London is by far the largest contributor (21.5 percent) to the economy among the countries and regions of the UK and makes its greatest contribution from real estate, renting and business activities and financial intermediation. In 2008 London's gross value added (GVA) was £265 billion. It is one of the world's leading centres for international financial and business services and it the headquarter base for many of the world's leading companies. The unemployment rate stood at 6.9 percent in the second quarter of 2008, higher than the UK rate of 5.4 percent.

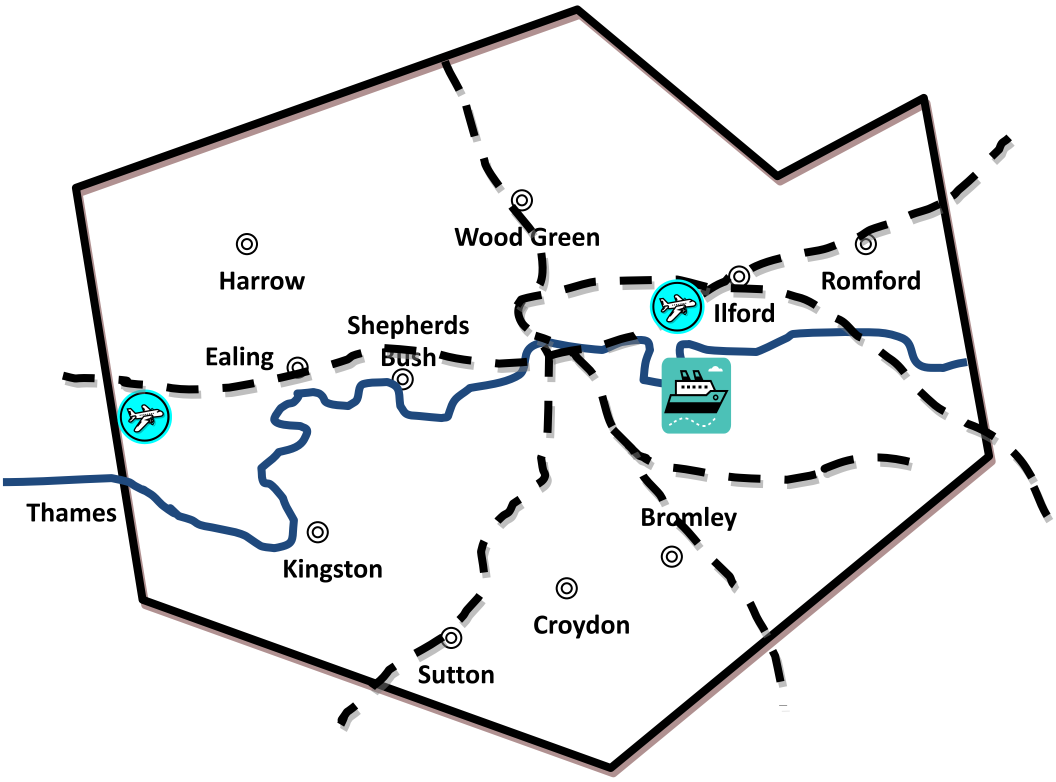


Figure 3-7. Key infrastructures in London.

Source: The London Plan (2009)

North East

The North East is one of the smallest of the English regions in both area (8,592 km²) and population (2.6 million) (ONS, 2010). According to Government Office for the North East "it is a region of great contrasts. Generally the region is hilly and sparsely populated in the North and West, and urban and arable in the East and South.

On the western part, there are hills, moorlands and forests of the North Pennines and Border Hills. Its eastern side is the North Sea coastline of 160 kilometres, on which long-established industrial conurbations are grouped around the main river estuaries of the Tees, Wear and Tyne.

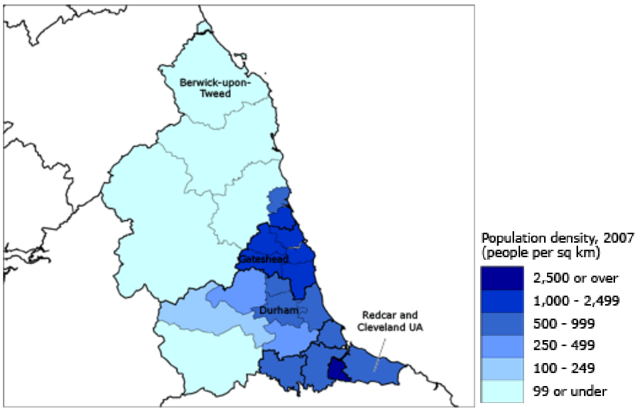


Figure 3-8. Population density in the North East.

Source: ONS website

The North East's infrastructure for logistics is relatively poor, especially the road and rail networks. The major routes into the North East are the A1(M), A1 and A19 which run north-south and the A69(T) and A66(T) providing the East-West connections. However, the volume of freight moved by road in the region is very low (less than half of GB average). Moreover, direct rail access between the two conurbations of the city-regions of Tyne & Wear and Tees Valley is poor.

The Air freight and multimodal interchange facilities are also underdeveloped. There are two international airports in the region, Newcastle and Durham Tees Valley, which together carried only 1.6 thousand tonnes of freight in 2007 (NEFF, 2009). The container traffic in the North East is also the lowest in GB.

There are, however, several major seaports in the North East, including Tees, Sunderland and Hartlepool, and Tyne. Teesport is the second largest port in the UK, in terms of tonnage handled and has aspirations to develop a deep sea container terminal.

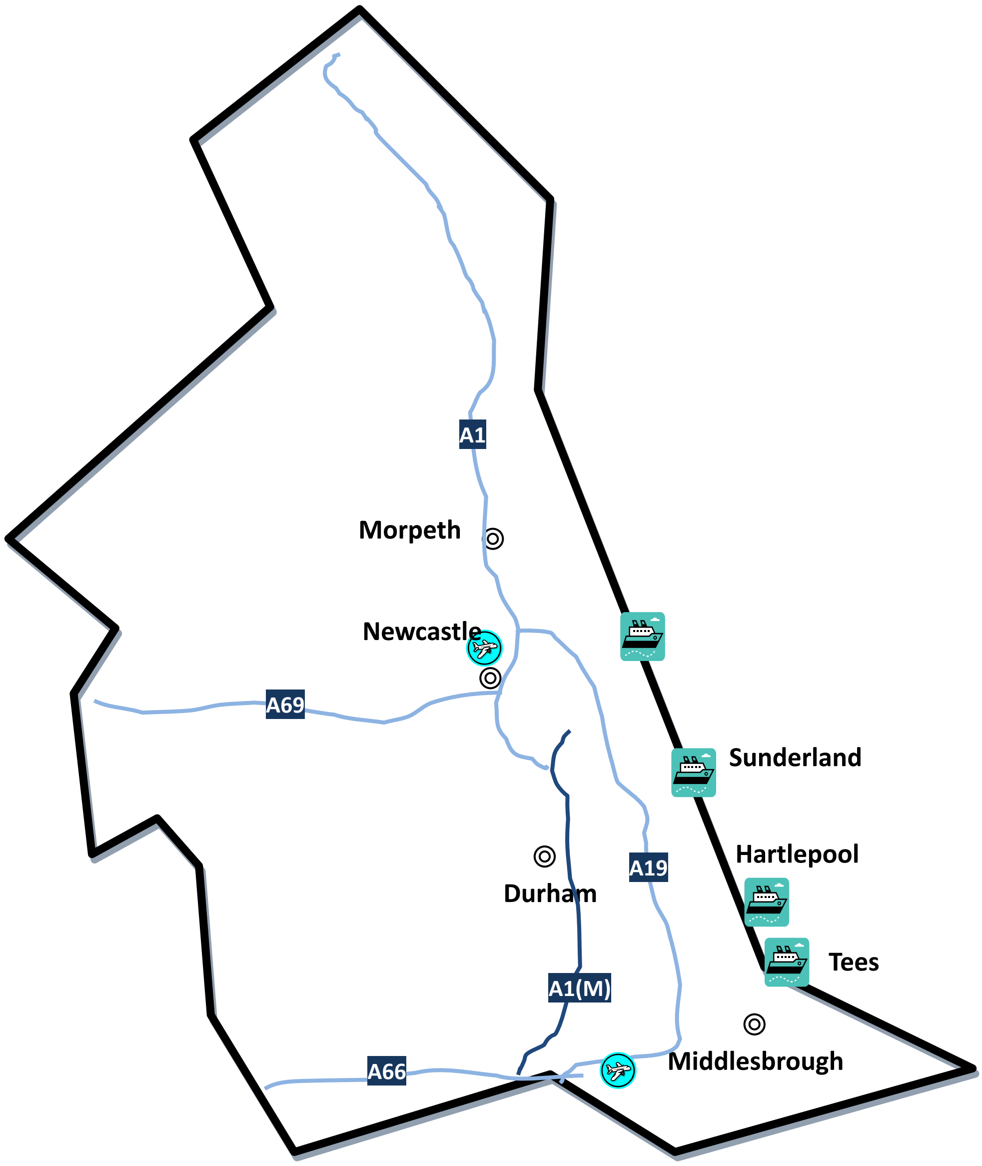


Figure 3-9. Key infrastructures in the North East.

Source: The North East of England Plan (2008)

For the economic performance, the North East is at lower level when comparing with other regions in the UK. The region had the lowest working-age employment rate in England, at 67.7 percent in May to July 2009. GVA per head in the North East at £15,700 was the lowest among the nine English regions in 2007, 21 percent below that of the UK. The chemicals, chemical products and man-made fibres industry produced almost 20 percent of the total GVA of the manufacturing industries in the region in 2006. The North East's exports, however, is the highest of all English regions in terms of percentage of GVA (24 percent in 2007, compared with the UK average of 18 percent).

North West

The North West covers an area of 14,165 km² with a population of 6.8 million (working age population is 4.2 million). North West England is bounded on the west by the Irish Sea and on the east by The Pennines mountain range. The region extends from the Scottish Borders in the north to the Welsh Mountains in the south. According to Government Office for the North West, four-fifths of the region is rural, but around sixty percent of the population live in the 2 core conurbations of Greater Manchester and Merseyside.

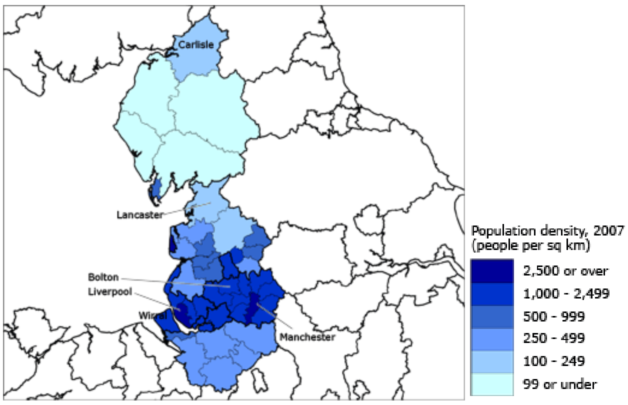


Figure 3-10. Population density in the North West.

Source: ONS website

First of all, the North West is well positioned at the intersection of two internationally important transport corridors running North-South (The M6 and West Coast Mainline) and West-East (the North European Trade Axis route), which contribute to the region's outstanding international market access.

In terms of infrastructure, the North West has developed a high quality network of road which carries more freight than any other regions in GB. The rail network in the North West has the potential to move a greater volume of freight, especially in the international and inter-modal markets. However, growth is constrained by network capacity, mainly the West Coast Main Line north of Crewe, and the Manchester Hub (The North West Regional Spatial Strategies, 2008).

The major seaports in the North West include Liverpool, Manchester, Heysham and Fleetwood, which in total account for 8.4 percent of the sea freight in the UK in 2008 (Maritime Statistics, 2009). The Ship Canal also has the potential to facilitate the movement of freight by water between the heavily urbanised North West Metropolitan area and other parts of the UK and Europe.

The primary international airport in the region is Manchester Airport. The World Freight Terminal of the Manchester Airport is located to the north-west of the site, with access onto the M56 at junction 6. However, increasing congestion on the motorway network and the M56 and M60 Manchester outer ring road in particular could affect accessibility in the future. The regions second largest, but fastest growing airport is Liverpool John Lennon Airport.

Equally distinguished is the region’s sufficient and high quality workforce in the logistics industry. It has the largest logistics workforce base which is well qualified. The cost of employing logistics employees in the North West, however, is lower than many other regions.

The North West also has the largest warehousing service capability in GB and above average transportation and value added service performance.

One of the biggest challenges for the North West, however, is the congestion on some rail routes and on the road in urban areas, which has a significant impact on journey time reliability, affecting the productivity of businesses and industry, as well as personal lives. Out of all the regions and countries of the UK, the North West makes the highest contribution to the UK's manufacturing industry GVA (ONS, 2010), which generates considerable logistics activities. Therefore another serious concern is the environmental impact of the region's logistics and manufacturing activities, which have made the North West the second largest emitter of CO_2 in GB (The North West Regional Spatial Strategies, 2008).

Out of all the regions and countries of the UK, North West makes the third largest contribution to the UK economy and makes the highest contribution to the UK's manufacturing industry GVA. The region generates 11 percent of the UK's Gross Domestic Product, despite a decline in traditional manufacturing and engineering industries. The employment rate for the region's working-age residents was sixth highest among English regions (70.8 percent in May to July 2009).

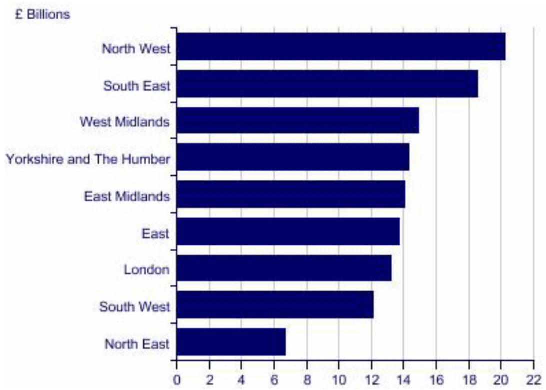


Figure 3-11. Manufacturing GVA of the UK regions.

Source: ONS website

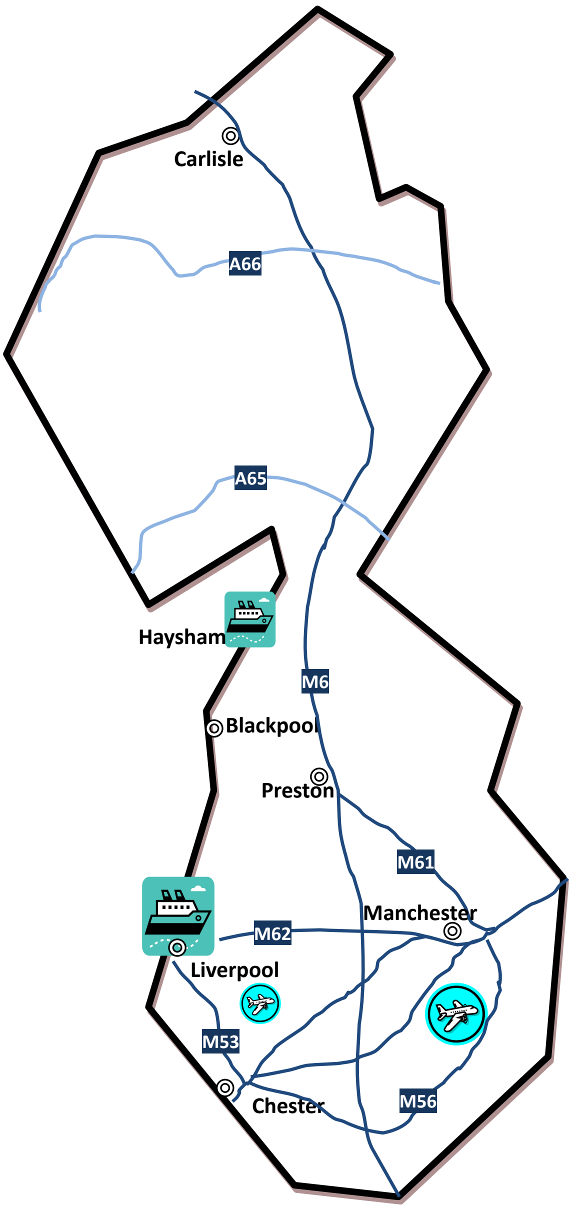


Figure 3-12. Key infrastructures in the North West.

Source: The North West Regional Spatial Strategies (2008)

Scotland

Scotland occupies the northern third of the island of Great Britain and covers an area of 78,722 km². It shares a border with England to the south and is bounded by the North Sea to the east, the Atlantic Ocean to the north and west, and the North Channel and Irish Sea to the South West. In addition to the mainland, Scotland owns over 790 islands including the Hebrides and the Northern Isles, which gives Scotland the longest aggregate coastline among the UK regions at 3,680 kilometres (Scottish Government, 2003).

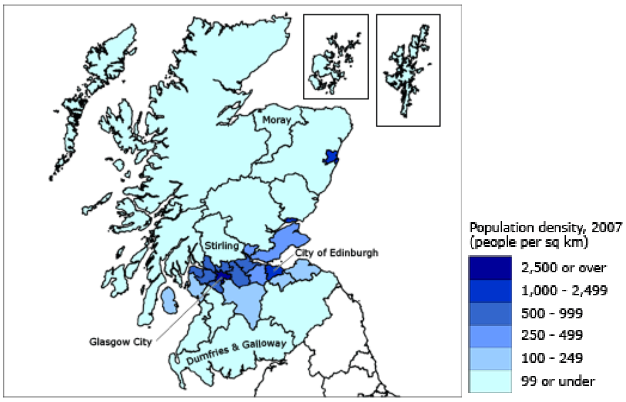


Figure 3-13. Population density in Scotland.

Source: ONS website

The mainland can be split into three geographic regions: Highlands, Central Lowlands, and Southern Uplands (Scottish Government, 2003). Scotland had a population of 5.1 million in mid-2007, which means there are approximately 65 people for every square kilometre of land – the lowest population density in the UK. The majority of the population are concentrated in the central area around Glasgow and Edinburgh. The Highlands and Islands have the most area but the fewest people.

Scotland is the northernmost region in Great Britain, which is also the largest region in terms of surface area. This means it is far from the other regions in GB.

Scotland also has the lowest population density in the UK - approximately 65 people for every square kilometre of land, which makes it even more difficult for logistic activities to service its population.

According to the Scottish Transport Statistics (2009), major seaports that accounted for the highest freight traffic in Scotland in 2008 include Forth (39 million tonnes), Sullom Voe (15 million tonnes) and Clyde (14 million tonnes).

Scotland also has good road and rail infrastructures. There were 55,838 kilometres of public road in Scotland at 1 April 2008. The trunk road network accounted for 6 percent of the total. The total route length of the railway network in Scotland is 2,745 kilometres, of which 639 kilometres is electrified. In addition, Scotland enjoys a logistics workforce that is both large in number and good in quality.

The intermodal and air freight infrastructures, however, are weak in Scotland. Scotland has five main international airports (Glasgow International, Edinburgh, Aberdeen, Glasgow Prestwick and Inverness) which together account for about only 2 percent of the total UK air freight (London dominates at 62 percent).

Equally weak in Scotland is the logistics service capabilities (including transportation, warehousing and value added), especially the value added service capacity.

Traditionally, the Scottish economy has been dominated by heavy industry underpinned by the shipbuilding in Glasgow, coal mining and steel industries.

Petroleum related industries associated with the extraction of North Sea oil have also been important employers from the 1970s, especially in the north east of Scotland. The unemployment rate stood at 4.2 percent in the second quarter of 2008, lower than the UK rate of 5.4 percent. The labour productivity (gross value added per hour worked) is also 4.4 percent below the UK average in 2007 (ONS, 2010).

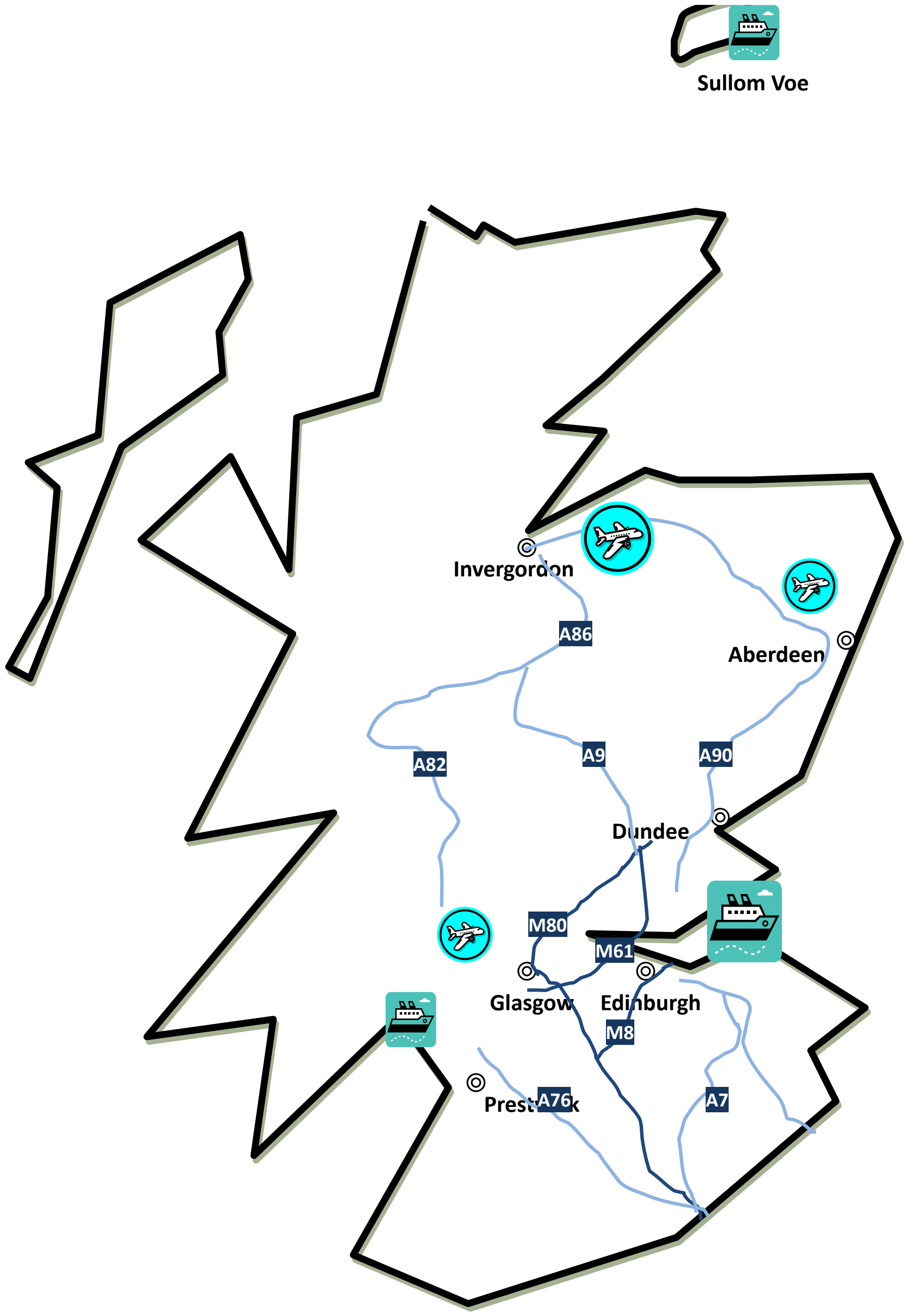


Figure 3-14. Key infrastructures in Scotland.
Source: National Planning Framework for Scotland (2009)

South East

The South East covers an area of 19,096 km² with a population of 8.2 million (working age population is 4.9 million). It is the largest region in terms of population and the third largest of the English regions in terms of area.

While it is without a single dominant urban centre, the South East region is home to two cities with populations of around 250,000 (Medway and Brighton and Hove) and five cities with populations of greater than 100,000.

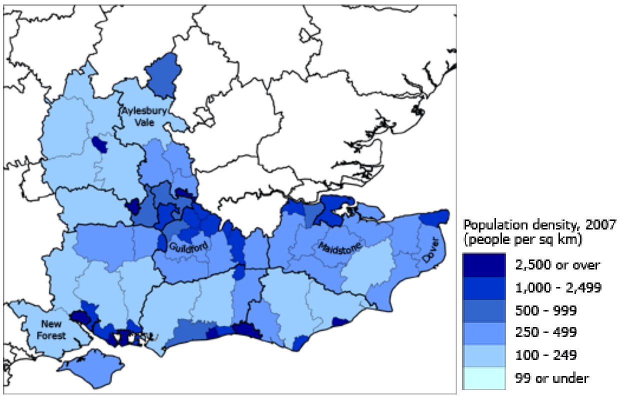


Figure 3-15. Population density in the South East.

Source: ONS website

The region is very well positioned to be near London and the East of England, its two largest trade partners. The region also enjoys a long coastline and deepwater ports which allows convenient European and wider international trade connections.

The South East has a strong logistics infrastructure, including 22 percent of the English motorway network and 15 percent of the major roads (SEFF, 2010). The UK's second busiest airport (Gatwick) is in the region, while the busiest airport (Heathrow) is immediately adjacent to it. The South East also hosts some of the country's major passenger and freight ports including Dover, Southampton and Portsmouth, as well as the Channel Tunnel, which make the South East the natural access point to continental Europe and beyond.

Moreover, the South East benefits from its large available logistics workforce base, which is also the most skilled in terms of NVQ qualification holder rate. The capacity in transport and warehousing of the South East are also among the highest in GB, as well as its value added service capacity.

However, the region's transport system faces a number of challenges (The South East Regional Spatial Strategies, 2008), including severe congestions on the road and rail networks that result from high volume of freight and passenger transportation, especially to/from the region's airports and ports, and growing concern regarding the impact of the transport system on the environment. Due to its busy logistics activities, the South East is the biggest polluter in terms of CO_2 emission.

The South East is a prosperous area with the second largest regional economy in the UK (after London) measured by GVA. It has the highest employment rate, although this has fallen recently like all other UK regions (ONS, 2010).

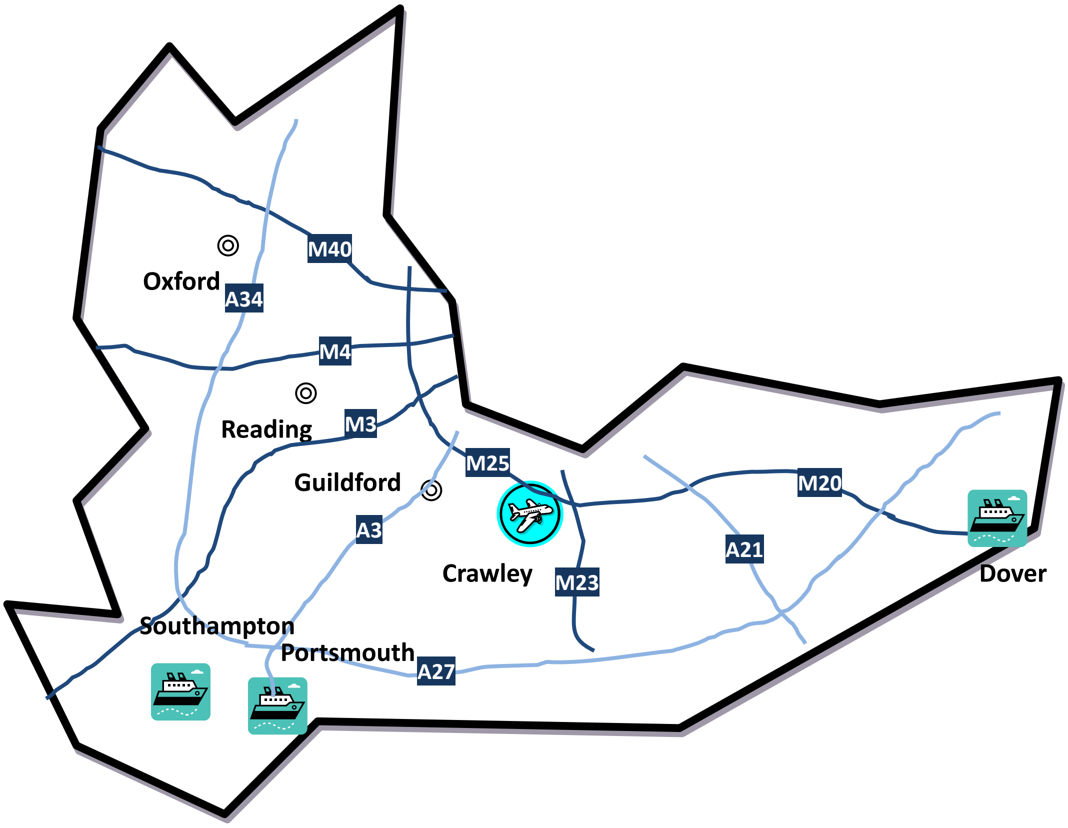


Figure 3-16. Key infrastructures in the South East.

Source: The South East Regional Spatial Strategies (2008)

South West

The South West is the largest of the nine English regions with an area of 23,837 km² and a population of 5.1 million (working age population is 3.2 million).

The South West region extends over 350km from the south west tip of Cornwall to the northern border of Gloucestershire. Most of the South West occupies a peninsula between the English Channel and Bristol Channel. It has a long coastline of 702 miles, the longest in the English regions (shorter than Scotland and Wales). The region also has the highest percentage of rural land of any English region and just under 10 percent is urban or suburban (SWFF, 2009).

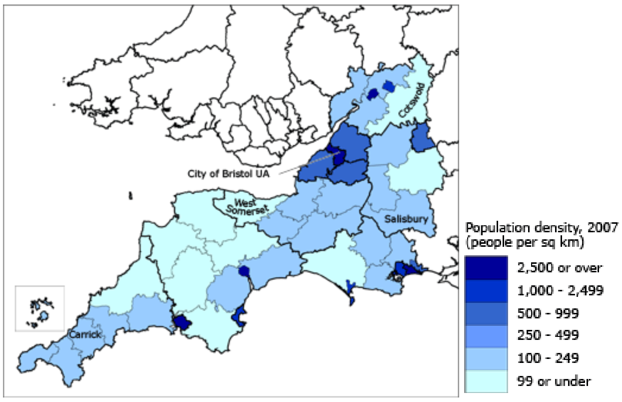


Figure 3-17. Population density in The South West.

Source: ONS website

Geographically, the South West is the largest region of England, second only to Scotland in Great Britain. The peninsular nature of the South West means that a significant part of the region is relatively remote, and the logistics activities rely on the relations it has with adjacent regions (the South East, West midlands and Wales) via road and rail connections, and with the European regions and beyond via port of Bristol and airports in the region.

The South West has a long coastline and there are also a number of ports in Bristol, Plymouth, Poole and Cornwall. But the only port of national significance is Bristol which has a number of key strengths, including deep-water capacity to accommodate large vessels and excellent connections to rail and motorway networks. Despite the overall rising volume of sea freight since 1999, the South West still handles a relatively small proportion (5 percent) of the nation's sea borne freight (GOSW, 2010).

Many parts of the South West, mostly those in the north and east of the region, are well connected to the main population and economic centres of the UK. The three major road routes into the South West from the east are the M4 from London, the A31 along the south coast, and the A303 mid-country.

The region has several main line railways, with good services east to west and along the south coast. However, some outlying areas are less well served, as are some north-south connections (SWFF, 2009). The Draft Regional Spatial Strategy for the South West also points out that the low freight volumes from and to the South West limit the viability of rail freight infrastructure, as well as the intermodal infrastructure. Since the region is not a major area for manufacturing, much of the freight moved into, and within, the region is for distribution. Therefore rail freight flows within the South West are limited in number and are concentrated on a small number of particular markets such as china clay, stone, coal and cars.

There are several airports in the South West at Bristol, Exeter, Bournemouth, Plymouth and Newquay which together carried 800 tonnes of freight during 2007. This represents only a very small share (0.03 percent) of the total volume of freight carried at airports in England (The South West Observatory, 2009).

The Workforce of logistics in the South West is quite weak comparing with the other regions in GB on both number and qualification levels, which drags down the overall logistics capability of the region.

The South West England (SWE) economy broadly follows trends seen in the national economy, experiencing a period of sustained growth since the early 1990s until 2008. Five economically important sectors (advanced Engineering, including aerospace; food and drink; ICT; leisure and tourism; marine) and three emerging sectors (biotechnology; creative industries; environmental technologies) have been identified in the Regional Economic Strategy by the South West of England Regional Development Agency.

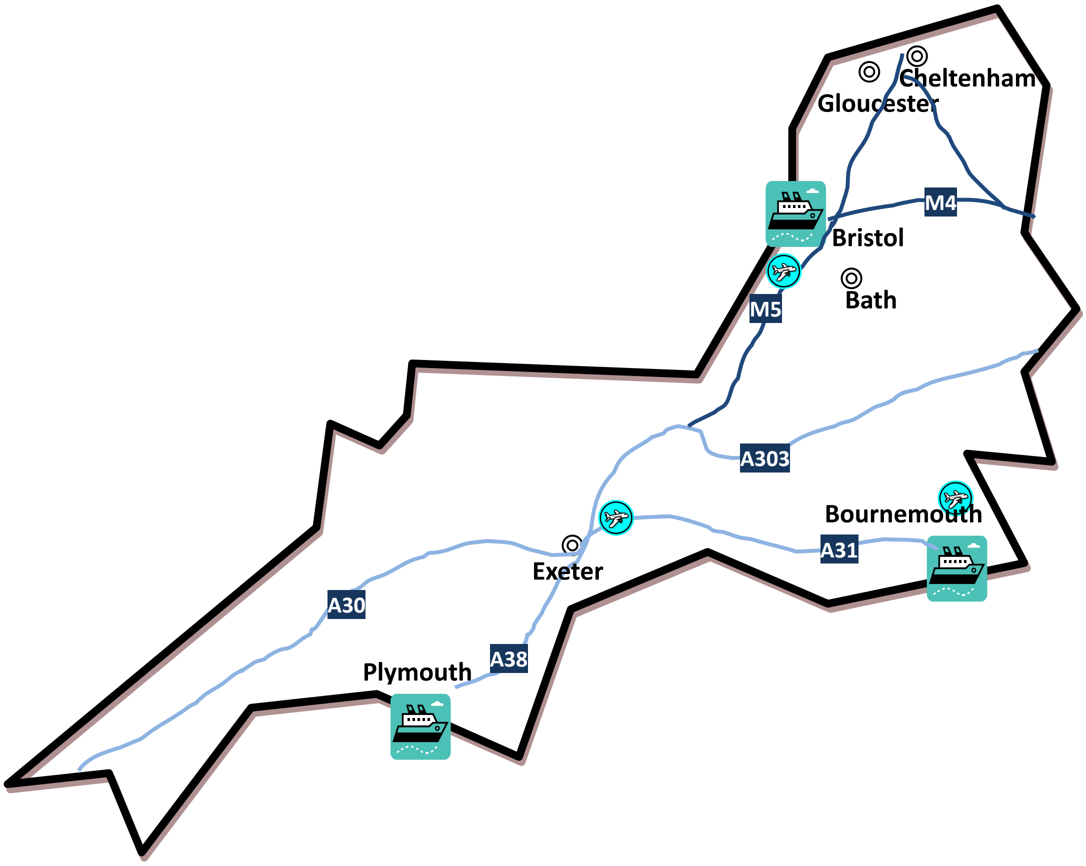


Figure 3-18. Key infrastructures in the South West.

Source: The South West Regional Spatial Strategies (2008)

Wales

Wales is located in central-west Great Britain and covers about 20,779 km² of area. It is bordered by England to the east and by sea in the other three directions: the Bristol Channel to the south, Celtic Sea to the west, and the Irish Sea to the north. Altogether, Wales has over 1,200 km of coastline, second only to Scotland. Much of Wales's diverse landscape is mountainous, particularly in the north and central regions.

The population of Wales was estimated to be 3.0 million in mid-2007 (ONS, 2010). The unemployment rate in Wales was 4.9 percent in the second quarter of 2008, which was lower than the UK average at 5.4 percent. The labour productivity (gross value added per hour worked) in Wales in 2007 was also below the UK average at 15.4 percent.

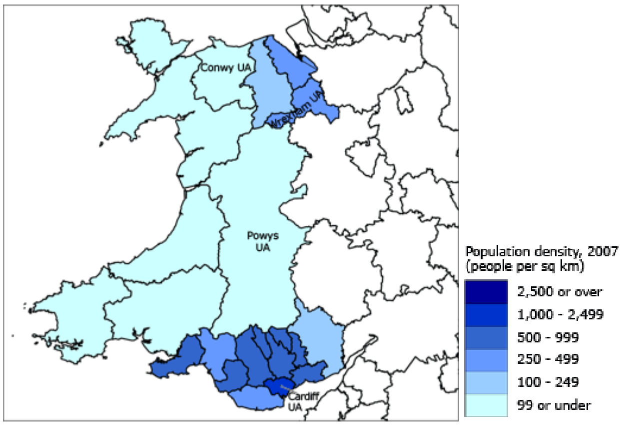


Figure 3-19. Population density in Wales.
Source: ONS website

In terms of location, Wales sits in central-west Great Britain and relatively far from London and other prosperous regions in the southeast. Although Wales has over 1,200 km of coastline (second only to Scotland) and potentially important role as a link in the Trans-European Network, the current connectivity and freight traffic of Wales are quite low on both international and domestic levels.

Wales has relatively few airports and only one international airport, the Cardiff International Airport, which is also the sole airport in Wales for air freight, and is ranked 19th in the UK in terms of freight movement (The Wales Transport Strategy, 2008). The air freight traffic overwhelmingly uses airports outside Wales, with commodities travelling by road to and from airports elsewhere in the UK.

As for seaports, Milford Haven is the fourth largest port in the UK in terms of tonnage and the busiest for oil products. Newport is the busiest UK port for iron and steel and Port Talbot is the third busiest for ores. Together they represent about 10 percent of the sea freight traffic at UK ports in 2008 (DfT, Maritime Statistics).

Most road and rail freight services in Wales run east to west, with the largest in south Wales, some services in north Wales and limited operations in mid Wales. Comparing with the GB average, the levels of road and rail freight capacity are much lower as well as the number and quality of freight interchanging facilities.

Although the cost of logistics workforce in Wales is among the lowest in all the regions in GB, the number of available workers and the qualification of the workforce remain weak.

There is also large potential for Wales to improve its ability to provide good logistics services, especially freight transport and warehousing.

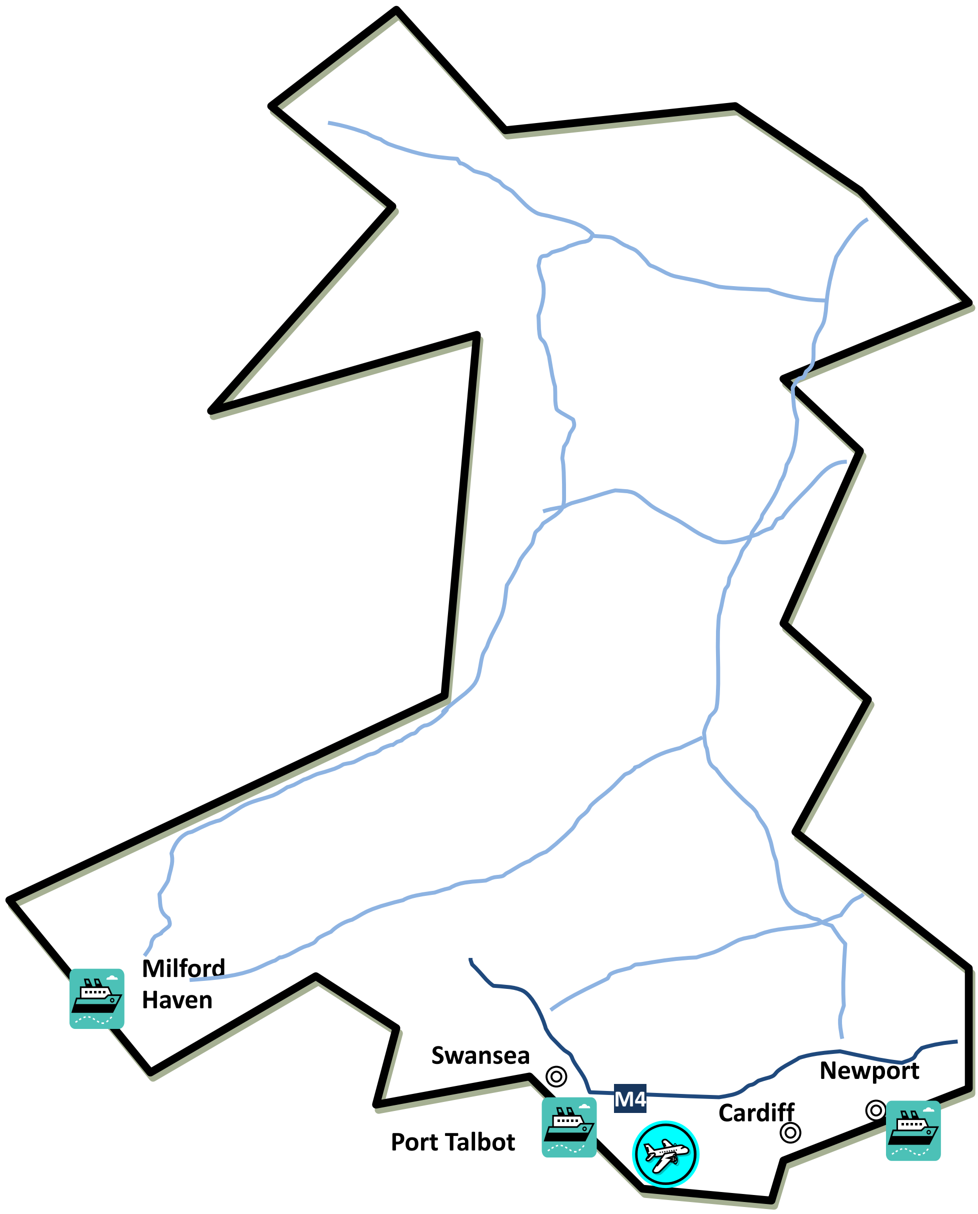


Figure 3-20. Key Walsh road, rail, port and airport infrastructure.

Source: ONS website

West Midlands

The West Midlands region is situated in the heart of England spanning an area from Stoke-on-Trent in the north down to Hereford and Evesham in the south, from Shrewsbury in the West to Rugby and Burton-on-Trent in the East. The region covers an area of 12,998 km² and accounts for a population of 5.27 million (working age population is 3.25 million). More than half of the region's population live in large conurbation areas, while over 2 million reside in the region's rural counties, which cover three-quarters of the region's area. The West Midlands Metropolitan Area (Birmingham, Black Country, Coventry and Solihull) occupies a central position within the region (GOWM 2010).

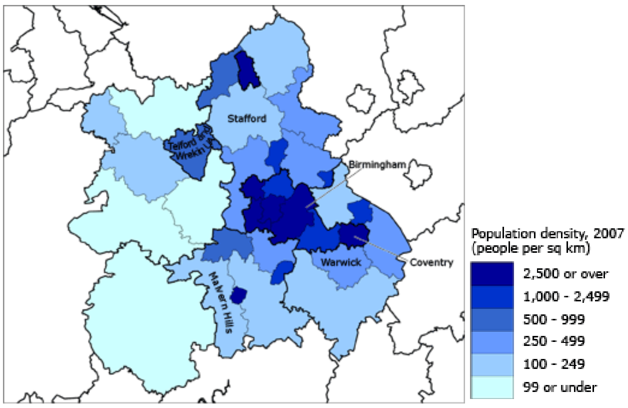


Figure 3-21. Population density in West Midlands.

Source: ONS website

The West Midlands region lies at the crossroads of two of the nation's most important motorway and rail transport corridors linking the North with the South East and South West meeting in the Birmingham and Coventry area. The main west coast line between London and the North West of England and Scotland passes through Birmingham and Coventry. West Midlands is the only land-locked region in the UK, which means the exports from West Midlands have to go through other regions for access to the seaports.

The M6 motorway is the most important north-south trunk route through the Region for road freight movement. The section of the motorway through Birmingham is one of the most heavily used motorways in Europe. The ‘M6 Toll Road’ was built to provide extra capacity at this section of the national road network, however it currently carries relatively few Heavy Goods Vehicles - 7% HGVs compared with a typical 30% on the “parallel” M6 (The West Midlands Regional Spatial Strategies, 2008).

The rail freight and intermodal infrastructure, however, lags behind with limited inter-modal terminal capacity and distribution warehousing located on rail linked sites.

Whilst freight opportunities for the large scale use of the inland waterway network is very limited, The River Severn has potential moving aggregates in Worcestershire and to Gloucester, and transporting coal, waste items and building materials.

The Birmingham International Airport, the UK’s fifth largest, is situated 14 miles to the south east of Birmingham (GOWM 2010), but the volume of freight has declined since the early 1990’s as a result of changes in the UK freight market, with operators concentrating on other airports, particularly the freight hub at East Midlands.

The logistics workforce in the West Midlands is below average in both number and quality, although cheaper than many other regions.

Thanks to the central cross road location of the region, there is a concentration of storage and distribution facilities in the West Midlands. As a result, the West Midlands enjoys good transport and warehousing capacities. In addition, since the region is greatly based on manufacturing (560,000 out of the 2.4 million working population in the region are in manufacturing), the West Midlands is very strong in the value added service too.

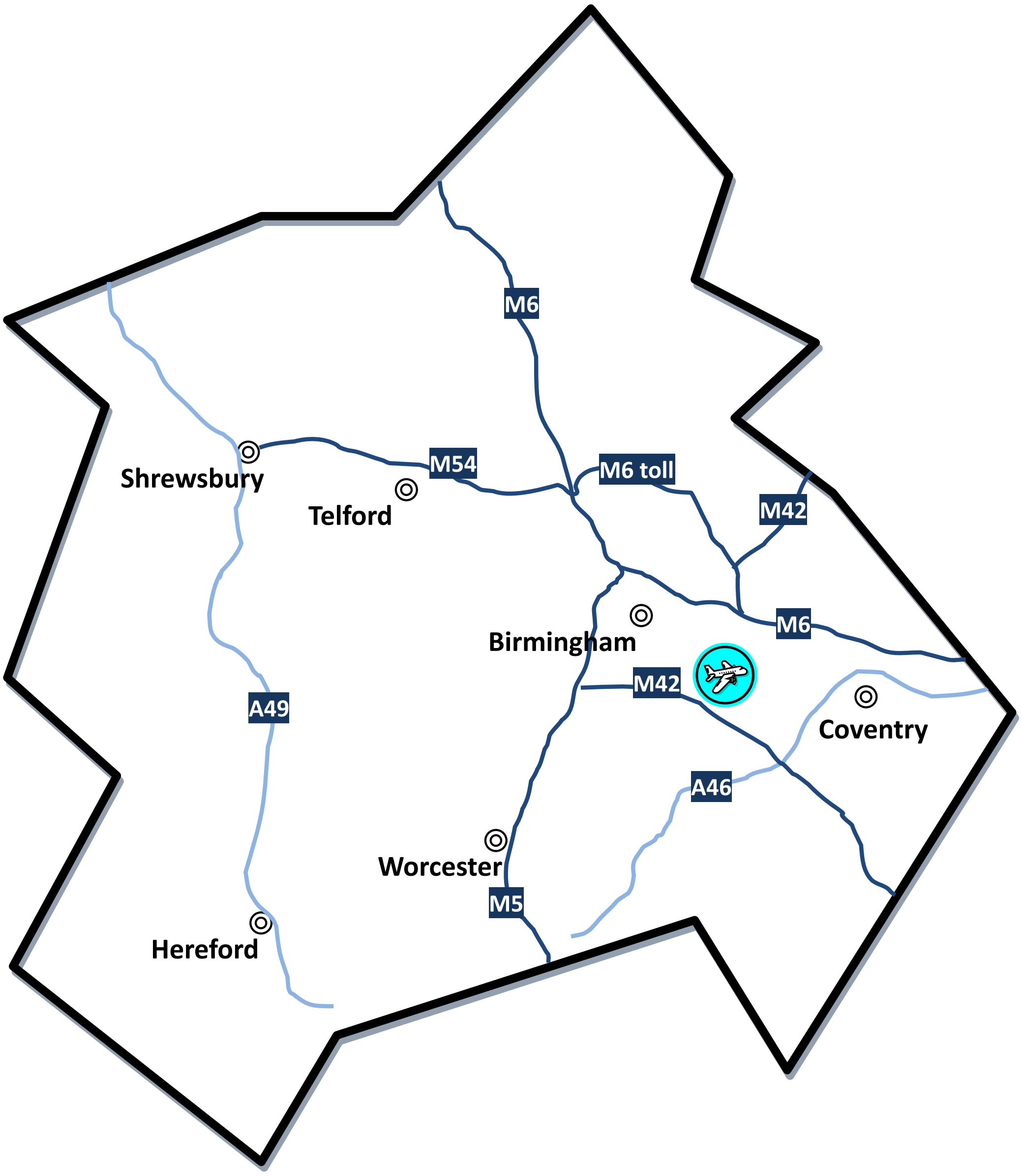


Figure 3-22. Key infrastructure in West Midlands.

Source: The West Midlands Regional Spatial Strategies, 2008

Despite a recent decline, manufacturing remains an important element in the economy, accounting for 20.4 percent of all regional employment. The service sector has expanded; increasing by over 250,000 jobs and now represents nearly 70 percent of the region's employment. The West Midlands is a major exporting region, accounting for approximately 8 percent of the national total by value.

Yorkshire and Humber

Yorkshire and Humber covers an area of 15,411 km² with a population of 5.1 million (working age population is 3.1 million). The region has a long eastern coastline facing the North Sea. To the west, the Pennine Hills separate it from the North West Region.

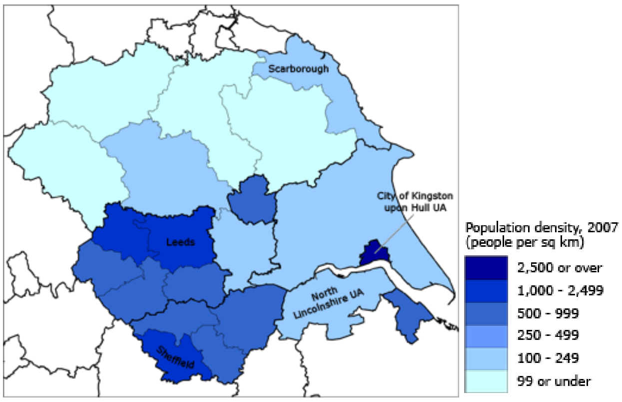


Figure 3-23. Population density in Yorkshire and Humber.

Source: ONS website

According to the Yorkshire and Humber Regional Spatial Strategies (2008), the Yorkshire and Humber enjoys outstanding strategic location as more than 60% of the country's manufacturing capacity is situated within a four-hour drive.

The Yorkshire and Humber region is easily accessible from the East Midlands to the south via the M1 motorway, A1 and the East Coast main line railway, with the latter two providing easy access from the North East (Kay, 2009). The A1/M1 Link Road provide a key long distance corridor in the regional motorway network, significantly improving links between the A1 north of Leeds and both the M62 and the M1. The major east-west route is the M62 and the A63 on the north Humber bank, as well as the M180/A180 on the south bank.

The rail network in the region is also important to the regional freight, although the gauge constraints over the Pennines currently limit the amount of freight traffic between Hull and Liverpool. There are also rail links to Humber ports Immingham (50 freight trains per day); Grimsby (direct quayside rail connections); Goole (rail terminal north of West Dock); Hull (links into parts of Hull Dock).

The Hull & Humber Ports complex is among the largest in the UK in terms of total volume. The natural waterway assets of the region mean that flows of products are far higher than average for the region with large volumes of aggregates, coal and mineral oils transported within, into and from the region. The main inland waterways of Yorkshire and Humber carry around 14 million tonnes (internal and seagoing traffic), a quarter of all waterway traffic in the UK. Of this total 11.5 million tonnes were seagoing and 2.5 million were used on trips with inland origins and destination (Yorkshire and Humber freight strategy, 2004).

Leeds Bradford International Airport, Robin Hood Airport and Humberside Airport are the major airports in the region. However, the air freight shipped to or from Yorkshire and Humber is currently largely serviced by airports outside the region. The air freight performance of Yorkshire and Humber is among the lowest.

Despite the cheap cost of the logistics employees in the Yorkshire and Humber, the logistics workforce is below GB average in both number and quality, which leaves large potential for improvement.

North Yorkshire and the Humber area are primarily rural, with a cluster of services and heavy industries around the Humber ports, whilst South and West Yorkshire are mainly urban, based on traditional industries undergoing transformation (YHFF, 2009).

According to Government Office for Yorkshire and The Humber, in the past two decades the region has suffered from the decline of traditional industries with substantial job losses in coal mining, steel, engineering and textiles. Yorkshire and The Humber was responsible for 7 percent of the UK's gross value added (GVA), nearly half of which was produced in West Yorkshire. Productivity in Yorkshire and The Humber was the lowest of all English regions, while its employment rate ranks in the middle of these regions. Manufacturing accounted for 17 percent of Yorkshire and The Humber GVA in 2006, compared with only 13 percent for the UK. The largest contributing sub-sectors of manufacturing were food, beverages & tobacco, and basic metals & fabricated metal (ONS, 2010).

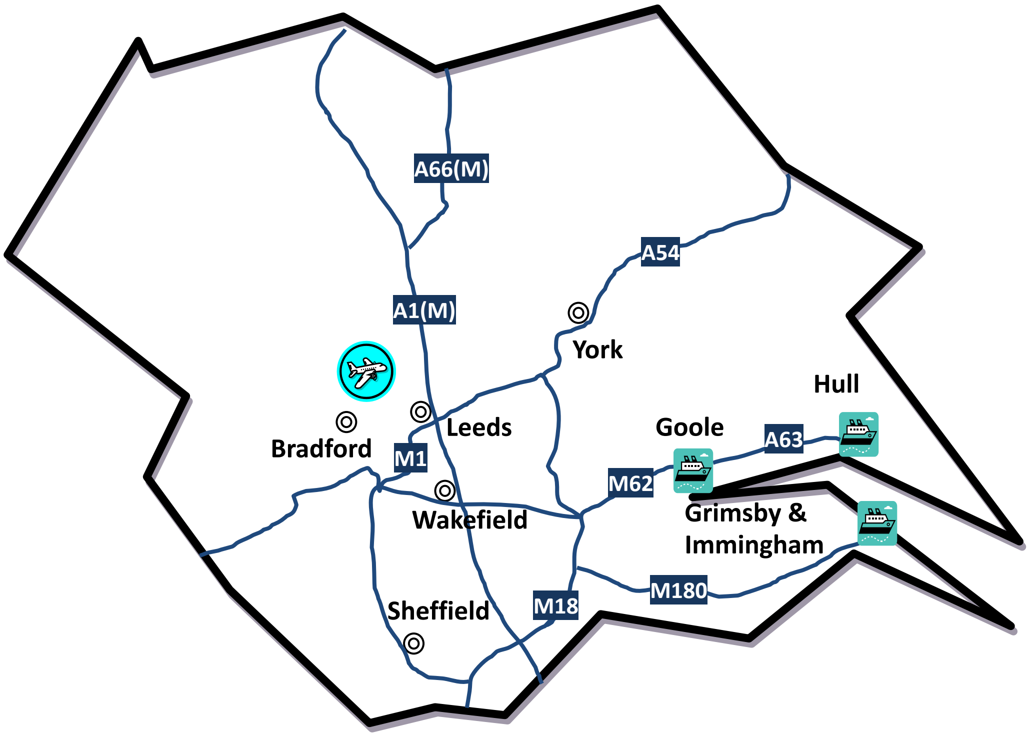


Figure 3-24. Key infrastructure in Yorkshire and Humber.

Source: The Yorkshire and Humber Regional Spatial Strategies (2008)

CHAPTER 4. RLC MEASUREMENT FRAMEWORK USING SMART-ROD METHOD

4.1 Introduction

As discussed earlier, a well-established measurement framework for regional logistics performance is missing from previous research. Therefore, this study aims to fill that gap and thereafter evaluate the logistic-economy relationships in the regions in GB. This chapter explains how the research has been designed and why the research methods being used have been chosen.

This chapter starts with a discussion on the meaning of ontological and epistemological positions and the research paradigms in the field of logistics and supply chain studies. It is argued that in the context of this study, the researcher should be independent from the researched reality in order to measure the overall regional performance in logistics as objectively as possible. Therefore a positivist perspective should be adopted.

To benchmark the 11 GB regions' RLC incorporating various indicators defined in Chapter Two, a multi-dimensional assessment tool of the regional logistics performance is needed to aggregate the difference component scores into a single RLC score. This fits the characteristics of a multi-attribute decision support problem. Two of the most widely used multi-attribute decision support methods in practice are: Multi-Attribute Utility Theory (MAUT) (Keeney and Raiffa, 1976; Edwards and Barron, 1994) and the Analytic Hierarchy Process (AHP) (Saaty *et al.*, 1983). Many specific tools stem from these two schools of methods for structuring and supporting decision making.

This chapter compares these two methods before the conclusion that MAUT fits the purpose of this study better for its sounder theoretical grounds, ability to consider all critical factors and give an overall numerical evaluation of the regions in GB integrating every aspect of RLC. In addition, MAUT provides richer details and allows direct comparison of different types of data. Finally, MAUT is simpler to use in both weight eliciting and performance score calculation.

The Simple Multi-attribute Rating Technique (SMART) is one of the most widely used models in the MAUT literature (Edwards and Barron, 1994). This chapter describes the evolution of the SMART method and discusses the most recent versions of the weight eliciting method (ROC and ROD) in detail. After comparing the procedures and advantages and disadvantages of various MAUT methods, the SMART-ROD method is chosen for this research which provides the best approximation to the true weights (Roberts and Goodwin, 2002).

Finally, a specific six-step checklist for the SMART-ROD method is presented at the end of this chapter as the standard procedure for this research.

4.2 Philosophical Consideration

Before designing the specific research method, it is important to understand different ontological and epistemological positions in order to ensure the validity and reliability of the research findings, since people’s views towards the world are different, which lead to different preferences of paradigmatic and methodological choices (Mangan *et al.*, 2004). This section discusses the philosophical consideration of the research paradigms which is essential to any research process.

As the most general lesson about the nature of being, ontology is the start point of any scientific problem study. Ontology implies epistemology, which refers to the considerations of what we stand upon for our understanding. As Solem (2003) states, “Epistemology consists, therefore, generally of reasoning processes, guarantees of truth, proofs, axioms of validity, or any other logic underlying a methodology”. Simply put, ontology refers to the nature of reality while epistemology addresses the relationship between the researcher and the researched (Bryman and Bell, 2003).

A paradigm is a very general conception of the nature of scientific endeavour within which a given enquiry is undertaken (Mangan et al., 2004). It represents “people's value judgements, norms, standards, frames of reference, perspectives, ideologies, myths, theories, and approved procedures that govern their thinking and action” (Gummesson 2000, p. 18). In the field of logistics and supply chain management research, owing to the influence of two entirely different thoughts, many researchers have shown their concern towards research methods by giving suggestions either on the quantitative side (positivist paradigm) or on the qualitative side (phenomenological paradigm) (Sachan and Datta, 2005). In the positivist paradigm, reality is considered to be objective, tangible and fragmentable; while the goal of phenomenologists is to understand a phenomenon. The alternative terms for positivist include:

“quantitative, objectives, scientific, experimentalist, deductive”; whereas for phenomenological the alternative terms include: “qualitative, subjective, humanistic, interpretivist, inductive”. The differences between positivism and phenomenology are summarised in the following Table 4-1:

Meta-theoretical assumptions	Question	Positivism	Phenomenology
Ontology	What is the nature of reality?	Researcher and reality are separate.	Researcher and reality are inseparable.
Epistemology	The relationship between the researcher and the researched?	Objective reality exists beyond the human mind.	Knowledge of the world is constituted through a person’s experience intentionally.
Research object	Is research object independent or dependent?	Research object has inherent qualities that exist independently of the researcher.	Research object is interpreted in the light of meaning structure of researcher’s lived experience.
Method	What is the process of the research?	Deductive process	Inductive process
Validity	Is it valid?	Data truly measures reality.	Defensible knowledge claims.
Reliability	Is it reliable?	Research results can be reproduced.	Researchers recognize and address implications of their subjectivity.

Table 4-1. Differences between positivism and phenomenology.

Source: adapted from Weber (2004)

With regard to research into decision making in logistics, Mangan *et al.* (2004) suggested that positivism is relevant for getting an overview and for considering the broad structure of decisions, whereas phenomenology is useful for finding out at the micro level about the behaviour of the decision maker.

There are a wide variety of methodologies available under the positivist paradigm, although some methodologies could be used under other paradigms as well (Mangan *et al.*, 2004). Such methodologies include cross-sectional studies, experimental studies, longitudinal studies, surveys, models and simulation (Hussey and Hussey, 1997).

Recall the central research objective of this study is to establish a measurement framework for qualitatively evaluating the logistics capacity of GB regions, and thereafter explore the relationship between logistics and a regional economy. In this case, the researcher should be independent from the researched reality in order to measure the overall regional performance in logistics as objectively as possible. Therefore a positivist perspective is more appropriate for this study to construct a model to measure RLC that incorporates various aspects of the regional logistics capabilities.

The next section analyses the characteristics of the research questions and proposes appropriate research methods.

4.3 Methodology Selection

4.3.1 RLC as a multi-attribute decision problem

In the social and behavioural science, many of the concepts are not directly measurable by a generally accepted measuring instrument, which are called “latent variables” (Blunch, 2008). The concept of “regional logistics capability” is one of such non-measurable variables and therefore must be measured by so-called “manifest variables”. For example, the RLC concept has to be measured by five direct measurement (five dimensions in the section 2.3.8) and several sub-measurement (twenty four indicators in the section 2.3.8). This fits the characteristics of a multi-attribute decision analysis problem. This section illustrates how the MCDA tools could solve the proposed research questions with examples of previous studies.

Multi-criteria decision analysis (MCDA), sometimes called multi-criteria decision making (MCDM), is a discipline aiming at supporting decision makers faced with making numerous and sometimes conflicting evaluations. MCDA aims at highlighting these conflicts and deriving a way to come to a compromise in a transparent process (Triantaphyllou, 2000). Multi-attribute utility theory (MAUT) is a popular MCDA tool.

MAUT provides a comprehensive set of quantitative and qualitative approaches to evaluate alternatives for complex problems involving multiple objectives (Collins *et al.*, 2006; Dyer *et al.*, 1998).

MAUT first produces an “attributes by options” matrix for identifying single attributes and then evaluating alternatives on them (see Table 4-2).

Attributes	A_1	A_2	A_3	…	A_n	Total
Weights	w_1	w_2	w_3	…	w_n	1
O_1	S_{11}	S_{12}	S_{13}	…	S_{1n}	$U(O_1)$
O_2	S_{21}	S_{22}	S_{23}	…	S_{2n}	$U(O_2)$
…	…	…	…	…	…	…
O_m	S_{m1}	S_{m2}	S_{m3}	…	S_{mn}	$U(O_m)$

Table 4-2. The MAUT attributes by options matrix.

Source: Roberts and Goodwin (2002)

Here O_i represents the *i*th option to choose from, A_j the *j*th attribute. S_{ij} is the score assigned to O_i according to its performance on A_j, which subjects to $0 \le S_{ij} \le 100$. The $w_j > 0$ are weights reflecting the relative importance of the attribute A_j, which is estimated by the decision makers. All the weights normalised to total sum of 1. $U(O_i)$ represents the aggregate multi-attribute utility of the O_i, which is composed of two values: the scores of the options with respect to each attribute and the weights of the attributes. Generally, MAUT methods use a simple additive function to aggregate $U(O_i)$ (Keeney and Raiffa, 1976):

$$U(O_i) = \sum_{j=1}^{m} w_j S_{ij} \qquad (4.1)$$

Obviously, $0 \le U(O_i) \le 100$.

MAUT models have been used in a variety of settings to solve real problems, from sitting an electricity generation facility (Keeney, 1980), choosing among vendors for the commercial generation of electricity by nuclear fusion (Dyer and Lorber, 1982) to selecting a nuclear waste cleanup strategy (Keeney and von

Winterfeldt, 1994). One of the primary tasks in the application of MAUT is to identify the overall best-in-class performer and justify a decision between alternatives (Collins *et al*, 2006). The MAUT approach enables the decision maker to incorporate preference and value trade-offs for each metric and measure the relative importance of each (Keeney and Raiffa, 1993).

Butler *et al.* (1997) illustrated the application of MAUT with a simple example site selection problem - coal power plant site selection. The selection is based on three notions: cost, environmental concerns and other technology specific features, which are captured by the measures of cost, air quality and site biology. They first establish the scaling constants (weight of each measure) and then derive the utility functions (component score of each measure) for each candidate site. Thereafter the best site choice is the one provides the highest value of a simple additive functions (See equation 4.1).

Dyer, *et al.* (1998) adopted the MAUT method to compare alternatives for the disposal of surplus weapons-grade plutonium. They evaluated 13 disposal alternatives on a hierarchy of objectives (Non-proliferation, Operational effectiveness and Environment, Safety and Health), sub-objectives and measures. The members of the Safeguards and Security time of the Department of Energy acted as advisers of the relative weights among different objectives and sub-objectives. And a team of experts from the Office of Fissile Materials Disposition of the Department of Energy assessed the single-attribute utility functions to be used for each measure to calculate the component scores. Similarly, an additive multiattribute utility model can be used to aggregate the results to identify the best disposition location among the 13 alternatives.

Collins *et al.* (2006) used MAUT method to benchmark warehouse performances. They first identified most interested areas for warehouse operating such as the tolerance levels for inventory accuracy; how well errors are handled during operation; the highest accuracy rate could be expected, etc. Then they select a set of proper performance metrics for the benchmarking study, including: Picking accuracy, Inventory accuracy, Storage time and Order cycle time. The next step is assigning utility values - they did so by working closely with experts associated with the study and assigning scores according to the warehouses' performance in each metrics above. Thus, each warehouse is given a component score for each metric. To bring these component score together to identify the best-in-class performer, Collins *et al.* (2006) also calculated the relative weights for the four metrics. They discussed with the sponsor organisation about the priorities of the current warehouse policies and determined initial relative weights should be assigned to the data, and then performed a sensitivity analysis to justify the relative weights. After the sensitivity analysis, the participant with the highest combined utility value is identified using the same additive function (see equation 4.1).

From the above examples, one can see that the MAUT methods provide a logical and tractable means to make trade-offs among conflicting objectives. Although the measurement of a region's logistics capability is not a decision as such, it does need to consider and balance various factors that affect the logistics performance of a region (as discussed in section 2.3) and eventually presents a quantitative model that reflects the overall logistics capability of the region.

Due to its multi-attribute nature, regional logistics capability could be measured by the MAUT approach in this study, if we see the 11 regions in GB as "alternative options" and different RLC indicators as "attributes". In this way, it is possible to benchmark how each regions performs on each of the RLC indicator and more importantly, get an overall RLC measure for each region that aggregates all the RLC indicators.

4.3.2 MAUT v.s. AHP

This section explains why the MAUT is the best tool to use when comparing with the other tool Analytic Hierarchy Process (AHP).

An alternative multi-attribute decision supporting tool that could be used here is Saaty's (1980) Analytic Hierarchy Process (AHP). AHP is built on very similar simple additive weighted value function as in MAUT, although the AHP weights (w_j) and scores (S_{ij}) are not explicitly distinguished whereas the MAUT approaches do distinguish between weights and scores in both theory and assessment means (Belton, 1986).

In the AHP, each weight and score is assessed by the construction of pairwise comparison matrix. The decision makers are asked to compare the importance of two attributes at a time by indicating the strength of their preferences by using integers from 1 to 9. Similarly, the scores also result from decision makers' pairwise comparisons of alternative options with respect to a particular attribute. In comparison, MAUT approaches are more direct in eliciting the weights by asking the decision makers to assign a value to each option on each attribute and assigning scores according to the actual performance data of alternatives on each attribute.

Edwards and Barron (1994) believe the judgements of indifference between pairs of hypothetical options required in AHP are more difficult and unstable, whereas more nearly direct assessments of the desired quantities are easier and less likely to produce elicitation errors. In the context of this study, the performance data of RLC indicators are often availably accessible from public sources, such as transport statistics and labour force surveys, which could be easily converted into the performance scores (S_{ij}) rather than going through pairwise comparison. This also means that the scores produced by MAUT approaches represent the objective "facts" rather than decision makers' subjective "preferences or opinions", and are therefore theoretically sounder (Dyer, 1990).

Hence MAUT is more suitable for the purpose of this research. MAUT proves to be effective in establishing priorities of several critical metrics and provides a method to compare these metrics across several participants (Collins *et al.*, 2006). The most powerful advantage to using MAUT to measure RLC is its ability to consider all critical factors and give an overall numerical evaluation of the regions in GB integrating every aspect of RLC. In addition, although MAUT methods tend to be more data intensive and structured with regard to their measures and scaling when comparing with AHP, they do offer more detail and allow readers to perceive the strengths and weaknesses of the various regions in logistics (Canbolat *et al.*, 2007). Also, MAUT allows different types of data to be directly compared. For example, regional unemployment (in percentage) and water freight volume (in tonnes) are converted into identical units, making comparison easier. Moreover, MAUT is simpler in structure and calculation therefore easier for application. Finally, the data used in other benchmarking methodologies is easily re-used for the MAUT analysis, providing more information.

Having justified the choice of the MAUT approach, the next section discuss the specific weight-eliciting methods (point allocation method, direct rating method), introduce the evolution of the SMART methods (SMART, SMARTS, SMARTER and SMART-ROD) and finally develops a checklist of the SMART-ROD method to be used in this study.

4.3.3 Point Allocation v.s. Direct Rating

There are different methods of assigning numerical judgements to attributes in order to signify their relative importance (w_j in Table 4-2 and equation 4.1). The two most commonly used are the point allocation method and the direct rating method. Although these two methods may seem to be similar, they do produce very different profiles of attribute weights (Bottomley *et al.*, 2000).

In the point allocation method the decision maker has a “budget” of points to allocate between the attributes in a way that reflects their relative importance. The decision maker is asked, for example, to divide 100 points among the attributes which are relevant to a particular decision. In this case, obviously, normalisation is not needed as the weights already sum to 100. The point allocation method is a more difficult task since the decision makers need to not only evaluate the relative importance of the attributes but also worry about the constraint that the total must be some specified value (Roberts and Goodwin, 2002).

In the direct rating method, "direct numerical ratio judgements" are used to represent relative attribute importance (von Winterfeldt and Edwards 1986). This could be done with either "Max100" or "Min10". Max100 takes 100 as the weight for the most important attribute and then to allocate weights relative to this 100 starting point as the weight of successive attributes whereas Min10 begins with assigning 10 points to the least important attribute and then the relative importance of the other attributes are evaluated from 10 points upwards (Bottomley and Doyle, 2001). The outcomes of Max100 and Min10 are called raw weights (w*), which need to be normalised with the following equation to sum to a total 1.

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* \qquad (4.2)$$

Doyle *et al.* (1997) compared these two methods of assigning numerical values to weights and indicate that direct rating is more preferred by people and gives more consistent and reliable weights. As a form of direct rating, Max100 shows the highest reliability and subject preference. Roberts and Goodwin (2002) also pointed out that direct rating method of selecting raw weights is normally used as it is cognitively simpler and therefore is assumed to yield more consistent and accurate judgements from the decision maker. Choosing the appropriate weight-eliciting method is crucial as it serves as a foundation of the MAUT methods. This will be illustrated later in the evolution of the SMART methods.

4.3.4 SMART, SMARTS and SMARTER

As a method of multiattribute utility measurement, SMART (Simple Multi-attribute Rating Technique) was originally sketched by Edwards in 1971 and first named in 1977. Since the early experiments, SMART has developed into SMARTS and SMARTER (Edwards and Barron, 1994).

With SMART the weights are elicited in two steps (von Winterfeldt and Edwards, 1986): first rating alternatives and then weighting attributes using the MAX100. Edwards and Barron (1994) listed shortcomings of this original procedure for overlooking the fact that importance of attributes should clearly be related to the attribute ranges. SMARTS (SMART using Swings) remedies this intellectual error of SMART along with some other improvements. SMARTS requires rather complicated judgemental steps where decision makers need to evaluate the relative importance of an improvement in one attribute from its worst level to its best level compared with changes in the other attributes.

Because the elicitation of weights via SMARTS can be a burden for the decision makers and the research itself, SMARTER (SMART Exploiting Ranks) uses ranking of the weights to eliminate the most difficult judgemental step in SMARTS. The SMARTER method asks the decision makers simpler questions about the relative importance of the attributes and uses “surrogate” weights that are intended to approximate the decision maker’s “true” weights based on the ranking of the attributes (Roberts and Goodwin, 2002).

The SMARTER method, as a simpler alternative produces rather satisfactory results as noted by Edwards and Barron (1994): “The results of extensive simulations … suggest that the SMARTS and SMARTER will agree on which option has the highest aggregate benefit in 75%-87% of cases. Even when they did not agree, the option identified by SMARTER as having the highest aggregate benefit tended to have a very similar score to the ‘best’ option identified by SMARTS, suggesting that an option which was ‘not too bad’ was being picked by SMARTER”.

In the next section, the underlying theoretical ground of SMARTER (rank order centroid) will be further explored based on the argument of Roberts and Goodwin (2002), and propose the SMART-ROD method as the best method for this study.

4.3.5 SMART-ROC (SMARTER) rational

Since the weights generated are highly influenced by the method used to produce them and there is no agreed method of eliciting the weights, there is no way of directly identifying the “true set of weights”. Therefore, the SMARTER method proposed by Edwards and Barron (1994) is one of the solutions to translate the rankings into “surrogate” weights that represent an approximation of the “true” weights. SMARTER method could be also called “SMART-ROC” method because it is based on centroid method to calculate Rank Order Centroid (ROC) weights as surrogate weights (Poyhonen *et al.*, 2001).

ROC weights are based on the assumption that the “true” weights are uniformly distributed and point allocation method has been used for eliciting weights. Consider the simplest example involving only two attributes first. The most important attribute must be given a weight (w_1) which is less than 1 and greater than 0.5. As the weights in the point allocation method sum to 1 the weight of the other attribute must be (1 - w_1). Assuming that the "true" weights are uniformly distributed, the means of the two distributions of the ranks would be 0.75 and 0.25 respectively. For the cases involving more than two attributes, a mathematical approach is required to determine the theoretical distribution of the ranked weights following a point allocation procedure. If the interval 0 - 1 is randomly cut into n sections by choosing n - 1 random points between 0 and 1, then ranking the sections by length then the exact probability distribution for the *k*th largest section is (Roberts and Goodwin, 2002):

$$f_{w_k}(x) = k(n-1)\left(\frac{n}{k}\right)\sum_{j=0}^{n-k}(-1)^j\left(\frac{n-k}{j}\right)\times\max\left\{0,[1-(k+j)x]^{n-2}\right\} \quad (4.3)$$

Where $k = 1,2,\ldots,n$

Thus the mean values of the distributions of the attributes are equivalent to the ROC weights. Generally, if n is the number attributes, assuming $w_1 \geqslant w_2 \geqslant \ldots \geqslant w_k$, then the weight of the *k*th attribute is

$$w_k = \left(\frac{1}{n}\right)\sum_{i=k}^{n}\left(\frac{1}{i}\right) \quad (4.4)$$

It is easy to see when there are two attributes (n = 2), the more important one will get the weight of 0.75 (w_1), the other 0.25 (w_2). Therefore, according to the above function the centroid weights for n=2 to 10 are calculated and listed in the following Table 4-3, which can be easily used to represent the "true" weights:

Number of Attributes (n)									
Rank (k)	2	3	4	5	6	7	8	9	10
1	0.75	0.6111	0.5208	0.4567	0.4083	0.3704	0.3397	0.3143	0.2929
2	0.25	0.2778	0.2708	0.2567	0.2417	0.2276	0.2147	0.2032	0.1929
3		0.1111	0.1458	0.1567	0.1583	0.1561	0.1522	0.1477	0.1429
4			0.0625	0.0900	0.1028	0.1085	0.1106	0.1106	0.1096
5				0.0400	0.0611	0.0728	0.0793	0.0828	0.0846
6					0.0278	0.0442	0.0543	0.0606	0.0646
7						0.0204	0.0334	0.0421	0.0479
8							0.0156	0.0262	0.0336
9								0.0123	0.0211
10									0.0100

Table 4-3. ROC weights for n=2 to 10 criterions.

Source: Edwards and Barron (1994)

Barron and Barrett (1996) found that “ROC is clearly and overwhelmingly the most efficacious.” However, note that the underlying assumption of ROC weights is that the decision maker’s “true” weights will naturally sum to a fixed total such as 1 or 100 which is obtained through the point allocation method, which places greater cognitive complexity on the decision maker than the direct rating method such as MAX100 (Doyle *et al.*, 1997).

Therefore, Roberts and Goodwin (2002) developed an alternative weight approximation method – Rank Order Distribution (ROD) method based on direct rating point allocation of determining raw weights in multivariate analysis.

4.3.6 SMART-ROD rational

As discussed earlier, in the direct rating method (MAX100), the most important attribute is commonly assigned a weight of 100 and the importance of the other attributes are then assessed relative to this benchmark. Assuming that all attributes have some importance, the ranges of the possible raw weights could be expressed by the following less-than-or-equal-to expression:

$$0 \le w_i^* \le w_{i-1}^* \le ... \le w_3^* \le w_2^* \le w_1^* \le 100$$

If assuming uniform distributions of the "true" weights again (Edwards and Barron, 1994; Roberts and Goodwin, 2002), it would apply to all the raw weights ranges specified above. For simplicity and without loss generality, consider the case for two attributes first. Assuming:

$$0 < w_2^* \le w_1^* \qquad w_1^* = 100$$

Then the normalised weights will be

$$w_1 = 100/(100 + w_2^*) \qquad w_2 = w_2^*/(100 + w_2^*) \qquad (4.5)$$

So assuming uniformity for w^*_2:

$$E(w_1) = \int_0^{100} 1/(100 + w_2^*)\, dw_2^* = [\log_e(100 + w_2^*)]_0^{100} = 0.693 \qquad E(w_2) = 1 - E(w_1) = 0.307 \qquad (4.6)$$

The ROD weights for two attributes are therefore 0.693 and 0.307, in comparison with 0.75 and 0.25 in the ROC method. Based on the same theory ground, Roberts and Goodwin (2002) have calculated all the ROD weights up to 10 attributes for 10 alternatives for easy implementation, which is shown in the following Table 4-4.

Number of Criterions (n)									
Rank (k)	2	3	4	5	6	7	8	9	10
1	0.6932	0.5232	0.4180	0.3471	0.2966	0.2590	0.2292	0.2058	0.1867
2	0.3068	0.3240	0.2986	0.2686	0.2410	0.2174	0.1977	0.1808	0.1667
3		0.1528	0.1912	0.1955	0.1884	0.1781	0.1672	0.1565	0.1466
4			0.0922	0.1269	0.1387	0.1406	0.1375	0.1332	0.1271
5				0.0619	0.0908	0.1038	0.1084	0.1095	0.1081
6					0.0445	0.0679	0.0805	0.0867	0.0893
7						0.0334	0.0531	0.0644	0.0709
8							0.0263	0.0425	0.0527
9								0.0211	0.0349
10									0.0173

Table 4-4. ROD weights for n=2 to 10 criterions.

Source: Roberts and Goodwin (2002)

In summary, the theory grounds for ROC and ROD weights suggest that the ROC weights are the best surrogate weights for the point allocation method of assigning raw weights while the ROD weights are the best for direct rating method. This study chooses the SMART-ROD method to evaluate the integrated regional logistics performance in the regions in GB and offers a quantified RLC score for benchmarking. A checklist of the procedures for the SMART-ROD will be presented in the next section.

4.4 A Checklist for SMART-ROD Method

Based on the previous discussion of the MAUT methods, the SMART-ROD method was chosen and this study adopts a six-step procedure to explore the GB regional logistics performance as shown in the following flow chart:

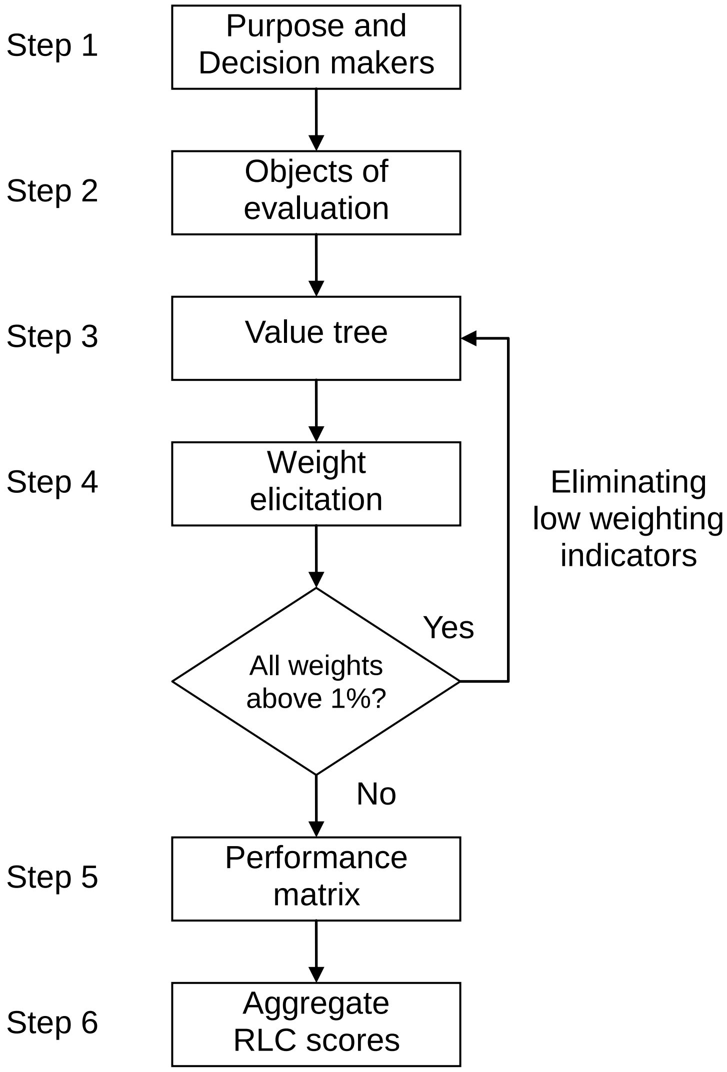


Figure 4-1. Flow chart of the research design.

Step one: Purpose and decision makers. This is the step to identify the purpose of the value elicitation and the individual, organisation(s) whose value should be elicited from. In this study, there is no “decision makers” per se as the purpose is to produce a quantitative measurement framework of RLC in GB rather than “choosing” the best alternative option. However, decisions need to be made about the relative importance of each indicator in determining the RLC. It is believed that such information would be the most reliable when comes from people working in and knowledgeable about the UK economy and logistics industry. Therefore, a list of UK academics, practitioners, and people working in the UK regional development agencies was compiled to play the role of the "decision makers" in this study. The outcome of this first step is a list of informants.

Step two: Objects of evaluation. This step produces a full list of objects of evaluation with number at least as large as the proposed number of attributes (Edwards and Barron, 1994). In this study, the objects of evaluation are the 11 regions in GB. To increase the observed data points, data of five years (2004 - 2008) are included in this study to give in total 55 data points.

Step three: Value tree. Elicit a value tree or a list of attributes potentially relevant to the purpose of the value elicitation. This was done in the Chapter Two by reviewing the relevant literature. Total 24 indicators which affect the logistics performance of a region are identified as preliminary RLC indicators and are categorised into five dimensions: location features, quality of infrastructure, local logistics services, size and quality of workforce, and local administration policies and efficiency (see Table 2-3 and Figure 2-13).

Edwards and Barron (1994) argued that the unimportant attributes which would result low weightings if retained should be omitted or combined to reduce the number of the attributes. In this study, we take 1% as the cut-point for low weightings.

Step four: Weight elicitation. Having specified the attributes (RLC indicators) and hierarchy structure in the last step, a questionnaire is designed to collect the regional logistics experts' views on the relative importance of the RLC indicators (see Appendix One). Since there is an element of subjectivity involved in this process, the number of logistics experts should be maximised to minimise bias. The questionnaire adopts the direct rating method (MAX100), where logistics experts are asked to give their weights in two steps: First rank the dimensional and sub-dimensional indicators from most important to least. Then assign 100 points to the most important indicator, before score the remaining indicators from 100 downwards relative to the 100 starting point benchmark.

These raw weights are then normalised to gain weights using the equation 4.2 discussed earlier. After taking the average of the weights, the ranking of the RLC indicators in each dimension is used to produce the final ROD weights (matching weights from Table 4-4). If any insignificant weights are found at this step (any low weights under 1%), it is needed to go back to the step three to omit them. The outcome of this step is a set of weights that illustrate the relative importance of the chosen RLC indicators.

Step five: Performance matrix. This step calculates the performance scores for each region on the different indicators to formulate a performance matrix of regions of evaluation by RLC indicators, such as the "MAUT attributes by options matrix" in Table 4-2. Note that the raw performance data (x) obtained from published statistical sources for each indicator are only numbers that a higher or lower is preferred in a value sense, *i.e.*, in the ordinal utility form. They have different ranges, units and different preferences therefore difficult to compare directly. For example, the range for GB regional sea freight traffic in

2008 is from 0 (West Midlands) to 96,346 thousand tonnes (Scotland) – the higher the better, whereas the range for unemployment rate is from 7.5 percent (North East) to 4.1 percent (South West) – the lower the better.

To make it possible to aggregate these numbers for individual indicators to a multi-attribute utility score, it is necessary to convert the ordinal performance data (x) to a single-dimensional cardinal performance score ($S(x)$) from 0 (the worst case) to 100 (the best case). So that ,for example, West Midlands and Scotland would be given 0 and 100 points for sea freight respectively; for unemployment rate, the North East 0 and the South West 100.

The raw performance data functions of physical or judged quantities which fall in one of the following four types of linear utility functions as shown in the following Figure 4-2 (Edwards and Barron, 1994). Type A are functions in which more of *x* is better than less, e.g. market access. Type B are functions in which less of *x* is better than more, e.g. labour cost. Type C include functions containing an interior maximum of x. Type D are direct judgmental utilities for which no underlying single physical variable exists.

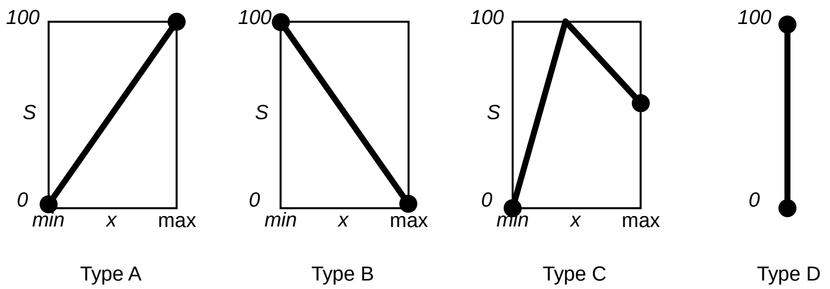


Figure 4-2. Four types of linear utility functions.

Source: Edwards and Barron (1994)

Therefore equations 4.7, 4.8, 4.9 are used to convert raw performance data (x) in type A, B, C to the performance score ($S(x)$) from 0 (the worst case) to 100 (the best case).

$$S_{ij} = S(x) = \begin{cases} 0 & x \le \min \\ 100 \times (x - \min)/(\max - \min) & \min < x < \max \\ 100 & x \ge \max \end{cases} \qquad (4.7)$$

$$S_{ij} = S(x) = \begin{cases} 100 & x \le \min \\ 100 \times (\max - x)/(\max - \min) & \min < x < \max \\ 0 & x \ge \max \end{cases} \qquad (4.8)$$

$$S_{ij} = S(x) = \begin{cases} 100 \times (x - \min)/(best - \min) & \min \le x \le best \\ 100 \times (\max - x)/(\max - best) & best < x \le \max \\ 0 & else \end{cases} \qquad (4.9)$$

For this study, this step would produce a matrix of performance scores on various RLC indicators by the 11 regions in 5 years. The scores are in the range of 0 to 100, where the best performer is given 100 points and the worst performer 0 points.

Step Six: aggregate the RLC scores. Having elicited the weights and the performance scores of RLC indicators, this finally step simply aggregates these data to an integrated RLC score for the regions in GB. Based on the SMART-ROD method, the overall regional logistics capability for region i can be described as:

$$R_i = \sum_j w_j S_{ij} = \sum_j w_j^D \sum_k w_{jk}^S S_{ijk} \qquad (4.10)$$

Where R_i is the overall RLC value of region i;

w^D_j and w^S_{jk} are both weights elicited in the step four. w^D_j is the weight assigned to dimension j to reflect its importance relative to the other dimensions whereas w^S_{jk} is the sub-dimensional weight assigned to indicator k under dimension j;

S_{ijk} is the performance score of region i on indicator k under dimension j.

4.5 Conclusion

A well-established measurement framework for regional logistics performance is necessary for the evaluation of the logistic-economy relationships in the regions in GB. This chapter builds on the previous chapters and develops a measurement framework for RLC in GB to quantify the RLC score.

Firstly, this chapter discussed the various research paradigms in logistics studies and argued a positivist perspective should be adopted for this research. Then it argued that the aim of the RLC measurement framework is to benchmark the RLC of different regions incorporating various indicators and to aggregate the difference indicators into a single RLC score, which is in fact a multi-attribute decision support problem. Thereafter two most widely used multiattribute decision support methods (MAUT and AHP) were discussed in this chapter before the conclusion that MAUT fits the purpose of this study better for its sounder theoretical grounds, ability to consider multiple factors and give an overall numerical evaluation. In addition, MAUT allows direct comparison of different types of data.

This chapter also compared various MAUT techniques and argued the SMART-ROD method is the most suitable for this research. Finally, a specific six-step checklist for the SMART-ROD method is presented at the end of this chapter as the standard procedure for this research.

CHAPTER 5. DATA COLLECTION AND AGGREGATION OF THE RLC SCORES

5.1 Introduction

This chapter is the first of two data analysis chapters. It focuses on how the research method is carried out. The collection of the data used in this research and the calculation of the RLC scores will be discussed here before more in-depth data analysis in the next chapter.

Due to its nature of large scale, this study relies on a combination of two datasets to aggregate the RLC scores for the 11 regions in GB: expert evaluations of the relative importance of the indicators and specific indicator performance data from public sources.

The weight evaluating dataset is first-hand data collected from 40 "experts in the UK regional logistics". To minimise individual subjective bias, a mix of academics, practitioners, and people working in the UK regional development agencies were selected as the source of information for the weighting data (see Table 5-1). Their views on the relative importance of the RLC indicators are collected by filling a guided questionnaire as attached in Appendix One.

The RLC indicator performance dataset includes second-hand data taken from public sources such as the Office of National Statistics (ONS), Department for Transport (DfT), HM Treasury and Her Majesty's Revenue and Customs (HMRC). The data on different scale will be converted into identical units To ease comparison as shown in the Step Five in the research design checklist.

The 11 government office regions in GB are the objects of evaluation in this study. To increase the observed data points, it would make sense to use the longest time series possible. However, for many of the indicators such as regional emissions, data previous to the year of 2004 are not available. Therefore data of five years (2004 - 2008) is included to give in total 55 data points.

The data in this study uses the UK Standard Industrial Classification of Economic Activities (SIC) for classifying industries[3]. Most of the data is classified under SIC (2003) while part of the 2008 data is classified under SIC (2007). SIC (2003) had 17 sections and 62 divisions and SIC (2007) has 21 sections and 88 divisions. The section I (Transport, storage and communications) in the 2003 version has been broken up to section H (Transportation and storage) and section J (Information and communication). In terms of logistics activities, relevant data is categorised under division 60-63 in SIC (2003) and division 49-53 in SIC (2007).

This chapter starts by presenting the eliciting procedures and results of the RLC indicator weights and then introduces how the actual regional performance scores for the 17 final RLC indicators was produced. Thereafter, the RLC scores are aggregated from the weights and performance scores of the indicators.

[3] See ONS introduction to SIC at: http://www.statistics.gov.uk/statbase/Product.asp?vlnk=14012

The analysis of the RLC of regions in GB is seriously constrained by the availability of regional data on logistics performance. This chapter also gives a discussion of the issues of the data used including omitted indicators, missing data and outliers. Appropriate procedures and remedies are conducted to each of these issues. Seven of the twenty four preliminary indicators are omitted from the model due to low weights, unavailable data and lack of relevance in the UK regional context. The missing values are estimated via “mean imputation” and “Hot Deck imputation” methods base on valid values of other variables and/or cases in the sample. The outliers are identified and dealt with by tracking and adjusting the source of inconsistent Annual Population Survey data in the year of 2004. Next, tests of normality are conducted to prepare for the further analysis of the data. Finally, a sensitivity analysis is conducted at the end of this chapter to ensure the robustness of the GB RLC measurement framework by proving that marginal changes in the original relative weights would not alter the RLC ranking of regions in GB significantly.

5.2 Data for Weights

5.2.1 Questionnaire design

Data collection is a very important part of any research project. Without the collection of the data, there is no way that the research questions could be fully answered (Aldridge and Levine, 2001). The questionnaire design is an important element in the success of data collection. This section discusses the designing of the questionnaire used in this study.

Past experiences have shown that it is very unusual to go through a research project process without having some type of data collection error (Polonsky and Waller, 2004). Therefore, attempts should be made to minimise the total error from any source that can affect the research findings when planning the research.

Brace (2008) claims that there are two generally recognised types of errors in all surveys: Sampling error and Non-sampling errors.

A sample is a relatively small subset of the population that is selected to be representative of the population's characteristics. The larger the sample, the more precisely it reflects the target group. Sampling errors result from the random variation in the selection of respondents. By increasing the size of the sample, the effects of sampling errors can be reduced. However, this method is often limited by factors such as: time available, budget and human resource available. Because the rate of improvement in the precision decreases as the sample size increases.

In this study, we are interested in investigating the logistics capabilities of the regions in Britain. Therefore, the sampling population need to be with knowledge of the GB regional economy and the logistics industry. The sample chosen in the study has to be representative of all the regions, and stands for all the stakeholders in the logistics industry. Hence, a list of 40 UK academics, industrial practitioners, and people working in the UK regional development agencies and government offices are selected as the "decision makers" in this study to provide estimation of the relative importance of indicators in determining the RLC.

The following Table 5-1 lists the basic information of the informants participated in this research, including their names, working fields and based regions.

Experts	Field	Region	Experts	Field	Region
Exp 01	Industrial	Yks	**Exp 21**	Industrial	London
Exp 02	Government	EA	**Exp 22**	Academic	NW
Exp 03	CILT	Yks	**Exp 23**	Consultant	Yks
Exp 04	Academic	Scot	**Exp 24**	Academic	SE
Exp 05	Academic	SE	**Exp 25**	Industrial	UK
Exp 06	Consultant	UK	**Exp 26**	Consultant	NE
Exp 07	Academic	NW	**Exp 27**	Consultant	Yks
Exp 08	Port	Yks	**Exp 28**	CILT	Wal
Exp 09	UKTI	NE	**Exp 29**	Industrial	EA/EM
Exp 10	Industrial	Yks	**Exp 30**	Industrial	NE
Exp 11	Academic	Scot	**Exp 31**	Industrial	UK
Exp 12	Government	Yks	**Exp 32**	Academic	SW
Exp 13	Industrial	EM	**Exp 33**	Industrial	London
Exp 14	Consultant	NW	**Exp 34**	Industrial	Scot
Exp 15	CILT	EM	**Exp 35**	Consultant	Scot
Exp 16	Government	Wal	**Exp 36**	Government	Yks
Exp 17	CILT	WM	**Exp 37**	Industrial	Yks
Exp 18	Consultant	London	**Exp 38**	Academic	Scot
Exp 19	CILT	EM	**Exp 39**	Academic	Yks
Exp 20	Industrial	Yks	**Exp 40**	Government	NE

Table 5-1. Expert list for eliciting weights.

The following Table 5-2 and Table 5-3 list the breakdown of experts contributed to the RLC weighting data of this study by their field and the region they are based in. A good balance among experts in the academia, industry and government agencies is shown in Table 5-2. Since the pilot study stage is carried out in the Yorkshire and Humber region, a higher percentage of respondents are from this region. The participants were asked to give responses based on all the regions in the UK. Therefore, it is possible the results are slightly biased to the “Yorkshire and Humber opinion”. However, this bias is not considered to be significant to the overall RLC weighting since the percentage is not overwhelming (27%) comparing with the other regions and 7% of the experts do not have a base region, therefore are representing all the regions.

Field	No. of participants	%
Academic	9	23%
CILT	5	13%
Consultant	7	18%
Government	5	13%
Industrial	12	30%
Port	1	3%
UKTI	1	3%

Table 5-2. Expert list by field

Region	No. of participants	%
EA	2	5%
EM	4	10%
London	3	7%
NE	4	10%
NW	3	7%
Scot	5	12%
SE	2	5%
SW	1	2%
UK	3	7%
Wal	2	5%
WM	1	2%
Yks	11	27%

Table 5-3. Expert list by Region

Non-sampling errors arise from mistakes made in areas such as the coding and data entry processes of the survey. Such mistakes can be fatal to the success of the survey. Therefore, it is crucial to properly design the questionnaire questions and analysis methods to collect the right information to address the objectives of the study and to minimise non-sampling errors. To do so, the following four points were followed in designing the questionnaire.

Firstly, the questions need to be closely related to the research objectives. The questionnaires used with all the informants are designed with the standard including brief introduction of the research objectives upfront. Also the questionnaire lists clear definitions of the terminologies used to avoid misunderstanding.

Secondly, the layout of the questions and format of the information required need to be easily understood by the informants and compatible with the data analysis method. In this study, the direct rating method (MAX100) is adopted, where logistics experts are asked to give their weights in two steps: First rank the dimensional and sub-dimensional indicators from most important to least. Then assign 100 points to the most important indicator, before score the remaining indicators from 100 downwards relative to the 100 starting point benchmark. As discussed earlier, this direct rating method is more reliable and preferable by the subjects than the point allocation method.

Thirdly, interviewer-administrated survey is adopt to collect accurate data in this study, where the completing of the questionnaire is guided by the interviewer over telephone or face to face interview. In this way, queries about the meaning of a question can be dealt with immediately without jeopardising the quality of the data collected under misunderstanding (Bryman and Bell, 2003). In addition, the respondents can be encouraged to provide deeper responses and further comments beyond the design of the questionnaire, which is especially important in the questionnaire piloting stage.

Fourth, the questionnaire design was first tested within the Yorkshire and Humber region. As a pilot study, twelve experts were interviewed and asked to give weighting estimates of the five criteria that determine RLC, and give insights of any other factors that influence the RLC in GB. The data collected in this pilot study were presented on the LRN2009 conference to illustrate the methodology employed to elicit feedback and verification of its applicability (Song *et al*., 2009). As a result, the questionnaire and the research method design were verified to be applicable with some minor changes to the indicator list and definition phrasing.

5.2.2 Ethical issues

Ethical issues arise at a variety of stages in business and management research, which cannot be ignored, in that they relate directly to the integrity of a piece of research and of the disciplines that are involved. Diener and Crandall (1978) broke ethical principles in business research into four main areas: Whether there is harm to participants; Whether there is a lack of informed consent; Whether there is an invasion of privacy; Whether deception is involved.

Following the "Check list of issues to consider in connection with ethical issues" suggested by Bryman and Bell (2003), the research was ensured to be conducted ethically:

- Check to ensure that there is no prospect of any harm coming to the participants and make sure that research participants understand:
  - ✓ What the research is about?
  - ✓ The purposes of the research?
  - ✓ The nature of their involvement in the research?
  - ✓ How long their participation is going to take?
  - ✓ That their participation is voluntary?
  - ✓ That they can withdraw from participation in the research at any time?
  - ✓ What is going to happen to the data?
- Make sure the privacy of the people involved in the research will not be violated.
- Ensure that the research participants will not be deceived about the research and its purposes.
- Ensure the confidentiality of data relating to the research participants will be maintained.
- Ensure the names of the research participants and the locations of the research are not identifiable.
- Ensure the strategy for keeping the data in electronic form comply with data protection legislation.

During the research, careful considerations were given to make sure the participants are fully aware of the purpose of procedures of the study, and their identity is protected.

5.2.3 Result of the questionnaire

The experts' evaluation of relative importance of the RLC indicators is elicited by guided survey using questionnaire as attached in the Appendix One. These raw weights are then normalised to gain weights using the equation:

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* \qquad (5.1)$$

Where w^*_i is the raw weights;

w^* is the normalised weights which sum to 1.

After taking the average of the weights, the ranking of the RLC indicators in each dimension is used to produce the final ROD weights of all 24 preliminary RLC indicators. Table 5-4 shows the weight eliciting processes and results. The "Raw weights" are normalised and averaged experts evaluating weights, which are used to rank the RLC indicators. The "ROD weights" are then produced according to this ranking. Finally, the "overall weights" are calculated by simply multiplying the sub-dimensional weights with their relative upper dimension weights.

	Raw weights	Ranking	ROD weights									Total
					Stra-location	**Mkt access**	**Geography**	**Stability**	**Environment**			
Location dimension	0.262	1st	34.71%	*Raw weights*	0.310	0.224	0.210	0.132	0.124			100%
				Ranking	1st	2nd	3rd	4th	5th			
				ROD weights	34.71%	26.86%	19.55%	12.69%	6.19%			100%
				Overall weights	**12.05%**	**9.32%**	**6.79%**	**4.40%**	**2.15%**			34.71%
					Road	**Water**	**Rail**	**Intermodal**	**Air**	**Pipeline**	**ICT**	
Infrastructure dimension	0.244	2nd	26.86%	*Raw weights*	0.229	0.176	0.166	0.127	0.115	0.099	0.088	100%
				Ranking	1st	2nd	3rd	4th	5th	6th	7th	
				ROD weights	25.90%	21.74%	17.81%	14.06%	10.38%	6.79%	3.34%	100%
				Overall weights	**6.96%**	**5.84%**	**4.78%**	**3.78%**	**2.79%**	**1.82%**	**0.90%**	26.87%
					Prof-skills	**Demography**	**Wage level**	**Int-language**				
Workforce dimension	0.190	3rd	19.55%	*Raw weights*	0.291	0.275	0.249	0.186				100%
				Ranking	1st	2nd	3rd	4th				
				ROD weights	41.80%	29.86%	19.12%	9.22%				100%
				Overall weights	**8.17%**	**5.84%**	**3.74%**	**1.80%**				19.55%
					Transport	**Warehousing**	**Value added**	**Knowledge**	**Financial**			
Service dimension	0.189	4th	12.69%	*Raw weights*	0.269	0.225	0.181	0.166	0.159			100%
				Ranking	1st	2nd	3rd	4th	5th			
				ROD weights	34.71%	26.86%	19.55%	12.69%	6.19%			100%
				Overall weights	**4.40%**	**3.41%**	**2.48%**	**1.61%**	**0.79%**			12.69%
					Gov-funding	**Red tape**	**Customs**					
Administration dimension	0.114	5th	6.19%	*Raw weights*	0.370	0.324	0.307					100%
				Ranking	1st	2nd	3rd					
				ROD weights	52.32%	32.40%	15.28%					100%
				Overall weights	**3.24%**	**2.01%**	**0.95%**					6.19%

Table 5-4. Unadjusted weight eliciting results (low weights identified).

	Raw weights	*Ranking*	*ROD* weights		**Stra-location**	**Mkt access**	**Geography**	**Stability**	**Environment**	*Total*
Location dimension	0.262	1st	34.71%	*Raw weights*	0.310	0.224	0.210	0.132	0.124	
				Ranking	1st	2nd	3rd	4th	5th	
				ROD weights	34.71%	26.86%	19.55%	12.69%	6.19%	100%
				Overall weights	**12.05%**	**9.32%**	**6.79%**	**4.40%**	**2.15%**	34.71%
					Road	**Water**	**Rail**	**Intermodal**	**Air**	
Infrastructure dimension	0.244	2nd	26.86%	*Raw weights*	0.229	0.176	0.166	0.127	0.115	
				Ranking	1st	2nd	3rd	4th	5th	
				ROD weights	0.3471	0.2686	0.1955	0.1269	0.0619	100%
				Overall weights	**9.32%**	**7.21%**	**5.25%**	**3.41%**	**1.66%**	26.86%
					Prof-skills	**Demography**	**Wage level**			
Workforce dimension	0.190	3rd	19.55%	*Raw weights*	0.291	0.275	0.249			
				Ranking	1st	2nd	3rd			
				ROD weights	52.32%	32.40%	15.28%			100%
				Overall weights	**10.23%**	**6.33%**	**2.99%**			19.55%
					Transport	**Warehousing**	**Value added**			
Service dimension	0.189	4th	12.69%	*Raw weights*	0.269	0.225	0.181			
				Ranking	1st	2nd	3rd			
				ROD weights	0.5232	0.324	0.1528			100%
				Overall weights	**6.64%**	**4.11%**	**1.94%**			12.69%
					Gov-funding					
Administration dimension	0.114	5th	6.19%	*Raw weights*	0.370					
				Ranking	1st					
				ROD weights	100.00%					100%
				Overall weights	**6.19%**					6.19%

Table 5-5. Adjusted weight eliciting results (low weights deleted).

Table 5-4 also identifies three insignificant weights (any low weights under 1%). In addition, survey feedback from the experts also highlighted four other indicators that are either not appropriate in the UK regional context or unable access to usable data. These seven indicators are highlighted in pink in Table 5-4 and will be omitted from the model as discussed later in this chapter (see section 5.3.1). The remaining weights are re-elicited using the same ROD method. The final weights of the 17 indicators are listed in Table 5-5.

The weight-eliciting results indicate that Location is the most important RLC dimension with weight of 34.7%. Infrastructure (26.9%) comes second to infrastructure and workforce (19.6%) the third as shown in Figure 5-1. Administration is the least important dimension to the logistics capability of a region with relative weighting of only 6.2%. This means when considering the logistics performance of a region in GB, its location and infrastructure should be given more priority than other dimensions.

At the sub-dimension level, the most important indicators are Strategic location (12.05%), Professional skills of the workforce (10.23%), Market access (9.32%) and Road connectivity (9.32%). In contrast, the least important indicators are Cost of labour (2.99%), Value added service (1.94%) and Air connectivity (1.66%).

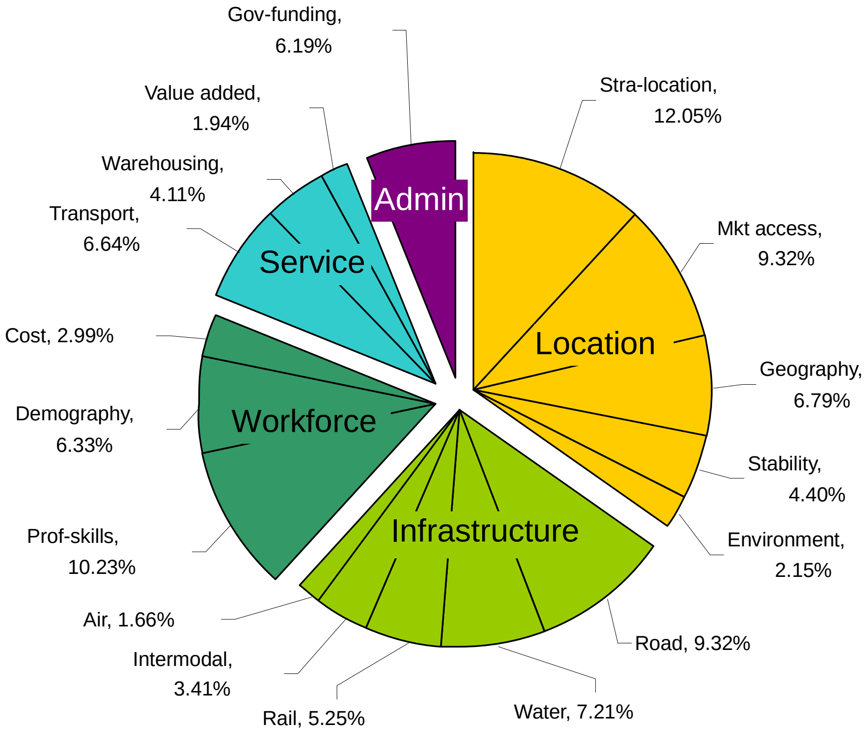


Figure 5-1. Final 17 RLC indicator weights.

5.3 Discussion of Data Used

5.3.1 Omitted indicators

Originally, 24 indicators are identified from the literature and interview with logistics experts as potential RLC indicators categorised into five dimensions: location features, quality of infrastructure, local logistics services, size and quality of workforce, and local administration policies and efficiency (see section 2.3.8 Indicator summary). However, in practice, seven of these preliminary indicators are omitted from the model due to low weights, unavailable data and lack of relevance in the UK regional context as listed in Table 5-6.

Omitted indicators	Weights	Definition and measurement	Reasons for omission
ICT infrastructure	0.90%	telephone/mobile/broadband subscribers per 100 inhabitants	Low weight
Pipeline infrastructure	1.82%	the capacity of pipeline infrastructure	Data availability
International language skills	1.80%	the international language skills of the logistics workforce	Not suitable in the UK regional context
Financial service	0.79%	the quality and cost of the financial services	Low weight; Not suitable in the UK regional context
Knowledge	1.61%	the number of logistics-related research	Data availability
Red tape	2.01%	the number and speed of import/export document processing	Not suitable in the UK regional context
Customs and border efficiency	0.95%	the average time taken to clear customs	Low weight; Not suitable in the UK regional context

Table 5-6. List of omitted indicators.

The ICT infrastructure indicator gets very low weight of 0.90%, which means it hardly impacts the overall RLC therefore omitted from the model.

The reason for eliminating pipeline infrastructure capacity from the model is due to the lack of available data that breaks down to regional level. However, the omission of the pipeline indicator should not significantly change the overall RLC due to its relative low weight of 1.82%.

The international language indicator is identified as not suitable for the UK context since most of UK's international trade partners speak English. Although the international language skills may significantly affect logistics capability in other regions in the world, it does not fit for the context of UK regions in this study.

The financial service indicator has get weight too low to be included in the model (0.79%). In addition, the financial service does not require physical access as much as other indicators. Its performance does not vary much across regions within UK. Therefore it is not appropriate in the context.

The indicator of knowledge in logistics is omitted because of the difficulty to find a quantitative measurement, as well as its relative low weight (1.61%). The skill aspect of logistics capability is covered by the "professional skills" indicator under the regional workforce dimension.

Finally, although the indicators of "red tape" and "customs and border efficiency" are crucial factors when considering the international trade and logistics (Arvis *et al*., 2007; Arvis *et al*., 2010), they do not fit the UK regional context. The UK Customs procedures are based on the common "Community Customs Code" which defines the legislation applicable to the import and export of goods between the European Community and non-member countries, therefore the custom clearance practice and procedure should be the same across the UK regions and even the EU[4]. In addition, the Entry Processing Units (EPU) previously located at all major air/ports are replaced by the single national site - National Clearance Hub (NCH), which claims that most goods are cleared through the ports inside 90 seconds. As the Policy Director of a trade facilitation

[4] See "The Community Customs Code", EUROPA website at: http://europa.eu/legislation_summaries/customs/do0001_en.htm

agency in the UK suggests that even minor UK regional differences in custom procedures and documents do exist, it is unlikely to make a significant impact to overall regional logistics performance. Hence they are eliminated from the model.

5.3.2 Missing data

For most research, missing data is rarely avoided. The impacts of missing data include the reduction of the sample size available for analysis, biased statistical results and erroneous conclusions (Hair *et al.*, 2010). Therefore, it is necessary to identify the patterns and relationships underlying the missing data in order to apply remedy that is as close as possible to original distribution of values.

For several indicators in this research, data are not available for all the years from 2004 to 2005 as listed in Table 5-7. This is most because either the official sources did not collect that data or have not yet published it. For the indicators "environment" and "Value added service", data are not available yet in regions. Moreover, little statistics are available on the UK rail freight at the regional level. Only the map of "Gross freight tonnage on the network in the base year (2004/05)" in the Network Rail published "Route Utilisation Strategy Report - freight (March 2007)" could be used to indicate the regional rail freight capabilities. As for rail statistics, there are not much available statistics for the intermodal freight movement in the UK. DfT's case study of "The container freight end-to-end journey" (December 2008) contains data for the "regional inwards container movements by road from UK container ports in 2007", which is used to illustrate the regional intermodal capability.

Indicator	Missing data	Reason	Remedy
Environment	2008	DECC 2008 UK emission statistics are not yet categorised in regions.	Mean imputation
Value added service	2008	ABI regional data for 2008 are not yet published.	Mean imputation
Rail infrastructure	2004, 2006-2008	Little available statistics apart from the Network Rail data in the base year (2004/05).	Hot Deck imputation
Intermodal infrastructure	2004-2006, 2008	Little available statistics apart from DfT data in 2007.	Hot Deck imputation

Table 5-7. List of missing values and remedy methods.

In order to minimise the impact of the missing data, appropriate imputation methods need to be chose as a remedy. Imputation is the process of estimating the missing value based on valid values of other variables and/or cases in the sample (Hair *et al.*, 2010). In the case of the datasets at hand, the missing values concentrate in specific indicators and years. For “Environment” and “Value added service”, valid data are available for the four years from 2004-2007 and are relatively consistent over time, therefore the missing 2008 value could be estimated based on the “mean imputation” method.

Another common method of imputation was “Hot Deck” imputation which is a means of imputing missing data with data from other observations in the sample at hand (Hair *et al.*, 2010). For the “Rail infrastructure” and “Intermodal infrastructure” indicators, data are only available for one year and missing for four, but the regional performances are unlikely to vary greatly from year to year. Therefore, the “Hot Deck” imputation method is appropriately used to substitute missing values with values from the available year as a remedy. These reasonable remedies would allow the GB RLC to be evaluated with the data available. Together the “Rail infrastructure” and “Intermodal infrastructure” indicators represent 8.66% of the total RLC weighting, therefore, the choice of reputational method will not significantly affect the RLC scores. However, there might also be disadvantages such as reduction in the variance of the distribution, which contributes to the limitation of this research.

5.3.3 Outliers

Outliers are “observations with a unique combination of characteristics identifiable as distinctly different from the other observations” (Hair *et al.*, 2010). Before the finally RLC scores are produced, an examination of outliers was conducted. This section presents the processes of identifying and dealing with the outliers.

Firstly, a graphical method of boxplot was conducted to examine the distribution of RLC values for the 11 regions in GB from 2004 to 2008 as shown in Figure 5-2. The upper and lower quartiles of the RLC values distribution form the upper and lower boundaries of the box, which contains the middle 50 percent of the RLC value. The median is represented by the solid line within the box. The whiskers represent the distance to the lowest and highest RLC values that are less than one quartile range from the box.

RLC for Wales in 2004 is identified as an extreme case, because its value is more than 3 box-lengths below the box in the boxplot – too low to be ignored. RLC for London, North West, Scotland and Yorkshire and Humber are identified as outlier cases, because their value is more than 1.5 box-lengths below the box in the boxplot (Kinnear and Gray, 2009).

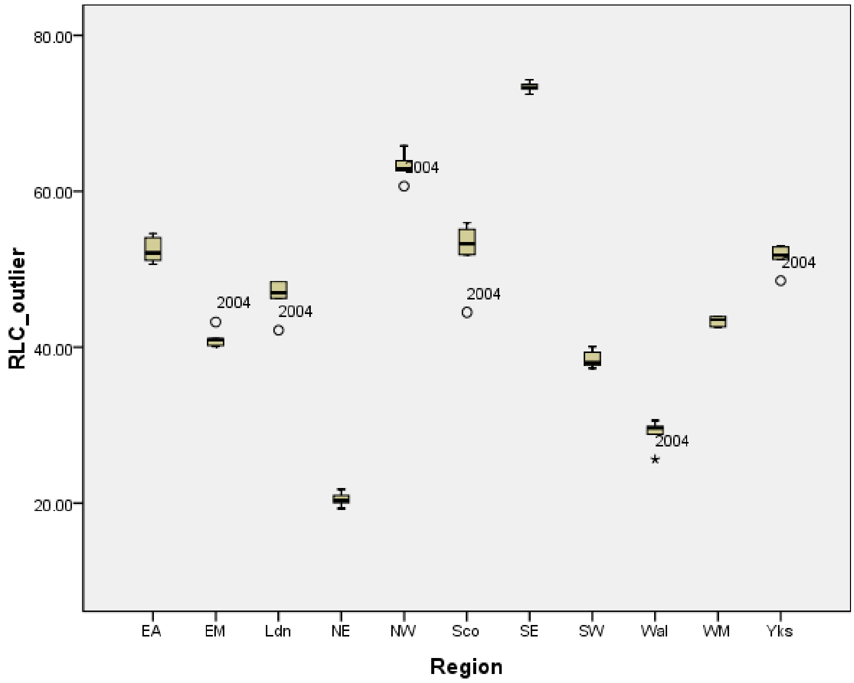


Figure 5-2. The boxplot of RLC scores with outliers.

A close inspection finds that the reason for the several unusual RLC values for the year 2004 is the inconsistent 2004 data of workforce from the Annual Population Survey. It is easy to see from Figure 5-3 that while the numbers are fairly consistent among the years from 2005-2008, the 2004 data is significantly different for almost all the regions. This is due to the different APS data collection methodology for the year 2004. According to the APS support team, such variations are because of a difference in the number of individuals interviewed for the APS in the different regions in the year 2004. The numbers reflect a sample and are not the total population. Thus if more people are interviewed, more will be working in a particular industry.

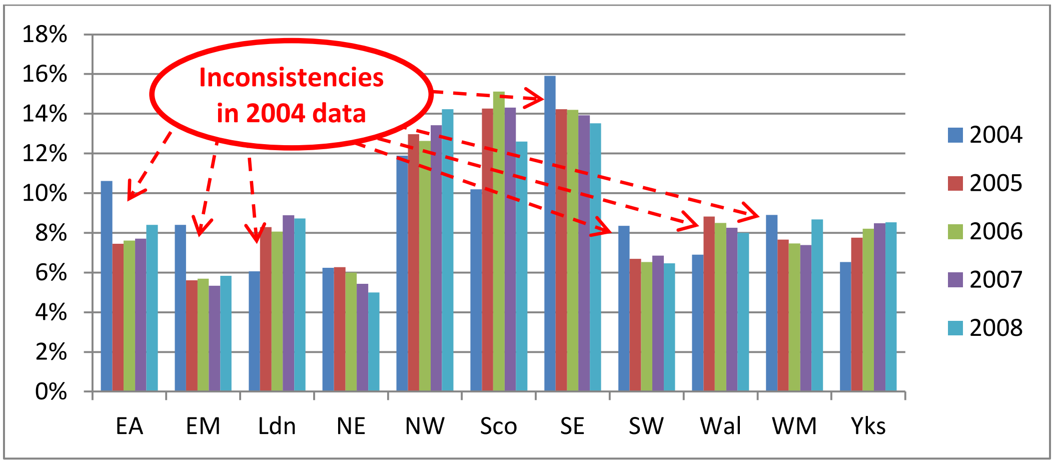


Figure 5-3. Biased logistics workforce data from raw APS dataset.

Therefore, an adjustment was made to divide the regional APS data by the total number of interviewees in that year. The adjusted data shows much improved consistency as in Figure 5-4. Rerun the boxplot analysis shows no more significant outliers as in Figure 5-5.

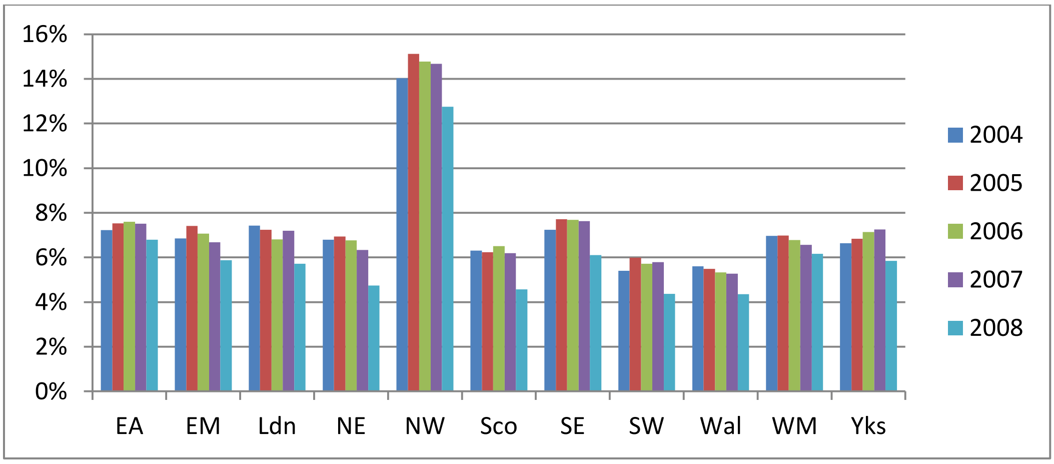


Figure 5-4. Adjusted logistics workforce data.

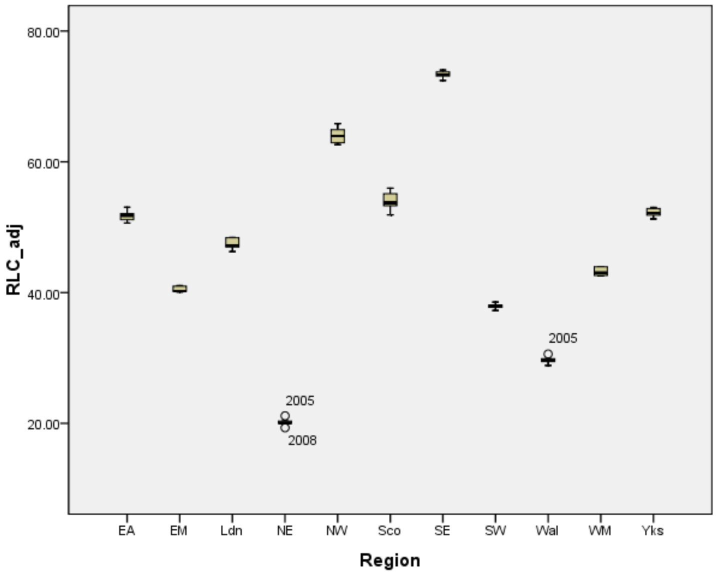


Figure 5-5. The boxplot of adjusted RLC scores.

5.3.4 Test of Normality

Before further in-depth analysis of the RLC data, it is important to point out that many data analysis methods including regression depend on the assumption that data obey normal distribution. However, normality can have serious effects in small samples (Hair *et al*., 2010). Therefore normality tests are needed to ensure the dataset of RLC is well-modelled to meet the common preliminary assumption of normality.

Firstly a test of *Shapiro-Wilk's W* was run with SPSS as a formal test of normality. *Shapiro-Wilk's W* may be thought of as the correlation between given data and their corresponding normal scores. For a given variable, *W* should not be significant if the variable's distribution is not significantly different from normal. In other words, if *Shapiro-Wilk's W* is bigger than 0.05 then the data is normally distributed. In this case, Normality is confirmed as shown in Table 5-8.

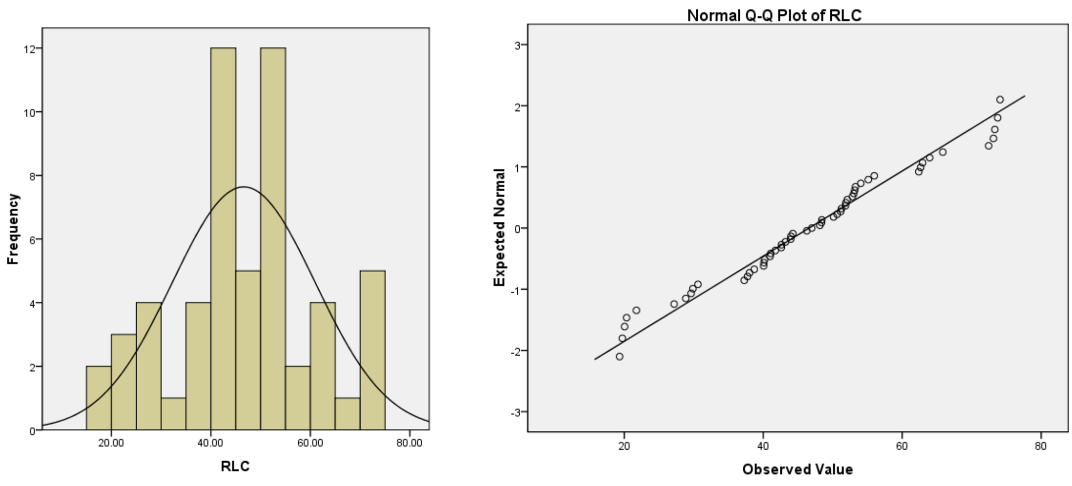
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RLC	.085	55	.200*	.966	55	.118

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Table 5-8. SPSS output for test of Normality.

Normality can also be visually confirmed by looking at a histogram of frequencies and the Normal Q-Q Plot. Histogram is a graph of the frequency distribution in which the vertical axis represents the count (frequency) and the horizontal axis represents the possible range of the data values. Normality is achieved when histogram fits a bell-shaped symmetrical distribution as shown in Figure 5-6(a). A normal Q-Q Plot is shown in Figure 5-6(b), where the points in the Q-Q plot will approximately lie on the line y = x, meaning the RLC data is normally distributed.



(a) (b)

Figure 5-6. RLC’s Histogram of frequencies and Normal Q-Q Plot.

5.4 Data for Performance Scores

After evaluating of the relative importance weights of the preliminary RLC indicators and omitting seven indicators which are less important, unsuitable for the UK regional context or inaccessible to usable data, this section presents the actual performance data of the 11 regions in GB on the 17 remaining RLC indicators between the years 2004 to 2008.

According to the Step Five in the research design, the performance scores are presented in a matrix such as the one in Table 4-2 of performance scores on various RLC indicators by the 11 regions in 5 years. The scores are in the range of 0 to 100, where the best performer is given 100 points and the worst performer 0 points.

First, raw performance data x on each indicator are obtained from published statistical sources. These raw data are then converted to a single-dimensional cardinal performance score $S(x)$ from 0 (the worst case) to 100 (the best case) using the four types of linear utility functions as shown in Figure 4-2 (Edwards and Barron, 1994) and following equations:

$$S_{ij} = S(x) = \begin{cases} 0 & x \le \min \\ 100 \times (x - \min)/(\max - \min) & \min < x < \max \\ 100 & x \ge \max \end{cases} \qquad (5.2)$$

$$S_{ij} = S(x) = \begin{cases} 100 & x \le \min \\ 100 \times (\max - x)/(\max - \min) & \min < x < \max \\ 0 & x \ge \max \end{cases} \qquad (5.3)$$

$$S_{ij} = S(x) = \begin{cases} 100 \times (x - \min)/(best - \min) & \min \le x \le best \\ 100 \times (\max - x)/(\max - best) & best < x \le \max \\ 0 & else \end{cases} \qquad (5.4)$$

As mentioned at the beginning of this chapter, this study relies on public sources specific indicator performance for GB regions due to the large scale. For better quality of the data, all the statistics are retrieved from official sources such as the Department for Transport (DfT), Office of National Statistics (ONS), Her Majesty's Revenue and Customs (HMRC), Civil Aviation Authority (CAA), Department of Energy and Climate Change (DECC), etc. The following Table 5-12 shows the specific indicator definitions and data sources, as well as their linear utility function types and the equations used to convert the raw data to the performance score.

Take the indicator of “Strategic location” and the year of “2005” as an example of RLC performance score calculation. As discussed in the Chapter 2, the “aggregated distance to other regions weighted by the trade volume” is chosen to show how proximate a region is to its main trading regions. Therefore, the “freight flow percentage among UK regions” is extract from DfT’s Continuing Survey of Road Goods Transport (see Table 5-9), and the “road distances between regional centres” is measured using AA routeplanner website (see Table 5-10).

Origin	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East	London	South East	South West	Wales	Scotland
NE		25.43%	31.85%	10.33%	7.51%	3.30%	0.78%	2.24%	1.23%	1.09%	16.24%
NW	6.58%		33.87%	18.57%	16.38%	5.99%	1.43%	3.49%	3.78%	4.19%	5.70%
YH	9.30%	38.21%		23.26%	8.89%	6.20%	1.59%	3.56%	2.44%	2.22%	4.33%
EM	2.63%	18.27%	20.29%		22.20%	17.88%	3.60%	7.42%	3.70%	2.61%	1.40%
WM	2.08%	17.52%	8.43%	24.15%		15.34%	4.02%	8.92%	10.40%	8.08%	1.06%
EA	0.89%	6.27%	5.75%	19.02%	15.00%		23.98%	20.37%	5.24%	2.43%	1.04%
Lonon	0.32%	2.28%	2.25%	5.84%	5.99%	36.54%		41.37%	3.48%	1.34%	0.58%
SE	0.72%	4.33%	3.92%	9.37%	10.35%	24.18%	32.22%		10.29%	3.78%	0.86%
SW	0.65%	7.71%	4.42%	7.67%	19.84%	10.22%	4.46%	16.91%		27.42%	0.71%
Wales	0.77%	11.43%	5.36%	7.24%	20.59%	6.33%	2.29%	8.30%	36.65%		1.05%
Scotland	22.20%	30.10%	20.26%	7.52%	5.24%	5.25%	1.93%	3.64%	1.83%	2.02%	

Table 5-9. Freight flow percentage among UK regions (total to and from), 2005

Origin	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East	London	South East	South West	Wales	Scotland
											kms
		Manchester	Leeds	Nottingham	Birmingham	Luton	London	Crawley	Bristol	Cardiff	Edinburgh
NE		234.48	158.84	257.82	332.81	404.27	456.73	520.94	475.88	509.20	194.89
NW			71.13	112.33	137.92	270.69	323.16	381.41	270.37	303.68	350.19
YH				117.64	192.64	264.09	316.56	380.77	335.71	369.02	352.29
EM					81.92	153.37	205.84	269.89	224.99	258.30	451.58
WM						138.56	191.03	233.52	147.42	180.57	470.57
EA							56.97	121.02	215.81	268.92	601.73
Lonon								49.57	190.22	243.33	654.52
SE									231.42	284.53	712.13
SW										70.97	601.73
Wales											634.40
Scotland											

Table 5-10. Road distance among UK regional centres (total to and from), 2005

Then for each region, sum up the total distance to other 10 regions in Table 5-10 weighted by the percentage of freight flow between the responsive region in Table 5-9, the “raw performance data” of strategic location for the regions was produced as shown in the second column in Table 5-11. This data is in the unit of million tonne*kms, which shows how far a region is from its main trading partner regions. Therefore the higher the value, the more isolated a region is from the other regions. In order to convert this raw performance data to a single-dimensional cardinal performance score *S(x)* from 0 (the worst case) to 100 (the best case), the linear utility function 5.2 is used to produce the RLC score as shown in the last column of Table 5-11. The final score suggests London has the best strategic location among 11 GB regions in 2005, whereas Scotland scores the lowest due to its remote location.

Regions	Strategic Location indicator (million tonne*kms)	RLC Score
NE	233.46	50.04
NW	160.06	76.42
YH	153.04	78.94
EM	145.61	81.62
WM	151.79	79.39
EA	148.14	80.71
London	94.46	100.00
SE	170.50	72.67
SW	178.66	69.74
Wales	193.12	64.54
Scotland	372.69	0.00

Table 5-11. Illustration of RLC calculation (Strategic location, 2005)

Based on similar grounds, RLC performance score calculation was conducted for each of the 17 indicators and each year from 2004 to 2008. The specific data sources and indicators used are listed in Table 5-12, as well as the type of linear utility function used during conversion. The final performance scores matrix is listed in Table 5-13, which are scored from 0 (the worst performer) to 100 (the best performer) as highlighted in green and red colours respectively.

Dimension	Indicator	Definition	Units	Source	Utility function	Equation
Location dimension	Strategic location	The aggregated distance to other regions weighted by the trade volume between that region	million tonne*kms	DfT Continuing Survey of Road Goods Transport (Freight flow percentage between UK regions); AA routeplanner website (Road distances between regional centres)	A	5.2
	Market access	Value of regional trade of goods outside EU	£ million	UK Regional Trade in Goods Statistics, HM Revenue and Customs	A	5.2
	Geography	The aggregated freight usable length of waterway by the draft capacity	m^2	DfT, Maritime Statistics	A	5.2
	Stability	All aged 16 and over unemployed as a percentage of total economically active	%	ONS, Annual Population Survey	B	5.3
	Environment	Carbon Dioxide emissions at Regional Level	kilo tonnes	DECC, UK emissions statistics	B	5.3
Infrastructure dimension	Road	Total regional freight moved by road in the UK	million tonne*kms	DfT, Road statistics	A	5.2
	Water	Foreign and domestic sea freight traffic at UK ports	million tonnes	DfT, Maritime Statistics	A	5.2
	Rail	Regional gross freight tonnage on the UK network	million tonne*kms	Network Rail, Route Utilisation Strategy Report	A	5.2
	Intermodal	Regional distribution share of inwards container movements by road from UK container ports	%	DfT, Continuing Survey of Roads Goods Transport	A	5.2
	Air	Freight lifted at UK airports	thousand tonnes	Civil Aviation Authority	A	5.2

Table 5-12. List of RLC indicator data sources.

Dimension	Indicator	Definition	Units	Source	Utility function types	Equation
Workforce dimension	Professional skills	Total regional employees NVQ Level 2 or above in the region	thousand people	Labour Market Factsheets, Skill for Logistics	A	5.2
	Demography	Total regional employees in the logistics industry (including SIC92 to SIC2007 job section I: Transport & Storage)	thousand people	ONS, Annual Population Survey	A	5.2
	Labour Cost	Gross weekly pay in Transport and storage industry (including SIC92 to SIC2007 job section I: Transport & Storage)	£	ONS, Annual Population Survey	B	5.3
Service dimension	Transport	Total light and heavy goods vehicles licensed in the UK regions	thousand vehicles	DfT, Vehicle Licensing Statistics	A	5.2
	Warehousing	Warehouses floorspace of the GB regions	thousand m^2	Communities and Local Government, Statistics for warehouses	A	5.2
	Value added	Approximate gross value added of regional cargo handling and storage service	£ million	ONS, Annual Business Inquiry	A	5.2
Administration dimension	Government policy&funding	Identifiable regional expenditure on transport	£ million	HM-Treasury, Public Expenditure Statistical Analyses	A	5.2

Table 5-12. List of RLC indicator data sources (continue).

	Location indicators					Infrastructure indicators					Workforce			Service			Admin.
	Location	Mkt.acc.	Geo.	Stability	Envir.	Road	Water	Rail	Inter.	Air	Pro.skill	Demo.	Cost	Trans.	Ware.	Value.	Funding
Weights	12.05%	9.32%	6.79%	4.40%	2.15%	9.32%	7.21%	5.25%	3.41%	1.66%	10.23%	6.33%	2.99%	6.64%	4.11%	1.94%	6.19%
EA (08)	81.65	45.58	45.07	76.47	62.91	88.31	34.76	42.19	100.00	17.04	21.64	37.01	65.32	58.82	60.77	94.74	12.68
EM (08)	83.67	17.00	13.69	50.00	78.09	76.80	1.55	78.42	44.00	18.69	0.00	9.19	97.96	43.36	65.52	93.34	8.32
Ldn (08)	100.00	93.68	19.80	17.65	58.62	0.00	54.97	0.00	24.00	100.00	34.28	40.42	0.00	27.70	52.63	78.76	100.00
NE (08)	58.02	1.55	21.84	0.00	100.00	6.75	55.34	1.66	0.00	0.12	2.67	0.00	99.04	0.00	0.00	32.23	0.00
NW (08)	80.67	37.83	36.49	35.29	22.48	100.00	47.19	74.00	36.00	10.39	91.87	100.00	77.77	69.42	100.00	83.61	26.92
Sco (08)	0.00	14.77	100.00	76.47	73.68	56.69	100.00	93.08	4.00	3.23	87.22	82.41	56.51	35.63	15.96	0.00	37.98
SE (08)	73.06	100.00	51.19	91.18	0.00	71.01	93.21	65.84	40.00	9.53	100.00	92.39	4.29	100.00	70.60	100.00	27.48
SW (08)	71.31	8.67	36.95	100.00	74.51	47.60	19.47	33.75	12.00	0.00	13.01	16.01	68.71	61.07	37.31	58.11	11.10
Wal (08)	69.09	0.00	14.03	35.29	99.34	12.44	57.91	9.41	4.00	0.06	27.03	32.55	100.00	14.43	3.95	33.33	5.58
WM (08)	80.81	22.49	0.00	17.65	64.61	66.53	0.00	65.70	24.00	1.26	30.53	39.90	97.16	73.74	83.37	85.76	15.01
Yks (08)	83.24	14.98	53.17	35.29	40.33	73.97	94.70	100.00	28.00	0.10	22.71	38.32	97.54	40.17	65.15	89.75	11.34
EA (07)	80.08	43.70	45.07	86.21	63.79	84.63	33.88	42.19	100.00	18.43	18.06	26.45	47.58	59.43	58.85	93.28	12.36
EM (07)	81.87	18.59	13.69	62.07	79.22	82.93	1.42	78.42	44.00	20.91	0.00	0.00	75.71	44.62	64.39	100.00	6.79
Ldn (07)	100.00	100.00	19.80	0.00	59.59	0.00	51.73	0.00	24.00	100.00	36.57	39.61	0.00	29.22	53.98	84.17	100.00
NE (07)	53.03	1.50	21.84	20.69	100.00	2.62	56.42	1.66	0.00	0.06	10.92	1.07	100.00	0.00	0.00	36.06	0.00
NW (07)	78.68	35.89	36.49	41.38	23.60	100.00	45.99	74.00	36.00	12.85	79.73	90.15	82.21	69.76	100.00	88.03	25.58
Sco (07)	0.00	16.80	100.00	72.41	75.15	63.99	100.00	93.08	4.00	4.61	100.00	100.00	77.38	35.71	16.05	0.00	42.65
SE (07)	73.83	96.96	51.19	89.66	0.00	70.57	92.29	65.84	40.00	15.19	98.41	95.61	8.75	100.00	69.86	88.52	29.89
SW (07)	70.22	10.49	36.95	100.00	73.93	62.38	18.58	33.75	12.00	0.00	19.46	17.02	74.18	60.70	37.02	65.55	10.85
Wal (07)	67.19	0.00	14.03	41.38	97.39	17.00	55.51	9.41	4.00	0.12	30.94	32.66	94.28	15.55	3.87	37.82	7.64
WM (07)	78.72	22.81	0.00	31.03	64.13	78.88	0.00	65.70	24.00	1.55	20.47	22.81	74.48	74.30	82.08	87.04	14.08
Yks (07)	81.60	18.63	53.17	44.83	42.02	81.19	91.14	100.00	28.00	0.08	24.28	35.12	77.75	41.08	64.55	80.74	10.67

Table 5-13. Performance score matrix.

	Location indicators					Infrastructure indicators					Workforce			Service			Admin.
	Location	Mkt.acc.	Geo.	Stability	Envir.	Road	Water	Rail	Inter.	Air	Pro.skill	Demo.	Cost	Trans.	Ware.	Value.	Funding
Weights	12.05%	9.32%	6.79%	4.40%	2.15%	9.32%	7.21%	5.25%	3.41%	1.66%	10.23%	6.33%	2.99%	6.64%	4.11%	1.94%	6.19%
EA (06)	81.84	43.65	45.07	76.92	63.11	86.17	34.00	42.19	100.00	19.18	13.66	20.36	38.94	59.01	57.18	96.28	16.02
EM (06)	80.66	22.39	13.69	61.54	77.86	71.08	1.40	78.42	44.00	21.53	0.00	0.00	83.21	45.02	61.14	87.77	9.54
Ldn (06)	100.00	100.00	19.80	0.00	57.72	2.36	51.10	0.00	24.00	100.00	24.90	25.15	0.00	29.82	54.92	70.08	100.00
NE (06)	52.71	0.00	21.84	17.95	100.00	0.00	59.16	1.66	0.00	0.03	13.06	3.29	92.81	0.00	0.00	31.16	0.00
NW (06)	78.72	38.31	36.49	61.54	23.22	100.00	47.76	74.00	36.00	12.22	66.03	73.55	87.35	69.05	100.00	75.04	31.24
Sco (06)	0.00	17.72	100.00	61.54	75.07	57.04	100.00	93.08	4.00	6.14	100.00	100.00	69.13	34.78	16.19	0.00	50.14
SE (06)	71.94	97.79	51.19	79.49	0.00	72.12	91.26	65.84	40.00	18.41	93.50	90.22	3.30	100.00	69.61	100.00	39.28
SW (06)	68.80	14.24	36.95	100.00	73.84	49.22	19.95	33.75	12.00	0.44	12.90	8.98	49.62	59.99	37.52	56.20	15.43
Wal (06)	65.86	5.48	14.03	61.54	97.71	9.33	55.79	9.41	4.00	0.14	28.69	29.84	100.00	15.63	4.77	33.22	7.26
WM (06)	77.59	26.24	0.00	53.85	64.03	69.03	0.00	65.70	24.00	1.75	17.41	18.86	85.82	72.23	78.78	81.07	19.25
Yks (06)	81.55	15.99	53.17	53.85	40.98	76.81	89.68	100.00	28.00	0.00	18.24	26.75	82.59	40.38	63.50	80.50	15.22
EA (05)	80.71	39.47	45.07	83.78	63.23	91.38	30.77	42.19	100.00	19.93	13.88	21.35	26.70	58.53	57.43	87.03	15.02
EM (05)	81.62	21.66	13.69	67.57	78.24	75.42	1.19	78.42	44.00	20.40	0.00	0.00	70.83	45.08	59.07	80.27	9.56
Ldn (05)	100.00	100.00	19.80	0.00	62.66	0.00	49.45	0.00	24.00	100.00	29.04	30.91	0.00	30.35	57.51	71.32	100.00
NE (05)	50.04	0.00	21.84	37.84	98.83	5.41	56.54	1.66	0.00	0.02	17.17	7.57	100.00	0.00	0.00	28.86	0.00
NW (05)	76.42	35.77	36.49	54.05	21.20	100.00	43.64	74.00	36.00	11.94	73.72	85.07	67.35	68.19	100.00	77.17	31.28
Sco (05)	0.00	17.70	100.00	48.65	79.87	57.67	100.00	93.08	4.00	5.69	97.84	100.00	65.10	32.52	16.78	0.00	34.53
SE (05)	72.67	92.09	51.19	91.89	0.00	81.93	79.66	65.84	40.00	17.65	100.00	99.68	2.69	100.00	70.34	100.00	36.94
SW (05)	69.74	13.23	36.95	100.00	74.23	53.68	17.59	33.75	12.00	0.46	15.76	12.51	59.73	58.21	38.29	48.95	13.69
Wal (05)	64.54	3.40	14.03	54.05	100.00	15.79	54.47	9.41	4.00	0.18	33.90	37.12	94.85	14.52	5.89	29.59	9.09
WM (05)	79.39	25.36	0.00	56.76	66.16	75.90	0.00	65.70	24.00	1.44	20.73	23.66	82.79	70.89	78.07	82.37	18.71
Yks (05)	78.94	15.11	53.17	64.86	42.70	80.28	81.42	100.00	28.00	0.00	16.29	24.82	82.41	39.03	62.50	91.78	12.13

Table 5-13. Performance score matrix (continue).

	Location indicators					Infrastructure indicators					Workforce			Service			Admin.
	Location	Mkt.acc.	Geo.	Stability	Envir.	Road	Water	Rail	Inter.	Air	Pro.skill	Demo.	Cost	Trans.	Ware.	Value.	Funding
Weights	*12.05%*	*9.32%*	*6.79%*	*4.40%*	*2.15%*	*9.32%*	*7.21%*	*5.25%*	*3.41%*	*1.66%*	*10.23%*	*6.33%*	*2.99%*	*6.64%*	*4.11%*	*1.94%*	*6.19%*
EA (04)	80.16	45.72	45.07	91.89	60.42	84.79	30.16	42.19	**100.00**	18.97	29.71	46.24	42.17	60.25	57.78	86.13	15.52
EM (04)	81.41	22.75	13.69	75.68	75.59	67.67	1.16	78.42	44.00	19.05	14.91	23.71	79.59	45.32	55.48	88.63	11.27
Ldn (04)	**100.00**	**100.00**	19.80	**0.00**	53.77	0.01	48.25	**0.00**	24.00	**100.00**	2.30	**0.00**	**0.00**	32.18	56.23	76.25	**100.00**
NE (04)	49.86	**0.00**	21.84	35.14	99.07	**0.00**	53.71	1.66	**0.00**	0.03	9.50	1.76	**100.00**	**0.00**	**0.00**	25.00	**0.00**
NW (04)	78.77	40.97	36.49	67.57	21.51	**100.00**	40.97	74.00	36.00	11.90	51.68	59.05	77.40	69.18	**100.00**	80.38	36.30
Sco (04)	**0.00**	20.11	**100.00**	45.95	64.04	63.15	**100.00**	93.08	4.00	5.79	45.44	41.87	71.52	31.55	14.23	**0.00**	33.65
SE (04)	72.67	99.00	51.19	91.89	**0.00**	78.74	75.95	65.84	40.00	18.44	**100.00**	**100.00**	6.07	**100.00**	68.47	**100.00**	43.76
SW (04)	67.49	15.09	36.95	**100.00**	74.40	52.73	16.74	33.75	12.00	0.40	22.26	23.19	62.61	60.52	38.24	48.38	14.32
Wal (04)	64.95	3.73	14.03	62.16	**100.00**	8.93	54.37	9.41	4.00	0.14	9.09	8.43	86.73	14.88	2.12	23.75	10.16
WM (04)	79.48	25.46	**0.00**	54.05	62.88	63.93	**0.00**	65.70	24.00	0.93	22.75	28.80	80.98	74.64	78.08	77.63	22.13
Yks (04)	80.65	15.03	53.17	70.27	35.31	84.97	76.10	**100.00**	28.00	**0.00**	**0.00**	4.64	72.84	38.97	62.40	98.63	12.84

Table 5-13. Performance score matrix (continue).

5.5 Aggregate RLC Scores

Having elicited the weights and the performance scores of RLC indicators, the finally step of the research design is to mathematically aggregates these data to an integrated RLC score for the regions in GB using equation

$$R_i = \sum_j w_j S_{ij} \qquad (5.5)$$

Where R_i is the overall RLC value of region i;

w_j is the weight assigned to indicator j;

S_{ij} is the performance score of region i on indicator j.

The final RLC scores are listed in the following Table 5-14.

	2004	2005	2006	2007	2008
EA	51.60	50.63	51.38	51.93	53.54
EM	41.29	41.46	41.27	41.94	41.64
Ldn	46.61	46.18	45.67	47.22	46.87
NE	20.93	22.22	20.80	21.00	19.63
NW	65.79	63.60	64.61	64.58	65.84
Sco	48.08	47.43	49.59	50.27	46.84
SE	69.26	68.89	68.31	68.66	68.80
SW	37.28	37.57	36.97	39.32	36.73
Wal	27.51	28.25	27.98	27.56	26.80
WM	42.69	43.47	42.39	42.06	42.80
Yks	51.20	50.57	51.35	52.15	51.54

Table 5-14. List of RLC scores for the 11 GB regions, 2004-2008.

It is obvious from Table 5-14 that the best performer in regional logistics is the

South East, with RLC near 70. The North West (RLC around 65) comes second. East of England, Yorkshire & Humber, Scotland and London come in the second cluster with RLC around 50. The Midlands and the South West score around 40 on RLC. Wales and North East are the worst performers with RLC scores around 28 and 21 respectively.

The purpose of this chapter is to present the collection and the result of the data. More detailed analysis and discussion will be conducted in the Chapter Seven and Eight.

5.6 Sensitivity Analysis

As a form of the MAUT method, the SMART-ROD method in this research design uses subjectivity in formulating the relative weight factors, therefore it is necessary to conduct a sensitivity analysis to ensure the robustness of the assessment in addition to maximise the sample size (Barron and Schmidt, 1988). The sensitivity analysis evaluates if the changes in weighting would significantly affect the output RLC scores for the regions in GB. A complete sensitivity analysis would allow testing of simultaneous variation of the all the weights (Butler *et al.*, 1997; Proll *et al.*, 2001), but requires quite complicated mathematical programming which prohibits the application of the method. Therefore, this research tests all 5 possible sets of weights that could be elicited from the original data set of experts' evaluation and compare the RLC rankings of the regions in GB.

There are five possible techniques to produce weights from the expert responses in the MAUT literature in the case of this research, namely, SMART-ROD, ROD-Normalised, SMART-ROC, ROC-Normalised, and Raw-Normalised. SMART-ROD is the method of choice in the research to produce the RLC scores. ROD-Normalised method differs from SMART-ROD in that after eliminating the seven inappropriate indicators (see Table 5-6), it normalize the remaining weights to sum to 1 instead of reassigning ROD weights. The SMART-ROC and ROC-Normalised methods are similar weight eliciting methods only that they are based on “Rank Order Centroid” weights as surrogate weights (see section 4.3.5). Again, SMART-ROC reassigns ROC weights to the remaining indicators after eliminating the seven preliminary indicators in Table 5-6 whereas the ROC-Normalised method normalised the remaining to 1. The last set of weights is raw weights simply normalised to sum to 1. The specific values of the five sets of weights as listed in Table 5-15.

Indicators	SMART-ROD	ROD-Normalised	SMART-ROC	ROC-Normalised	Raw-Normalised
Strategic	12.05%	12.05%	20.86%	22.04%	13.37%
Mkt access	9.32%	9.32%	11.72%	12.39%	10.34%
Geography	6.79%	6.79%	7.16%	7.56%	7.53%
Stability	4.40%	4.40%	4.11%	4.34%	4.89%
Environment	2.15%	2.15%	1.83%	1.93%	2.38%
Road	9.32%	7.74%	11.72%	10.05%	7.72%
Water	7.21%	6.50%	6.59%	6.17%	6.48%
Rail	5.25%	5.32%	4.02%	4.23%	5.31%
Intermodal	3.41%	4.20%	2.31%	2.94%	4.19%
Air	1.66%	3.10%	1.03%	1.97%	3.09%
Skills	10.23%	9.00%	9.58%	8.62%	9.07%
Demography	6.33%	6.43%	4.35%	4.48%	6.48%
Cost	2.99%	4.12%	1.74%	2.41%	4.15%
Transportation	6.64%	5.43%	5.50%	4.34%	4.89%
Warehousing	4.11%	4.20%	2.50%	2.44%	3.78%
Value added	1.94%	3.06%	1.00%	1.49%	2.75%
Government	6.19%	6.19%	4.00%	2.58%	3.59%

Table 5-15. Five sets of weights for the Sensitivity Analysis.

With the same aggregating method (see equation 5.5), five sets of RLC scores could be produced using the five sets of weights (see Table 5-16).

	Average RLC Scores (04-08)				
	SMART-ROD	ROD-Normalised	SMART-ROC	ROC-Normalised	Raw-Normalised
EA	51.81	51.97	55.94	56.62	53.14
EM	41.52	42.48	45.15	46.23	43.35
Ldn	46.51	47.94	51.65	52.81	47.35
NE	20.92	21.80	23.14	24.44	22.94
NW	64.88	63.67	66.08	65.20	63.91
Sco	48.44	46.13	45.24	43.40	46.28
SE	68.78	66.39	72.25	70.99	67.12
SW	37.57	37.18	41.17	41.36	38.17
Wal	27.62	27.94	30.81	31.70	29.05
WM	42.68	42.63	45.71	45.73	42.85
Yks	51.36	51.04	54.55	54.83	51.94

Table 5-16. RLC scores[5] five sets of weight-eliciting techniques.

	RLC Ranking				
	SMART-ROD	ROD-Normalised	SMART-ROC	ROC-Normalised	Raw-Normalised
1st	SE	SE	SE	SE	SE
2nd	NW	NW	NW	NW	NW
3rd	EA	EA	EA	EA	EA
4th	Yks	Yks	Yks	Yks	Yks
5th	Sco	Ldn	Ldn	Ldn	Ldn
6th	Ldn	Sco	WM	EM	Sco
7th	WM	WM	Sco	WM	EM
8th	EM	EM	EM	Sco	WM
9th	SW	SW	SW	SW	SW
10th	Wal	Wal	Wal	Wal	Wal
11th	NE	NE	NE	NE	NE

Table 5-17. RLC rankings of different weight-eliciting techniques.

[5] These are average RLC scores of the years from 2004 to 2008.

Table 5-17 shows the ranking of the 11 regions in GB of RLC scores produced with different weight-eliciting techniques. It is clear that the top four and bottom three performers stay the same regardless of the weight-eliciting techniques used. Minor changes exist among the rankings of Scotland, London, West Midlands and East Midlands, however, the ranges of these four regions' RLC scores distribution do not exceed 6.3 (in the case of London), which is only 12% of the total RLC range.

Therefore the sensitivity analysis proved that marginal changes in the original relative weights would not alter the RLC ranking of regions in GB significantly, especially the top 4 and bottom 3 regions. This confirms the robustness of the RLC measurement framework in the research.

5.7 Conclusion

This chapter presented the application of the research design as discussed in the previous chapter. Due to its nature of large scale, this study relies on a combination of two datasets to aggregate the RLC scores for the 11 regions in GB: expert evaluations of the relative importance of the indicators (RLC indicator weights) and specific indicator performance data from public sources (RLC indicator performance scores). This chapter introduced the sources for these two datasets and the specific procedures of producing the RLC scores from the RLC weights and performance scores for the regions in GB.

This chapter also gave a discussion of the issues of the data used and appropriate procedures and remedies: Seven of the twenty four preliminary indicators are omitted from the model due to low weights, unavailable data and lack of relevance in the UK regional context. The missing values were estimated via "mean imputation" and "Hot Deck imputation" methods based on valid values of other variables and/or cases in the sample. The outliers were identified and dealt with by tracking and adjusting the source of inconsistent Annual Population Survey data in the year of 2004.

Moreover, tests of normality were conducted in this chapter for preparation for further data analysis in the next chapter. Finally, a sensitivity analysis was conducted to ensure the robustness of the GB RLC measurement framework in the research.

CHAPTER 6. CORRELATION AND REGRESSION ANALYSIS OF THE RLC SCORES

6.1 Introduction

The previous chapter introduced the procedures of collecting the two datasets used in this study and how the importance weights and performance data of the RLC indicators are aggregated into the RLC scores for each of the 11 regions in GB. This chapter digs deeper into the data to explore the RLC and economy relationships as well as the relationship between RLC and its own indicators.

In order to explore the relationship of logistics capabilities and economic performance at the regional level, correlation analysis will be conducted with SPSS of RLC scores produced in the research and regional economic indicators such as regional GVA, productivity, household income, unemployment rate, international trade value and manufacturing GVA.

It would also be useful to investigate the relationship between RLC and its indicators. In order to understand which among the RLC indicators (independent variables) are related to the RLC (dependent variable), and to explore the strengths, direction, and statistical significance of these relationships, a stepwise regression will be performed between RLC as the dependant variable and Location, Infrastructure, Workforce, Service and Administration as independent variables.

Finally the issue of research reliability and validity will be discussed towards the end of this chapter.

6.2 RLC and Regional Economy Correlations

6.2.1 GB regions economic indicators

Indicators on economic performance of regions are necessary for good understanding of the GB regional status. Gross Value Added (GVA) per head is one of the most popular indicators used in the UK regional policy. However, Dunnell (2009) proposes that GVA per head, which divides output of those working in a region by everybody living in the region, should not be used as an indicator of either regional productivity or income of residents, because it does not take account of people commuting to work in and out the regions and regional differences in labour market structures. She also proposes GVA as a good measure of economic output of a region and promotes the use of productivity, income and labour market indicators in combination to give a more complete picture of regional economic performance.

Gross Value Added (GVA) provides a measure of the value added to materials and other inputs in the production of goods and services by resident organisations before allowing for depreciation or capital consumption. It is equal to GDP plus subsidies less taxes on products. The following Figure 6-1 shows the regional percentage of the GB GVA in the year 2008.

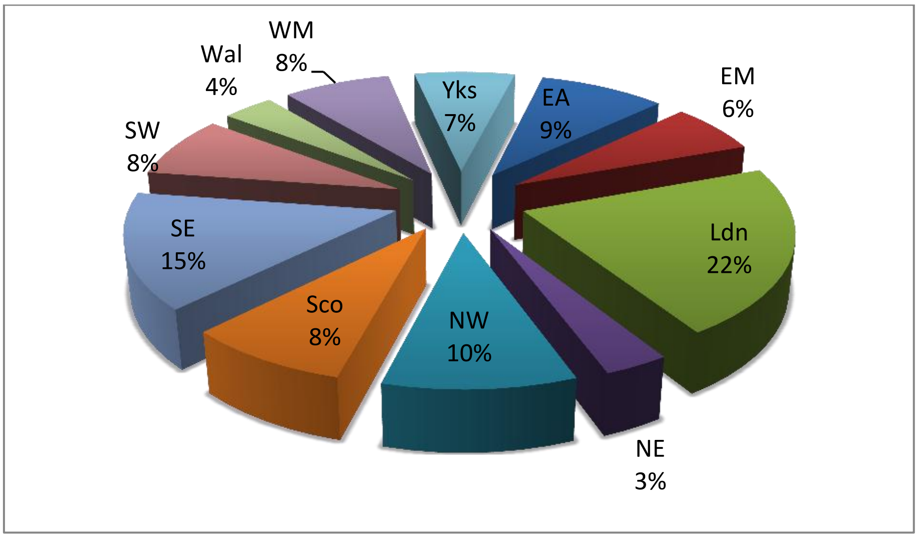


Figure 6-1. Regional gross value added as a percentage of GB, 2008

Source: Office for National Statistics

Productivity is measured by dividing the GVA of each region by the number of hours worked in this region. The following Figure 6-2 shows the comparison of the regions in GB in Labour Productivity (UK is 100). London is well ahead of the UK average (over 140) in workforce productivity while the other regions score around 90. The South East is the only other regions apart from London which scored above average.

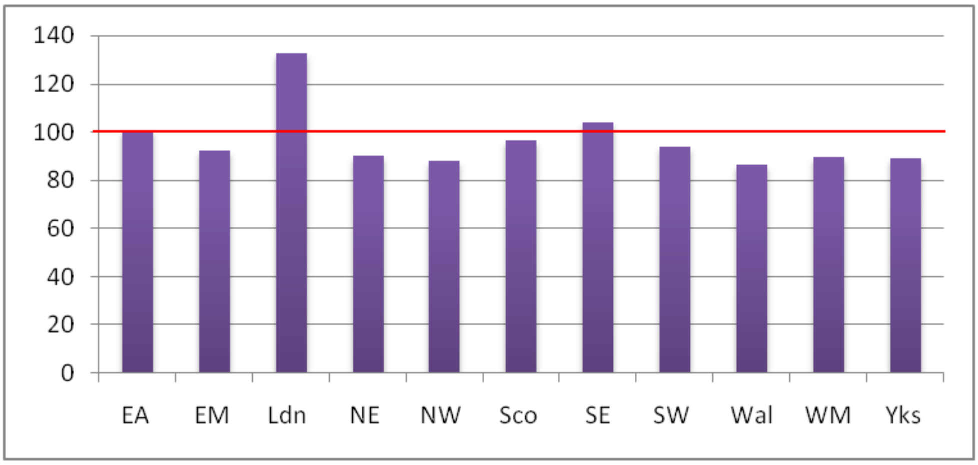


Figure 6-2. Regional Labour Productivity in Great Britain, 2008

Source: Office for National Statistics

Household Income covers the income received by households and non-profit institutions serving households. Gross disposable household income is the total income less certain cost items such as tax payments and social security contributions. In essence, this is the value of the resources that the household sector actually has available to spend. London, South East and East are the top three while the North East scores the lowest as shown in Figure 6-3.

Figure 6-3. Gross disposable household income in 2008 (£).

Source: Office for National Statistics

Unemployment Rate is the percentage of the unemployed in all economically active people aged 16 and over. The comparison of unemployment in 2009 is illustrated in the following diagram. London, West Midlands and the North East have relatively higher unemployment rate while the South East and the South West have the lowest unemployment rate as shown in Figure 6-4.

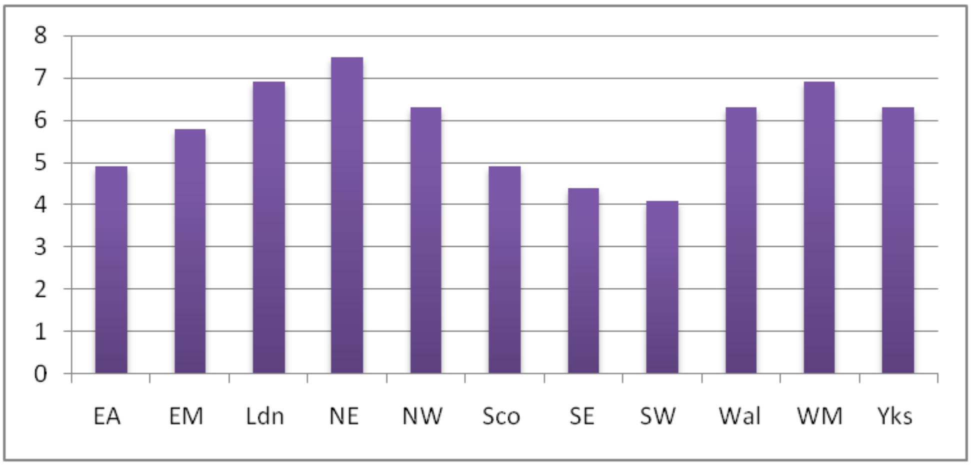


Figure 6-4. Unemployment rate in GB regions (%), 2008.

Source: Office for National Statistics

International trade value statistics for the regions in GB are published by the HM Revenue and Customs, which is another insightful indicator for regional economy. As Figure 6-5 shows, the South East has the highest value for import and export, followed by London and East of England.

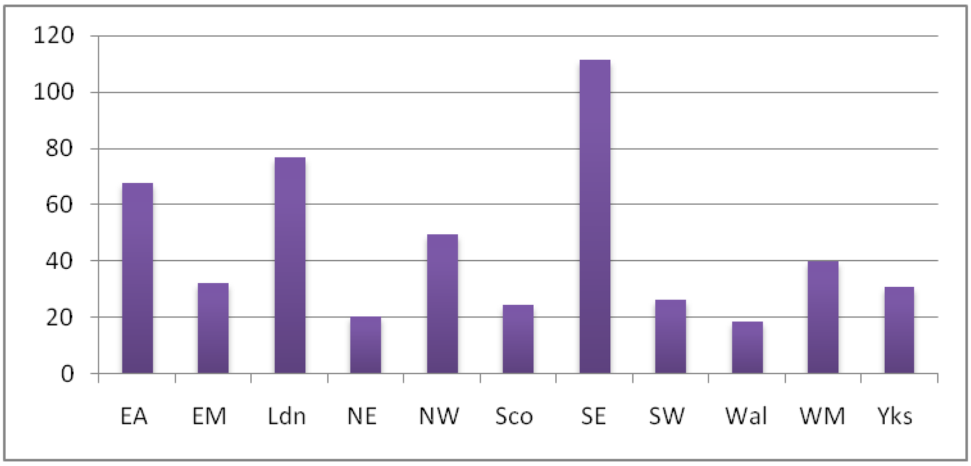


Figure 6-5. Total value of GB regional trade in Goods in 2008 (£b).

Source: UK TradeInfo.com

Regional manufacturing GVA is another economic indicator included in this research to explore the relationship between logistics capability of a region and its manufacturing capacity. It is clear from Figure 6-6 that the North West and the South East are the two major manufacturing centres, whereas the North East and Wales lag behind in their manufacturing capacity.

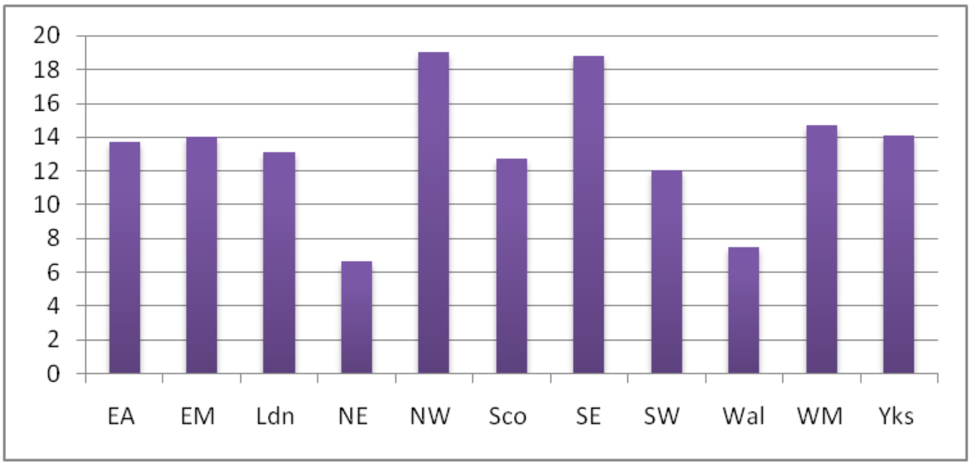


Figure 6-6. GB regional GVA in the manufacturing industry (£b), 2008.

Source: Office for National Statistics

6.2.2 Correlation analysis

The simplest way to investigate if two variables are associated is to look at the covariance of the two (Field, 2009). If there were a relationship between the two variables, then as one variable deviates from its mean, the other variable should deviate from its mean in the same or the directly opposite way.

The Pearson product-moment correlation coefficient, or "Pearson's correlation" invented by Karl Pearson is the most popular standardised measure of relationship between two variables. Pearson uses a correlation coefficient r to measure the effect size of a relationship, which is obtained by dividing the covariance of the two variables by the product of their standard deviations. The following equation 6.1 gives the definition of the correlation coefficient *r* between two random variables *X* and *Y* with expected values μ_X and μ_Y and standard deviations σ_X and σ_Y:

$$r_{XY} = corr(X,Y) = \frac{cov(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y} \quad (6.1)$$

where *E* is the expected value operator, *cov* means covariance, and, *corr* a widely used alternative notation for Pearson's correlation.

The Pearson correlation coefficient r indicates the strength of the association and its value of lies between -1 to +1. When r = +1, it means there is a perfect positive linear relationship between the two variables. When r = -1, it means there is a perfect negative linear relationship between the two variables. When r = 0, there is no relationship at all. Any other value between −1 and 1 indicates some degree of linear dependence between the variables. As it approaches zero there is less of a relationship. The closer the coefficient is to either −1 or 1, the stronger the correlation between the variables. The commonly used measure of the correlation coefficient effect size is: values of ±0.1 represent a small effect, ±0.3 is medium effect and ±0.5 is a large effect (Hair *et al.*, 2010).

It is worth pointing out that caution must be taken when interpreting correlation coefficients because they do not mean causality. Even if correlation is detected, causality cannot be assumed as there might be other unmeasured variables affecting the result. Moreover, correlation coefficients do not specify the direction of causality (Field, 2009).

Correlation analysis was conducted with SPSS to explore the relationship of RLC scores produced in the research and regional economic indicators introduced in the last section, namely, regional GVA, productivity, household income, unemployment rate, international trade value and manufacturing GVA. The analysis includes 5 years' statistics from 2004 to 2008 and the results are presented in the next section.

6.2.3 Correlation results

Correlations							
	RLC	GVA	Productivity	House Income	Unemployment	GVA Manufacturing	Int'l Trade
Pearson Correlation	1.000	.572**	.252*	.745**	-.326**	.947**	.708**
Sig. (1-tailed)		.000	.032	.000	.008	.000	.000
N	55	55	55	55	55	55	55
**. Correlation is significant at the 0.01 level (1-tailed).							

Table 6-1. Correlation analysis outputs of RLC and GVA

RLC and GVA. As Table 6-1 shows, the correlation analysis confirms that RLC and GVA are significantly related, r =.57, p(one tailed)<.001. This is also visible in the scatterplot in Figure 6-7. It seems the higher one region's logistics capability the better regional economy it has in term of GVA.

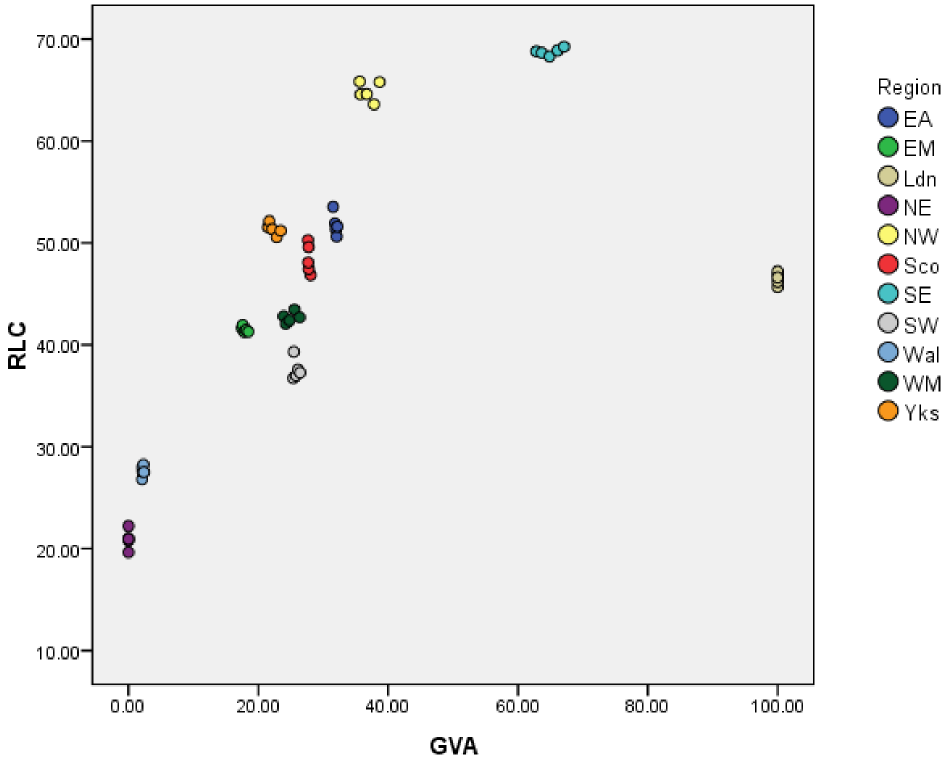


Figure 6-7. Scatterplot of RLC and regional GVA

RLC and Productivity. RLC is also found to be associated to the productivity of a region, however, the effect size is not as large as with GVA: r =.25, p (one tailed) <.05.

RLC and Household income. A strong positive correlation is observed between RLC and the household income of a region, r =.75, p(one tailed)<.001. This means those regions with better logistics capabilities tend to have higher disposable household incomes.

RLC and Unemployment rate. The logistics capabilities of a region are found to be negatively related with its employment rate, r =-.33, p(one tailed)<.01. This means those regions with better logistics capabilities tend to have lower employment rate.

RLC and Manufacturing GVA. A very strong correlation is found between a region's logistics capability and its manufacturing capacity, r =.95, p(one tailed)<.001. If the correlation coefficient was squared, we get a measure of the amount of variability in one variable that is shared by the other (known as the coefficient of determination, R^2). This means $(.947)^2$=89.7% of the variability in manufacturing GVA is shared by RLC, which shows the close connection between manufacture industry and logistics industry.

RLC and International trade. Finally, RLC is found to be positively related to a region's international trade value, r =.71, p(one tailed)<.001. This means $(.708)^2$=50% of the variability in a region's international trade value is shared by its RLC, which shows the critical role of regional logistics capability and a region's international trade.

6.3 Multiple Regression Analysis

6.3.1 Stepwise multiple regression

In the previous section, the relationship between logistics capability and economic indicators were explored with correlation analysis. This section uses regression analysis to investigate the relationship between RLC and its indicators.

Multiple regression analysis is a statistical technique that can be used to analyse the relationship between a single dependent variable and several independent variables (Tabachnick and Fidell, 2005). A general multiple regression model of one dependent variable (y) and n independent variables (x_1 to x_n) is presented as:

$$y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \cdots + b_n x_n + e$$

Where b_n is the coefficient and shows how the typical value of the dependent variable changes when one of the independent variables is varied, while the other independent variables are held fixed (Hair *et al.*, 2010). The prediction error or residual is represented by "e" in the model.

In this study, regression analysis is useful to understand which among the RLC indicators (independent variables) are related to the RLC (dependent variable), and to explore the strengths, direction, and statistical significance of these relationships. Therefore, the regression analysis gives insights to the relative importance of each RLC indicators in the prediction of the RLC (Hair *et al.*, 2010).

To examine the contribution of each independent variable to the regression model, a sequential regression method - stepwise regression method is used. In stepwise regression, the decisions about the order of entry for independent variables are made solely on statistical decision: the computer goes through a step-by-step procedure with a number of predictors to discover the best combination of predictors (Kinnear and Gray, 2009). Therefore, the stepwise multiple regression method is chosen in this study as a test to the relationship between RLC and its indicators.

6.3.2 Sample size and the dataset

According to Hair *et al.* (2010), the minimum ratio of observations to variables is 5:1, but the preferred ratio is 15:1, which should increase when stepwise estimation is used. Therefore, to do stepwise regression of all the 17 RLC indicators, at least 85 observations are needed and 255 preferred. The 5 years data available for the 11 regions in GB gives 55 observations, which is relatively a small sample size especially using stepwise multiple regression method.

Therefore in order to ensure statistical significance, regression analysis is conducted on the dimensional level (5 variables) instead of the indicator level (17 variables). In other word, the original 17 RLC indicators are integrated into 5 dimensions (Location, Infrastructure, Workforce, Service and Administration) based on their hierarchy structure. The score for each dimension is produced from the performance score in Table 5-13. Performance score matrix. Table 5-13and importance weight factors from Table 5-5. This process is not different from the RLC calculation apart from it is aggregation on the lower level in Figure 2-13. The data is also standardised to the scale from 0 (worse case) to 100 (best case) and the 2008 data listed in the following Table 6-2 for illustration.

Regions	RLC	Location	Infrastructure	Workforce	Service	Administration
EA (08)	68.98	74.75	78.40	17.81	70.15	12.68
EM (08)	44.78	38.45	55.76	4.62	62.25	8.32
Ldn (08)	55.40	90.22	11.40	7.81	45.19	**100.00**
NE (08)	**0.00**	**0.00**	**0.00**	0.88	**0.00**	**0.00**
NW (08)	93.98	47.10	87.37	**100.00**	89.51	26.92
Sco (08)	55.34	15.82	84.51	50.33	22.08	37.98
SE (08)	**100.00**	**100.00**	89.42	56.49	**100.00**	27.48
SW (08)	34.79	48.13	21.76	**0.00**	56.10	11.10
Wal (08)	14.59	14.81	8.26	16.09	10.52	5.58
WM (08)	47.13	21.77	37.96	27.27	86.23	15.01
Yks (08)	64.91	45.05	**100.00**	20.24	59.51	11.34

Table 6-2. Regression dataset: RLC and the five indicators in 2008.

6.3.3 Regression results

A stepwise regression was performed between RLC as the dependant Variable (second column in Table 6-2) and Location, Infrastructure, Workforce, Service and Administration as independent Variables (last five columns in Table 6-2).

As Table 6-3 shows, the five RLC indicators enter the regression model one by one. The indicator which contributes most to the prediction of dependent variable (RLC) enters first. When all the five RLC indicators are loaded in the model, the overall adjusted R^2 as a measure of overall model predictive accuracy is very close to 1 with a significant $F = 2692$, $p < .001$ (See Table 6-3 and Table 6-4). This means almost all the variation of RLC could be explained by the combination of the five indicators of Infrastructure, Location, Workforce, Service, and Administration[6].

---

[6] F-ratio represents the ratio of the improvement in prediction that results from fitting the model, relative to

Model Summary[f]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.819[a]	.671	.665	16.53635	.671	108.076	1	53	.000
2	.938[b]	.879	.875	10.10863	.208	89.831	1	52	.000
3	.987[c]	.974	.973	4.69630	.095	189.922	1	51	.000
4	.995[d]	.990	.989	2.99068	.015	75.760	1	50	.000
5	.998[e]	.996	.996	1.80566	.007	88.164	1	49	.000

a. Predictors: (Constant), Infrastructure
b. Predictors: (Constant), Infrastructure, Location
c. Predictors: (Constant), Infrastructure, Location, Workforce
d. Predictors: (Constant), Infrastructure, Location, Workforce, Service
e. Predictors: (Constant), Infrastructure, Location, Workforce, Service, Administration
f. Dependent Variable: RLC

Table 6-3. Model summary of regression analysis.

This is not surprising as the value of RLC score is built on indicators on indicators in these five dimensions. What we are more interested in is the proportion of each indicator's contribution. This could be shown by the R^2 Change statistics in Table 6-3. The first indicator enters the model, Infrastructure, causes R^2 to change from 0 to .671, this change in the amount of variance explained gives rise to an F-ratio of 108.076 ($p<.001$). This means Infrastructure accounts for 67.1% of the variation in RLC. The addition of a second indicator (Location) causes R^2 to increase by .208 ($F=89.831$; $p<.001$), therefore accounts for 20.8% of the RLC variation. Similarly, the Workforce indicator accounts for 9.5% of the RLC variation ($F=189.922$; $p<.001$). Service and Administration account for only 1.5% and 0.7% of the RLC variation respectively.

---

the inaccuracy that still exists in the model (Field, 2009). A high F value here can be interpreted as meaning that the model (with the five indicators) has significant ability to predict the outcome variable (RLC), which is unlikely to happen by chance.

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29553.489	1	29553.489	108.076	.000[a]
	Residual	14492.898	53	273.451		
	Total	44046.387	54			
2	Regression	38732.793	2	19366.396	189.524	.000[b]
	Residual	5313.594	52	102.185		
	Total	44046.387	54			
3	Regression	42921.569	3	14307.190	648.698	.000[c]
	Residual	1124.818	51	22.055		
	Total	44046.387	54			
4	Regression	43599.178	4	10899.794	1218.647	.000[d]
	Residual	447.209	50	8.944		
	Total	44046.387	54			
5	Regression	43886.627	5	8777.325	2692.100	.000[e]
	Residual	159.760	49	3.260		
	Total	44046.387	54			

a. Predictors: (Constant), Infrastructure
b. Predictors: (Constant), Infrastructure, Location
c. Predictors: (Constant), Infrastructure, Location, Workforce
d. Predictors: (Constant), Infrastructure, Location, Workforce, Service
e. Predictors: (Constant), Infrastructure, Location, Workforce, Service, Administration
f. Dependent Variable: RLC

Table 6-4. ANOVA results of regression analysis.

The regression coefficient (b) and the standardised coefficient (Beta) reflect the change in the dependent variable for each unit change in the independent variable. The sign of the coefficient denotes whether the relationship is positive or negative, and the value of the coefficient indicates the change in the dependent value each time the independent variable changes by one unit (Hair *et al.*, 2010). The standardised beta values are all measured in standard deviation units and so are directly comparable. Therefore we also use the "Standardised Coefficients" in Table 6-5 to show the importance of the five indicators to RLC. It is obvious all the five indicators have positive relationships with RLC: However, the most important indicator is Infrastructure, followed by Location and Workforce. Service and Administration are identified as less important. This result is compliant with the total variation explained by the indicators (adjusted R^2).

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	16.835	4.023		4.184	.000		
	Infrastructure	.653	.063	.819	10.396	.000	1.000	1.000
2	(Constant)	2.403	2.893		.831	.410		
	Infrastructure	.532	.040	.668	13.154	.000	.901	1.110
	Location	.442	.047	.481	9.478	.000	.901	1.110
3	(Constant)	-.404	1.359		-.297	.767		
	Infrastructure	.346	.023	.434	14.963	.000	.594	1.682
	Location	.499	.022	.544	22.644	.000	.868	1.152
	Workforce	.340	.025	.380	13.781	.000	.659	1.517
4	(Constant)	-1.998	.885		-2.258	.028		
	Infrastructure	.288	.016	.362	17.856	.000	.494	2.023
	Location	.396	.018	.432	21.601	.000	.508	1.967
	Workforce	.325	.016	.363	20.554	.000	.651	1.535
	Service	.183	.021	.200	8.704	.000	.384	2.603
5	(Constant)	-3.306	.552		-5.989	.000		
	Infrastructure	.321	.010	.403	31.007	.000	.438	2.284
	Location	.291	.016	.317	18.455	.000	.251	3.985
	Workforce	.275	.011	.306	25.009	.000	.494	2.026
	Service	.233	.014	.255	16.929	.000	.326	3.064
	Administration	.129	.014	.121	9.390	.000	.446	2.241

a. Dependent Variable: RLC

Table 6-5. Coefficients of regression analysis

Another statistics which shows whether the predictor is making a significant contribution to the model is the t value as listed in Table 6-5. The t value measures the significance of the partial correlation of the variable reflected in the regression coefficient (Hair *et al.*, 2010). From the magnitude of the *t*-statistics we can see that again the Infrastructure (31.007) and Workforce (25.009) have more significant impacts to RLC, whereas Location (18.455) and Service (16.929) have medium impacts. Administration (9.390) does not appear to be of importance in determining RLC.

6.3.4 Checking assumptions and multicollinearity

Normality, linearity and homoscedasticity are three assumptions required by regression analysis. Residuals scatterplots may be used as a basic test of identifying assumption violations for the overall relationship (Field, 2009). When all assumptions are met, the null plot shows the residuals falling randomly, with relative equal dispersion about zero and no strong tendency to be either greater or less than zero (Hair *et al.*, 2010). As shown in Figure 6-8, scatterplot of residuals showed acceptable distributions given relatively small sample size of 55 observations.

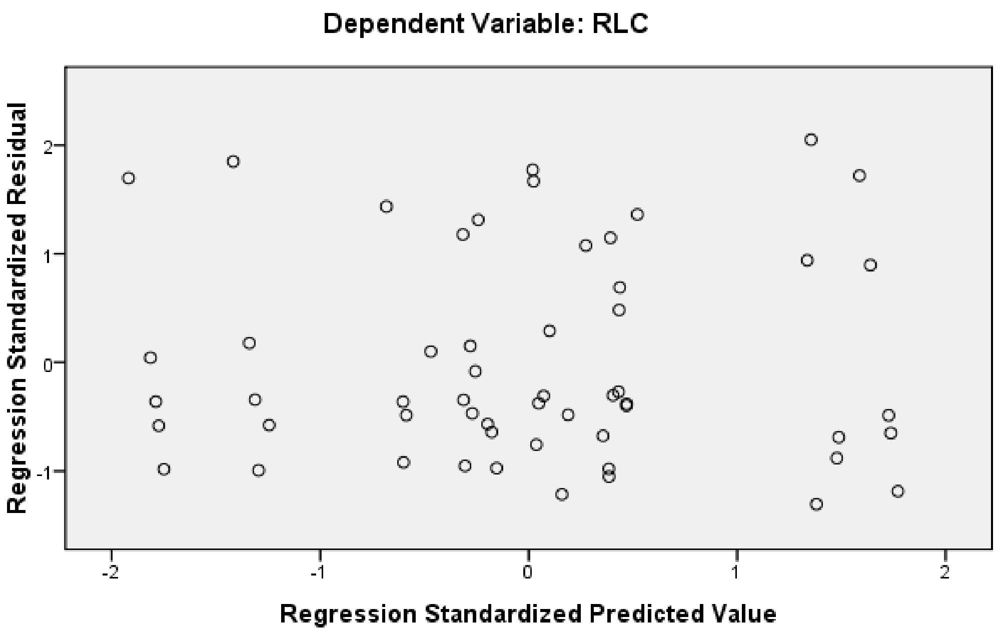


Figure 6-8. Residuals scatterplots of regression analysis

The histogram and normal probability plot of standardised residual in Figure 6-9 also confirm acceptable normal distribution of the dataset (Mean = .000; Std Dev = 0.95).

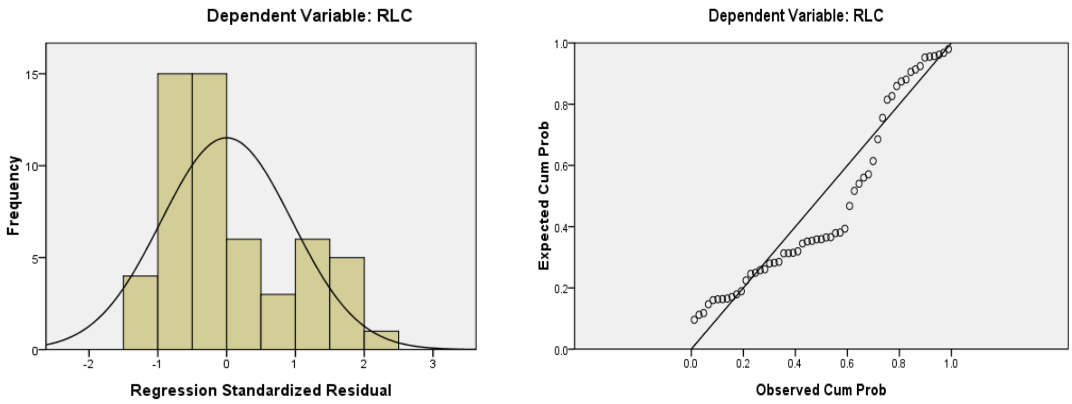


Figure 6-9. Histogram and normal probability plot for regression analysis

The issue of multicollinearity happens when there are strong correlations among the independent variables (Hair *et al.*, 2010). Multicollinearity creates "shared" variance between variables, thus decreasing the ability to predict the dependent measure as well as ascertain the relative roles of each independent variable. It also reduces the overall R^2 that can be achieved, and negatively affects the statistical significance tests of coefficients (Field, 2009).

The simplest and most obvious means of identifying Collinearity is an examination of the correlation matrix for the independent variables. As Table 6-6 shows, there are no presence of high correlations (.90 or higher) which would be an indication of substantial Collinearity (Hair *et al.*, 2010).

Other common measures for assessing Collinearity are tolerance and its inverse, the variance inflation factor. Tolerance is the proportion of a variable's variance not accounted for by other independent variables in the equation (Kinnear and Gray, 2009). Tolerance is then calculated as $1\text{-}R^{2*}$, where R^{2*} is the amount of that independent variable that is explained by all the other independent variables in the regression model. The tolerance value should be high, which means a small degree of multicollinearity. Field (2009) provided a few guidelines about multicollinearity:

- If the largest VIF is greater than 10 then there is cause for concern (Bowerman & O'Connell, 1990; Myers, 1990).
- If the average VIF is substantially greater than 1 then the regression may be biased (Bowerman & O'Connell, 1990).
- Tolerance below 0.1 indicates a serious problem.
- Tolerance below 0.2 indicates a potential problem (Myers, 1995).

Correlations

		RLC	Location	Infrastructure	Workforce	Service	Administration
Pearson Correlation	RLC	1.000	.691	.819	.639	.814	.361
	Location	.691	1.000	.315	.028	.676	.548
	Infrastructure	.819	.315	1.000	.562	.585	-.045
	Workforce	.639	.028	.562	1.000	.304	.165
	Service	.814	.676	.585	.304	1.000	.130
	Administration	.361	.548	-.045	.165	.130	1.000
Sig. (1-tailed)	RLC	.	.000	.000	.000	.000	.003
	Location	.000	.	.010	.419	.000	.000
	Infrastructure	.000	.010	.	.000	.000	.373
	Workforce	.000	.419	.000	.	.012	.114
	Service	.000	.000	.000	.012	.	.171
	Administration	.003	.000	.373	.114	.171	.
N	RLC	55	55	55	55	55	55
	Location	55	55	55	55	55	55
	Infrastructure	55	55	55	55	55	55
	Workforce	55	55	55	55	55	55
	Service	55	55	55	55	55	55
	Administration	55	55	55	55	55	55

Table 6-6. Correlation matrix of regression analysis

As shown in the previous Table 6-5, for the current model, the VIF values are all well below 10 and the tolerance statistics all well above 0.2. Therefore there is no significant collinearity in the data.

6.4 Reliability and Validity

Rigor is of great importance in logistics research (Mentzer and Flint, 1997). To ensure the conclusions from a research study with some confidence, two important characteristics of a measure need to be addressed (Hair *et al.*, 2010): Reliability (the extent to which a variable or set of variables is consistent in what it is intended to measure) and Validity (the extent to which a measure or set of measures correctly represents the concept of study). Reliability relates to the consistency of the measures, whereas validity is concerned with how well the concept is defined by the measures.

To ensure the reliability of the SMART-ROD method used in this study, a sensitive analysis was conducted to test if changes in weighting would significantly affect the output RLC scores for the regions in GB, and the results confirms the robustness of the RLC measurement framework in the research (see section 4.6 Sensitivity Analysis, page 162). Reliability could also be assessed by correlating performance on two halves of a test (split-half reliability). A commonly used measure is Cronbach's α, which is equivalent to the mean of all possible split-half coefficients. The reliability analysis with SPSS returns satisfactory results with Cronbach's α =.71 (see Table 6-7). Therefore, we can be confident that the results of this study are reliable.

Reliability Statistics

Cronbach's Alpha	N of Items
.701	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Location	27.9204	122.579	.457	.652
Infrastructure	32.9907	93.427	.587	.598
Workforce	38.4431	130.252	.401	.676
Service	39.1585	123.090	.699	.567
Administration	44.0684	173.221	.249	.722

Table 6-7. SPSS results for reliability analysis

According to Mentzer and Flint (1997), there are four components of the concept of validity: statistical conclusion validity, internal validity, construct validity and external validity. Each of these aspects will be discussed here.

Statistical conclusion validity refers to whether there is a statistical relationship between two phenomena. In this study, several statistics techniques are used to explore the relationships between RLC and economic indicators (Correlation analysis) and among RLC indicators (Multiple regression). As discussed in more detail in the Chapter six, the assumptions are met and significant results produced for these analyses. Therefore the conclusions for this study meet the statistical validity.

Internal validity is primarily used in experimental research designs to check if the experimental manipulation of the independent variable actually causes the observed results. Since this study is not an experiment in nature, and the dependent variable in this study (the RLC score) is calculated from the various independent indicators, the internal validity is not relevant.

Construct validation checks the underlying construct being measured is what the researcher means to measure. The components of construct validity are nomological validity, content validity, and trait validity issues (Mentzer and Flint, 1997).

Nomological Validity is a qualitative assessment of the tightness of the theory building (its logical consistency, and its consistency with previous research and the real world) and the definition of the constructs (Mentzer and Flint, 1997). In order to satisfy the nomological validity, efforts have been made in this study to ensure the clear and proper definition of terms and their relationships from theory development, research design to data collection.

Content validity (also called face validity) checks how well the content of the research are related to the variables to be studied. To make sure this study meets content validity, the RLC variables are all identified from credible literature sources that cover all aspects of the regional logistics capability. The list of indicators are later examined by the 40 logistics experts in the UK during the collection of weighting data to confirm that it is a good measurement construct that captures the essence of RLC.

Similar to the reliability analysis, the trait validity issues (which is composed of convergent validity, discriminant validity, and reliability) are examined with SPSS and the Cronbach's α indicates satisfactory in trait validity issues.

Finally, the external validity examines the degree to which the research findings can be generalized to the broader population. In order to reduce biases and to ensure the representativeness of the respondents, careful considerations were given to the sample selection of informants in this study. It is believed that the information about RLC's indicators would be the most reliable when comes from people working in and knowledgeable about the GB economy and logistics industry. Therefore, a list of GB academics, practitioners, and people working in GB regional development agencies is compiled as information sources. Total 40 complete questionnaires are gathered with shows a common pattern. Therefore, I could argue that the RLC measurement framework in this study is representative of reality in GB, and therefore could be generalised to other times and other researchers' works on regional logistics in GB. Moreover, the framework of this study could also apply to other regions outside Britain, with small necessary adjustments to suit the actual geographic and economic situations. These adjustments would most likely be deleting or adding RLC indicators and changes in the relative importance weighting, decided by the experts in that region.

As Mentzer and Flint (1997) pointed out, no single study can ensure validity in every aspect. This study is strong in statistical conclusion validity and external validity, and the fact that the results can be readily replicated. However, it suffers from relatively weak internal validity (making the leap from correlation to causation), which is the advantage of case study methods.

6.5 Conclusion

This second data analysis chapter builds on the previous data analysis chapter to explore in more depth of the RLC data in GB.

A SPSS correlation analysis was conducted to confirm that RLC are significantly related with several economic indicators especially regional GVA (r =.57, p(one tailed)<.001), household income (r =.75, p(one tailed)<.001), manufacturing GVA, (r =.95, p(one tailed)<.001) and international trade value, (r =.71, p(one tailed)<.001). This observed close relationship between RLC and economy answers the Research Question 1 (see page 3).

Having confirmed the close relationship between regional logistics and regional economy, a stepwise regression was conducted to understand the relationship between RLC and its indicators. The results show that the combination of the three indicators gives a total 97.3% explanation of the RLC variation: Infrastructure (67.1%), Location (20.8%) and Workforce (9.5%). The standardised coefficients and the magnitude of the t-statistics also indicate that the most important indicator to RLC is Infrastructure, followed by Location and Workforce. Service and Administration are identified as less important. These results are useful in preparing to answer the Research Question 1 (see page 4).

CHAPTER 7. DISCUSSION OF RLC PERFORMANCE IN THE GB CONTEXT

7.1 Introduction

The previous data analysis chapter confirms the existence of a close relationship between regional logistics and regional economy with correlation analysis, and discovers that the most important factor in determining RLC is the regional Infrastructure followed by the Location and Workforce of a region.

This chapter aims to explore in detail regional logistics performance in the context of the regions in GB. Firstly the RLC scores of the regions in GB are compared by time period and composition. Then each region's strengths and weaknesses in logistics capabilities are discussed, thereafter proposing specific suggestions for improvement in light of the findings of the previous data analysis chapter and specific regional conditions. Finally, general guidelines to improve RLC in GB are summarised at the end of this chapter.

7.2 Regional Logistics Performance in GB

Figure 7-1 shows the comparison of the RLC scores of the regions in GB in each year from 2004 to 2008. It appears the RLC scores remain constant in time for the regions in GB. Figure 7-1 also identifies four groups of regions by their logistics capabilities as illustrated by the red lines: the top performers (Top group) in regional logistics are the South East with RLC near 70 and the North West (RLC around 65). East of England, Yorkshire & Humber, Scotland and London come in the upper-medium group with RLC around 50. The Midlands and the South West score around 40 on RLC in the Lower-medium group. Wales and the North East are the worst performers with RLC scores around 28 and 21 respectively (Bottom group).

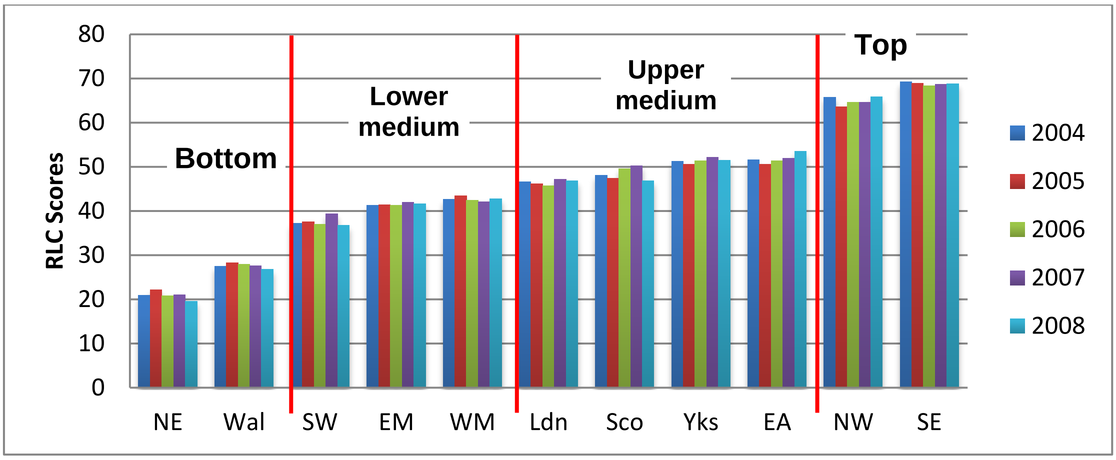


Figure 7-1. Five-year RLC comparison of GB regions.

Figure 7-2 shows the contribution of each dimension of regional logistics indicators to the overall RLC scores. It seems that Location indicators contribute the most to RLC scores especially for London. Infrastructure and Workforce dimensions are also important in defining the ranking of RLC, whereas the Service and Administration dimensions are less influential. This is consistent with the results of the regression analysis in the Chapter Six that Infrastructure, Location and Workforce are the three most important determents of a region's RLC.

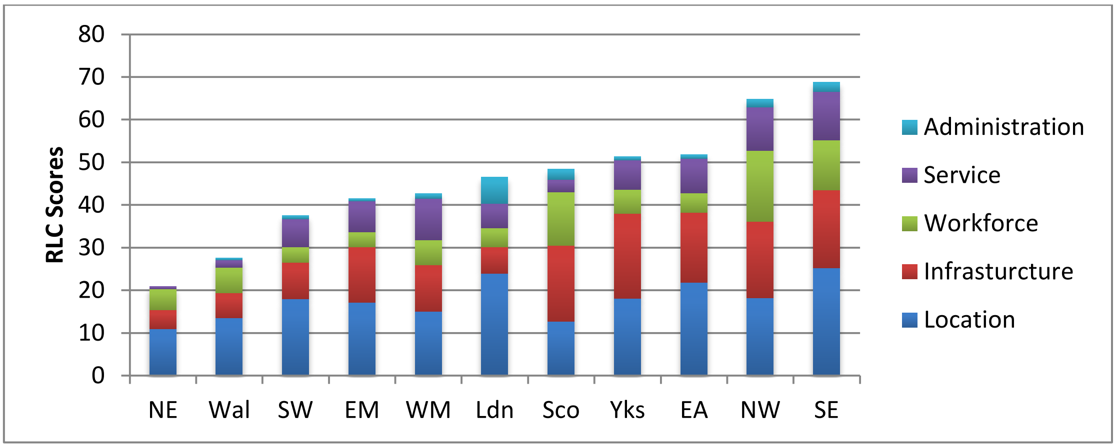


Figure 7-2. The composition of RLC scores[7] of GB regions.

Figure 7-2 also shows that each region is unique in its RLC performance and composition. Therefore, in order to highlight their strengths and weaknesses and give recommendations accordingly, each of the regions in GB will be explored in more detail of their RLC performance comparing with the GB average. The RLC scores of each region are illustrated with polargrams (see Figure 7-3 to Figure 7-13) which is a useful way to display multivariate observations with an arbitrary number of variables (John *et al.*, 1983). Each region's RLC scores (2004-2008 average) are represented by a "RLC star" – a blue star-shaped Figure with one ray for each dimension. The higher value a ray is the better performance this region has in this dimension. The large area a RLC star covers, the better overall performance in the regional logistics. The GB average performance is illustrated by the red lines as a benchmark.

The strengths and weakness of the regions in each of the four groups will be discussed in the context of regional characteristics before recommendations given about how to sustain and develop the logistics competitiveness for each

[7] These are average RLC scores of the years from 2004 to 2008.

region in GB to support regional economic growth.

7.2.1 Top group regions

South East

The South East region sees itself as the prime UK gateway in terms of both economic activity and physical travel. As the best regional logistics performer in Great Britain, the South East scores significantly higher at all dimensions than GB average (see Figure 7-3). The shape of the RLC star of the South East is very similar to the GB average therefore the region's development of the logistics capabilities is seen as balanced.

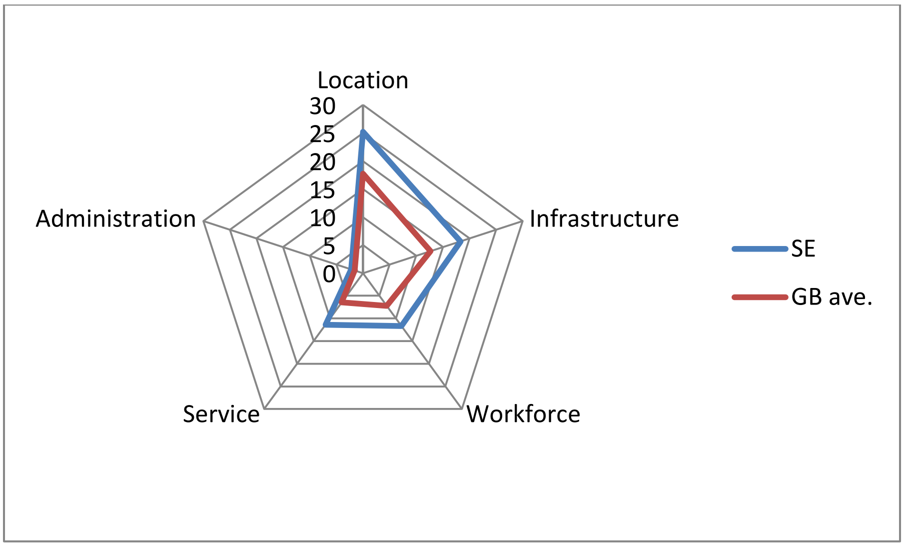


Figure 7-3. Polargram of the South East RLC (2004-2008 average)

The South East is undoubtedly the best performer in regional logistics in Great Britain. First of all, the South East has an excellent location advantage. The South East is in no sense an island - its physical, social and economic relationships with adjoining regions and the rest of the world are of considerable importance. The region is very close to its two largest trade partners - London and the East of England. The region also enjoys a long coastline and deepwater ports which allows convenient European and wider international trade connections.

As discussed in section 3.3 GB Regional Profiles, the South East has a strong logistics infrastructure (see Figure 3-16. Key infrastructures in the South East.), which include 22 percent of the English motorway network and 15 percent of the major roads (SEFF, 2010), the UK's second busiest airport (Gatwick), some of the country's major passenger and freight ports such as Dover, Southampton and Portsmouth, as well as the Channel Tunnel, which make the South East the natural access point to continental Europe and beyond.

Since Infrastructure is of significant importance in determining a region's logistics capability, the South East needs to firstly continue maintaining and making the best use of the existing transport infrastructure as an asset. Secondly, there is potential to further improve and develop transport connections to the region's international gateways (ports, airports and international rail stations) and develop road and rail links along the south coast and the Western Corridor and Blackwater Valley, which would help ease congestions in the transport network. Two port-related EU projects are promoted by SEEDA: FINESSE (Freight Intermodality and Exchange on Sea and Straits in Europe) and IMPACTE (Intermodal Port Access & Commodities Transport in Europe) manages C2C (Connect to Compete). These initiatives have involved the ports of Southampton, Portsmouth, Dover, Ramsgate and Shoreham to promote enhanced access to ports and sustainable distribution of freight (SEEDA, 2011).

Moreover, majority of UK's current air freight volume moves from airports in London. Therefore, there might be potential to encourage Southampton Airport to sustain and enhance its role as an airport of regional significance in the South East.

Moreover, the South East benefits from its large available logistics workforce base, and good capacity in transport, warehousing and value added service capacity. According to the results of the last chapter, the most important determinants of RLC are Location, Infrastructure and Workforce, on which South East scores very high. However, the region's transport system faces a number of challenges (The South East Regional Spatial Strategies, 2008), including severe congestions on the road and rail networks that result from high volume of freight and passenger transportation, especially to/from the region's airports and ports, and growing concern regarding the impact of the transport system on the environment. Due to its busy logistics activities, the South East is the biggest polluter in terms of CO_2 emission.

The efficient movement of freight through the region is a key issue arising from its gateway function. If the South East is to sustain its top position in regional logistics competitiveness in GB, it has to effectively deal with above logistics challenges. Rail freight has an important role to play in reducing the environmental impacts associated with the transport system. Therefore the railway system should be developed to carry an increasing share of freight movements. There is a need to protect routes on the rail network that benefit freight movements and to address bottlenecks on the network that adversely affect rail freight. Recently, SEEDA has reduced CO_2 emissions by 30% before 2011 through the Corporate Plan to help reduce carbon emissions and ease traffic congestion on the road network (SEEDA, 2011).

North West

As the second best overall performer in RLC, The North West surpasses the GB average in all dimensions especially in Infrastructure, Workforce and Service (see Figure 7-4).

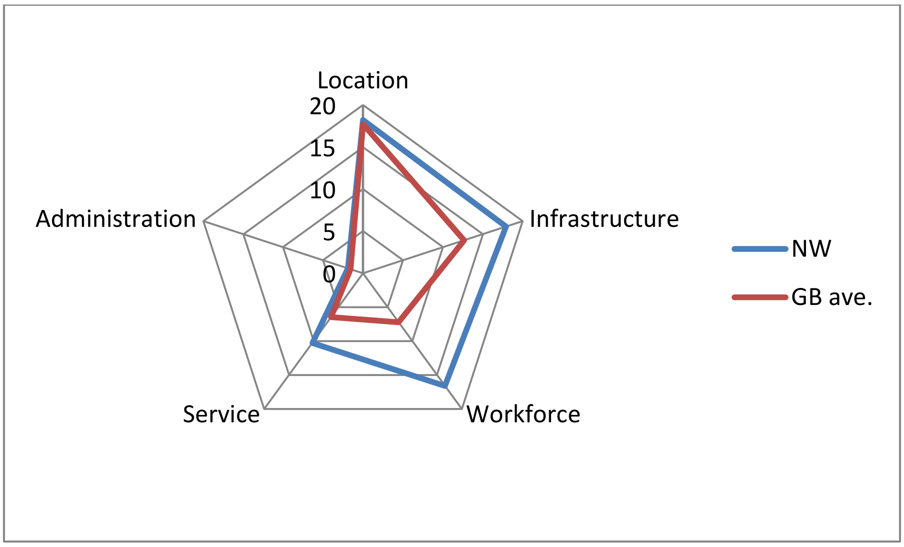


Figure 7-4. Polargram of the North West RLC (2004-2008 average).

Although the North West is not immediately next to London as South East, it is well positioned at the intersection of two internationally important transport corridors running North-South (The M6 and West Coast Mainline) and West-East (the North European Trade Axis route) as discussed in section 3.3 GB Regional Profiles.

In terms of infrastructure, the North West has developed a high quality network of road which carries more freight than any other regions in GB (see Figure 3-12. Key infrastructures in the North West.). The region also has the largest logistics workforce base which is well qualified by cheap. The North West also has the largest warehousing service capability in GB and above average transportation and value added service performance.

Therefore to keep the top position of the region's logistics performance, the North West needs to firstly maintain and fully utilise the existing transport infrastructure. Similar to the South East, one of the biggest challenges for the North West, is the environmental impact of the region's logistics and manufacturing activities, which have made the North West the second largest emitter of CO_2 in GB (The North West Regional Spatial Strategies, 2008). This is partly due to that fact that the region's strong manufacturing base. Out of all the regions and countries of the UK, North West makes the highest contribution to the UK's manufacturing industry GVA (see section 3.3 GB Regional Profiles), which generates considerable logistics activities. Therefore another serious concern is the congestion on some rail routes and on the road in urban areas, which has a significant impact on journey time reliability, affecting the productivity of businesses and industry, as well as personal lives.

Therefore North West needs to reduce the adverse impacts of transport in terms of safety hazards, congestions and carbon emissions by using more sustainable modes of transport instead of road. For example, to transport cargoes such as containers and bulk freight by water (short-sea and coastal shipping) or rail instead of road. Another opportunity is to develop intermodal freight terminals and infrastructure close to the major origins and destinations of freight in the region to encourage modal shift of freight transportation from road.

7.2.2 Upper-medium group regions

<u>East of England</u>

The East of England has the third best regional logistics capability among the regions in GB. In Figure 7-5, it is easy to see that the overall logistics capability of the East of England is slightly above GB average since its RLC star covers more area than the red RLC star for the GB average. The Location and Infrastructure dimensions score significantly more than average, while Workforce lags behind.

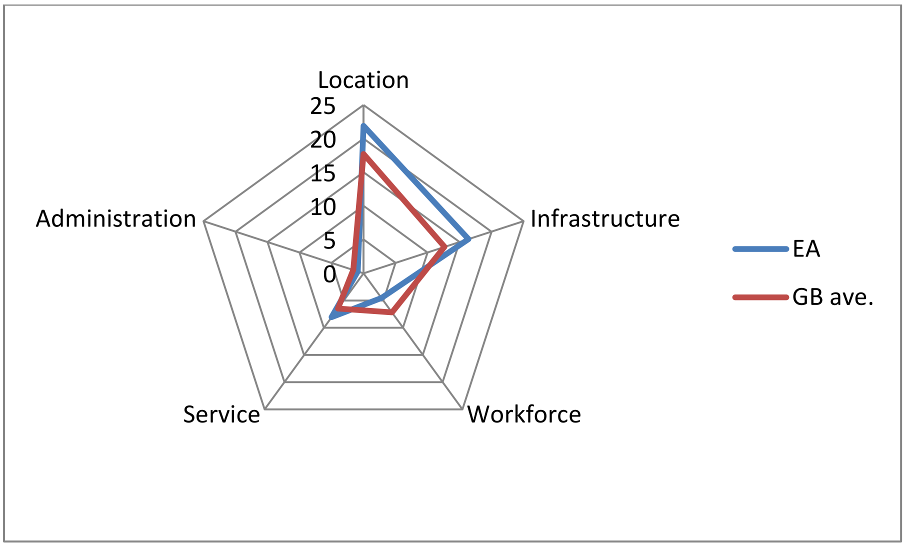


Figure 7-5. Polargram of East of England RLC (2004-2008 average).

The East of England benefits from its location close to London and well-constructed infrastructure to forge good inter-regional and international linkages (see discussion in section 3.3 GB Regional Profiles and Figure 3-3. Key infrastructures in East of England.) Apart from crucial regional infrastructure at Luton, Stansted, Felixstowe and Harwich, it is worth pointing out that the region is also better equipped with intermodal infrastructures to handle the large portion of the UK containers. Therefore the East of England needs to make sure of maintaining and strengthening the region's inter-regional connections to access to the economic opportunities in London, and ensure the maintenance and effective operation of ports and airports which act as international gateways. Considering the importance of the container transportation to the UK economy, the East of England needs to fully utilise its strength in multimodal transportation capacity, and increase rail freight portion which also reduces the environmental impact of the logistics activities.

The biggest challenge for the East of England in terms of RLC, however, is workforce, which is identified as an important factor to RLC scores. The Workforce in the East of England, however, lags behind its overall logistics performance. At an average salary rate, the availability and quality of the logistics workforce are much worse than the other regions. Therefore, the priorities for the East of England if it is to catch up with the top regions in the logistics performance would be to take effective measures to attract and develop a larger workforce base in logistics and encourage more professional skills training of the logistics workforce. Such deficiency in qualified workforce in the East of England is also identified in the Regional Priorities Statement (2010), which suggests the region needs to develop the proportion of technical and higher skilled people within the workforce, especially in the Engine of Growth areas. Such areas include ports & logistics centres and transport gateways such as Thames Gateway South Essex, Milton Keynes South Midlands and Luton as a regional city, the London Arc, Haven Gateway, and Greater Peterborough

Moreover, the government spending on the transportation is slightly under average too. So effort should be made to fight for more support of UK government to ensure the development the regional RLC.

Yorkshire and Humber

Yorkshire and Humber has an overall RLC score above GB average as shown in Figure 7-6. Although slightly lagging behind in government support and logistics workforce, the RLC of Yorkshire and Humber has high score for Infrastructure due to its busy port system and rail network linking the ports.

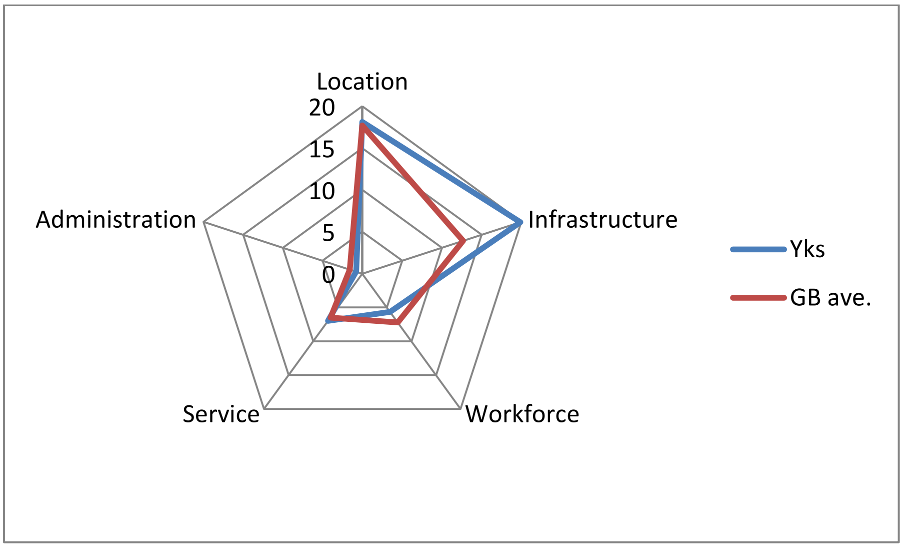


Figure 7-6. Polargram of Yorks&Humber RLC (2004-2008 average).

The Yorkshire and Humber region mostly benefits from its busy Hull & Humber Ports complex on the Humber River, which is the largest in the UK in terms of total volume (see discussion in section 3.3 GB Regional Profiles). The highest score on rail performance is also given to Yorkshire and Humber due to the high volume of bulk freight transported by trains from the Humber ports. The major airports in the region are less used for freight comparing with its peer regions. Therefore the air freight performance of Yorkshire and Humber is among the lowest. Despite the cheap cost of the logistics employees in the Yorkshire and Humber, the logistics workforce is below GB average in both number and quality, which leaves large potential for improvement.

As a region in the upper-medium group of RLC performance, the Yorkshire and Humber region has great natural advantage of inland waterways and seaports. But before catching up with the top regions, the region needs to firstly fully capitalise on the opportunities provided by the Humber Ports as an international trade gateway for the region and the country. Further improve rail and road connectivity to the ports, especially A63 Castle Street in Hull, A160 improvements in North Lincolnshire and rail capacity improvements to Immingham, Grimsby and Hull docks. Secondly, it must seek to grow the regional logistics workforce and improve the quality of the workforce. Beyond that, Yorkshire and Humber should carry out improvements to multi-modal facilities in the region to promote more environmental freight transport modes such as water and rail. Locate storage/distribution developments which generate high levels of freight near to intermodal freight facilities, rail freight facilities and port facilities to make the best use of existing and future logistics infrastructure and capacity. Moreover, examine the scope for building air freight facilities within region.

Scotland

Scotland has an overall regional logistics capability that is slightly above GB average according to this research. From Figure 7-7 we can see that the RLC star for Scotland is very unbalanced taking the GB average as a benchmark. Although Scotland is at significant disadvantage for logistics activities for its remote location and weak logistics services capacities, the region has a well-developed infrastructure and an outstanding logistics workforce base, as well as above average government support.

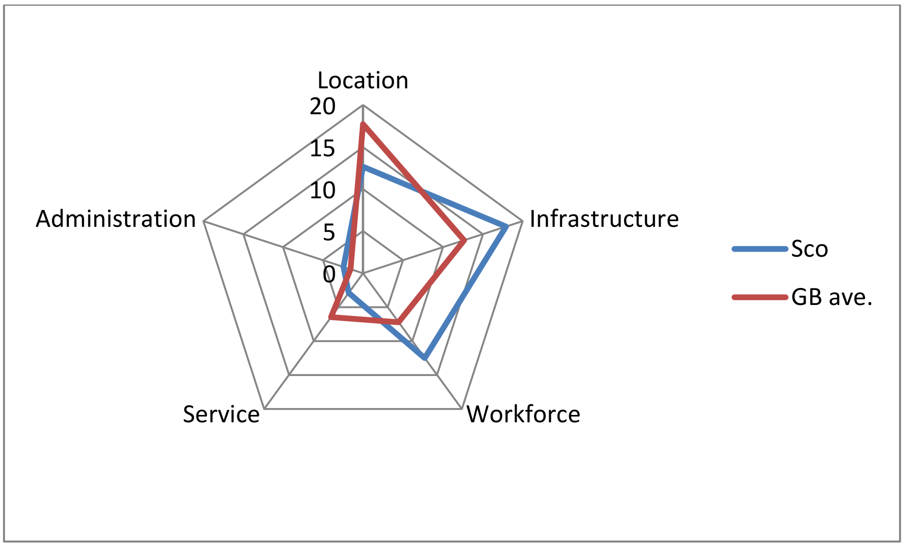


Figure 7-7. Polargram of Scotland RLC (2004-2008 average).

As discussed in section 3.3 GB Regional Profiles, Scotland is the largest region in terms of surface area, but also the northernmost region in Great Britain. This means it is far from the other regions in GB. Scotland also has the lowest population density in the UK - approximately 65 people for every square kilometre of land, which makes it even more difficult for logistic activities to service its population. The long coastline and navigable water of Scotland, however, has contributed greatly to the region's number one position in water freight in GB (see Figure 3-14. Key infrastructures in Scotland.). Other strengths of Scotland include good road and rail infrastructures and a logistics workforce that is both large in number and good in quality. Although its physical location cannot be changed, Scotland should make effort to increase its international market penetration by fully capitalise on its ports as national gateways.

The intermodal and air freight infrastructures, however, are weak in Scotland. Equally weak in Scotland is the logistics service capabilities (including transportation, warehousing and value added), especially the value added service capacity. Based on these analyses, it is proposed that Scotland should give enough effort to develop intermodal infrastructures to handle more containers directly from the ports. Moreover, consideration should be given to encourage more air freight through airports within Scotland.

Scotland needs to enhance its transport service capacity, warehousing capacity to enhance its logistics competitiveness. To develop value added service capacity for cargo storage and handling might require economic structure changes to a larger manufacturing base, which would contribute positively to the RLC of Scotland.

London

At the first glance, one may find the logistics performance of London is under expectation. Overall, London ranks 6th in GB with around average RLC (See Figure 7-8). Comparing with the GB average, the logistics capability of London is rather unbalanced. It is in the centre of the UK economic and logistics activities and enjoys greater support from the government. However, the logistics Infrastructure and Workforce lag behind the GB average. London may be a unique case where its logistics capabilities should be better than reflected by its RLC score.

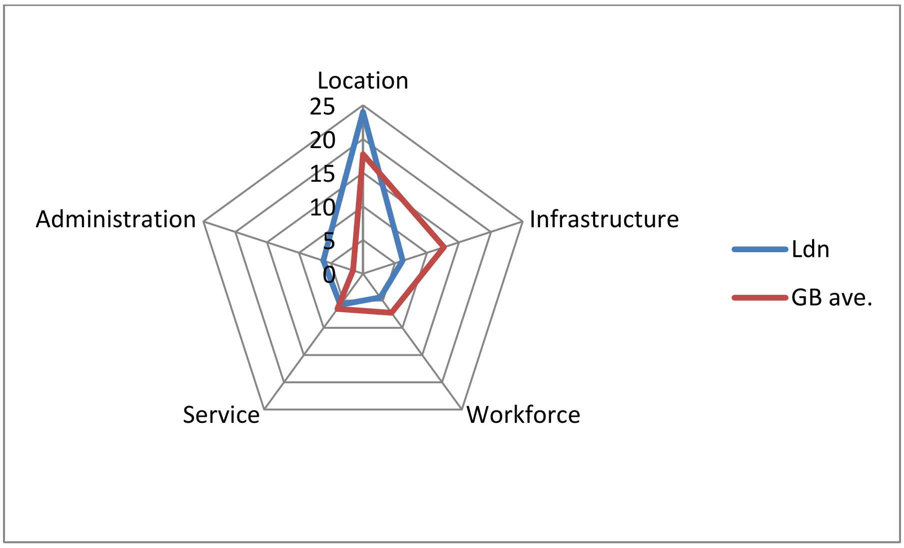


Figure 7-8. Polargram of London RLC (2004-2008 average).

With no doubt, London enjoys its centre location where most of the international trade as well as inter-regional trade in GB happen. London also has the best international market accessibility among all the regions in GB.

Motorways and national rail networks also provide London with essential connectivity to and from the rest of the UK (see Figure 3-7. Key infrastructures in London.). However, London scores low on rail freight capacity due the congested rail paths with passenger transport. Similarly, road freight tends to go around London to avoid congestion.

The primary concern of London in terms of logistics is congestion and other adverse impacts of transportation. Therefore in addition to promote new developments in the logistics infrastructure, London could seek to develop alternative rail and road freight routes outside London to avoid conflicts, as well as promoting more economic development and employment growth in outer London to divert logistics activities and reduce the congestion in the central London.

It should be pointed out that the RLC score is not reflecting the fact that London is within easy reach of the principal UK international seaports including Southampton in the South East and Felixstowe in the East of England. In addition, London is unique among the British regions also in that a significant proportion of the workforce resides in neighbouring regions which is not picked up by the region employee indicator. Therefore, although the labour cost is higher in London than any other region, the logistics workforce indicator in London would actually be better than the RLC indicates.

7.2.3 Lower-medium group regions

<u>West Midlands</u>

The West Midlands has an overall RLC score very close to but slightly lower than the GB average. It lags slightly behind the other regions in GB in all dimensions apart from the logistics service capabilities (see Figure 7-9).

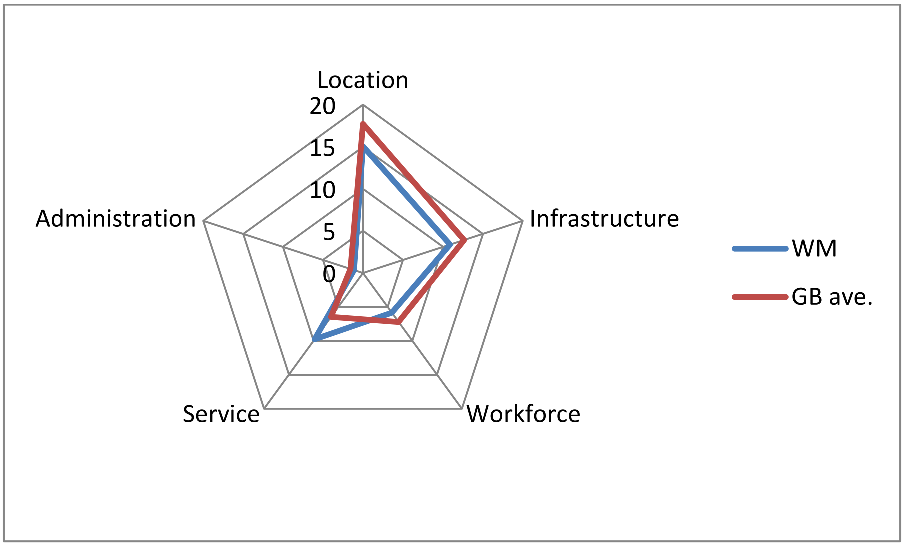


Figure 7-9. Polargram of West Midlands RLC (2004-2008 average).

The West Midlands has a relative central location and easy access to its main trading regions. However, the slightly lower Location score for West Midlands is due to the fact that it is the only land-locked region in the UK, which means the exports from West Midlands have to go through other regions for access to the seaports. Therefore the West Midlands should give its RLC development priority to building better linkages to seaports in the neighbouring regions to make up the lack of sea access within the West Midlands.

As discussed in section 3.3 GB Regional Profiles, the majority of the air freight of the West Midlands is carried by airports in other regions. Also, the rail freight and intermodal infrastructure lags behind other regions with limited inter-modal terminal capacity and distribution warehousing located on rail linked sites. Therefore, there is potential for rail to make a larger contribution to the freight transportation in the region. To develop a more balanced logistics performance and fully utilise the advantage of its location, it is proposed that the West Midlands encourage the development of new rail freight terminals and improving access to existing terminals. Also locate developments that generate significant amounts of freight in locations that have good access to the rail network. Also to ease the environmental impact of freight, the region should set out measures such as building more intermodal terminals to encourage the use of rail and inland waterways for freight. Finally, the region should take measures to encourage air freight to be handled by airports within the region.

The logistics workforce in the West Midlands is below average in both number and quality, although cheaper than many other regions.

Thanks to the central cross road location of the region, there is a concentration of storage and distribution facilities in the West Midlands. As a result, the West Midlands region enjoys good transport and warehousing capacities. In addition, since the region is greatly based on manufacturing, the West Midlands is very strong in the value added service too.

East Midlands

Overall, the East Midlands has poorer RLC than the GB average. However, its performance does not vary greatly from the GB average apart from the Workforce dimension (see Figure 7-10). This is probably where the region needs to work on if the East Midlands is to catch up with the other regions.

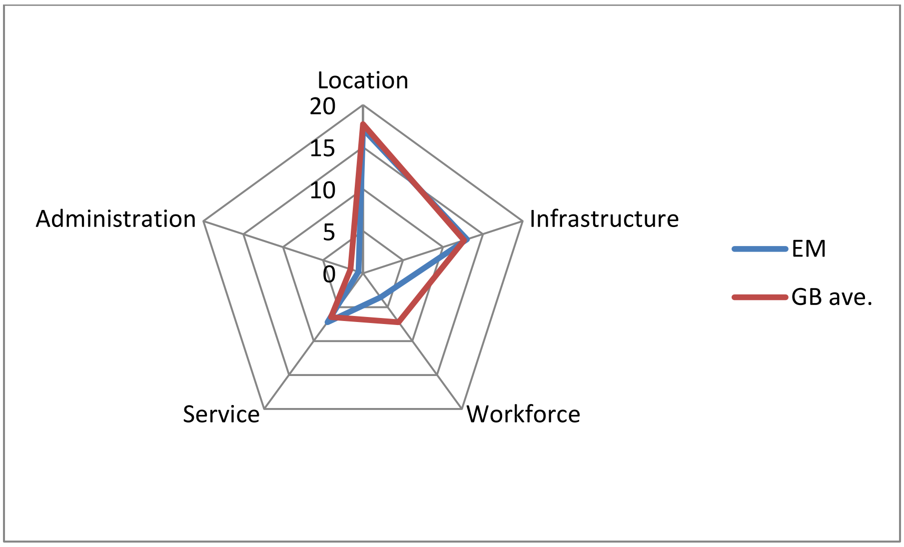


Figure 7-10. Polargram of East Midlands RLC (2004-2008 average).

The East Midlands region, as introduced in section 3.3 GB Regional Profiles, has reasonable strategic location with good road and rail transport links (see Figure 3-5. Key infrastructures in East Midlands.). The air freight capacity of the region is above average as East Midlands International Airport 15 miles from Nottingham and Derby which is the second largest freight airport in the UK. However, the sea freight capacity is low with Boston being the major seaport in the region and accounts for only 0.1% of the sea freight volume in the UK in 2007.

The south of East Midlands is of special importance as it is at the cross roads of many of the freight movements in the UK, particularly those from the east coast ports. Therefore the East Midlands should develop more intermodal freight terminals within the region to accommodate the intermodal freight from the principle east coast ports and capitalise on the region's manufacturing advantage.

The analysis of this research indicates that infrastructure enhancements alone will not significantly improve the logistics capability of the East Midlands. It is worth pointing out that a higher proportion of the workforce in the East Midlands is in lower skilled occupations, which has resulted in the lowest scores on logistics workforce qualification and base number for the East Midlands. Therefore there is large potential for the East Midlands in developing a larger logistics workforce with higher level of professional skills. In fact, Transport Equipment is one of the workforce sectors identified by the East Midlands which demonstrate competitive advantage and growth opportunities, and one that should be given most priorities (EMSPS, 2011).

The strong manufacture base of the region has also resulted in the good value add service capacity in the East Midlands, although the transport and warehousing capacities are only average comparing with other regions in GB.

Finally, the government support in the East Midlands is below national level. The region therefore needs to make great effort to fight for more government support to improve its logistics capabilities.

South West

As the RLC star in Figure 7-11 shows, the South West matches the average GB performance in Location, Administration and Service. However, large gaps remain in the logistics Infrastructure and Workforce capabilities between the South West and other regions in GB. This has left the South West with below GB average RLC scores, only better than the North East and Wales. Hence the most crucial areas to work on would be Infrastructure and Workforce.

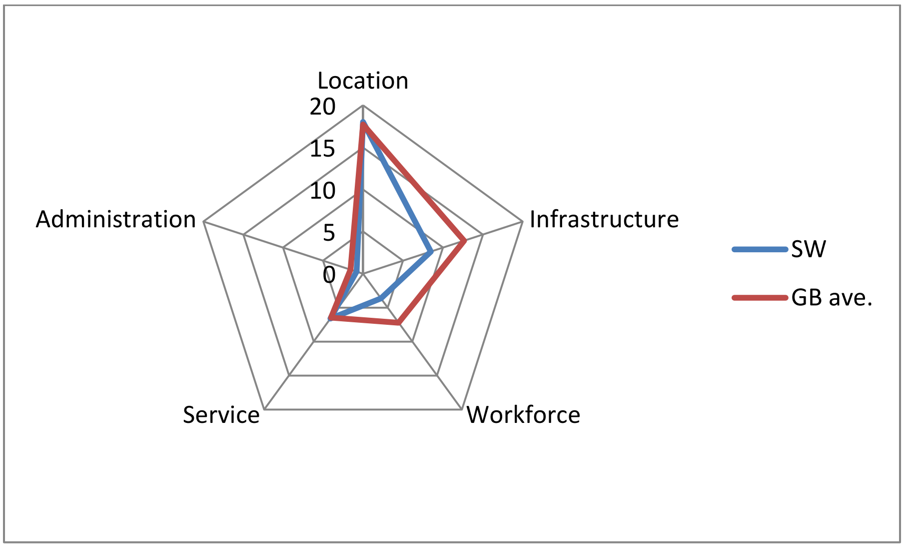


Figure 7-11. Polargram of the South West RLC (2004-2008 average).

As discussed in section 3.3 GB Regional Profiles, the South West is largely remote apart from the main population and economic centres in the north and east and relies on road and rail connections, port of Bristol and airports in the region for its logistics activities. The long coastline of the South West gives potential to develop its connectivity to the rest of the world via sea freight. However large development in sea freight infrastructure is needed as the only deep-water port in the South West of national significance is Bristol. Therefore to fully capitalise on the deep-water capacity of the Bristol port and development new deep sea ports is the priority of the RLC development, to attract more container traffic, and increase the international market access of the region.

The Draft Regional Spatial Strategy for the South West also points out that the low freight volumes from and to the South West limit the viability of rail freight infrastructure, as well as the intermodal infrastructure. Since the region is not a major area for manufacturing, much of the freight moved into, and within, the region is for distribution. If the South West is to catch up with the other regions in the logistics capabilities, it needs to promote the development of intermodal infrastructures at the port and the capacity of rail network to accommodate the container freight movement.

The regional airports in the South West carry a very small share (0.03 percent) of the total volume of freight carried at airports in England (see section 3.3 GB Regional Profiles). Hence there might be potential to reduce freight journeys to airports outside the region, particularly road traffic to Heathrow and Gatwick by increase the use of airports within the South West.

The Workforce of logistics in the South West is quite weak comparing with the other regions in GB on both number and qualification levels, which drags down the overall logistics capability of the region. Therefore, this study suggests for the region to develop a larger and better trained logistics workforce within the region to support efficient logistics activities.

7.2.4 Bottom group regions

Wales

Wales is the second worst overall logistics performer among all the regions in GB. As its RLC star obviously shows in Figure 7-12, Wales needs significant developments in all logistics aspects especially Infrastructure, Service and Workforce.

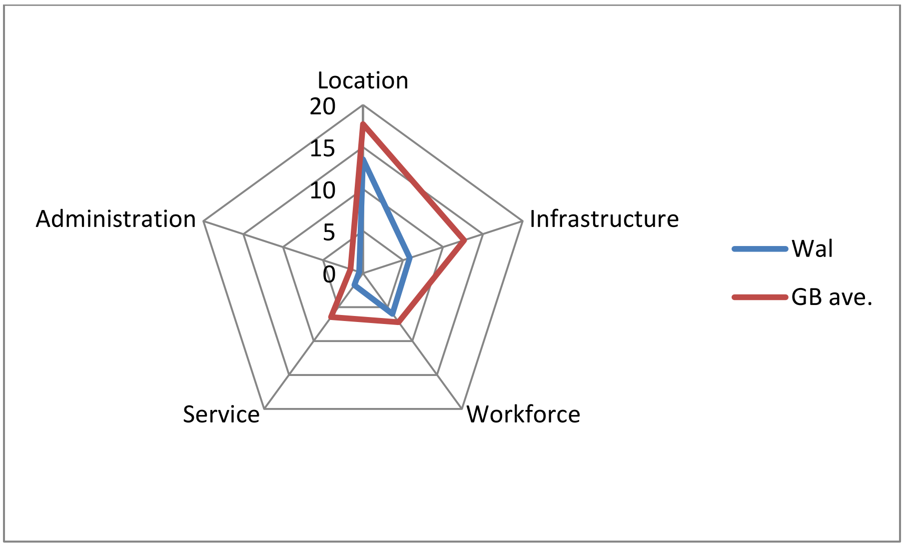


Figure 7-12. Polargram of Wales RLC (2004-2008 average)

Earlier discussion in section 3.3 GB Regional Profiles has shown that Wales is relatively far from London and other prosperous regions in the southeast. In addition the current connectivity and freight traffic of Wales are quite low on both international and domestic levels. These all contribute negatively to the locational RLC score of Wales. Although it is difficult to improve the physical features of the region, effort could be made to increase the international significance of the region and therefore improve the market reach of Wales and RLC scores. Wales has a long coastline, which should be fully utilised to improve international connectivity and attract more international freight with direct routing to Wales, rather than via intermediate ports or airports. To use the sea-access advantage of Wales to serve not only Wales but also other regions, especially land-locked West Midlands close by. This then requires significant development in infrastructure.

Wales has average sea freight infrastructure, however, the road, rail, intermodal and air infrastructure are poor comparing with the other regions (see Figure 3-20. Key Walsh road, rail, port and airport infrastructure.). As the previous chapter suggests, infrastructure indicators carry much weight in the overall RLC. Therefore, much could be done in developing the freight infrastructure of Wales for a stronger RLC. Firstly, make the best use of existing roads and rail network to accommodate freight movement, as well as to develop new capacities to handle the flow of traffic. The aim is to forge better road and rail-freight connections to the main freight ports and access to Cardiff International Airport. Then it is equally important to promote modern freight interchanges to attract more container traffic and increase the share of freight moved over rail and water, where environmental, economic and social benefits can be achieved.

Much left to be done for Wales to catch up with other regions in its logistics capabilities. Although the cost of logistics workforce in Wales is among the lowest in all the regions in GB, the number of available workers and the qualification of the workforce remain weak. Therefore Wales needs to develop a more solid workforce base for logistics activities. In addition, there is also large potential for Wales to improve its ability to provide good logistics services, especially freight transport and warehousing.

North East

The North East has the worst logistics capabilities among the 11 regions in GB according to this study. As the RLC star in Figure 7-13 shows, the North East obviously has poorer performance in every dimension of the RLC indicators.

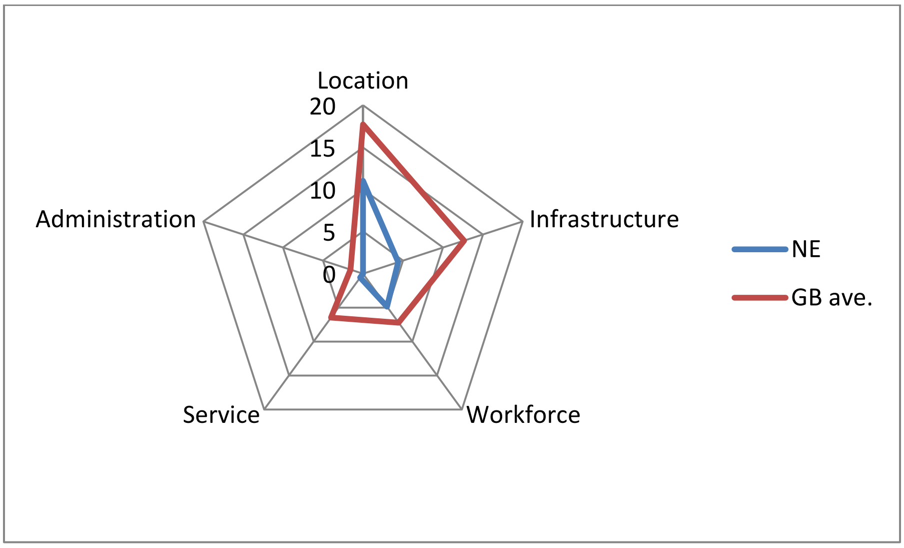


Figure 7-13. Polargram of the North East RLC (2004-2008 average)

The international market accessibility of the North East is the lowest in GB, as well as the freight movement to, within and from the region. On the bright side, this has led to the lowest level of carbon emission. However, the lagging behind logistics capabilities, particularly poor infrastructure, unqualified workforce and low quality logistics service, have also slowed down economic development of the North East. As the polycentric territorial development strategies point out (Territorial Agenda of the European Union, 2007) the North East region could have an important role in strengthening the Trans-European networks with its location facing the continent. If the region is to achieve this aim and support its regeneration and economic growth, the North East needs to quickly grow its logistics capabilities to enhance connectivity and accessibility within and beyond the region. This suggestion fits with the Regional Spatial Strategy of the North East Region (The North East of England Plan, 2008), which argues the improved connectivity and accessibility within and beyond the region will contribute towards the delivery of a North East renaissance.

As introduced in section 3.3 GB Regional Profiles, the North East's infrastructure for logistics is relatively poor, especially the road and rail networks (see Figure 3-9. Key infrastructures in the North East.). The Air freight and multimodal interchange facilities are also underdeveloped with the lowest container traffic in GB. Sea freight is the strongest aspect in infrastructure with several major seaports in the North East, however is only as good as national average.

To catch up with the top region in RLC quickly, North East needs to firstly enhance its freight infrastructure, as it is one of the most significant RLC determinants and it could more easily improved comparing with locational factors. The utilisation of the existing port infrastructures need to be improved to attract more freight volume to go through the region. The North East has an advantage that it does not suffer as severely from congestion problems as in the South East, which could be an opportunity for the region to develop its ports as alternatives to congested southern ports. The aspirations of Teesport to develop a new deep sea container terminal would reflect such ambitions for a greater share of southern ports' traffic (The North East of England Plan, 2008).

Moreover, effort must be made to ensure that the North East has a high quality, integrated, safe and roust network of transport infrastructure of freight to handle the freight traffic. Improve access to the region's international gateways including airports and ports, as well as high quality networks linkage to other regions in GB and beyond. Priorities should be given to develop strategic services and multimodal freight interchange capacity at existing operational facilities, including rail connected ports, for example the rail loading gauge enhancements to Teesport to enable 9' 6" container traffic to be handled by rail. The recent £1m commitment of the Northern Way in commissioning Network Rail to develop detailed plans for the gauge enhancement is a step towards this suggestion (One North East, 2010). The planned routes for gauge enhancement are from Teesport to the East Coast Main Line, as well as the Ports of Hull and Immingham to the East Coast Main Line. The airports are also important economic drivers for the region, so effort should be made to increase of the share of airport within the region for freight transport.

Equally important to the infrastructure enhancements, the North East also needs to develop a sound workforce for the logistics industry that is both sufficient and qualified. Similar to Wales, the North East has a cheap but small logistics workforce, which lacks professional qualification training. Therefore North East should try to build a well-trained and sufficient workforce for the logistics industry.

The available transportation and warehousing capacities in the North East are not enough for developing a stronger overall logistics capability in the region, according to this research. Hence the next priority for the North East should be to seek to build higher transportation and warehousing service capacities that are also needed to accommodate the growth in the freight traffic.

Finally, the support and funding from the government is also the lowest in the North East. The region needs to attract more attention of the government funding, which is the necessary catalyst of the RLC development and regional economic regeneration.

7.3 General Guidelines

Through the above discussions of the strengths and weaknesses of each of the regions in GB some common patterns and general themes emerged, which are summarised and laid out by groups in this section as general guidelines for RLC improvement.

For the regions in the top RLC group, it is obvious that their performances in all aspects are superior to the GB average, especially Location, Infrastructure, Service and Workforce. Maintaining these advantages is the priority of the top region especially on the locational, infrastructural, and workforce aspects, which are the key factors of RLC identified in the analysis in Chapter six. The major common concerns for these regions are to reduce the negative side effects of the logistics activities such as environmental impacts, road safety issues and congestions, which have significant impact on journey time, reliability and productivity. In order to stay in the top positions of regional logistics performance to sustain their economic development, these regions should set priorities to firstly continue maintaining the existing transport infrastructure as an asset.

At the same time, effort should be made in the top RLC regions to reduce the environmental impacts by increasing the share of more sustainable modes of transport such as rail and water for freight movement instead of road. One effective way of minimising the adverse logistics impacts is to locate freight generating developments close to the freight terminals such as port, airport and intermodal terminals to reduce unnecessary freight movement.

The regions in the upper and lower medium RLC performance groups have very different situations in their RLC development. Most regions have stronger performance in one or two dimensions but are weak in the rest. Generally speaking, they should seek to fill the gaps in their weak areas of RLC for a more balanced logistics capability development, with priorities in the Infrastructure, Location and Workforce as discussed in the previous chapter.

For infrastructure, best use should be made of the existing infrastructure and new capacities should be developed wherever needed, especially the surface transport network linking the ports and airports. In addition, they should promote more and better road-water and road-rail intermodal infrastructures. This would not only attract more container traffic to the region, but also reduce the negative environmental impacts of freight movement by using more environmental friendly modes of transport. This also reduces freight movement to London airports by encouraging more freight to be handled by airport within the regions.

Although not much could be done to change their natural locations, the regions in the upper and lower medium RLC performance groups could promote the development of a solid workforce for the logistics industry, which is an often overlooked element in developing RLC. Infrastructure enhancements alone will not significantly improve the logistics capability of a region. Great efforts need to be made in developing a larger logistics workforce with higher level of professional skills.

The two regions in the bottom group both have poor logistics performance and need significant improvements in every aspect of RLC. Again, according to the findings of this study, priorities should be given to Infrastructure, Location, and Workforce capacities when developing these regions' logistics capability.

Although the physical location of the disadvantaged regions cannot be changed, they could raise the regional significance by making effort to increase its international connectivity and market penetration. By fully capitalising on the existing and positively developing new seaport and airport infrastructure as national gateways, these regions could seek to attract more freight with direct routing to the regions rather than via intermediate ports or airports in the other regions. Major developments in the accordant transport network infrastructures including motorways, rail and intermodal terminals, are also necessary to accommodate the growth in the freight transport from other regions in GB and other counties. Equally important is to development a large and well-trained workforce to support the growth in the logistics activities.

Finally, the logistics service capacities including transport, warehousing and value added services should not be over looked, although they are of less significance and must be built on the solid ground of Infrastructure, Location and Workforce.

7.4 Conclusion

This chapter explored in detail of the regional logistics performance in regions in GB. The discussion started with a comparison of the RLC scores of the regions in GB by time period and composition for categorising the 11 GB regions by their logistics performance, and then moved on to the specific strengths and weaknesses in logistics capabilities of each region. Thereafter specific suggestions for RLC improvement were proposed in light of the findings of the previous data analysis chapters and specific GB regional conditions.

Finally, general guidelines to improve RLC in GB were summarised at the end of this chapter as an answer to the Research Question 2 (see page 4). The priority for the top regions should be to continue maintaining the existing transport infrastructure as an asset and to reduce the adverse impacts of logistics activities by switching to more sustainable modes of transport and reduce unnecessary freight movement. For the regions in the medium RLC performance groups, great efforts should be made to fill the gaps in their weaker areas of RLC for a more balanced overall logistics capability development. As for the bottom regions, significant improvements are needed in every aspect of RLC, however, priorities should be given to Infrastructure, Location, and Workforce capacity developments to firstly raise regional significance, connectivity and international market penetration. Then through fully capitalising on the existing and positively developing new freight infrastructure, these regions could seek to further increase their RLC to regenerate economic development. In the meantime, it is necessary to development a large and well-trained workforce to support the growth in the logistics activities in these regions.

CHAPTER 8. CONTRIBUTIONS, GENERALISABILITY, LIMITATIONS AND FUTURE STUDIES

8.1 Introduction

The reliable movement of goods and services is the lifeblood of an economy, on both the national level and regional level. The best logistics performers could gain better access to more distant markets and consumers, and achieve more benefits from globalisation. Therefore the role of logistics is essential to a region for better connection with global trade partners, particularly in an era of escalating globalisation and international trade.

The importance of logistics to the national economy was pointed out by researchers in the early 1980s (Childerley, 1980; Christopher, 1981) and highlighted again by the World Bank's LPI reports (Arvis *et al*., 2007; Arvis *et al*., 2010). The crucial role of logistics capability in regional economic development, however, is not well studied. Huggins (1997) suggested that the physical flow of products is an obvious essential of the trade and linkages among different regions across the world. Vickerman *et al.* (1999) added that improved access to input materials and to markets will cause firms in a region to be more productive, more competitive and hence more successful than those in regions with inferior accessibility. This thesis is an attempt to add to the investigation of the logistics-economy relationship at the regional level, taking the regions in GB as subjects of study.

This chapter first summarises the four main contributions of this thesis. Then the generalisability of the results and methods are discussed. This chapter also analyses the limitations of this study and finally offers potential directions for future studies.

8.2 Contributions

8.2.1 Definition and measurement framework

The first contribution of the thesis is the definition and measurement of RLC. The conventional definitions of logistics mostly focus on activities within organisations and businesses, or among different partners within the supply chain (Ballou, 2007). Little logistics research attempts to address the role of logistics in regional economic development. Similarly, the traditional logistics performance measurement literature also emphasises measuring the logistics efficiency and effectiveness of a company or a supply chain, rather than reflecting the logistics capacities of a region (Caplice and Sheffi, 1994; Chow *et al.*, 1994; Forslund, 2007; Griffis *et al.*, 2007; Gunasekaran *et al.*, 2001; Neely *et al.*, 1995).

After reviewing the relevant literature, this study firstly gives a definition of RLC from an efficiency and effectiveness perspective: "The effectiveness and efficiency of a region in facilitating logistics activities both within the region and across regional borders." (see section 2.3.1 Defining Regional Logistics Capability, page 29)

Here "logistics activities" refers to all the operation of the goods during the flow from point of origin to point of consumption, including transportation, warehousing, packaging, handling, and information integration *etc*. Finally, “both within the region and across regional borders” means RLC covers both domestic and foreign flow of goods of a region.

To be able to explore the relationship between logistics and regional economy, a measurement framework for evaluating the logistics capability of regions is needed. This study fills this gap by firstly reviewing the logistics performance literature to identify 24 indicators categorised into five dimensions which affect the logistics performance of a region (see section 2.3.8 Indicator summary, page 60). Then a measurement framework was setup based on a multi-dimensional assessment, the SMART-ROD model, which quantifies and aggregates individual logistics related indicators into an overall RLC score (see section 4.4 A Checklist for SMART-ROD Method, page 122). Finally, this study produced the RLC scores for the 11 regions in GB with data collected from the two datasets (expert evaluating the relative importance of the indicators and specific indicator performance data from public sources).

The RLC measurement framework introduces the SMART-ROD method into the regional logistics study field, which is an effective tool to benchmark performance of different participants in a certain area.

8.2.2 Confirmation of the close logistics-economy relationship

The second contribution of this thesis is the confirmation of the existence of the close relationship between the logistics capabilities of the regions in GB and their economic development. With SPSS, a correlation analysis was conducted between the RLC scores of the regions in GB and several regional economic indicators such as regional GVA, productivity, household income, unemployment rate, international trade value and manufacturing GVA (see section 6.2.2 Correlation analysis, page 172). The correlation results confirm that RLC is significantly related to several economic indicators, especially regional GVA (r=.57, p(one tailed)<.001), household income (r=.75, p(one tailed)<.001), manufacturing GVA, (r=.95, p(one tailed)<.001) and international trade value, (r=.71, p(one tailed)<.001).

The close relationships between RLC scores and other regional economic indicators confirm the crucial role of logistics in the regional development in GB, especially in international trade and manufacturing. This suggests to the policy makers that logistics should not be ignored when creating regional policies.

8.2.3 Confirmation of the key indicators for RLC

Having confirmed the close relationship between regional logistics and regional economy, this study makes the third contribution by investigating the relationship between RLC and its indicators. In order to understand which among the RLC indicators (independent variables) are related to the RLC (dependent variable), and to explore the strengths, direction, and statistical significance of these relationships, a stepwise regression was performed between RLC as the Dependant Variable, and Location, Infrastructure, Workforce, Service and Administration as independent variables (see section 6.3 Multiple Regression Analysis, page 176). The results show that the combination of the three indicators gives a total 97.3% explanation of the RLC variation: Infrastructure (67.1%), Location (20.8%) and Workforce (9.5%). The standardised coefficients and the magnitude of the t-statistics also indicate that the most important indicator to RLC is Infrastructure, followed by Location and Workforce. Service and Administration are identified as less important. These results have significant implications to strategies to prioritise development projects in improving RLC.

8.2.4 Guidelines for growing RLC in GB

This study explores in detail regional logistics performance in the regions in GB by comparing their RLC scores by time period and composition, and then discussing the strengths and weaknesses of each region in their logistics capabilities. Finally, general guidelines are proposed towards the end of Chapter Seven for building stronger RLC in the regions in GB to support economic development.

Regions at different levels of RLC and economic performance should have different priorities in developing their logistics capabilities. These guidelines are of important practical implications because they integrate both current economic and logistical conditions of the GB regions and the key RLC factors found in this thesis.

8.3 Generalisability

The results of this research are closely connected with the current geographical and economical circumstances in GB. Cautions need to be taken when generalising these results to regions in the other regions or the other time periods. However, the RLC measurement framework could be easily adapted to suit other scenarios by removing or adding certain indicators and adjusting the weighting factors. For example, when comparing the logistics capabilities among international regions, certain factors might become more significant than regions within one country, such as the custom efficiency and regulations. The methodology presented in this thesis is still valid given that the step two (objects evaluation) and step five (weight elicitation) are performed properly to accommodate the specific circumstances. When applying this method to compare the RLC of regions in other country or countries, the objects evaluation needs to be carried out carefully from the top as described in chapter four, which involves reviewing relevant literature to identify a new set of indicators appropriate to the characteristics of the regions under study, as well as piloting the identified indicators with local logistics experts for sense checking and then weight elicitation. This step is crucial to the correct construct of the RLC score and validity of the research. Thus, the RLC measurement framework could be generalised to other regions beyond GB in comparing logistics performance or even comparing capabilities in other area apart from logistics if the appropriate measures have been chosen.

8.4 Limitations

This study is the first attempt to address the logistics capability at the regional level in GB. Due to its large scale nature, such research has to rely on secondary data sources for various logistics related performance data. Therefore the limitations of this thesis primarily derive from the lack of mature theories on regional logistics capabilities and limited available data of regional logistics performance in GB, which restrict this study on several levels.

Firstly, the absence of usable quantitative data at the regional level in GB has limited the number of indicators included in the RLC measurement framework. Thus it is a threat to the construct validity to the research. For example, the data for pipeline capacity in GB is not available at the regional level, therefore has to be eliminated from the model. The choice of some indirect indicators such as “unemployment rate” for measuring economic stability and “CO_2 emission” for measuring environment status may be debatable.

Secondly, the unavailable historical data seriously restricts the sample size. For some indicators, the history data before 2004 does not break down to regional level and some data after 2008 are not published yet on the regional level. Thus the usable data for RLC analysis is limited to the five year period from 2004 to 2008. This gives only 55 data points to analysis (5 years multiplied by 11 regions), which is a relatively small size for statistical analysis. For the missing data of some years on the regional level, such as the data for the indicators “environment” and “Value added service” of 2008 (see Table 5-7. List of missing values and remedy methods.). Although appropriate reputation methods have been used to enable the further analysis, there are still disadvantages such as reduction in the variance of the distribution, which contributes to the limitation of this research (see section 5.3.2 Missing data).

8.5 Future Research

Regional logistics is a new area that needs much attention from both academic researchers and policy makers. This study is generally discussed the logistics-economy relationship with five years’ RLC data. However, future studies are needed to further explore the RLC in GB and its causal relationship with economic development with in-depth case studies to validate the findings of this study and add to the internal validity of the RLC theory. For example, taking one or two GB regions and study the logistics performance of this region and its impact to the economic development from a quantitative perspective, this is a more appropriate method for in-depth understanding of a phenomenal. The future researchers could use the findings of this research as a guide but dig deeper into the specific historical, geographical and economical circumstances in the regions with rich descriptive data from archive documents and interviews. This information will then be used in the following discussion to explore the RLC construct and the regional logistics-economical relationship and thus support or perfect the findings of this thesis. In addition, the future studies could answer pending RLC questions such as “why is a region not able to achieve a particular logistics capability?”

Also, it would be useful if future study could validate the research findings with cases from other countries. Due to the constraints of time, this study sets the boundary of studying RLC within GB. However, as discussed earlier in the section 8.3, when generalising the RLC measurement method to other regions and countries, the current RLC model needs to be further developed to accommodate many more indicators that accurately reflect the international characteristics. Major work will be needed to achieve this, but it would add significant implication to both logistics and regional development theories, such as the LPI study of the World Bank.

REFERENCE

Aldridge, A. and Levine, K. (2001) *Surveying the Social World – principles and practice in survey research*, Open University Press

Arvis, J., Mustra, M. A., Panzer, J., Ojala, L. and Naula, T. (2007, 2010) "Connecting to Compete - Trade Logistics in the Global Economy: The Logistics Performance Index and Its Indicators", The World Bank, available at: www.worldbank.org/lpi [accessed on 15/07/10]

Aviation Statistics (2009) "Statistics - UK Airport, Airline and Punctuality Statistics", *Civil Aviation Authority*, available at: http://www.caa.co.uk/default.aspx?catid=80&pagetype=90 [accessed on 15/02/10]

Ballou, R. (2007) "The evolution and future of logistics and supply chain management", *European Business Review*, 19(4), 332-348

Banerjee, A., Duflo, E. and Qian, N. (2009) "On the Road: Access to Transportation Infrastructure and Economic Growth in China", *MIT Working Paper*, March 2009, available at: http://igov.berkeley.edu/China09papers/On_the_Road_Access_to_Transportation_Infrastructure_and_Economic_growth.pdf [accessed on 14/04/10]

Banister, D. and Berechman, Y. (2001) "Transport investment and the promotion of economic growth", *Journal of Transport Geography*, Volume 9, Number 3, September 2001 , pp. 209-218(10)

Banomyong, R. (2007) "Logistics Development Study of the Greater Mekong Subregion North South Economic Corridor", Asian Development Bank website, available at: http://pid.adb.org:8040/pid/TaView.htm?projNo=39084&seqNo=01&typeCd=2 [accessed on 17/09/08]

Barron, H. and Barrett, B. (1996) "Decision quality using ranked attribute weights", *Management Science*, 42(11), 1515-1523

Barron, H. and Schmidt, C. (1988) "Sensitivity analysis of additive multi-attribute value models", *Operations Research*, Vol. 36 No. 1, pp. 122-7

Beaumont, J. (2009) "Portrait of the East Midlands", *Regional Trends*, No 41, Office for National Statistics

Belton, V. (1986) "Comparison of AHP and a simple multi-attribute value function", *European Journal of Operational Research*, 26, pp.7-21

Bender, P. (2007) "Value Adding Networks Might Render Supply Chains Obsolete", *World Trade*, Aug 2007, 20, 8, pp. 34

Berglund, M., Van Laarhoven, P., Sharman, G. and Wandel, S. (1999) "Third-party logistics: is there a future?", *International Journal of Logistics Management*, 10 (1), 59–70

Blunch, N. (2008) *Introduction to Structural Equation Modelling Using SPSS and Amos*, Sage Publications: London

BMI (2010) "United Kingdom Freight Transport Report", Business Monitor International 1-47, available at: www.businessmonitor.com [accessed on 12/05/10]

Bottomley, P., Doyle, J. and Green, R. (2000) "Testing the reliability of weight elicitation methods: Direct rating versus point allocation", *Journal of Marketing Research*, 37(4), 508-513

Bottomley, P. and Doyle, J. (2001) "A comparison of three weight elicitation methods: Good, better, and best", *Omega, 29*(6), 553-560

Brace, I. (2008) *Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research*, Kogan Page: London

Brewer, A., Button, K. and Hensher, D. (2001) *Handbook of logistics and supply-chain management*, Pergamon

Bryman, A. and Bell, E. (2003) *Business research methods*, Oxford University Press: New York

Butler, J., Jia, J., Dyer, J. (1997) "Simulation techniques for the sensitivity analysis of multi-criteria decision models", *European Journal of Operational Research*. Iss. 103, pp. 531-545

Byrne, B. (2010) *Structural Equation Modeling with AMOS*, 2nd edt, Routledge: London

Cairncross, F. (2001) *The Death of Distance: Communications Revolution and Its Implications*, Texere Publishing

Canbolat, Y., Chelst, K. and Garg, N. (2007) "Combining decision tree and MAUT for selecting a country for a global manufacturing facility", *Omega*, 35(3), 312

Caplice, C. and Sheffi, Y. (1994) "A review and evaluation of logistics metrics", *The International Journal of Logistics Management,* Vol. 5 No. 2, pp. 11, 28

Chanda, N. (2007) *Bound Together: How Traders, Preachers, Adventurers, and Warriors Shaped Globalization*, 1st ed. Yale University Press

Childerley, A. (1980) "The importance of logistics in the UK Economy", *International Journal of Physical Distribution and Logistics Management*, 1980, Vol 10, Iss 4, p 185-192

Chow, G., Heaver, T. D., Henriksson, L. E. (1994) "Logistics performance: Definition and measurement", *International Journal of Physical Distribution & Logistics Management*, 24(1), 17

Christopher, M. (1981) "Logistics & the National Economy", *International Journal of Physical Distribution & Materials Management*, 11(4), 3

Christopher, M. (2005) *Logistics and supply chain management*, 3rd ed., London, Prentice-Hall

Coe, N., Kelly, P. and Yeung, H. (2007) *Economic Geography: A Contemporary Introduction*. Blackwell: Oxford

Collier, P. (2007) *The Bottom Billion*. New York: Oxford University Press

Collins, T. R., Rossetti, M. D., Nachtmann, H. L. and Oldham, J. R. (2006) "The use of multi-attribute utility theory to determine the overall best-in-class performer in a benchmarking study", *Benchmarking: Benchmarking in Total Quality Management*, 13(4), pp.431

Combes, P., Mayer, T. and Thisse, J. (2008) *Economic geography: the integration of regions and nations.* Princeton University Press

Cooke, P. (2001) "Regional innovation systems, clusters, and the knowledge economy", *Industrial and Corporate Change*, 10(4), pp. 945-974

Cooke, P. (2007) "Global Bioregions: Knowledge Domains, Capabilities and Innovation System Networks", *Industry and Innovation*. Vol. 13, Iss. 4; pp. 437-458

Corke, S. and Wood, J. (2009) "Portrait of the East of England", *Regional Trends*, No 41, Office for National Statistics

Coyle, J. J., Bardi, E. J., Langley Jr., J. C. (1996) *The Management of Business Logistics*, Sixth ed. West Publishing Company, New York

CSCMP (2004) Council of Supply Chain Management Professionals website, available at: http://cscmp.org/aboutcscmp/definitions.asp [accessed on 26/07/10]

DECC (2010) "Department of Energy & Climate Change, UK Legislations on emission", available at: http://www.decc.gov.uk/en/content/cms/legislation/legislation.aspx [accessed on 08/03/10]

DfT (2008) "Delivering a sustainable transport system: the logistics perspective", available at: http://www.dft.gov.uk/pgr/freight/dastslogistics/

[accessed on 13/03/10]

DfT (2009a) "Transport Statistics Great Britain: 2009 edition", available at: http://www.dft. gov.uk/transtat/tsgb [accessed on 02/03/10]

DfT (2009b) "Britain's Transport Infrastructure Strategic Rail Freight Network: The Longer Term Vision", available at: http://www.dft.gov.uk/pgr/rail/ strategyfinance/strategy/freightnetwork/strategicfreightnetwork.pdf [accessed on 21/04/10]

DfT (2009c) "Transport Statistics Report: Maritime Statistics", available at: http://www.dft.gov.uk/pgr/statistics/datatablespublications/maritime/ [accessed on 05/06/2010]

Dicken, P. (2007) *Global Shift: Mapping the Changing Contours of the World Economy*, Sage Publications

Dixit, A. and Stiglitz, J. (1977) "Monopolistic Competition and Optimum Product Diversity", *American Economic Review* 67, 297-308

Doyle, J., Green, R. and Bottomley, P. (1997) "Judging relative importance: Direct rating and point allocation are not equivalent", *Organizational Behaviour and Human Decision Processes*, 70(1), 65-72

Drucker, P. (1962) "The Economy's Dark Continent", *Fortune*, Vol . 65, April 1962, pp. 103, 265-70

Dunnell, K. (2009) "National Statistician's article: measuring regional economic performance", *Economic &Labour Market Review*, Vol 3, No 1, pp 18. January 2009

Dyer, J. (1990) "Remarks on the analytic hierarchy process", *Management Science*, 36, pp. 249-258

Dyer, J., Edmunds, T., Butler, J. and Jia, J. (1998) "A multiattribute utility analysis of alternatives for the disposition of surplus weapons-grade plutonium", *Operations Research*, 46(6), 749-762

Dyer, J. and Lorber, H. (1982) "The multiattribute evaluation of program-planning contractors", *OMEGA 6*, 673-678

East of England Plan (2008) *Government Office for the East of England,* available at: http://www.gos.gov.uk/goee/docs/Planning/Regional_Planning/Regional_Spatial_Strategy/EE_Plan1.pdf [accessed on 01/12/2009]

Edwards, W. and Barron, F. H. (1994) "SMARTS and SMARTER: improved simple methods for multiattribute utility measurement", *Organizational Behaviour and Human Decision Processes*, pp. 306–325

EMFF (2009) "East Midlands Fact Files", available at: http://www.gos.gov.uk/facts/factem/ [accessed on 01/02/2009]

EMSPS (2011) "The East Midlands Skills Priorities Statement, 2011-2012", available at: http://www.emda.org.uk/uploaddocuments/EastMidlandsSPS.pdf [accessed on 28/01/2011]

ERN, RDA, ODPM and DfT (2005) *Regional Futures: England's Regions in 2030, Final Report.* Available at: http://www.southwest-ra.gov.uk/media/SWRA/RSS%20Documents/Technical%20Documents/Regional_Futures_Report.pdf [accessed on 28/05/2010]

Field, A. (2009) *Discovering Statistics Using SPSS*, 3rd edt, SAGE: London

Forslund, H. (2007) "The impact of performance management on customers' expected logistics performance", *International Journal of Operations & Production Management*, 27(8), 901

Gallup, J., Sachs, J., & Mellinger, A. (1999) "Geography and Economic Development", *SSRN Working Paper Series*, Rochester: May 1999

Gammelgaard, B. and Larson, P. (2001) "Logistics skills and competencies for supply chain management", *Journal of Business Logistics*, 22(2), 27-50

GOSW (2010) "Government Office for the Southwest - Regional profile", available at: http://www.gosw.gov.uk/gosw/OurRegion/, [Accessed on 30/ 01/2010]

GOWM (2010) "Government Office for the West Midlands - Regional profile", available at: http://www.gos.gov.uk/gowm/OurReg/, [Accessed on 30/ 01/2010]

Grant, D., Lambert, D., Stock, J. and Ellram, L. (2006) *Fundamentals of Logistics Management*, McGraw Hill Higher Education, European edition

Greenergy Background paper (2007) "UK Oil Supply Chain", available at: http://www.greenergy.co.uk/perspectives/UK_oil_supply_chain.pdf [accessed on02/03/08]

Griffis, S.E., Cooper, M., Goldsby, T.J. & Closs, D.J. (2007) "Aligning Logistics Performance Measures To The Information Needs Of The Firm", *Journal of Business Logistics*, 28, No. 2 (January 1): 35-V

Gummesson, E. (2000) *Qualitative Methods in Management Research*, 2nd ed., Sage Publications, London

Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001) "Performance measures and metrics in a supply chain environment", *International Journal of Operations & Production Management*, 21(1/2), 71-87

Hair, J., Black, W., Babin, B. and Anderson, R. (2010) *Multivariate data analysis: a global perspective*, London: Pearson Education

Hardy, C., Phillips, N. and Lawrence, T. (2003) "Resources, Knowledge and Influence: The Organizational Effects of Intel-organizational Collaboration," *Journal of Management Studies,* Vol. 40, No. 2, pp. 321-347

Helpman, E. and Krugman, P. (1985) *Market Structure and Foreign Trade - Increasing Returns, Imperfect Competition, and the International Economy,* Cambridge, MA: MIT Press

Heskett, J., Glaskowsky, N. and Ivie, R. (1973) *Business Logistics*, 2nd ed., The Ronald Press, New York, NY, pp. 14-21

Hesse, M. and Rodrigue, J. (2004) "The transport geography of logistics and freight distribution", *Journal of Transport Geography*, Iss 12, 2004, pp. 171-184

Huggins, R. (1997) "Competitiveness and the Global Region", *In Simmie, J. (eds) Innovation, Networks and Learning Regions?* Spon Press: London

Hussey, J. and Hussey, R. (1997) *Business Research: A Practical Guide for Undergraduate and Postgraduate Students*, Macmillan Press, London

Jiang, C. and Peng, Y. (2008) "The theory and practice of Logistics Infrastructure Capability: Evidence from China", *International Symposium on Information Processing (ISIP 2008)*, MAY 23-25, 2008 Moscow RUSSIA, p 662-669

John, C., Cleveland, W., Kleiner, B. and Tukey, P. (1983) Graphical Methods for Data Analysis. Wadsworth. pp. 158-162

Kahn, K., Maltz, E. and Mentzer, J. (2006) "Demand Collaboration: Effects On Knowledge Creation, Relationships, And Supply Chain Performance", *Journal of Business Logistics*, 27(2), 191-VIII

Kay, I. (2009) "Portrait of Yorkshire and The Humber", *Regional Trends*, No 41, Office for National Statistics。

Keeney, R. (1980) *Sitting Energy Facilities*, Wiley: New York

Keeney, R. and Raiffa, H. (1976) *Decisions with Multiple Objectives: Preferences and Value Trade-offs*, Wiley, New York

Keeney, R. and von Winterfeldt, D. (1994) "Managing nuclear waste from power plants", *Risk Analysis 14*, 107-130

Kinnear, P. and Gray, C. (2009) *SPSS 16 Made Simple*, Psychology Press

Kobayashi, I. (1973) "Management of physical distribution cost", *Proceedings* *of International Physical Distribution Conference*, Tokyo, p. 9

Krugman, P. (1986) *Strategic trade policy and the new international economics*. Cambridge: MIT Press

Krugman, P. (1991) "Increasing returns and economic geography", *Journal of Political Economy*. 99, 483-99

Krugman, P. (1995) *Development, Geography and Economic Theory*, Cambridge: MIT Press

Krugman, P. (1993) "On the relationship between trade theory and location theory", *Review of International Economics* 1:11-22

Lai, K. H. (2004) "Service capability and performance of logistics service providers", *Transportation Research, Part E, Logistics & Transportation Review, 40E*(5), 385-399

Larson, D. and Halldorsson, A. (2002) "What is SCM? And, where is it?" *Journal of Supply Chain Management*, 38(4), 36-44

Lee, H. and Choi, B. (2003) "Knowledge Management Enablers, Processes, and Organizational Performance: An Integrative View and Empirical Examination", *Journal of Management Information Systems*, Vol. 20, No. 1, pp. 179-228

Li, P. and Vellenga, D. (1993) "The government's roles in promoting logistics services in China", *Logistics and Transportation Review*, 29(4), 301

Lin, C. (2007) "Factors affecting innovation in logistics technologies for logistics service providers in China", *Journal of Technology Management in China*, 2(1), 22

Mangan, J., Lalwani, C. and Gardner, B. (2004) "Combining quantitative and qualitative methodologies in logistics research", *International Journal of Physical Distribution & Logistics Management*, 34(7/8), 565-578

Maritime Statistics (2009) DfT website, available at: http://www.dft.gov.uk/pgr/statistics/datatablespublications/maritime/ [accessed on 12/02/10]

Martin, R. and Sunley, P. (1996) “Paul Krugman's geographical economics and its implications for regional development theory: A critical assessment”, *Economic Geography*, 72(3), 259

Martin, R. and Sunley, P. (2003) “Deconstructing clusters: chaotic concept or policy panacea?”, *Journal of Economic Geography*, 3(1), 5

Matthews, H. and Gardiner, V. (1999) *The Changing Geography of the United Kingdom*, Routledge

McDonald, F.; Huang, Q; Tsagdis, D. (2006) “The development of industrial clusters and public policy”, *Entrepreneurship & Regional Development*, 18, November (2006), 525–542

McDonald, F.; Huang, Q; Tsagdis, D; Tüselmann, H. (2007) “Is There Evidence to Support Porter-type Cluster Policies?”, *Regional Studies*, Vol. 41.1, pp. 39–49, February 2007

Mentzer, J. and Konrad, B. (1991) “An Efficiency/Effectiveness Approach to Logistics Performance Analysis”, *Journal of Business Logistics*, Vol. 12, No. 1, pp.33-61

Mentzer, J. and Flint, D. (1997) “Validity in logistics research”, *Journal of Business Logistics*, 18(1), 199-216

Murphy, G. (1972) *Transport and Distribution*, Business Books, London, p. 7

National Planning Framework for Scotland (2009) National Planning Framework for Scotland2 – INFRASTRUCTURE, *Scottish Government*, available at: www.scotland.gov.uk/Publications/2009/07/02105627/5 [Accessed on 20/ 02/2010]

Neely, A., Gregory, M. and Platts, K. (1995) “Performance measurement system design”, *International Journal of Operations & Production Management*, Vol. 15 No. 4, pp. 80-116

NEFF (2009) “North East Fact Files”, available at: http://www.gos.gov.uk/facts/factne/ [accessed on 01/02/2009]

Network Rail (2007) “Route Utilisation Strategy Report – freight”, available at: http://www.networkrail.co.uk/browse%20documents/rus%20documents/route%20utilisation%20strategies/freight/freight%20rus.pdf [accessed on 11/02/09]

Nikolar, D., Carl-Stefan, N. and Markus, Z. (2005) “Logistics in emerging markets”, *McKinsey Quarterly*, 2005, Iss 1, P15-18

Olson, D. (2001) “Comparison of three multicriteria methods to predict known outcomes”, *European Journal of Operational Research*, Vol.130, No.3, pp. 576-587

One North East (2010) "Gauge Enhancement for Teesport a Step Nearer." http://www.onenortheast.co.uk/page/news/article.cfm?articleId=4481 [Accessed on 20/12/2010]

ONS (2010) “UK regional profile”, *Regional Trends*, available at: www.statistics.gov.uk/regionalprofiles/ [Accessed on 20/ 02/2010]

Panayides, P. (2006) “Maritime Logistics and Global Supply Chains: Towards a Research Agenda”, *Maritime Economics & Logistics*, 2006, 8, (3–18)

Patti, A. (2006) “Economic clusters and the supply chain: a case study”, *Supply Chain Management*, Bradford: 2006. Vol.11, Iss.3; p. 266

Pike, A., Rodriguez-Pose, A. and Tomaney, J. (2006) *Local and Regional Development*, Routledge

Polonsky, M. and Waller, D (2004) *Designing and Managing a Research Project - A Business Student's Guide*, Victoria University, Australia

Porter, M. (1998) “Clusters and the new economics of competition”, *Harvard Business Review*, 1998, vol. 76, issue 6, p 77, ISSN 00178012

Porter, M. (2002) Regions and the New Economics of Competition. In Scott, A. (ed.) *Global City-Regions: Trends, Theory, Policy* (pp. 1-37) USA: Oxford University Press.

Porter, M. (2003) “The economic performance of regions”, *Regional Studies, 37*(6,7), 549-578

Poyhonen, M. and Hamalainen, R. (2001) “On the convergence of multiattribute weighting methods”, *European Journal of Operational Research*, 129(3), 569-585

Proll, L, Salhi, A. and Rios Insua, D. (2001) “Improving an Optimization-based framework for sensitivity analysis in MCDM”, *Journal of Multi-Criteria Decision Analysis*, 10: 1-9

Rafele, C. (2004) “Logistic service measurement: a reference framework”. *Journal of Manufacturing Technology Management*, 15(3), 280-290

Reader, J. (1998) *Africa: A Biography of the Continent,* Penguin Books

Rietveld, P. and Vickerman, R. (2003) “Transport in regional science: The "death of distance" is premature”, *Papers in Regional Science, 83*(1), 229-248

Roberts, R. and Goodwin, P. (2002) “Weight approximations in multi-attribute decision models”, *Journal of Multicriteria Decision Analysis*, 11(6), 291-303

Saaty, T. L. (1980) *The Analytic Hierarchy Process*, McGraw-Hill, NY

Sachan, A. and Datta, S. (2005) “Review of supply chain management and logistics research”, *International Journal of Physical Distribution & Logistics Management*, 2005, 35(9/10), pp. 664

Scott, A. (2002) “Global City-regions”. In Scott, A. (ed.) *Global City-Regions: Trends, Theory, Policy* (pp. 1-37) USA: Oxford University Press

Scott, A. and Storper, M. (1992) "Regional development reconsidered", *In Ernste, H. and Meier, V. (eds) Regional Development and Contemporary Industrial Response: Extending Flexible Specialisation*. London: Belhaven

Scottish Government (2003) "Scotland In Short", February 17, 2003, available at: http://www.scotland.gov.uk/Resource/Doc/923/0010669.pdf [Accessed on 20/ 02/2010]

Scottish Transport Statistics (2009), "Scottish Government: No. 28", available at: http://www.scotland.gov.uk/Publications/2009/12/18095042/0 [accessed on 12/04/10]

SEEDA (2011) "SEEDA Infrastructure", available at: http://www.seeda.co.uk/ about-the-south-east/infrastructure [accessed on 07/01/2011]

SEFF (2009) "Southeast Fact Files", available at: http://www.gos.gov.uk /facts/factse/ [accessed on 01/02/2009]

SfL (2009) "Skills for Logistics – UK Labour Market Profiles", available at: www.skillsforlogistics.org [accessed on 12/12/09]

SfL (2010) "Sector Skills Assessments for the Freight Logistics and Wholesale Sector", available at: www.skillsforlogistics.org [accessed on 12/12/09]

Sheffi, Y. (2001) "Supply chain management under the threat of international terrorism". *International Journal of Logistics Management*, 12(2), 1-11.

Simpson, J. and Weiner, E. (1989) *The Oxford English Dictionary*, Oxford, Clerendon Press

Skill for Logistics (2009) "UK Labour Market Factsheets", *Skill for Logistics website*, available at: http://www.skillsforlogistics.org/en/index/reports/lmi/ lm-factsheet [accessed on 09/04/10]

Smith, A. (1776) *The Wealth of Nations*, Alfred A. Knopf, New York.

Solem, O. (2003) "Epistemology and Logistics: A Critical Overview", *Systemic*

Practice and Action Research, Dec 2003, 16, pp. 6

Song, J., Mangan, J. and Butcher, T. (2009) "Regional Logistics Capability and Economic Development in the Yorkshire and Humber Region", *Proceedings of the Logistics Research Network Annual Conference*, 9-11 September 2009

Stephenson, A. (1975) "A Regional Survey of Physical Distribution Problems and Practice", *Productivity Promotion Council of Australia*, Melbourne, p. 7-10

SWFF (2009) "Southwest Fact Files", available at: http://www.gos.gov.uk/facts/factsw/ [accessed on 01/02/2009]

Tabachnick, B. and Fidell, L. (2005) *Using Multivariate Statistics*, 5th Pearson Education: Boston

The London Plan (2009) "Spatial Development Strategy for Greater London", Greater London, Authority, available at: http://www.london.gov.uk/ shaping-london/london-plan/docs/london-plan.pdf [Accessed on 20/ 02/2010]

The North East of England Plan (2008) "Regional Spatial Strategy to 2021", *Government Office for the North East*, available at: http://www.gos.gov.uk/gone/transport/rts/?a=42496 [Accessed on 20/ 02/2010]

The South West Observatory (2009) "State of the South West", available at: http://www.swo.org.uk/publications/state-of-the-south-west/ [accessed on 12/02/2010]

The Wales Transport Strategy (2008) "One Wales: Connecting the Nation", Welsh Assembly Government, April 2008 available at: http://new.wales.gov.uk/deet/publications/transport/wts/wtstrategy/wtsfe.pdf?lang=en [Accessed on 20/ 02/2010]

Thisse, J. (2008) "Location Theory", *The New Palgrave Dictionary of Economics*, Second Edition, Eds. Steven N. Durlauf and Lawrence E. Blume.

Palgrave Macmillan

Tinbergen, J. (1962) *Shaping the World Economy: Suggestions for an International Economic Policy*. New York: The Twentieth Century Fund

Tongzon, J. (2007) "Determinants of Competitiveness in Logistics: Implications for the ASEAN Region", *Maritime Economics & Logistics*, 9(1), 67-83

Triantaphyllou, E. (2000) *Multi-Criteria Decision Making: A Comparative Study.* Netherland: Kluwer Academic Publishers

United Nations (2005), "Core ICT indicators", available at: http://www.itu.int/ITU-D/ict/partnership/material/CoreICTIndicators.pdf [accessed on 17/09/08]

Vickerman, R., Spiekermann, K. and Wegener, M. (1999) "Accessibility and economic development in Europe", *Regional Studies*, Feb 1999, 33, p1

Visser, E. (2007) "Logistic innovation in global supply chains: an empirical test of dynamic transaction-cost theory", *GeoJournal*, 70(2-3), 213-226

Von Winterfeldt D. and Edwards W. (1986) *Decision Analysis and Behavioral Research*, Cambridge University Press: Cambridge, MA

Weber, R. (2004) "The Rhetoric of Positivism Versus Interpretivism: A Personal View", *MIS Quarterly*, Vol.28, No.1, pp.3-12

YHFF (2009) "Yorkshire and Humber Fact Files", available at: http://www.gos.gov.uk/facts/factyh/ [accessed on 01/02/2009]

Appendix 1

Regional Logistics Capability Weighting Questionnaire

RLC and economic development in the 11 GB regions

<u>Introduction</u>:

This is a study that aims to evaluate the Logistics Capability of the government office regions in GB and explore the logistics-economy relationship on a regional level. The findings of this research will contribute to a route map for regional economic growth through improved logistics. The purpose of this simple questionnaire is to help estimate the relative importance weights of a set of Regional Logistics Capability (RLC) variables, so that the logistics performance of each region could be quantified before being compared with the regional economy data to explore the potential relationship. Various practitioners/academics/policy makers from all the regions in GB would be asked to fill in the questionnaire. I am greatly thankful for your time and help. Please read the basic definitions and guidance before answering. Thanks again.

Byron Jiashi Song

PhD Candidate, Hull University Logistics Institute

M: 07828681893 E: J.Song@2006.hull.ac.uk

55 Thwaite St, Cottingham, E Yorkshire, HU16 4QX

<u>Interviewee</u>:

Name ____________________________________

Organisation ____________________________________

Division ____________________________________

Job Title ____________________________________

Industry ____________________________________

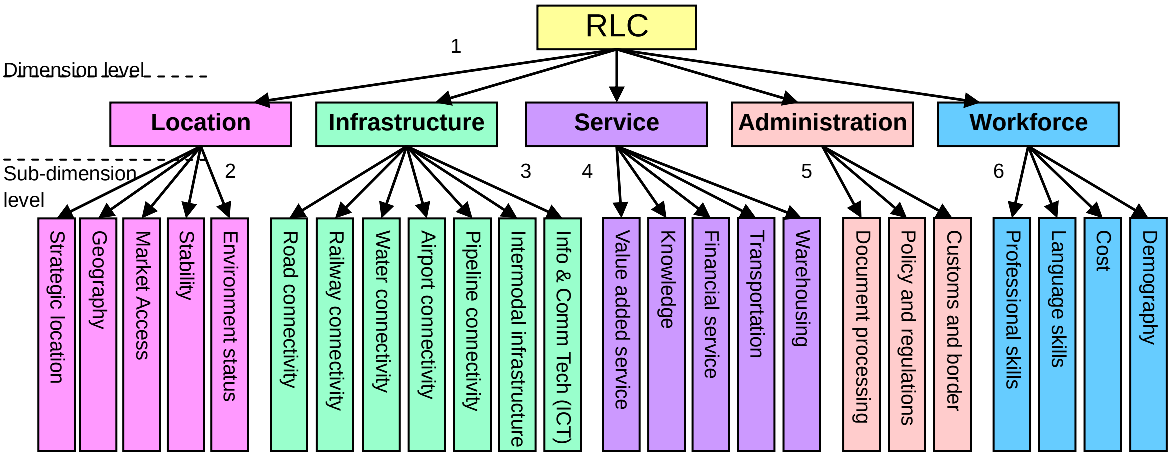
Region ____________________________________

Basic definitions:

Logistics： *'Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services and related information from the point-of-origin to the point of consumption in order to meet customers' requirements'. (CLM 2004)*

Regional Logistics Capability: *'The effectiveness and efficiency of a region in facilitating logistics activities both within the region and across region border.'*

Guidance:



Determinants of Regional Logistics Capability

The above tree diagram summarises the structure of the determinants of Regional Logistics Capability. Please fill in the following questionnaire based on your understanding of your region to help evaluate the weighting factors on both overall dimension and sub-dimension levels.

<u>Overall weighting</u>: Among the five sub-dimensions of regional logistics capability indicators in the following table, how would you rank them as to the relative importance to a region's logistics performance? And <u>if the most important dimension is given a score of 100</u>, how many points would you give to the others? (Please fill in any number from 0 to 100)

Sub-Dimension	Definition/measure	Rank	Score
Location	Regional strategic location, geography, market accessibility, stability and environment status.		
Infrastructure	Regional road/rail/water/air connectivity and inter-model/ICT infrastructures.		
Service	Regional service industry performance including warehousing, transport, finance, knowledge and value added services.		
Administration	Governmental efficiency in the custom clearance and logistics relevant policies in the region.		
Workforce	The availability, cost and quality of regional logistics workforce.		

<u>Location</u>: Among the five sub-dimensions of Location indicators in the following table, how would you rank them as to the relative importance to a region's logistics performance? And <u>if the most important dimension is given a score of 100</u>, how many points would you give to the others? (Please fill in any number from 0 to 100)

Sub-Dimension	Definition/measure	Rank	Score
Strategic location	The aggregated distance to other regions weighted by the trade volume between that region		
Market access	Value of regional trade of goods outside EU		
Geography	The aggregated freight usable length of waterway by the draft capacity		
Stability	All aged 16 and over unemployed as a percentage of total economically active		
Environment	Carbon Dioxide emissions at Regional Level		

<u>Infrastructure</u>: Among the seven sub-dimensions of infrastructure indicators in the following table, how would you rank them as to the relative importance to a region's logistics performance? And <u>if the most important dimension is given a score of 100</u>, how many points would you give to the others? (Please fill in any number from 0 to 100)

Sub-Dimension	Definition/measure	Rank	Score
Road connectivity	Total regional freight moved by road in the UK		
Rail connectivity	Freight traffic volume in the region.		
Water connectivity	Freight traffic through ports in the region.		
Air connectivity	Freight traffic through airports in the region.		
Pipeline connectivity	Pipeline capacity in the region.		
Intermodal infrastructure	Intermodal freight traffic volume in the region.		
ICT infrastructure	Households with landline/mobile/broadband access.		

<u>Service</u>: Among the five sub-dimensions of service indicators in the following table, how would you rank them as to the relative importance to a region's logistics performance? And <u>if the most important dimension is given a score of 100</u>, how many points would you give to the others? (Please fill in any number from 0 to 100)

Sub-Dimension	Definition/measure	Rank	Score
Transport	Total light and heavy goods vehicles licensed in the region.		
Warehousing	Warehouses floorspace in the region.		
Knowledge	No. of logistics-related research in the region.		
Financial	Quality and cost of the financial services in the region.		
Value added	Gross value added of cargo handling and storage service		

Administration: Among the three sub-dimensions of administration indicators in the following table, how would you rank them as to the relative importance to a region's logistics performance? And if the most important dimension is given a score of 100, how many points would you give to the others? (Please fill in any number from 0 to 100)

Sub-Dimension	Definition/measure	Rank	Score
Customs efficiency	The average time taken to clear customs in each region.		
Document processing	The number and speed of document processing in each region.		
Government policy and funding	The government regional expenditure on transport in GB regions.		

Workforce: Among the four sub-dimensions of workforce indicators in the following table, how would you rank them as to the relative importance to a region's logistics performance? And if the most important dimension is given a score of 100, how many points would you give to the others? (Please fill in any number from 0 to 100)

Sub-Dimension	Definition/measure	Rank	Score
Demography	Total number of logistics employees in the region.		
Professional skills	Total number of logistics workforce with NVQ Level 2 or above in the region.		
International language skills	Level of International language skills of regional logistics workforce.		
Wage level	Regional average weekly earnings in the logistics industry.		

Thank you

This is the end of your questionnaire. Thank you very much for your time! If you know any other logistics experts in your region, please put down your suggestions here:

Name	**Position**	**Contact**