Modelling the impact of port-centric logistics cluster on inter-firm competition

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

Amanpreet Singh

Bachelor of Engineering in Textiles, Maharashi Dayanand University, India

MBA, Federation University, Australia

School of Fashion and Textiles

College of Design and Social Context

RMIT University

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DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

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ABSTRACT

This study aims to develop a model, based on Michael Porter's cluster model (1998), to estimate the impact of spatial clustering of port-centric logistics firms on inter-firm competition. Globalization and the resultant interdependencies between producers and the markets they serve have increased the importance of sophisticated global seaport clusters and trade networks. Port-centric logistics clusters are intermodal gateways of international trade, which connect national economies with global production networks. These clusters are the spatial aggregation of interconnected and interdependent logistics firms that collaborate and compete within the globalised marketplace. Port logistics clusters such as Singapore, Rotterdam, and Dubai are known gateway hubs, which constitute high-performing logistics firms to enhance supply chain efficiency. The formation of these clusters stimulates regional economic growth, employment generation, and conducive business environment to promote global trade within a geographically bounded area.

Despite the increasing popularity of cluster theory, there is a lack of a unified theoretical framework that integrates spatial clustering of firms within the close vicinity of the port and inter-firm competition. In addition, there is no single universally accepted method to delineate the geographic boundary of the port-centric logistics cluster. Existing models and theories such as agglomeration economies, industrial districts, knowledge spillover, regional development, innovation system, and supply network provide the theoretical foundation of the cluster formation, yet they do not explain the scale and magnitude of inter-firm competition within and outside the cluster. There has been insufficient evidence to empirically evaluate the prevalence of port-centric logistics clusters and their functionalities and industrial diversity.

To accomplish the aim of this study three key questions have been developed: what industries typically constitute a port-centric logistics cluster within a geographically bounded area; how to delineate the boundary of port-centric logistics cluster in Melbourne; and do port-centric logistics firms exhibit more inter-firm competition through higher competitive rivalry than those located away from the port area?

In this study, a four-stage research methodology is developed to estimate the impact of spatial clustering of port-centric logistics firms on inter-firm competition. A spatial approach is adopted to geographically delineate the spatial congregation of port-centric logistics firms using Melbourne as a case. Using the Census data from the Australian Bureau of Statistics, this study identifies the industries that characterise the port-centric logistics cluster followed by delineating the geographic boundary of cluster around the Port of Melbourne that represents the area from where the seaport draws its workers in different port-related industries. Using the information about where people live and work, and what industry they work in, the total workforce employed in port-related industries within the close vicinity of Port of Melbourne is calculated. Areas, where port-related employment is above the national average of logistics employment and spatially adjacent, are categorized as part of the port-centric logistics cluster. The employment gradient mapped in GIS illustrates the territorial representation of the port-centric logistics cluster.

A survey-based quantitative approach is adopted to model the relationship between the port-centric logistics cluster and inter-firm competition. An online and paper-based survey was administered to 379 logistics firms within and outside the port cluster. Six constructs were developed and measured to test the relationships between various dimensions of inter-firm competition and clustering of logistics firms these include; ‘bargaining power of buyers’, ‘bargaining power of suppliers’, ‘threats of substitutes’, ‘barriers to entry’, ‘competitive rivalry’ and port-centric logistics cluster. The constructs were adopted based on Five Forces

Model and from previous cluster studies. The measurement and structural models were tested using structural equation modelling (SEM) and analysis of moment structures (AMOS).

The results show that *road freight transport, postal services, and rail transport* were the major employment providers in the PCL industry. *Road freight transport* is a major contributor to PCLC, followed by postal and warehousing services in Melbourne. PCLC is anchored on the Port of Melbourne with a large concentration of logistics employment vis-à-vis industries near the city centre and in the western parts of Melbourne such as Altona, North Melbourne, Laverton, and Footscray. Further, a significant impact of the clustering of logistics firms on inter-firm competition through competitive rivalry among firms was also confirmed. The study found a significant positive effect of port-centric logistics cluster on 'bargaining power of buyer', 'threats of substitutes', 'competitive rivalry' and 'threats of substitutes' on 'competitive rivalry'. Higher bargaining power of buyers, threats of substitutes, and competitive rivalry within the port-centric logistics cluster might be due to the presence of numerous competing firms that offer similar or complementary services. A significant negative impact of 'barriers to entry' on 'competitive rivalry was also observed. This reveals that low barriers of entry might help to enhance the levels of competitive rivalry among the logistics firms.

Results from a multi-group analysis show a significant difference between two groups in relation to the impact of location within and outside the port cluster on inter-firm competition. Logistics firms tend to exhibit higher inter-competition in a clustered environment than for those firms located away from the port cluster. This shows the positive impact of land use consolidation by the State Government in its effort to boost greater competition among firms in the transport and warehousing industry closer to the Port of Melbourne.

The findings of this study have numerous theoretical and methodological contributions as well as practical implications for industry practices and policy-making. Theoretically, it developed a new theoretical framework that integrates the cluster model with the Five Forces model to examine the effect of port-centric logistics cluster on inter-firm competition. It adopts a multi-disciplinary approach to delineate the geographic boundary of port-centric logistics cluster using three principles that include; the degree of concentration, spatial adjacency and distance decay. From the managerial perspective, this study offers an opportunity for the managers to decide the location of their operation. The decision is based on considering the potential benefits of collocating into the clustered environment. Practically, the knowledge created through this study can be utilized to draft policies regarding transportation planning and urban land use to support the geographical area around the port which may, in turn, stimulate the logistics firms to work in the designated zone. The major limitation of the study is using the data only from Melbourne. A future study may consider comparing the data from two different cities or countries to validate the results of this study of the positive impact of clustering on the competitive rivalry. Area-based strategic investment to enhance the inter-firm competition and collaboration in the Melbourne port-centric logistics cluster would provide opportunities for organizations to achieve agglomeration economies, increase rivalry among organizations to promote competition, closer proximity between customers and suppliers, increased inter-firm interactions, and resource sharing.

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LIST OF ABBREVIATIONS

ACT	Australian Capital Territory
NT	Northern Territory
OT Undefined	Other Territories Undefined
NSW	New South Wales
PCL	Port-centric logistics
PCLC	Port-centric logistics cluster
EFA	Exploratory Factor Analysis
JIT	Just-in-time
IT	Information Technology
GPS	Global Positioning System
RFID	Radio frequency Identification
SWS	Single Window System
GDP	Gross Domestic Product
ZLC	Zaragoza Logistics Centre
MIT	Massachusetts Institute of Technology
NIS	New Industrial Spaces
NEG	New Economic Geography
MAR	Marshal Arrow Romer
ABS	Australian Bureau of Statistics
GIS	Geographic Information System
JTW	Journey to Work
SEM	Structural Equation Modelling
SLA	Statistical Location Area
SPSS	Statistical Package for Social Sciences
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
SCLAA	Supply Chain and Logistics Association of Australia
GOF	Goodness of Fit
AMOS	Analysis of Moment Structures
OLS	Ordinary Least Square
KMOMSA	Kaiser-Meyer-Olkin measure of Sampling Adequacy

BTOS	Bartlett's Test of Sphericity
SMC	Squared Multiple Correlation
RMSEA	Root Mean Square Error of Approximation
RMR	Root Mean Square Residual
SRMR	Standardised Root Mean Square Residual
CFI	Comparative Fit Index
TLI	Tucker Lewis Index
IFI	Incremental Fit Index
PNFI	Parsimony Normed Fit Index
PCFI	Parsimony Comparative Fit Index
CMB	Common Method Bias

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This thesis is dedicated to my mother.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Globalization has opened access to new markets to promote international trade by removing most of the trade barriers between the nations. The growing economic interdependencies as a result of globalization, liberalisation, and privatisation, provide many opportunities to businesses to not only gain access to bigger markets but also the choice to co-locate their production activities in low-cost locations (Mangan et al., 2008a). This spatial fragmentation of production systems has contributed to a rapid increase in freight volume and the need to distribute goods globally in a cost-efficient way.

Ports play a significant role in shaping the way freight is distributed globally. In a globalised marketplace, industries tend to exhibit a greater propensity for relocating logistics activities closer to key economic hubs and localized growth centres (Gordon and McCann, 2000). Hence, ports are increasingly becoming strategic nodes in the global supply chain that are a part of an integrated logistics system. Unpredictable and growing demand for commodities, in addition to higher expectations of the customers to improve service quality, that include; on-time delivery, price sensitivity, and quick response time, requires a responsive yet a lean supply chain. These trends necessitate the development of an agile supply chain, which can potentially be achieved through relocation of logistics operations near the ports to not only reduce time and cost but to promote supply chain integration, competition and collaboration.

Ports are logistics facilities, which provide the connection between the maritime and inland transport (Stopford, 2009). The rapid growth of international trade, deregulation of transportation, and the geographic shift in production networks have changed the functional roles of ports from a simple transhipment hub to a logistical node in the transport chain. Contemporary ports are increasingly becoming customer-centric ports, which offer supply chain optimization solutions through lean and agile strategies to provide customised logistics services based on customer demand (UNCTAD, 1999; Flynn et al., 2011; Lee and Lam, 2016). Hence, the changing logistics landscape has led to an improvement and strengthening of the port services by offering integrated logistics solutions in line with the strategic goals of the company and to fulfil the diverse and volatile demand for goods in a globalised market.

The growing influence of the port is not just reflected on the hinterland it serves but on the global port networks through the development of distribution centers and logistics hubs that operate from the port hinterland (Notteboom and Rodrigue, 2005). Ports are consistently adopting and offering the new value add services to cope with changing demand in a competitive global market. There are only a handful of studies (Tongzon and Heng, 2005; Alessandri et al., 2009) that empirically investigated the methods and strategies to improve efficient distribution, inland connection and resource-sharing. Cluster is one strategy that is widely adopted to enhance economic growth, reduce cost and improve efficiency through the process of agglomeration. Cluster is an agglomeration of the inter-related firms that cooperate and compete, to generate wealth when working in spatial proximity (Porter, 1998). A number of studies (Panayides and Song, 2008; Mangan et al., 2008b; Notteboom and Rodrigue, 2009) have argued for a need for conducting an empirical study to evaluate the benefits of the cluster in the context of port. There is a lack of understanding on how and why logistics services are clustered around key strategic hubs such as ports and airports. The growing influence of port-centric logistics clusters such as Singapore and Dubai need to be examined to provide a sound policy framework to support investment decisions to enhance competitiveness and increase trade.

Port-centric logistics clusters are key strategic nodes in a complex global supply chain web to support the efficiency of the supply chain network (Sengpiehl, 2010; Chhetri et al., 2014). Port-centric logistics cluster is relatively a new concept that is given greater importance in port planning and management due to the globalization of production. Port-centric logistics clusters facilitate the inter-linkage between logistics firms and related organizations (such as transport, warehousing and other logistics functions related to assisting port operation) around the port vicinity by establishing commonalities and complementariness to add value in the supply chains and also enabling other firms to co-locate in a geographically concentrated area to gain benefits (Porter, 1998; Mangan et al., 2008b; Singh et al., 2016). The firms in the port-centric logistics cluster could achieve logistics process integration and economic advantage through agglomeration, economies of scale, information exchange, knowledge spillover, resource sharing and increased competition due to the existence of a bigger pool of suppliers and customers near to the proximity. Yet there is no major study that empirically explored the benefits of co-location of firms from an inter-firm competition perspective.

There are studies (Mangan et al., 2008a; Chettri et al., 2014; Singh et al., 2016) that argue port-centric logistics clusters to foster inter-firm competition. The co-location of firms is also critical to enhance competition because generic inputs can be easily available and accessible within the cluster. The increased international trade volume and higher throughput make the ports an important logistics node in the supply chain for the logistics firms to cluster around it. In this study, the logistics cluster built around Melbourne port is examined as a spatialised organization of logistics firms to model inter-firm competition. Does a cluster-led approach be considered an effective mechanism to enhance inter-firm competition driven by location-based benefits? The current body of knowledge supports the argument that integrated supply chains and cluster-based regions enable companies to gain resource efficiency and economic growth (Porter, 2000; Sheffi, 2013), but there is little evidence to support whether clustering of firms stimulates inter-firm competition (Singh et al., 2016). There are few studies (Porter, 1998; Enright, 2000; Porter, 2000; Bengtsson and Solvell, 2004) that examined the processes and dimensions through which inter-firm competition is enhanced within a clustered environment. Do various dimensions of the competition, as identified by Porter (1998) in his Five Forces model such as barriers to entry, threats of substitutes, bargaining power of buyer and bargaining power of supplier foster the inter-firm competition through the higher competitive rivalry between the clustered firms around the port?

1.2 AIM AND RESEARCH QUESTIONS

This study aims to develop a model, based on Michael Porter's cluster model (1998), to estimate the impact of spatial clustering of port-centric logistics firms on inter-firm competition. Three interrelated research questions are developed to answer this research aim. These include:

1. What industries typically constitute a port-centric logistics cluster within a geographically bounded area?
2. How to delineate the boundary of port-centric logistics cluster in Melbourne
3. Do port-centric logistics firms exhibit more inter-firm competition through higher competitive rivalry than those located away from the port area?

This study will focus on the logistics firms that are directly or indirectly involved in port operation and management. The logistics activities that exist in manufacturing operations have been excluded. The employment in logistics firms is then aggregated to collectively represent the port-centric logistics sector. Further, in this study, the inter-firm competition is defined and examined through the competitive rivalry between the logistics firms. Competitive rivalry defines the extent of competition among the port-centric logistics firm. The scope of this study is, therefore, to develop a framework to examine inter-firm competition through competitive rivalry among the firms that help drive the port logistics system.

1.3 RATIONALE FOR THIS STUDY

Ports in Australia are a vital intermodal facility for freight transport. It is due to the fact that Australia is a large and relatively isolated continent with a highly concentrated population base along the eastern seaboard. The international trade in Australia is predominantly carried out using sea freight, where 98 per cent of trade is conducted through ports (Ports Australia, 2019). Port throughput is continuing to grow at the rate of around 7.9 per cent (see Figure 1.1) between the years 2016 and-2018 (Port of Melbourne, 2017-18). The port of Melbourne is a key gateway to major destinations in the world with a container throughput of 2.93 million TEUs in the year 2017-18. This increased throughput of the Melbourne port makes it an important logistics hub to move the freight throughout Australia. The port of Melbourne is the main entry point for freight as it is a key node in the distribution network of Victoria.

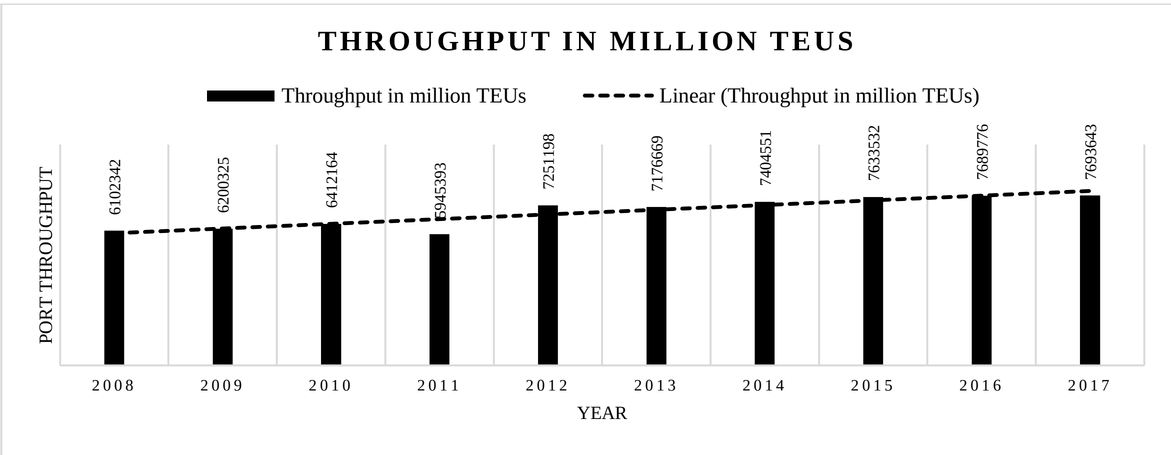


Figure: 1.1 Throughput of Australian Ports (Source: (CEIC, 2017))

The modern ports have established an efficient infrastructure to offer integrated logistics services that directly impact the economy (Baccelli et al., 2008). Contemporary ports offer the services more than just the transshipment hub in an integrated manner where logistics and allied firms collaborate to compete to gain the benefits scale economies as well as economy of agglomeration. A collaboration related benefits of clustering such as offering value-added services, career mobility, trust-building, and sharing of resources and information, have been extensively explored in previous studies (Sölvell et al., 2003; Li and Geng, 2012; Sheffi, 2013; Rivera Virgüez; 2014, Rivera et al., 2014). However, the role and impact of spatial clustering on inter-firm competition, especially among the logistics firms around the ports, has not been addressed previously in the literature, maybe due to the structure and focus of the port as an individual entity (Mangan et al., 2008b). The competition among the clustered firms leads to higher productivity and an innovative environment, which in turn stimulates regional economic growth (Porter, 1998; Porter, 2000).

Port led agglomeration of logistics activities is of growing interest to researchers and policymakers alike. It is because of the ability to deal with increased throughput, variable demand, and product customization (Notteboom and Rodrigue, 2005; Mangan et al., 2008; Vassilios K.Zagkas, 2010; Sheffi, 2013; Rodrigue et al., 2016). The ports such as the port of Rotterdam, Singapore, Dubai, and others have developed distriparks making use of their strategic location to support the global supply chain. Previous studies (Porter, 2000; Tallman et al., 2004; Chhetri et al., 2014; Rivera Virgüez, 2014; Singh et al., 2016) have also identified the benefits of geographic clustering of firms that include better economic footprint, high employment opportunities, productivity gain due to competitive environment, knowledge creation, attracting foreign direct investment, highly skilled labour pool, accessibility of large supplier and customer base, and low transaction cost. Apart from this, there may be well-developed infrastructure and resources to be used by each member in a cluster which otherwise is beyond the scope of an individual firm (Rivera Virgüez, 2014). However, there is a lack of empirical studies that have examined the impact of clustering of logistics industries on inter-firm competition through higher competitive rivalry.

Australian economy is largely driven by trade as manufacturing is diminishing due to higher production cost, trade liberalisation and the broader effects of globalization (Chhetri et al., 2014). Arguably, logistics and transport are the major industries for the nation as it facilitates production and distribution of goods. The Australian logistics industry contributes 8.6 per cent of the total GDP of Australia, which is estimated to be worth $131.6 billion in the year 2013 (Australian Logistics Council, 2014). The Australian logistics industry offers employment to around 1.2 million people, which is about 4.9 per cent of the total population in 2016 (ABS, 2016). The annual revenue of the Australian transport and logistics industry is estimated to be $95.4 billion with the number of business operations around 84,635 where 48,747 business is registered in road freight transport ranging from a single owner to multinationals (Australian Industry and Skills Committee, 2019).

Operational inefficiencies and lower productivity are seen as a major issue in Australia. Logistics firms are increasingly exhibiting a tendency to cluster near major logistics hubs such as ports, airports, major rail or road networks (Sheffi, 2013; Chhetri et al., 2014; Rivera et al., 2014; Singh et al., 2016). Moreover, due to the road congestion in the inner-city area, few suburban-based logistics clusters have emerged along major highways to take advantage of the cheaper land value and larger land sizes in Melbourne (Chhetri et al., 2014). These clusters create an environment where firms tend to collaborate and compete because of several benefits and spill over effects (Porter, 2000). Many previous studies (Prevezer, 1997; Hall, 2004; Rees, 2005) have examined the effect of clustering on inter-firm collaboration and their spill over effects on the firm's increased performance, efficiency, and inter-linkages. However, it is yet to be empirically examined the effect of logistics firms clustering around the port periphery on increased inter-firm competition through competitive rivalry which is measured through various dimensions such as bargaining power of buyer and supplier, threats of substitutes and barriers to entry (Porter, 2000)

Previous studies have examined the port-centric development from different perspectives which include dry ports (Roso et al., 2009; Monios and Wilmsmeier, 2012), container depots or ICD’s, distriparks (Van Horsen, 1991; Eller, 1995; Nam et al., 2011) and districenters (De Langen, 2004). Cluster-based studies have focussed on: the identification of logistics clusters (Rivera Virgüez, 2014); types of clusters (Qi and Liu, 2015); port-centric logistics (Mangan et al., 2008b); spatial logistics employment clusters (Chhetri et al., 2014), and delineation of cluster boundary (Singh et al., 2016). The port-centric cluster concept, however, has not been extensively explored hence it is considered as a strong case because modern ports are more customer-centric and act as a logistics hub where several logistics firms offer a range of services. Moreover, current research in the realm of industry cluster has not explicitly taken into account the inter-firm competition, which allows a comparison of competition between the logistics firms within and outside the cluster. Porter (1998) theorizes that the firms within the cluster tend to intensify collaboration and competition when they are co-located within the same milieu.

In recent years, the cluster concept is widely regarded as a policy-making tool to support port development and strategic management (Zhang and Lam, 2013). Despite the acceptance of cluster policy in Australian in public sector planning, there has been insufficient evidence to demonstrate whether cluster-based approaches to port development are effective in operational efficiency and business process improvement. In addition, there is no agreement in terms of how port-centric logistics clusters are defined and delineated to help the development of a spatial unit that can practically be used for regional planning and development perspective. Moreover, there is an acceptance and implementation of porter’s cluster policy in different nations, yet no empirical study has been conducted to find the relationship and impact of the clustering of logistics firms on inter-firm competition within the context of the port. Porter (1993) argued that firms compete and not the nations. The presence of competing clusters is the main factor of a nation's competitiveness. The aspect of competition among firms within or outside the cluster is relatively less explored. This understanding will provide new evidence to support policymakers to promote and incentivize co-location of firms in closer vicinity to port such as those implemented around Busan port. There are many case studies and success stories aligned to this theoretical framework however empirical justification is largely lacking (Malmberg and Maskell, 2002), which this study intends to fulfil.

1.4 RESEARCH CONTRIBUTION

Since the port-centric logistics cluster is relatively an emerging phenomenon, this research purports to develop new knowledge on inter-firm competition in a clustered environment to guide practitioners and policymakers of the benefits and limitations. The proposed study will contribute theoretically to the existing body of knowledge in the field of port-centric logistics cluster and practically to the industry and policymakers by identifying the potential managerial implications for firms. The key contributions of this study are two-fold. Firstly, this study theorises the notion of the port-centric logistics cluster as a platform for inter-firm competition. Secondly, this study identified and contextualised the dimensions of competition such as bargaining power of buyers, bargaining power of suppliers, threats of substitutes, barriers to entry, and competitive rivalry that are driven from Porter's Five Forces model (Porter, 2000), and interpreted them based on port-centric logistics framework.

Methodologically, this study will develop a new spatial method to delineate the boundary of port-centric logistics cluster for Melbourne using ABS Census data. This new method will address some of the challenges associated with the boundary of a geographic cluster because there is no agreed formulation of geographical demarcation of the clusters. It is unclear that to what level of industrial aggregation is required to be defined as a cluster and the range of associated industries involved. According to Porter (1998), the clusters can be found and measured at almost any level of spatial aggregation. The level of spatial aggregation can span from neighbouring countries to regions to the cities and even smaller scale. This study will develop a spatial unit to delineate the boundary of port-centric logistics cluster.

From a practical perspective, this study will provide empirically based evidence on how clustering of logistics firms around major transport hubs, a port in this case, affect inter-firm competition which can form the basis of future policies to support the cluster formation around major transport hubs. Porter (2000) identified that inter-firm competition in a cluster is a source of region's growth, competitiveness and prosperity (Porter, 2000) thus this study will help the government to develop business climate policies with an aim to make the area surrounding port more attractive by providing adequate infrastructure. The favourable policies may result in the collocation of firms to help strengthen the cluster and increased performance of the region such as given around major ports: Rotterdam, Singapore, Beijing, and Dubai.

1.5 RESEARCH METHODOLOGY

This section outlines the research methodology, which includes study area and research framework. In this study, a quantitative research approach is chosen where two types of data sets are used to answer research questions that include secondary data obtained from the Australian Bureau of Statistics and the primary data captured using the survey questionnaire.

1.5.1 Study Area

The Port of Melbourne is selected as a case study for two main reasons. Firstly, the port of Melbourne is a major transport link in the supply chain for containerized and general cargo for Victoria and ranks itself in the world's top 50 container ports worldwide. It handles around $90 million of exports on an average every day. It is a major contributor to economic well-being by contributing $2.5 billion annually. In the year 2017-18 total container throughput of the Port of Melbourne was 2.93 million TEUs which was 8.5 per cent higher than last year and was the strongest of the last 6 years (Port of Melbourne, 2018). This projected growth in container throughput exhibits a potential to transform the manufacturing-oriented region into the logistics landscape by placing a higher demand for offering value-added services around the port.

Secondly, recent land use consolidation by the Victorian government has contributed to the clustering of logistics and transport firms in and around the Melbourne port especially in western suburbs such as Altona, Laverton, Footscray, and Sunshine. Firms anticipate the co-location to enable better and efficient utilization and sharing of resources, improve inter-firm collaboration, market expansion through higher competition which in turn increases the opportunity to enhance productivity, reduce cost and reduce empty container movement. Furthermore, a greater concentration of population in Melbourne lives in east and southeast suburbs however the freight movement from port to logistics cluster then to the market creates empty container movement. This empty container movement thus increases the demand for containers at the freight terminals and also increases the cost of transportation. This study will produce evidence to reflect the efficient functioning of the port-centric logistics cluster in Melbourne to help improve freight movement and effectively respond to the changes in the market demand driven by globalization and online shopping.

1.5.2 Research framework

This research is designed in three broad stages: theoretical phase, modelling phase and implication phase as shown in figure 1.1.

1.5.2.1 Theoretical phase

This phase develops the conceptual framework to guide the empirical model that examines inter-firm competition within a port-centric logistics cluster. The extant of literature will be reviewed through presenting the current knowledge on changes in the activities from traditional port function to modern ports, what value addition activities take place around modern ports, what specific activities characterize the port-centric logistics cluster, historical footprints of the cluster and how cluster concept has developed over time. The theoretical stage will create the theoretical foundation, to identify the impact of the port-centric logistics cluster to enhance inter-firm competition through competitive rivalry, which is based on Porter's cluster model and the Five Forces model. The research hypothesis will be drawn from the theoretical foundation to help guide the subsequent modelling on the impact of clustering on inter-firm competition.

To examine and compare the impact of spatial clustering of logistics firms on inter-firm competition within and outside the port vicinity, a questionnaire survey will be conducted to collect the data from logistics industries that deal with the port operation, within Melbourne. The questionnaire will be designed to measure inter-firm competition through competitive rivalry which is based on Porter's Five Forces model (i.e. – 'bargaining power of buyers', 'bargaining power of suppliers', 'threats of substitutes', 'barriers to entry' and 'competitive rivalry'). The survey will be responded by people who hold a senior management position within the company as they may be the decision authority. Data will be collected using an online method and also through the mails. Next, multivariate technique (structural equation modelling) will be used to assess the validity and reliability of the model.

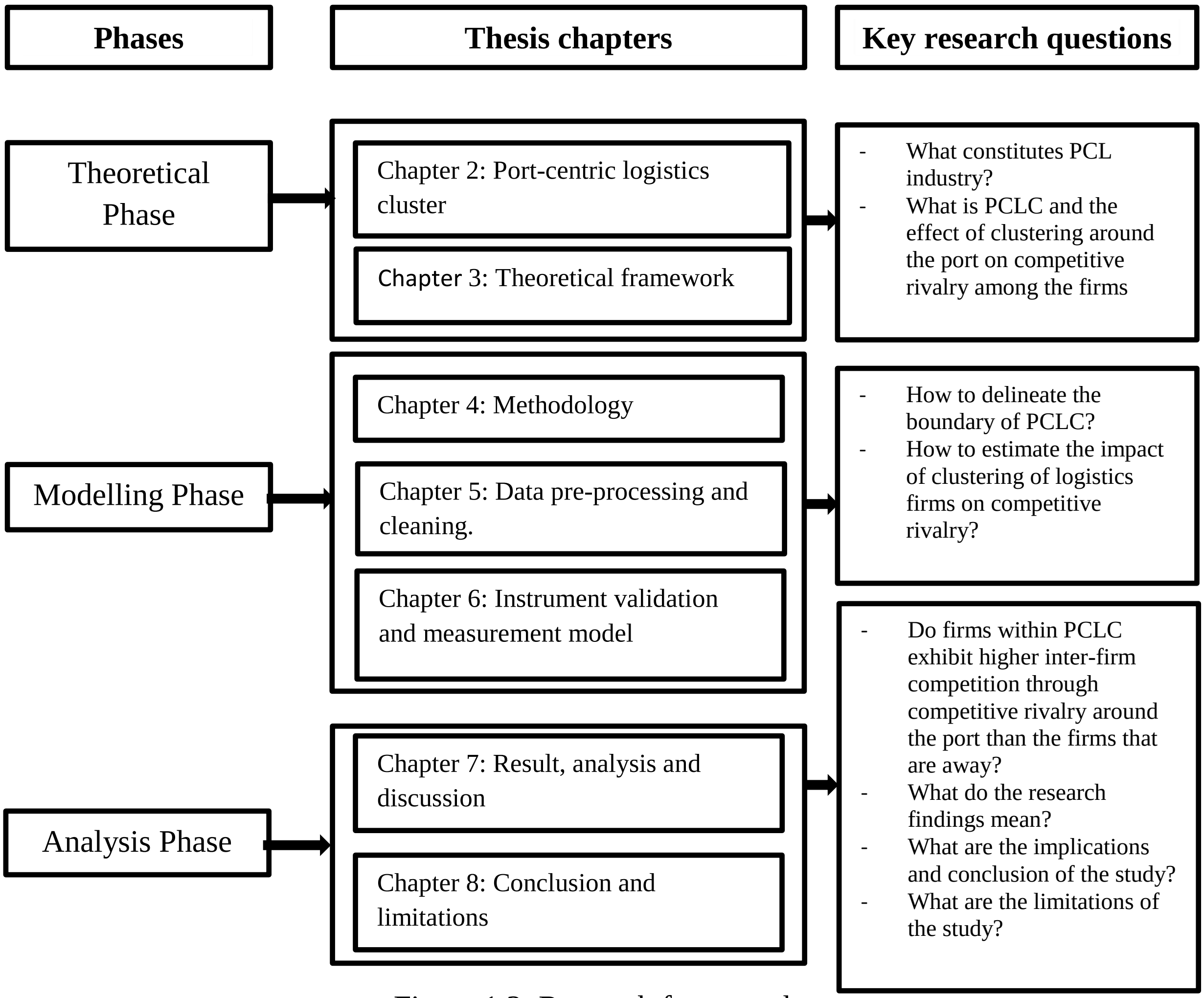


Figure 1.2: Research framework

1.5.2.2 Modelling phase

This phase will develop a structural model to examine the effect of spatial clustering of logistics industries, that assist port function, on inter-firm competition through competitive rivalry. It starts with the identification of the industries that characterise port-centric logistics. Port-centric logistics industries will be identified using census data from the Australian Bureau of Statistics (ABS, 2006) on employment that contains information about the journey to work (JTW) which reflects where people live and where they work. A spatial extent of the port-centric logistics industry will be captured using Geographic information system (GIS) which delineates the geographic boundary of port-centric cluster around the Port of Melbourne.

Structural equation modelling will then be used to establish the theoretical foundation of inter-firm competition within the cluster by testing the model fit and hypothesis. Overall, the modelling phase discusses the model development, data gathering, and data analysis considering the pre-requisites for conducting structural equation modelling.

1.5.2.3 Analysis phase

This phase analyses the results and validates the hypothesis. A multigroup invariance test will be conducted to compare inter-firm competition (through comparing competitive rivalry) within and outside the clustered environment around the Port of Melbourne. This discussion lays the foundation for theoretical, managerial and policy implications. This stage will provide strategic direction for the policymaking to enhance the location around the port vicinity by incentivizing the firms who wish to collocate within cluster to offer better and efficient services. Overall, this phase will discuss the potential implications of the findings for firms, how valuable they are, and why they are valuable.

1.6 THESIS STRUCTURE

This chapter has introduced the topic for this investigation, set out the aim and research questions and highlighted the rationale behind the research. Research methodology has been briefly introduced, followed by discussing the stages of research that form the research framework for this study. The subsequent chapters are described below:

Chapter two critically analyses and synthesizes an in-depth literature review in the field of cluster research by discussing the historical evolution and the factors that impact the formation of port-centric logistics cluster. This chapter lays the foundation of discussion on the changing functional roles of the ports, importance of logistics industry and its impact on the economy, and finally the concept of cluster and how these concepts (port, logistics, and cluster) when intertwined into one change the nature of operations of logistics-related firms around the port vicinity and impacts inter-firm competition. Overall, this chapter defines the concepts of port-centric logistics and the scope of relevant literature with an identification of the gap to build the context to conduct this research.

Chapter three develops a conceptual framework for this study guided by Porter's cluster model (clustering of the firms, spatially) that promotes and intensifies inter-firm competition through increased competitive rivalry. This chapter begins by outlining various perspectives on cluster formulation, followed by how the process of clustering impacts competition. The theoretical relationships are developed based on Porter's cluster and Five Forces model to examine and compare inter-firm competition between clustered logistics firms around the port and away from the port vicinity.

Chapter four details the research methodology. This chapter explains the study context, methodological framework, data sets, and analytical considerations. The chapter describes the details of the survey method used, information of participants, identification of the instruments used to assess the latent constructs, followed by different reliability and validity measures used. Overall the modelling and analytical techniques to analyse the research data are introduced and discussed in this chapter.

Chapter five details the pre-processing and cleaning of data. The chapter explains the content of the data collection followed by exploring the data so that it meets the fundamental requirements for the statistical techniques to be used (SEM in this study). This chapter presents descriptive analysis followed by results of basic tests such as missing data, normality assessment, identification of outliers, unengaged responses, non-response bias, and common method bias.

Chapter six presents the findings on identification of the industries that characterise port-centric logistics cluster, and how to delineate the boundary of port-centric logistics cluster. The chapter then analyses and presents the results in relation to the inter-firm competition within and outside the Melbourne port-centric logistics cluster. It discusses the findings of correlation, EFA, single factor congeneric models, and final measurement model.

Chapter seven summarises the findings in conjunction with the research questions and hypotheses that are driven from the theory. This chapter discusses the findings of the structural model followed by multigroup invariance test conducted between clustered firms around and away from the port vicinity.

Chapter eight presents the key conclusions and major limitations of this research, followed by proposing future directions. This chapter discusses the managerial implications and policy recommendations driven from the survey analysis on how co-location of the logistics firms can get benefits from increased competition and accessing the resources easily within the cluster.

1.7 SUMMARY

This chapter established the research background and set out the aim and research questions. It provided the rationale for undertaking the research by highlighting the importance of cluster led approach in Melbourne port to measure the inter-firm competition of the port-centric logistics firms within the port proximity and away. It formulated the three-phase research framework including theoretical, modelling and analysis phases. The chapter concluded with a brief outline of the thesis structure.

The next chapter introduces the concept of port-centric logistics cluster and critically reviewing the literature that relates to port-centric development and its impact on inter-firm competition.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Chapter 2 presents a systematic review of the port-centric logistics cluster-related (hereafter, PCLC) literature and lays the foundation for the development of a conceptual framework to examine inter-firm competition within and outside a port-centric logistics cluster. It describes the changes in the scope and functions of contemporary ports as they shift their focus to becoming a logistics hub, rather than performing just the traditional services to support freight transportation. With the growing dominance of transnational companies and the flexibility required to support global supply chains, it is important to understand the key functions of ports, and of their evolution over time.

This chapter begins by defining the meaning of a port and its roles in an integrated global supply chain. The chapter also discusses the evolutionary stages of port development with the aim to illustrate the trajectory over time. Finally, a conceptual framework of a PCLC and its effect on inter-firm competition will be developed.

Specifically, this chapter addresses the following questions:

- What are the key functions of contemporary ports and their evolutionary stages?
- Do ports transform into port-centric logistics clusters to help gain the benefits of the economies of agglomeration?
- How does the development of a port-centric logistics cluster affect inter-firm competition?

2.2 LITERATURE REVIEW

This study aims to explore the changing role of ports in the global supply chain and the concept of port-centric logistics cluster. To accomplish this aim a systematic review of literature is adopted with a primary goal to examine the development of ports from various dimensions and then to define the concept of port-centric logistics cluster, underlining the research gaps in the literature. For this purpose, a selection of a list of the scientific journal papers over a period of 30 years (from 1990 to 2020) was aimed based on three main disciplines that include spatial, transportation, and logistics.

The main reason for selecting 1990 is due to the rising privatization and port restructuring (Witte et al, 2018). Moreover, a sharp increase in globalization and supply chain management concept during this time is also attributed to the selection of this year. In addition to this, the concept of port generation was also introduced by UNCTAD in this year. The review process included journal articles, conference publications, books and book chapters, technical proceedings and research thesis for both Masters and Ph.D. The grey literature such as websites and companies' content was excluded from the literature review. A list of keywords that were used to find the articles from a range of well-established academic databases such as Google Scholar, Scopus, EBSCOhost, and Sci-founder include port functions, port evolution, port development, logistics hubs, transport hubs, freight village, distriparks, districenters, inland ports, port generations and, port-centric logistics.

Based on this selection 145 papers that seemed relevant based on initial screening of title, abstract and the keywords were collected. The list was narrowed down after reading the abstract, introduction, conclusions, and recommendation. The papers that were considered for further analysis were based on their relevancy to the central concept, the changing role of ports and the port-centric logistics cluster. A list of 84 papers was finally retained for the final review process. These papers were then further analysed in detail and relevant information was extracted.

In review, it was found that little attention was paid (around 6 studies) to integrate the port into the global supply chain until 2000 except a study of port generations that explored the changing role of the port, proposed by UNCTAD (1990). However, the term port regionalization published by Notteboom and Rodrigue (2005) set a precedent to direct the research towards exploring the changing role of ports from a simple transloading facility to a supply chain integrator. From 2000 to 2011 around 35 publications were noted to be related to the core topic. From 2012 onwards a sharp inclination in publications (around 43) was observed that were based on spatial, functional and economic aspects. During this period the main emphasis was given on port as a logistical system rather externalities of the port system (ref-review). That's why the keywords from these studies were primarily focussed on the inland port, supply chain, spatial concentration, port regionalization, districenters, distriparks, port-centric logistics and agglomeration of logistics firm around ports.

Finally, after careful analysis of previous literature, the development of ports was categorised into three dimensions that include the spatial dimension that focusses on the geographic extent of port and the spatial agglomeration of the logistics firms around it, the functional dimension that emphasises on logistics process integration in the global supply chain and temporal dimension that signifies the way activities around ports have changed over time. Table 2.1 discusses the definitions of these three categories, and the concepts and terminologies that outline the categories.

Drawing the gap from the previous literature this study aims to extend spatial and functional development by empirically examining the effect of spatial agglomeration of logistics firms around the port on inter-firm competition. The spatial agglomeration of logistics firms that is sought in this study, which is also defined as a port-centric logistics cluster, may provide a competitive environment that is conducive for other businesses to collocate that inturns foster integration through value-driven chain system.

Table 2.1 – Dimensions of port development

Port Development	Definition	The concept and terminologies used
Spatial Development	It discusses the development of port periphery to higher geographical scale. Spatial development is influenced by containerization, intermodality, and ICT (information & communication technology).	Hinterland development, maritime and hinterland networks, logistics zone, scattered ports to port regionalization, distriparks, districenters
Functional Development	It discusses the development of a port in terms of its operations and functionality.	Distribution network. Port city to port network, value-driven chain system, logistics integration
Temporal Development	It discusses the development of ports over time.	Port generations, port evolution, port levels (from cargo ports to customer-centric ports)

The next section commences with discussing what ports are, their evolutionary stages, and how the functional roles of ports have changed over time. Finally, combining the concepts and activities of contemporary ports lays the foundation for the port-centric logistics concept.

2.3 DEFINING PORTS

The word port comes from *portus*, which means a gateway (Rodrigue et al., 2016). Ports are the point of convergence of inland and coastal transport functions: the point where freight arrives, directly using road or rail transport or indirectly through feeder port or inland ports, as described in Figure 2.1 (Rodrigue et al., 2016). Different authors have defined ports in terms of different dimensions (as listed in Table 2.2), such as space (Mangan et al., 2008a; Rodrigue et al., 2016), activity (Notteboom and Rodrigue, 2005; Pettit and Beresford, 2009), and time (Beresford et al., 2004; Flynn et al., 2011; Lee and Lam, 2016). However, some studies such as UNCTAD (1990) and Flynn et al. (2011) defined port from space and time dimensions together but their main emphasis was time as they explored the concept of port generations in their studies.

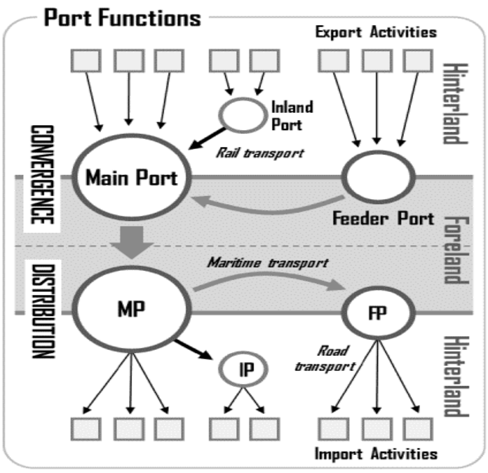


Figure 2.1: Port functions - (source: Rodrigue et al., 2016)

2.3.1 Port as a space

A port in terms of space is an interface between land and the sea where its location can't be changed but the site can be improved on the basis of demand and consumption (Mangan et al., 2008a; Rodrigue et al., 2016). Carbone and Martino (2003) identified that ports are the natural sites for transshipment where goods are moved from one mode to another. Ports mainly provide a connection between maritime and inland transport, and play a vital role in managing freight and flow of the information as in both imports and exports, the freight has to move through the ports.

Table 2.2 – Port definitions and their different dimensions

Key studies	**Definition**	**Dimensions**
Chen (2001)	Port is a place in the global supply chain that provides an efficient infrastructure and an ability to have an inland connection to provide value to the customer.	Space
Rodrigue (2016)	Port is a point of convergence where land meets the sea.	Space
Carbone and Martino (2003)	Ports are defined as natural sites to transfer goods from one mode to another.	Space
Charlier and Ridolfi (1994)	Ports are four modal nodes, where ocean ships, short sea/river ships, road, and rail modes converge.	Space
Notteboom and Rodrigue (2009)	Ports perform a set of activities to support the supply chain by managing and coordinating the materials and information from suppliers to the customers efficiently and providing value-added services in terms of logistics.	Activity
Centin et al. (2012)	Ports act as a link to foster trade where transshipment activities take place.	Activity
Panayides and Song (2013)	Ports are facilities that promote and offer value-added activities in the supply chain.	Activity
Paixio and Marlow (2003)	Ports act as a link in the global distribution channel by extending their functional ability in global sourcing and intermodal operations.	Activity
Flynn et al. (2011)	Ports have developed over time based on the functions they perform from basic transloading functions to being a value-added affiliation and	Time

	customer-centric logistical node in the global supply chain.	
UNCTAD (1990)	Ports are the facilities that have developed over time in terms of the services they offer and the level of IT integration.	Time
Lee and Lam (2016)	Ports are the sites that have evolved over time based on two criteria: economic activity; and complexity of the port operation.	Time

2.3.2 Port as an activity

Ports, as an activity, can be defined on the basis of their functions such as loading, unloading, storage, and value-added logistical services. Traditionally, seaports have been viewed only as a link to foster trade and as a facility where loading, unloading, and storage of different commodities happen before being shipped to another country (Centin et al., 2012). However, the focus of contemporary ports has changed, from that of a loading and unloading facility to a more advanced value-added affiliation within the supply chain (Panayides and Song, 2013). Panayides and Song (2013) also suggest that the ports must transform in order to extend their functional ability in global sourcing and intermodal operations to evolve as a stronger link in the global distribution channel.

2.3.3 Port as a time

Ports, in terms of the time dimension, can be defined on the basis of port developmental stages over time. Ports have evolved through different stages based on the services that they offer and the infrastructure that they require to support such services. Five stages of port development are often identified (Flynn et al., 2011; Lee and Lam, 2016), wherein ports have developed from, initially, offering a basic transloading function, to adding value by providing: logistics activities; distribution activities; lean and agile supply chain solutions; and by offering customised solutions to individual customers to fulfil their demands.

2.4 FUNCTIONS OF PORTS

The spatial dispersion of production activities requires global production systems to be connected with the domestic distribution network. Hence, there have been significant changes observed in logistics and supply chain activities around the ports to support this transformation. Port activities are becoming more customer-centric and embedded with advanced information technology (Lee and Lam, 2016).

An effective supply chain needs all inter-and intra- firm operations to be integrated. Port plays a vital role in supply chain integration. The role of a port is to seamlessly connect and integrate global production operations to local distribution networks. Traditionally, ports have been viewed only as a link to facilitate trade and as an infrastructure facility where loading, unloading, and storage of different commodities take place. However, Panayides and Song (2013) demonstrate that contemporary ports have transformed their roles from merely an isolated facility to an integrated affiliation in global supply chain. Modern ports perform advanced value-added solutions such as light manufacturing, and postponement in addition to the basic transloading functions.

The functions of ports have also shifted from being reactive (to market changes) to more proactive. Modern ports act as an interface between complex local transport web and the wider logistics network wherein logistics activities tend to agglomerate around the vicinity of the ports to proactively responding to the market changes by offering customised solution to the end customer. This increase in logistics activities that spread across the port results in increased productivity of the hinterland, driven by higher inter-firm competition (Robinson, 2002; Marlow and Casaca, 2003; Panayides and Song, 2008). The functions of port have extended to help enhance regional productivity, stimulate regional economic growth and generate employment opportunities (Mangan et al., 2008; Chhetri et al., 2014; Singh et al., 2016). Ports are also becoming a trade facilitator, a supply chain integrator, a value chain-driven system, and an engine of economic growth. These are discussed in the following sub-sections.

2.4.1 Ports as a trade facilitator

To facilitate trade, container shipping plays a substantial role which helps in connecting ports around the globe, to distribute products that are produced in one country and consumed in another country. The role of ports has changed over time as a result of globalization, which has stimulated trade by removing most of the physical, political, and economic barriers between nations (Panayides and Song, 2013). Ports facilitate freight transport by providing a facility where services from basic transhipment activities to more customised solutions are performed. Around 6 billion tonnes of freight are traded throughout the world every year, using various modes of transportation, of which maritime transport is the most preferred choice in global trading due to the advantages of lower cost and high capacity (Coyle et al., 1996; Panayides and Song, 2008).

World trade has grown almost 27-fold from 1950 to 2006, at an annual rate of 5.9% (Mangan et al., 2008). Container throughput has increased from 50 million TEUs in 1980 to around 750 million TEUs in 2017, as shown in Figure 2.2 (Rodrigue et al., 2017) This growth in trade has been experienced in Australia too, where a two-way trade increased from A$764bn to A$853bn for the years 2017 to 2018, an 11.6 per cent increase (Department of Foreign Affairs and Trade, 2018). This unprecedented growth in trade and high container throughput necessitates the development of new ports, to facilitate trade in an uninterrupted way, or by increasing the capacity and capability of existing ports. In the past, existing ports in Australia have built additional capacity for transloading (Whitlam and Affairs, 2013). This spatial concentration of port services in a few ports along with land-use changes in Australia has resulted in a shift of ports' logistics operations, such as maritime transport, logistics functions, and other value-added services closer to the ports (Singh et al., 2016; Sakalayen et al., 2017). Thus, the changing trade pattern and emerging business opportunities have redefined the roles of ports by recognizing their ability to facilitate trade and transport and offer a platform for regional growth.

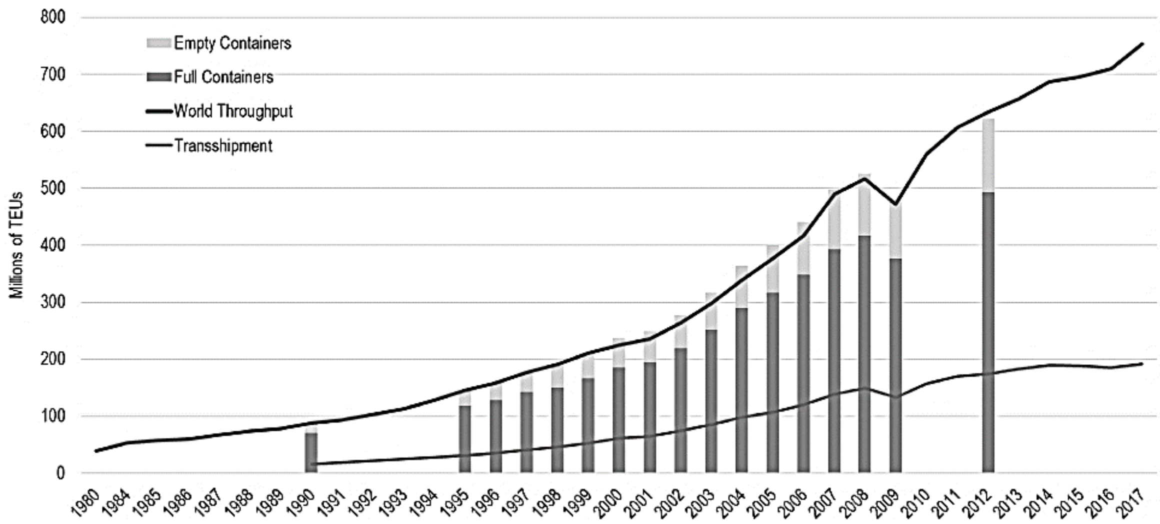


Figure 2.2 - World container throughput, 1980-2017 (millions of TEUs): Source: (Rodrigue et al., 2017)

2.4.2 Ports as a supply chain integrator to support co-location of firms

The rapid growth in trade and the rapid integration of logistics services through IT have redefined the structural and functional roles of ports. The role of modern ports has changed, from being an isolated entity to an integrated node within the global supply chain where a range of logistics activities are provided such as freight forwarding, stevedoring, importing, exporting, light manufacturing, customs, and many more activities (Kim and Shin, 2002; Hummels, 2007).

Contemporary ports are strategic nodes in a global supply network, which tend to offer integrated logistics solutions that are better for both the organizations and port authorities to attract other companies to operate from or near the ports. Some countries and port authorities also offer some incentives in terms of subsidies, and tax rebates for companies to collocate their businesses near the port vicinity to promote collaboration and competition led regional growth (PortNews, 2017). The collocated companies offer seamless services to their customers, and build a collaborative network such as that developed around ports in Singapore and Busan (Nam et al., 2011). This collocation results in the clustering of logistics firms around ports, to offer differentiated services that add value in the final product to serve the customers more effectively than ever before (Nam and Song, 2011). The outcome of this agglomeration, around the ports, of similar and complementary industries that are related to logistics is increased competition among the firms in an attempt to outperform others and gain a larger market share.

2.4.3 Ports as a value-driven chain system

Ports are an important element of the value-driven chain system as they add value to the commodities and deliver value to the shippers and third-party service providers (Robinson, 2002). Globalization has caused agglomeration of production in a few, low wage and resource- concentrated countries (Sölvell et al., 2003). Due to the intense competition driven by globalization, firms have adopted new approaches such as global sourcing, outsourcing of logistics activities, and postponement to overcome the problems of higher labour cost, longer lead time, and the need for agility in the supply chain. These new approaches require more responsive logistics systems which can be developed by adopting lean and agile principles in port systems.

Modern ports are more logistics-oriented, where their success can be measured on the basis of how lean or agile, they are. Such a measure reflects how efficient they are in providing logistics services and cutting down on wasteful activities, in supporting the lean format, and how responsive and quick they are in countering last-minute changes to support the agile function (Panayides and Song, 2008; Marlow and Casaca, 2003). Paixao and Marlow (2003) explain that ports extend their role to serve customer needs through cost reduction in transportation and also by offering a diverse range of services. Providing seamless services, reduced operational cost, Just in Time delivery (JIT) and system integration are emerging characteristics of modern ports.

The ever-changing demand has enabled products to not be finalised until the later stage of the supply chain (Yang et al., 2004; Boone et al., 2007). Thus, ports may act as a natural decoupling point; a concept that is facilitated by postponement, where the base products are received from different countries, stored on the ports, then further customized as customer-specific products, on or near the ports (Pettit and Beresford, 2009). The lean and agile concepts have gained phenomenal results in manufacturing that have helped organizations to drive their supply chain more effectively and efficiently and in a cost-effective way (Goldsby et al., 2006). Identically, implementation of these concepts in port operations has assisted in improved efficiency, integration upstream and downstream, high throughput, increased market capture, reduction in prices, responsiveness to change, high profitability, lowered wasteful activities and a wide range of products and services being offered (Paixão and Marlow, 2003; Bichou and Gray, 2004).

Paixio and Marlow (2003) have developed indicators to measure performance in terms of cost and responsiveness, which are referred to as lean and agile principles, respectively. These measures include flexibility, cost, efficiency, effectiveness, speed, information sharing and operational indicators that include productivity, throughput, and customized services offered. These indicators reflect a more integrated framework where the port act as an important logistical node that should perform the operations efficiently in order to integrate supply chain functions (Panayides and Song, 2008). Thus, the changing role of the port needs to be considered in terms of the application of port-centric logistics and how improvements can be made in offering an environment, in the port or in the hinterland, where easy-to-sophisticated logistics services form the foundation for competing in the market (Paixão and Marlow, 2003).

2.4.4 Ports as an engine of economic growth

Ports are viewed as an engine for economic growth. The economic contribution of the port sector in the UK in 2011 was nearly £21.2 billion, which offered employment to around 391,800 (Oxford Economics, 2013). Port of Singapore has also played a vital role in economic development as it contributes 7 per cent of Singapore's GDP and provides employment to around 170,000 people, in the year 2015 (MPA Singapore, 2015). According to the study conducted by Belgian National Bank (2015), Antwerp port generates 4.3 per cent of Belgium's GDP and creates around 61,000 direct and indirect jobs within the port and around 82,000 jobs outside the port area (Port of Antwerp, 2019). The Australian port industry directly contributed $9 billion to the GDP in 2012-13 and offered direct employment to 31,000 and jobs to further 13,927 people who were indirectly associated with port functions. The revenue generated in the form of direct tax in Australia was $900 million in 2012-13 (Australian Shipowners Association PWC, 2015).

Growing and diversified range of port activities create economic benefits through business development, new employment opportunities, port-related auxiliary activities, and additional revenue for the government such as taxes, excise, export and import duties (Grobar, 2008; Song and Van Geenhuizen, 2014). For instance, the ports of Singapore, London, Dubai, Busan and many more have developed logistics hubs, known as distriparks, to offer integrated logistics services that directly impact the economic growth of their countries (Zhu et al., 2002). The development of major ports in China such as in Shanghai and Shenzhen has increased the competition among HongKong, Busan and Singapore ports (Wright, 2007; Lee et al., 2008). These ports outside the china have developed free trade zones and developed facilities for value-added activities around the ports to retain their freight traffic from competition raised by Chinese ports (Mangan et al., 2008b). The ports are economic entities that serve a wide range of customers, such as shippers, freight forwarders, transport companies, and logistics and any allied companies (Montwiłł, 2014). Ports tend to offer the ideal location for the setting up of distribution centres by retailers and manufacturers, which in turn affects the economic growth of the hinterland.

2.5 EVOLUTION AND DEVELOPMENT OF PORT SYSTEM

Technological changes and containerisation have enabled ports to handle more freight, which was previously handled manually in pieces. Ports have evolved over time from traditionally being viewed only as an intermodal link to foster freight transportation, to more advanced value-added connection within the supply chain. A number of external factors such as business development, regional economic growth, technological development, and industrial expansion have affected the way ports have developed over time from simple loading and unloading facilities for cargo to value-added logistics centres in the supply chain, (Montwiłł, 2014).

UNCTAD developed a port generation concept, which defines port development as an evolutionary process to explain how port activities have changed over time with an increase in globalization and the way ports have adapted to the political, technological, and operational changes. This was then further expanded by the WORKPORT study (Beresford et al., 2004) which refers to the development of port systems as a part of an evolutionary process rather than revolutionary. The model discusses that port development does not happen in discrete steps, but it is continuous that consistently seeks to adopt new technologies, legislations and work practices. The UNCTAD model of port generational change identifies three generations of ports that were considered to be time-discrete (Beresford et al., 2004; Lee and Lam, 2016). These three generations were defined on the basis of the period of development and how industrial activities and increased cargo throughput enabled the changing roles of ports to provide more value-added services.

The UNCTAD model explains how seaport operations have changed over time by turning the emphasis from being a transloading facility to offering value-added services to respond to demand variability and uncertainty. Modern ports offer management and coordination functions for the key stakeholders including buyers and sellers, shippers, transporters, exporters/importers, freight-forwarders and various government agencies. They also offer services such as light manufacturing, intermodal services and important logistics services (Notteboom and Rodrigue, 2009).

However, Flynn and Lee (2011) divided the port evolution into five generations which they defined as levels, on the basis of their functionality, external environment, spatial and port organization, and strategy. These levels are:

- Level one - cargo ports;
- Level two – logistics ports;

- Level three – supply chain management ports;
- Level four – globalized e-ports; and
- Level five – customer-centric community ports.

Table 2.3 synthesises these evolving functionalities of ports by differentiating services offered at different generations of ports.

Table 2.3 – Changing port functions across different generations of port development process

Activities	**First Generation**	**Second Generation**	**Third Generation**	**Fourth Generation**	**Fifth Generation**
Loading, unloading, and storage	×	×	×	×	×
Advanced automation					×
Total integration			×	×	×
Information Standardization					×
Labour intensive	×	×	×		×
Capital intensive		×	×	×	×
Value-added services		×	×	×	×
Leanness				×	×
Agility				×	×
Innovation					×
Passenger traffic			×	×	×
Tourism focussed					×
Environmental Protection			×	×	×
Total quality management				×	×
Human resource management				×	×
Collaboration					×
Competition					×

Source: (complied from Beresford et al., 2004; Flynn et al., 2011; Lee and Lam, 2016)

2.5.1 First generation ports (Up till the early 1960s) – Transport hubs

First-generation ports are the facilities that are isolated from transport, trade activities, and surrounding municipality. Moreover, the companies working in the port vicinity are also isolated and no co-operation takes place between the firms to promote the port at a commercial level. The first-generation ports are mainly labour- and capital-intensive facilities that act as a simple transport hub where the dominant cargo is breakbulk cargo. The range of services offered at the first-generation ports is loading/unloading, storing, controlling cargo, and simple administration activities (Montwiłł, 2014). Until the early 1960s, ports played the simple role of goods moving through them and assist in loading and unloading for international transport. Considering the services offered during that era, the authorities and government only focussed on developing the port-related facilities that would enhance cargo handling services (ESCAP, 2002). The infrastructure in first-generation ports is mainly public sector owned and use of technology is minimal as the facilities are not developed to handle big cargos. Hence, high degree of manual work was involved to handle such cargoes.

2.5.2 Second generation ports (1960-1980) – Industrial complexes

In second-generation ports, the functions of ports began to diversify and grow in terms of infrastructure to support packaging, sorting, and physical distribution during 1960 and 1980. This era is characterised by increased international trade, containerization, technological advancements, reduction in import taxes and regulatory changes. These changes, largely led by globalization, augmented the demand for various products which in turn disperse the production activities in low-cost countries. This spatially fragmented production systems at a global scale required maritime efficiencies to distribute the products downstream, as shipping is considered to be the most cost-effective transportation means; thus, increasing the importance of the port in the global supply chain context.

The main focuses of second-generation ports were on acting as a transport hub, offering commercial services, and development of industrial complexes around the ports (Beresford et al., 2004; Lee and Lam, 2016). The range of services offered, in addition to the ones offered in first-generation ports, included processing of goods and complex administrative services. However, the relationship with the city was ad hoc (Montwiłł, 2014). Many organizations that offered port-related services could be found near ports or in the hinterland. These service providers started to have better relationships amongst each other, and with their customers whom they would offer their services.

2.5.3 Third generation ports (1980-2000) – Logistics centres

The third-generation ports started from the 1980s, when container transportation revolutionised the maritime logistics. This was further propelled by globalization-led international trade and the introduction of an intermodal system through rail connectivity between port and its hinterland. This era reflects the transition from local economies to the global competitive economies, which changed the logistics landscape around the ports. The logistics services started integrating into the global commodity chains, which earlier were fragmented and working in silos.

The key functions of third-generation ports with their stakeholders were to provide efficient transportation, logistics and distribution services, and value-added services such as light manufacturing, freight forwarding, importing and exporting among many others. The services offered, in addition to those listed in the first two generations, involved cargo distribution, value-added logistics services, information linkages upstream and downstream, and organizing the supply chain (Montwiłł, 2014). The third-generation ports preferred to make closer ties with organizations that operate within the port precinct. The port authorities also adopted efficiency over effectiveness (Lee and Lam, 2016), whereas the latter was the underlying concept of the first two generations of ports.

2.5.4 Fourth generation ports (2000 onwards) – Lean and agile centres

The fourth-generation ports started from the year 2000 with the goals to provide tailor-made services to customers. During this period, a transformation in manufacturing from mass production, which is characterised by economies of scale, to mass customisation, which is based on postponement of value-added activities has occurred in several industrialised nations (Paixão and Marlow, 2003). This strategic shift in manufacturing coupled with outsourcing of production activities, necessitated the development of an integrated logistics landscape around the port to respond to the volatile changes in demand. The ports respond to these fluctuating changes in demand through implementing the pull system to reduce the inventory in the pipeline. To achieve this, ports have transformed the way they operate and create value in the system by developing various value-adding roles such as consolidation, product mixing, cross-docking, and breaking bulk.

The main functions of fourth-generation ports are intermodal services, and supply chain optimization through lean and agile strategies. The concepts such as on-time resource planning (OTRP) and on-time distribution planning (OTDP), which are based on Just in Time (JIT) philosophy to reduce muda (waste) from the system, are implemented (Paixão and Marlow, 2003). A range of services offered, in addition to those of the first three generations, to improve services through logistics automation and providing integrated logistics solutions, and system improvement through seamless and consistent interactions between internal and external partners.

2.5.5 Fifth generation ports – Customer-centric ports

The fifth-generation ports, also known as customer-centric ports, have become key facilitators in global trade. The fifth-generation ports acquire the capacity and capabilities to integrate port-related activities for their customers to manage demand better, through individuals to firms, by providing customised solutions (Flynn et al., 2011). This modern era reflects changes in terms of conservation of the environment, integration of supply chain activities, incorporation of total quality management concepts, assimilation of information technology, and increased collaborative and competitive practices.

The fifth-generation ports indirectly encompass commercial, residential, cultural and tourism functions within their vicinity to stimulate economic growth of the region. The objective of the fifth-generation port is based around a customer-centric approach and the well-being of the local community with global outlook. This has affected the dynamics of port operations in the way they operate and offer services to customers. The range of services offered, in addition to those of previous generations, encompasses tailor made logistics services to help cater the demand of individual customers and the development of tourism and retail centres.

The main feature that differentiate the fifth generation of ports from earlier generations is the heavy reliance on advanced IT, such as the use of tracking devices such as GPS (global positioning system) and RFID (radio frequency identification) and SWS (Single window system), which are now used in numerous ports such as Singapore, Busan and Hong Kong ports (Lee and Lam, 2016). The advanced use of IT in fifth-generation ports saves time and cost by connecting customers through better means of communication and sharing of information electronically, thus reducing the need for documentation and labour input.

One major shift that occurred in this phase is a rapid co-location of logistics firms in closer vicinity to ports. This is to take advantage of the economies of agglomeration, and externalities such as improved access to high capacity infrastructure. This development of ports is to provide integrated and seamless logistics solutions, that are customer-centric, enables more firms, to collocate their operations near to a port's periphery, to gain the benefits of working in the agglomerated environment, which is also known as a port-centric logistics cluster. PCLC provides an environment where firms collaborate and compete to foster regional growth. The next section discusses the conceptual definition of a port-centric logistics cluster, and how companies working in a cluster compete and gain benefits.

2.6 DEFINING A PORT-CENTRIC LOGISTICS CLUSTER

A port-centric logistics cluster, in simple terms, is a spatial agglomeration of logistics firms around the port that facilitate the port logistics and maritime operations. Port-centric logistics is not only related to the functions that deal with maritime transportation such as loading/unloading, moving cargo, and sea voyage, but also serve pervasive functions of logistics activities that include warehousing, inventory management, stripping/stuffing, quality control, testing, packaging, assembling, breaking and creating bulk, process and supply chain smoothing, inland connection, and activities related to reverse logistics such as repair, repacking, and reverse movement of the goods and re-use (Mangan et al., 2008a; Pettit and Beresford, 2009; Monios and Wilmsmeier, 2012). In principle, PCLC is similar to the concept of logistics clusters, manufacturing clusters, maritime clusters and service clusters (Porter, 1998; Waits, 2000; Benito et al., 2003; Zhang, 2011; Sheffi, 2013; Chhetri et al., 2014). Previous studies have explored the port-centric approach from different frame of references which include dry ports (Roso et al., 2009; Monios and Wilmsmeier, 2012), container depots or ICD's, distriparks (Van Horsen, 1991; Eller, 1995; Nam et al., 2011) and districenters (De Langen, 2004).

Mostly the logistics cluster evolves around major transportation hubs such as ports and airports because of easy transhipment or mode change (Sheffi, 2013). There are enormous logistics clusters worldwide, which are named differently such as “Distribution Park or Districenter”, “Logistics Village”, and “Logistics Platform” to name a few (Sheffi, 2013). Studies conducted, mainly in Europe (Van Horsen, 1991, Eller, 1995, Langen, 2002, European Commision, 2008), have shown some evidence of benefits to port logistics industries after collocating and collaborating their activities in a geographically bounded area.

The development of port-centric logistics is an emerging concept, which, to a large extent, has been designed to deal with increased demand of shippers and customers, and the rapidly changing role of ports in the context of globalised supply chain systems (Pettit and Beresford, 2009). Companies tend to work in freight villages to conduct activities relating to transport, logistics, and distribution of the goods and services for both national and international accounts (Mangan et al., 2008).

A distripark is an area around the port which has better connectivity with the market. The distriparks offer a variety of facilities which include short- and long-term storage, physical distribution, light manufacturing such as packaging, barcoding, and tagging, breaking and creating bulk, cross-docking, inventory control and product customization (Notteboom and Rodrigue, 2005). These functions are essential for any supply chain to work in accordance with customer-specific requirements in an effective manner (Zhu et al., 2002).

PCLC operates in a similar way to manufacturing or services clusters which functions at a different scale. PCLC happens to exist due to the changing role of ports where the purpose of the port is to link the local distribution network with globally dispersed manufacturing. A cluster can be local (tourism in a city), regional (e.g. London financial cluster, and Minnesota industrial cluster), or interregional (e.g. a car manufacturing cluster in Germany). Clusters range from a collection of small firms located along a stripe of major highway or along a beach or a larger agglomeration of bigger firms working in collaboration such as Microsoft and Boeing in Seattle (Enright and Roberts, 2001). Several studies have shown the successful application of cluster concept in various industry types such as manufacturing, logistics, maritime and services. Significant logistics clusters around ports, which are discussed in boxes 1, 2 and 3 include the Rotterdam port, Busan port and Singapore port. Examples of manufacturing and services clusters include the Silicon Valley cluster, movie making in Hollywood, the North Italian fashion and design cluster in Milan, and financial clusters in London, New York, and Tokyo and many other cities.

Box 1, 2, 3: Logistics clusters around ports

Box 1: Port-centric logistics cluster in Rotterdam

The Rotterdam distripark was developed by Rotterdam Municipal Port Management (RMPM). The Rotterdam port comprises three distriparks which are at Botlek, Eemshaven, and Maasvlakte, providing ample space for logistics and transport companies to offer their services, with the strategic aim of handling and processing 95% of less than a container load (LCL) of Rotterdam in these three distriparks (Van Horsen, 1991). The choice of place is mainly because of proximity to the market and container terminal, availability of a skilled labour pool, and easy physical and e-connectivity. Many big companies such as Reebok, Pro Logis, DHL/Exel, Hankook, and Nippon express, operate from this distripark (Ng and Liu, 2014).

Box 2: Port-centric logistics cluster in Busan

Busan Newport Distripark offers 16 births and a logistics facility zone. Many multinationals operate from this distripark; and with the growing demand, it is set to provide an additional logistics facility. Busan port developed this distripark to stay competitive by focussing on developing their port hinterland and offering comprehensive logistics services in one location (Nam et al., 2011). The services offered at this distripark range from basic activities such as handling, storage, processing and labelling, to auto-knockdown services. In a similar way, distriparks have been developed adjoining the Port of Singapore, in Hull by Associated British Ports (ABP), and at London gateway by Dubai Ports World (formerly known as P&O) (Zhu et al., 2002).

Box 3: Port-centric logistics cluster in Singapore

With its locational advantage, Singapore serves the Asian market, as the Netherlands serves the European market, by establishing a central distribution centre (CDC). There has been a growing trend in Asia to have CDCs. In order to cater to their needs, the Singapore authorities have provided a hub to the surrounding area (Fremont, 2007). Many multinational companies have outsourced logistical services in Singapore; and, in turn, these third parties have started providing an integrated solution rather than providing only transportation and warehousing facilities. This makes the logistics industry attractive in Singapore, accounting for around 7% of Singapore’s GDP. Singapore has all the necessary infrastructure to offer the world’s leading services in logistics. There are more than 6000 logistics companies in the logistics cluster around the port that offer comprehensive services to national and multinational companies (Nam and Song, 2011).

The changing trade pattern, globalization of production and consumption, higher throughput of the ports, higher demand of products, cost efficiency and supply chain agility have raised the need to change the role of the ports from offering basic port functions to act as logistics system. The contemporary ports provide seamless integrated logistics solution through agglomeration of logistics firms around the port vicinity, also known as PCLC, that work in a co-optation manner (collaboration and competition together). As logistics services can't be offshored, unlike manufacturing clusters that can connect and operate through information exchange, therefore they need to agglomerate based on spatial geography, around transport hubs (Sheffi, 2013). Hence, from an in-depth literature study, the PCLC can be defined as:

'The spatial consolidation of cooperating and/or competing firms and institutions within all sectors, sub-sectors and economic activities directly or indirectly linked to the port logistics industry, maritime transport and the utilization of the sea in general'.

Hence, the key features of PCLC includes spatial agglomeration of logistics firms, proximity around the port, higher inter-firm competition, higher inter-firm collaboration, higher value-added activities, better information sharing, and total integration of processes in the global supply chain.

2.7 BENEFITS OF PORT-CENTRIC LOGISTICS CLUSTERS

The increased efficiency and performance enhancement created through the process of clustering strengthens companies' capabilities and increases the industries' competitiveness (den Hertog et al., 2001; Johnston, 2003). Langen (2002) suggests that clustering has become a vital benchmarking framework for analyzing the performance of nations and industries in terms of their ability to attract global firms to collocate. Clusters provide benefits for firms such as access to better inputs for production, knowledge sharing, availability of skilled labor and evolving competitive pressure that pushes the firms toward innovation and higher productivity. Rivera et al. (2014) found several benefits of agglomeration of logistics companies, such as firms' collaboration to provide advanced logistics and value-added services, job creation, frequent interactions for innovation, and closer monitoring and reduction in transportation cost due to the proximity of service facilities and amenities. Apart from this, there are opportunities for infrastructure development with enormous benefits which might be difficult for an individual firm to undertake due to financial constraints. But, it might be collectively achievable when firms collaborate within a cluster to develop such a facility for a larger benefit. Table 2.4 lists the benefits of clusters as identified by various authors; while a detailed description of the benefits of logistics clustering is described in the next section.

Table 2.4 – Benefits of PCLC

Cluster Benefits	(Marshall, 1890)	(Appold, 1995)	(Porter, 1998)	(Mangan et al., 2008)	(Sheffi, 2013)	(van den Heuvel et al., 2011)	(Chhetri et al., 2014)	(Rivera et al., 2016)
ECONOMIC BENEFITS								
Access to larger labour pool	×				×	×	×	
Access to larger market			×		×			×
Scale Economies	×		×		×			
Economic Advantage	×		×					
Reduced input cost								
Employment generation			×			×	×	
RESOURCE UTILIZATION BENEFITS / SHARING BENEFITS								
Access to large pool of resources	×				×			
Resource sharing (such as transport, labour, and warehousing)					×	×		×
Knowledge creation and sharing	×		×		×	×		
Knowledge spill over	×				×			
Access to larger supplier base	×				×	×		
Access to larger buyer base					×			
OPERATIONAL AND LOGISTICS BENEFITS								
Efficient Local labour market	×				×			×
Reduction in average cost of production								
Operational Flexibility			×					×
Consignment consolidation					×		×	×
Increased operational productivity		×	×		×	×		
SUPPLY CHAIN BENEFITS								
Open innovation			×					
Vertical relationship			×					
Horizontal relationship			×					
Trust among suppliers and buyers					×			
Enhanced supplier and buyer interaction			×		×			
Increased collaboration			×				×	×
Increased competition	×		×	×			×	×

2.7.1 Economic benefits

Economic benefits are the positive effects of or gains from any decision, event or policy on employment generation, and income growth (Hirschey et al., 1996). The economic benefits of clustering can be assessed in terms of increased employment opportunities, access to a larger labour pool, gain in Gross Domestic Product, and benefits gained through scale economies (Chhetri et al., 2014; Rivera et al., 2016). These benefits include reduced input cost, as transaction cost is lower because of easy access to large supplier and buyer base within the cluster. A cluster attracts foreign direct investment that helps to enhance the economic growth of the region through higher productivity and creating more job opportunities. A cluster-based approach provides the region with strategic formulation of favourable business environment conditions where skills upgradation and low job search opportunities are available at an ease.

The economic benefits of a maritime cluster in Greece is such an example, where the shipping sector is part of a maritime cluster that significantly contributes to the Greek economy (Icaza et al., 2009). According to Zagkas (2010), $17 billion was the net gain from the shipping industry in Greece, which contributed 7% of the GDP in 2007. It also provided employment to 76,200 people in the cluster, which was around 43.3% of the total maritime employment in Attica. Furthermore, the economic contribution of the Port of Melbourne is also significant as it contributes $2.5 billion annually by handling around $90 million of exports on an average day.

The jobs created in a logistics cluster are not only tied to logistics operations but are also in design, planning, consulting and information technology services. UPS supply chain solutions, which is a subsidiary of UPS offers planning and consulting to cargo shipment operators, in a seamless supply chain solution with IT services, having over $6 billion sales and offering employment to thousands of people (Sheffi, 2013). Therefore, some authors also consider clusters as an engine for economic growth (Porter, 1998; Sanchez and Omar, 2012; Rivera et al., 2016). Cluster provides a large pool of specialised supplier that are created through the concentration of the firms within a similar location, a large number of specialised firms that provide intermediate inputs and a large customer base. This accrual of firms brings external economies of scale whereby each firm working within the cluster receives an efficiency gain from reduced transaction cost and specialised labour pool (Spencer et al., 2010). This external economies of scale results in higher productivity of the region thus helps increase the economy.

2.7.2 Resource utilization benefits

Collocation of firms in a strategic location, generally, help improve resource utilisation through freight consolidation, demand synchronisation, joint business planning, access to a larger pool of suppliers and buyers that work in proximity. The resources are efficiently utilised through labour division, specialised skill development and created knowledge that is available only within a cluster (You and Wilkinson, 1994). This division of work and labour creates a system that is mutually dependent which needs cooperation to perform the work efficiently.

The benefits of working in a cluster consist of resource sharing, knowledge creation, and knowledge spill over (Malmberg and Maskell, 2002; Tallman et al., 2004; Sheffi, 2013). In a large pool of firms, resources are shared by the resident firms in a cluster-led cooperative environment. A cluster environment also enables knowledge creation through centres of excellence, which knowledge, in turn, is shared among the resident members of the cluster to tackle supply chain problems. Zaragoza Logistics Centre (ZLC) has been developed as a result of the partnership between Zaragoza and MIT Institute of Transportation and Logistics, where knowledge is created through cutting-edge research and innovation which in turn is shared to enhance the capabilities of firms to compete in a global market as well as to foster talent and entrepreneurship.

In addition, as the volume and frequency of in-and-out freight is greater a cluster, higher capacity conveyances are used, and full container loads can be sent out of the cluster instead of less than a container load by consolidating the demand and sharing the vehicle space. This will help reduction in empty container movement. Thus, cluster fosters a collaborative work environment, therefore avoiding a higher cost of delivery per unit in partially filled containers: the firms cooperate and share their capacities to maximize the space utilization in each container. For example, companies located within the Airport Logistics Park of Singapore share warehouse and transportation capabilities, in the case where one company's capacity is full for a short period of time and another company has space for lease (Sheffi, 2013). Moreover, sharing the load can significantly reduce the cost to the companies by achieving economies of scale as a consequence of operating from within the same location.

2.7.3 Operational and logistics benefits

Operational and logistics benefits include productivity improvement, through efficient resource utilization or easy availability of the resources at the firm's disposal. The operational productivity in a cluster is enhanced through the existence of an efficient local labour market, shared resources, availability and easy access of a specialised supplier pool, operational flexibility, consignment consolidation, seamless information flow, and efficient resource utilization (Caniëls and Romijn, 2003; Sheffi, 2013; Rivera et al., 2016). Clustering of the firms increases the degree of specialization that diffuses throughout the cluster. This creates an abundant supply of skilled and qualified labour and growth of specialised services that is made possible through combined demand and higher productivity. This concentration of the firms leads to large scale industrial production and higher efficiency which is beyond the scope of an individual entity (Sheffi, 2013). Hence, these positive external economies to individual firms stem from geographical proximity

Location within the cluster provides access to specialised inputs such as components, machinery, extensive market information, technical know-how, skilled personals and economies of density (for freight consolidation) (Porter, 2000). The proximity of firms enables industries to exchange knowledge, free movement of labour, and high pace of innovation, through a Marshall-Arrow-Romer (MAR) (Junius, 1997) spill over effect that results in higher productivity of the cluster region. Moreover, the formation of a cluster, in turn, provides ample employment opportunities that range from low-level logistics to executive, IT and other technical jobs. A study conducted on China's Zhejiang province by Li and Geng (2012) identifies that the productivity and performance of firms in a clustered environment are more than those of non-clustered ones, through the shared resources and spillover capacity that are available only in the cluster.

The spatial logistics clusters are potentially geostrategically positioned, around the transport hubs such as ports and airports, to help create freight corridors through designing hub and spoke model (Rodrigue et al., 2016). The logistics clusters act as a hub for high volume freight routes to efficiently connect to other distribution networks. This will help in cost reduction to distribute the products through shared infrastructure and proximity to other firms within a cluster as opposed to point-to-point distribution networks where the firms are distantly located from each other hence distribution cost is increased. The optimal freight network within cluster will enable other port dependent activities such as warehousing, distribution, and transportation to collocate. This is because as the demand grows the cluster expands its capabilities and attracts other firms or helps create another sub-cluster.

2.7.4 Supply chain benefits

Supply chain benefits relate to facilitating better integration, coordination, and collaboration between firms within a supply chain. These benefits are attained in clusters by creating an environment for social interactions through collaborative work practices, relationship building between suppliers and buyers, and building trust (Tallman et al., 2004). The cluster promotes personal and business relationships through formal and informal interactions among suppliers and buyers, joint activities that assist in easy knowledge spill over locally, and exchange of ideas (Porter, 1979; Porter, 1993; Sheffi, 2013). The joint supply chain activities of firms in a cluster, such as promotional events, business planning, optimizing the order quantity, demand forecasting, and transport and storage capability sharing can help in the development of better infrastructure by influencing the government to invest more strategically in the area. This enables other firms to collocate within the cluster, thus generating more employment and better economic wellbeing of that region (Jing and Cai, 2010). For example, in the Port of Rotterdam, where the companies and port authorities work together with the government to invest more resources to help gain benefits for businesses and the community. Lobbying with the government results in a positive outcome, as shown in many countries, to reduce the burden of bureaucracy (Sheffi, 2013). Through clustering, firms can collectively raise concerns and lobby to help build infrastructure to enhance port supply chain efficiency whilst protecting the environment through better planning and management. Economies of effort can be also be achieved in the supply chain where transactions can be significantly reduced through system integration and information sharing among cluster members. This is evident from the fact that export transactions in Germany require one signature by the authorities, while in Australia they are approved by two signatures, and in the Republic of Congo more than 40 signatures, and 39 in Nigeria are required.

Open innovation within suppliers is another benefit of working in a cluster. Firms within a cluster can collaborate to conduct an open innovation project, for instance, a development of demand synchronisation software, through partnership both internally and externally. The knowledge and experience of partnering on a project provide a broader perspective to solve supply chain challenges and enhance the ability to innovate rather working in isolation (Maskell and Lorenzen, 2004).

Firms' ability to collaborate and compete is also enhanced in a clustered environment (Porter, 1998). The collaborative links between firms are a source of flexible specialization for an Italian industrial cluster (Rabellotti, 1998; Becattini, 2002). However, these private firms compete in the cluster to gain bigger market share and grow their business. The collaborative practices in the cluster help firms to gain benefits by exchanging knowledge and sharing resources; and competition among the firms enables the industries to innovate more and perform better more consistently, to maintain their position as an individual entity in the value chain.

The next section discusses how clustering of firms enhances competition, which in turn lays the foundation for this study of the effect of PCLC on inter-firm competition.

2.8 CLUSTERS AS A NODE FOR INTER-FIRM COMPETITION

Over the last few decades, the cluster concept, where companies of similar interests tend to spatially agglomerate and work together in contrast to operating in isolation and compete against each other, has gained considerable attention (Rialland, 2009). A cluster provides opportunities for firms to compete within and outside cluster through the competitive advantage of location (Porter, 2000). Porter (2000) argues that although the process of clustering has been explained by the localization of economies through to industrial complexes (Isard, 1975) and innovation millieu (Maillat et al., 1993); but that the key to understanding cluster dynamic lies in the broader context of competition and competitive strategy when viewed in the light of the global economy.

Porter (1998) asserts that geographic clustering promotes both competition and cooperation, and both can coexist as they work at different magnitudes. A number of perspectives are in place that explains the impact of clustering on economic development thus providing the theoretical foundation for the claim that clustering of the economic activities brings competitive advantage by fostering competition and collaborative practices. The flexible specialization perspective explains the concept of flexible competitive districts that represent clustering of small firms to offer a responsive solution to fluctuating demand through cooperation and competition among the resident firms (Scott, 1988; Van Dijk, 1995). Stigler (1951) identified that localization enables the growth of industries through specialization, which seldom can be achieved in a dispersed geographical environment, through auxiliary and complementary industries. Isard (1975) argued that the spatial concentration in an urban area brings benefits by engaging in a multi output production system similar to a vertically integrated environment.

Porter (2000) proports the cluster as a business strategy that enhances productivity and competitiveness. He encapsulates the cluster from various perspectives such as industrial linkages, complementarities, knowledge creation, spillover, innovation, horizontal and vertical collaboration (Porter, 1993; Porter, 2000). He identified that these traits and advantages enable a firm to be more competitive in an environment created by the firms within the vicinity through intense interfirm rivalry and collaborative practices. Together, collaboration and competition increase the profit for companies by increasing productivity and innovation capability, and through the formation of new businesses. Although there is an assumption that localization stimulates both collaboration and competition, yet, most of the studies have only focussed on geographical clusters enables collaboration thereby increasing the ability of clustered firms to create and sustain competitive advantage (Saxenian, 1996; Lipparini and Sobrero, 1997; Lazerson and Lorenzoni, 1999).

The cooperation aspect of the inter-firm relationships helps to minimize the disadvantages of small size, while the competitive aspects, along with the specialization, impart the dynamism and flexibility that are often lacking in large integrated firms. Clustering affects competition in three different ways that are driven and then amplified in the Diamond Model of Porter (2000).

- Increasing the productivity of the integral firms;
- Capacity enhancement of cluster firms to innovate; and
- The new business formation that enlarges the cluster.

Several studies (JaÄe et al., 1993; Antonelli, 1999; Enright, 2000) have scoped the geographical clusters from an aggregated level however only a few studies have empirically assessed the impact of cluster on inter-firm competition through competitive rivalry, at inter-firm level. Here, in this study, inter-firm competition refers to the competition (extent of rivalry) among the local firms within the cluster offering the same products or services and serving the same customers. Piore and Sabel (1984) identified that according to organizational theory the interfirm rivalry is defined as “all against all” fight. Whereas, a resource-based view explains extreme division of labour within the cluster that fosters specialization which supports the idea of rivalry lies with few competitors (Lazerson and Lorenzoni, 1999). This study has adopted organizational perspective where localization provides an opportunity for the firms to notice other firms, their work practices, products they offer, and finally compete against them.

Inter-firm competition is a local phenomenon where geographical distance has greater influence because of observability and availability (Porac et al., 1995). Observability refers to the noticeability of the firms which is obvious in closer proximities and availability refers to accessibility of information and resources which is evident in a cluster. The proximity of localised firms has greater influence on inter-firm competition as they are more noticeable by other firms and have similar accessibility to the information and resources. Yet, this needs to be empirically supported as not many studies have verified this phenomenon in the context of port-centric logistics cluster.

Competition can be defined as the rivalry between individuals or economic agents with similar activities to capture bigger market share. Competition is defined as a dynamic state in which many actors in a geographical area struggle to access scarce resources, and produce and sell very similar products or services to serve their customers (Osarenkhoe, 2010). Schumpeter (2010) identifies competition in terms of industrial efficiencies gained through innovation of new products, and the development of new technology. The competition among some competitors is better than that among others, and this difference in competition will allow differential growth of firms and their profitability and, in turn, of the economic growth of the areas (Copeland, 1958). This argument is supported by Porter (1998), who recognizes that some locations are more productive than others because of their strategic position in an effort to reduce production and distribution costs. A geographical area where firms are clustered creates a competitive environment that enables the firms to outperform other firms which are widely dispersed so as to gain a larger market share (Porter, 1998).

Firms compete rigorously to retain customers, and this rivalry is accentuated within a cluster due to multiple contending firms. Otherwise the cluster would more likely to fall apart in its ability to compete in a globalised marketplace. Competition in a globalised world is partly driven by the productivity of the region, and relies on how firms compete with one and another. Success is not merely based on the individual firm’s output and input (Porter, 1998).

For an economy to be more productive, firms must compete with sophistication, such as in operational efficiency and product differentiation; and this complexity determines the prices of their products and services (Porter, 1998). However, the way these companies compete in a location is dependent upon microeconomic policies such as on the road system, the legal system, and the tax system. Therefore, a well-established rival location acts as a catalyst for specialization and enhanced productivity that embraces the pursuit of competitive advantage.

Location is seen as a competitive advantage to help enhance both operational and labour productivity as the generic inputs are easily accessible and abundantly available within the cluster (Porter, 2000). Despite the greater competition within the cluster, there are numerous benefits such as access to superior inputs, availability of skilled labor, and business services, as compared to vertical integration, composite mills, and import from a distant location, the latter which increase the costs for companies. Thus, proximity and locational advantages are far greater through cooperation and collaboration among firms than the firms that are spatially dispersed.

The proximity to competitors is likely to increase the quality and intensity of inter-firm competition (Bengtsson and Sölvell, 2004). This is due to the presence of well-informed buyers who have access to a larger market and product knowledge to drive the supplier in favor of fulfilling their requirements. The cluster also attracts other firms to collocate their operations within it, which makes it easier for coordinating service delivery and managing supply chain. This, in turn, creates internal pressure for continuous improvement to be competitive in the marketplace. Clustering nurtures co-location which shortens the process of the spillover effect, which is as an outcome of competition, that help to foster local supplier development and gives rise to new competitors. The by-product of this competition is knowledge creation, the pool of technology, and the reputation of the cluster location, as well as other advantages.

The competition among the firms around the ports is not solely based on how efficient or effective they are, but also the competitiveness of the firms which are located within the port and local market to help drive regional economic growth (Bichou and Gray, 2004; Chhetri et al., 2014). The local market is paramount to closely engaging with inland distribution service networks including various levels of government and port-dependent logistics providers. Cluster-based local competition enables the adoption of best practices that fosters innovation. This innovation leads to competitive advantage of location hence competition should be encouraged within agglomerated firms (Piore and Sabel, 1984; Porter, 1993).

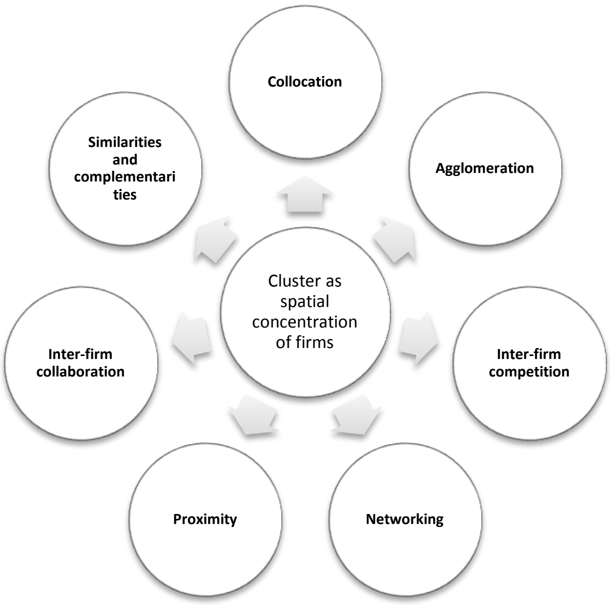


Figure 2.3: Cluster concept

In conclusion, previous studies on port and logistics clusters primarily have focussed on their benefits, and how firms cooperate within the cluster to add value in the supply chain (Haezendonck, 2001; Sheffi, 2013; Rivera et al., 2016). In addition to this, previous studies have also identified the impact of clustering in enhanced firms' collaboration- and increased inter-firm competition in the manufacturing and logistics sector (Porter, 2000; Sheffi, 2013; Chhetri et al., 2014; Rivera Virgüez, 2014). In addition to this the cluster concept has also been explored and discussed from various perspectives as shown Figure 2.3 that include agglomeration of firms that improve inter-firm collaboration and competition, collocation of the firms within proximity to have easy access to suppliers and the buyers, and networking of the firms that have similarities and complementarities. Yet, fundamentally cluster is a region or a space where firms work together and gain advantage from each other and compete at the same time.

However, there are no major studies that have empirically examined the effect of port-centric logistics clustering on inter-firm competition through competitive rivalry. The cluster formation that is sought to be used in the port-centric environment is a spatial concentration of logistics firms that have a mutual goal of providing value-added services to the end customer by cost reduction and knowledge sharing of cluster members. This geographic concentration of similar and complementary industries occurs to also enhance competitive rivalry that is influenced by various dimensions of competition as described by Porter in his Five Forces model (Porter, 1993). Porter (1993) identified that 'bargaining power of buyer', 'bargaining power of supplier', 'threats of substitutes' and 'barriers to entry 'are the dimensions that impacts 'competitive rivalry'. Therefore, this study seeks to establish empirical evidence to verify the effect of port-centric logistics cluster on inter-firm competition through assessing the competitive rivalry status, that is driven from Porter's Five Forces model.

2.9 SUMMARY

This chapter has defined and discussed the concept of a PCLC. It discussed major themes of interest: how the importance of ports increased in response to the growth in international trade; how the role of ports has diversified to offer integrated logistics solutions in a global supply chain; and how ports have evolved over time in terms of their key functions to provide customised services to clients with greater agility and leanness in their operations. Finally, this chapter defined competition and its dimensions based on Porter's Five Forces that impacts competitive rivalry and how inter-firm competition is affected by PCLC.

The next chapter will discuss various cluster perspectives and draw the final model based on Porter's Five Forces model.

CHAPTER 3

PORT-CENTRIC LOGISTICS CLUSTER – A THEORETICAL FRAMEWORK

3.1 INTRODUCTION

Chapter 3 establishes the theoretical framework to examine the effect of the port-centric logistics cluster on the inter-firm competition through competitive rivalry. Cluster concept is examined from a range of perspectives that includes economics, regional science, spatial, and competitiveness. To understand the port cluster dynamics, new theoretical and methodological frameworks based on a spatial perspective are required to first delineate the boundary of port-centric logistics cluster and second to model the relationships between various dimensions of inter-firm competition.

The chapter commences with a review of various theoretical perspectives on the cluster concept, followed by the development of the conceptual framework based on Porter's cluster model and the Five Forces model. This chapter then develops the hypotheses based on the conceptual framework that links the dimensions of competition with the process of cluster development. Thus, this chapter aims to answer the following questions:

1. What are the different theoretical perspectives that explain the clustering of economic activities?
2. Can the Five Forces model of Porter be used to theorise the relationship between clustering and inter-firm competition?

3.2 THEORETICAL PERSPECTIVES ON CLUSTER

A theoretical perspective is a way of explaining a concept from a particular viewpoint. In the past, various theoretical perspectives have been developed to explain the spatial clustering of firms to achieve location-specific benefits (Fingleton and Fischer, 2010). Many previous studies (Launhardt, 1882; Weber, 1929; Porter, 1979; Audretsch and Feldman, 1996;

Bergman and Feser, 1999; McCann and Sheppard, 2003) have established a strong link between regional development and the formation of clusters.

Despite the increasing popularity of cluster concept, there remains a lack of a unified theoretical framework to explain the process of cluster formation, and a universally accepted method to delineate cluster boundaries (Chhetri et al., 2014; Singh et al., 2016). As a result, various concepts of clusters were introduced including but not limited to agglomeration economies, industrial districts, knowledge spillover, innovation system, and network. This disagreement among academics and practitioners on the basic concept of cluster requires various theoretical perspectives to be described and discussed.

Table 3.1 presents various perspectives of cluster with an aim to review the theoretical propositions and evolution of literature that seeks to explain the cluster concept and establish its link with regional development driven from different streams of literature such as economics, regional science, geography, and business. Though various perspectives discuss different dimensions from which the cluster concept is explained, yet, the underlying principle is to provide a location-based environment where firms interact, cooperate, and compete to gain benefits of operating in an agglomerated environment. This agglomeration enables the growth of the region through innovation, knowledge creation and sharing, productivity enhancement and access to a larger pool of suppliers and buyers. The following sub-section discusses the concept brief and inherent capabilities of these perspectives.

Table 3.1 – Different perspectives of cluster theory

Perspectives	**Key studies**	**Concept brief**
Spatial economics	Von Thunen (1826)	The importance of transportation means to connect production with the market because of cost differentials between spatial locations.
Location analysis	Wilhelm Launhardt (1882)	Determination of the optimum industrial location of the production based on minimum transportation cost.
Classical agglomeration theory / Industrial districts	Alfred Marshal (1890), Bertil Ohlin (1933), Edgar M.Hoover	Benefits such as labor pool, proximity to supplier and buyer, knowledge creation and resource sharing are realized due to the localized agglomeration of the firms.
General theory of industrial location / Least cost location theory	Alfred Weber (1929)	Determination of an optimal location based on the low cost of labour, transportation, and distribution.
Growth pole	Francois Perroux (1950)	The growth of an area is a derivative of agglomeration of the economic activities. The industrial pattern of agglomerated firms attracts more industries and acts as a growth pole.
Innovative milieu	GREMI (Groupe de Recherche European Sur les Milieux Innovateurs) (1980)	A dynamic perspective of collective learning through socio-relational space where production system and social interactions among the local networking agents are considered the factors affecting innovative capabilities and economic performance of a specific local area.
New industrial spaces	A. Scott and M. Stroper (1989)	NIS is represented by a different group of regions with specialized subsectors which are not based on similar agglomerations, that is experienced in industrial districts, rather region has uniqueness but has common causal dynamics.
Competitiveness	Michael Porter (1990)	The cluster can be defined as a business strategy that enhances productivity and competitiveness by incorporating supplier and buyer relationship for inputs, resources and infrastructure availability, the participation of government and private institutions, agencies and associations, information and research institutions and allied partners
Flexible specialization	Sebastiano Brusco (1982), M. Stroper (1989), Frank Pyke et al (1990), A. Scott	Small-sized firms that are specialised in certain processes work in a cluster to offer a responsive solution to the volatile demand.

	(1988)	
Dynamic externalities	Arrow (1971), Romer (1986), Lucas (1988), Glaeser, et al (1992)	There is a significant effect of externalities related to knowledge creation and spillover bringing cost advantages
New economic geography	Paul Krugman (1991), Masahisa Fujita, and Jacques-Francois Thisse (2002)	Profitability increases at a firm-level in both localization and urbanization economies

3.2.1 Spatial perspective

The importance of geography (i.e. location/space) in economic wellbeing can be found by the seminal work of Thunen (1826) who considers the importance of location is not only because of qualitative factors of the land but also the way manufacturing or production system is connected to the market. Transportation plays a vital role in producing cost differentials between different locations, which needs to be considered as well. Thunen (1826) conceptualised the model of '*concentric rings'* to discuss the way different activities were distributed around the central marketplace. The highly productive activities were clustered around the market and less profitable were dispersed away.

Later Thunen's theoretical framework was used by a German author Launhart (1882) to determine the optimal location of production facility based on transport cost. This further became the precursor of Weber's (1929) work who identified transport cost minimization as the main factor that impacts the decision of selection of location. He proposed the concept of '*Locational triangle'* by which a significant reduction in transportation cost can be achieved. This helps in deciding the location, at the centre of a triangle where firms agglomerate, to access raw materials from two locations and the market (Weber, 1929; Backhaus, 2000).

More recent locational studies such as ‘New Economic Geography’ (Krugman, 1993) and ‘industrial clustering’ (Porter, 1998) attempted to explain the location choices and the behavioural tendency for agglomeration to gain the benefits of externalities from colocation process of the industries (Fujita and Thisse, 1996; Fujita and Krugman, 2004).

3.2.2 Flexible specialization perspective

The flexible specialization perspective is based on clustering of small firms where mass production does not form the basis of competitiveness. The region itself is specialized with flexible production capabilities with localised accumulation of smaller firms that offer a responsive solution to ever-changing demand (Brusco, 1982; Piore and Sabel, 1984; Storper, 1989; Van Dijk, 1995). The rapid growth of globalization and intense competition between firms may have contributed to the establishment of a flexible production system (Scott, 1988). The underpinning phenomenon to the survival of the smaller firms was collaboration and a flexible production system that was strategized on a high standard of performance efficiency (Pyke et al., 1990; Scott, 1988). This concept offered response to the volatile demand by application of ‘just in time’ concept that was also considered to be the basis of Marshal’s industrial district concept to bring the similar and related industries within the region to gain benefits from spillover effect and scale economies (Van Dijk, 1995; Paniccia, 2002).

Previous research on industrial agglomeration focussed on traded interdependencies as a factor of customer-supplier relationship but these flexible specialised zones added another dimension of collaborative work with an informal exchange of information and informal interactions that in turn developed untraded interdependencies (Storper, 1989; Newlands, 2003). This perspective discusses the cluster concept from a fragmented global production system in the modern world. This is due to the specialization of the regions based on natural endowment or location-based advantages such as the existence of clusters near transport hubs. This approach encouraged the clustering of small firms, to compete in the global market, that typically located in Italy, Germany, and other countries. World-renowned ports such as the port of Shanghai, Singapore port and Busan ports are such an example where logistics firms work in cooperation around the ports to offer 'just in time' solutions to the market demand.

3.2.3 Innovative milieu perspective

The innovative milieu or *milieu Innovateur*, developed in 1980, is a dynamic perspective of collective learning within a socio-relational space where the production system and the social interactions among local networking agents are key drivers of innovative capabilities and regional economic performance (Maillat et al., 1993). The '*milieu Innovateur'* sets its foundation on the Division of Labor, and Marshallian externalities that are generated through high input-output interactions and scale economies, fostered by collaborative actions within a confined geographical space (Maillat et al., 1993; Crevoisier, 2004). Camagini (1996) explains that the competitive advantage of innovative milieu is based on agglomeration, accessibility and social interaction within a defined territory that creates an innovative environment. He further evaluated that the strong interaction between economic actors, such as local suppliers and buyers, within a region, produces knowledge which forms the basis of collective learning. The innovative milieu approach proposes that economic development happens through innovation processes that are understood from the economic, political and cultural context and not through production costs; competition among territories; and on marketing mechanism (Crevoisier, 2004).

3.2.4 New industrial spaces perspective

The new industrial spaces (NIS) perspective is grounded on a flexible production system that offers a quick response, to the changing demand, by adjusting the production capabilities to demand variability (Scott and Stroper, 1994). Each firm within the new industrial space specialises and complements other firms. This interdependency, networking, and business interactions foster a competitive environment. NIS is represented by different group of regions with specialised subsectors which are not based on similar agglomerations, that is experienced in industrial districts. The regions rather have uniqueness but has common causal dynamics in which the focus remains on external economies, division of labour, and re-agglomeration of production (Scott and Stroper, 1994).

The NIS perspective is also known as a transactional cost perspective (Coase, 1937; Henry, 1992). The transactional cost is dictated by the inter-industry linkages and linkage length which is space-dependent. In other words, a greater dispersion of supplier and buyer may incur a higher transaction cost which converges the economic activities based on a geographical center of gravity. Hence, higher transactional cost creates spatial pull whereby industries agglomerate to shorten the length of the transaction thus a reduction in transaction cost.

Stroper (1989) acknowledged that ‘new industrial space’ (NIS) in a post-Fordist mass production era, is a spatial agglomeration of high-tech firms and associated suppliers and buyers. The distinguished examples of industrial spaces include Silicon Valley in the US, and Third Italy in Italy (Baker, 1996). According to Pyke and Sengenberger (1990), these spaces should not be viewed only from an economic perspective but should be understood holistically from political, economic, social and cultural perspectives. Granovetter (1985) defined the economic relationship between the firms are embedded with social and interpersonal relations by supporting his argument with an example from Italian districts where firms cooperate and have social ties for the economic success of the region.

3.2.5 New economic geography (NEG) perspective

The new economic geography (NEG) perspective describes the spatial agglomeration of economic activities to gain the benefits of lower transportation costs and labor mobility (Krugman and Venables, 1996). The most common reasons for geographical concentration of economic activities are factor endowment and accessibility to natural resources. However, some regions reflect a higher concentration of economic activities even without access to natural advantages (Schmutzler, 1999). Schmutzler (1999) further explained that the increasing returns, lower transportation cost, and increased supplier-buyer linkages foster concentration of firms within closer geographic proximity. This geographical concentration of firms results in a high share of production that then becomes a second natural advantage which attracts more firms to collocate their operations.

The New Economic Geography is driven by two forces that include centripetal and centrifugal forces. The centripetal force signifies agglomeration (such as bigger market size, larger labour pool, and increased external economies) whereas centrifugal force represents the dispersion of economic activities due to external diseconomies and immobile resources (Krugman and Venables, 1996; Martin, 1999).

Both ‘new economic geography’ and ‘general location theory’ are developed to explain the economic agglomeration of firms in a geographical region (Fujita, 2010). The traditional location theories such as Weber’s industrial location theory (1929) were based on partial equilibrium in which only a few constraints were considered such as location and prices be endogenous. New Economic Geography, on the other hand, consists of full equilibrium models that take into account prices, location, and the geographical distribution of demand

and supply (Krugman, 1998). Moreover, other location theories such as proposed by Christaller (1966) and Lösch (1938) did not clearly predict market outcomes and also failed to explain how spatial structures would be created and maintained by individual organizations. Whereas NEG explains the emergence of spatial structures as a dynamic process and firms choose their location based on the spatial arrangement of other firms in that region.

3.2.6 Agglomeration perspective

The spatial agglomeration of firms is mainly driven from Marshal's (1890) concept of '*Industrial Districts'*. Marshall (1890) was a prominent scholar who published the concept of agglomeration of people and economic activities in an industrial district, in his book named '*Principles of Economics'*. He found that agglomeration causes external economies of scale which helps in the growth of localised economies. Marshall (1890) considered that these external economies, which he referred to as *externalities*, are not due to the scale and the size of an individual firm but are external to the organization. These externalities offer the benefits of knowledge spillover among firms, local labor pool, easy access to suppliers and easy access to the buyers (Marshall, 1890; Simmie and Sennett, 1999; Gordon and McCann, 2000) (see Figure 3.1).

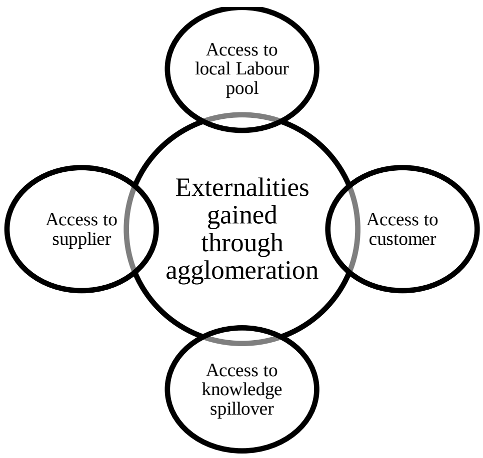


Figure 3.1 Marshal's agglomeration externalities (Marshall, 1890)

Marshall paved the ground for other scholars to explore the concept of cluster, following the similar principles as propounded by Rosenfeld (1995) who defined a cluster as an agglomeration of similar industries in a geographic area bounded by similarities to achieve business synergy. Following the Marshal's era, the work on the agglomeration of firms was explained by the Fordist regime that focussed on large scale industrialisation with the emergence of extended industrial complexes. These concentrated industrial districts acted as 'growth poles' to attract more industries (Perroux, 1950). These growth poles largely attracted larger and heavy industry, surrounded by suppliers, to propel regional growth and economic development. Perroux (1950) identified that the factors of innovation and development of industrial sector in a region are attributed to the group of firms that act as a pole of attraction for other economic activities and resources, in turn, stimulating economic growth. This propulsive approach of industrial accumulation at planned growth pole is expected to make the region more attractive to the industrial activities for their backward and forward linkages (Cella, 1984). Perroux (1950) argued that growth occurs in the form of clusters and is disproportionate, as it happens at a specific location. His theory was based on three factors that were;

1. *external economies* explaining the change in the output of a firm that impacts other industry's operation positively or negatively within the clustered region;
2. *theory of development* that states that the firms will agglomerate in a particular location;
3. *inter-industrial linkages* that postulate the connection of the firms within a cluster with forward and backward linkages through the exchange of ideas and products.

Marshal's principles further form the basis of Hoover's (1937) work on identifying the economics of agglomeration which he defined as 'economies of localization', 'economies of urbanization', and 'internal returns to scale' (Vom Hofe and Chen, 2006). Hoover's (1937) 'economies of localization' are similar to Marshal's economies of agglomeration. However, his concept of 'economies of urbanization' included different types of industries within the vicinity. He identified that the *internal return of scale* is an outcome of accrual of larger and specialized firms of production.

Puga (2010) purports that urban clustering and agglomeration of activities are evidenced through the following processes. Firstly, a space with comparative advantage is expected to attract more productive activities. Secondly, the area with the higher wages and rent is anticipated to have clustered activities and some productive advantages. The third is the variation in productivity across space, which resulted in some areas growing faster than others. There are some proven advantages of working in an agglomerated area where the activities are dense (Puga, 2010). According to him, the advantages of working within a cluster are numerous, as discussed by other scholars earlier. However, these advantages share the same underpinning prediction of causing the productivity increase but to quantify the magnitude of the effect individually is difficult (Duranton and Puga, 2004).

3.2.7 Dynamic externalities perspective

The *dynamic externalities* perspective views the spatial accumulation of economic activities as a dynamic process, which is denoted by the concept of Marshall-Arrow-Romer (MAR) externalities. Romer (1986) suggested that skilled labor, researchers, and universities, generate the ideas and accumulate the knowledge which is dynamic and not static. However, this spatial accumulation of economic activities in the area, that makes it dynamic, evolve over time and helps to generate resources such as knowledge, assets, and labour. The firms that work in geographic proximity generate innovation which is a dominating factor for economic growth and localization of economies. Historical evidence of externalities, as an outcome of cluster formation, is attributed mainly to Marshal who acknowledged the positive effect of spatial agglomeration on economies of scale, skilled labor pool, enhanced networking and trustworthy relationship among suppliers and buyers (Hoover, 1937; Marshall, 2004). However, the work of Romer (1986) and Lucas (1988) emphasized that agglomeration and geographical proximity of the firms facilitate knowledge creation and knowledge transfer, in turn, has a significant effect on economic affluence.

3.2.8 Competitiveness perspective

The competitiveness perspective conceptualises clustering of firms within a closer vicinity is largely driven by inter-firm collaboration and competition. Significant and influential work on these guidelines is tagged to Porter (1993) who seeks to explore the dynamics of industrial clustering in the context of creating a competitive and collaborative environment due to the localization of similar and complementary economic activities (Porter, 1993; Porter, 1998). He claims that the regional and urban economies, which foster the formation of an industry cluster, may help in creating the foundation of continued competitiveness, growth in exports, income generation, the source of jobs and innovation.

Supporting his argument, Feldman and Audretsch (1999) also found that the increased competition among the firms which is conducive to innovation is an outcome of the clustering of firms. Jacob (1984) also acknowledged that the competition between different production entities, that are agglomerated in a region, lead to the higher economic growth of the region. The new affirmative economic agenda, according to Porter (2000) focuses on enhancing the role of clusters, as this type of geographic concentration appears to be the way for improving the local economy and the success of the firms hence lead the way for better economic conditions. Porter (1993) attributes the success of the firm in a particular location to four major components that are:

- factor conditions,
- demand conditions,
- related and supporting industries, and
- firm strategy, structure, and rivalry.

Later he added two more attributes that were the *role of government* and *chance*. Though these attributes play an important role, “space” should also not be neglected for a successful cluster formation. A cluster is a manifestation of these attributes. Porter (1993) identified that these attributes enable a firm to be more competitive. He further acknowledged that the firm’s decision to collocate is not due to location specific comparative advantages such as natural endowment and amenities but the spatial proximity of the firms. The spatial proximity of the firms creates favourable conditions for economic growth through enhanced competition and collaboration which is expedited through a clustered environment. The uniqueness of Porter’s explanation on cluster discourses more about competition than the competitiveness of a location (Vom Hofe and Chen, 2006). Porter’s theory does not reflect where to locate the firms on the basis of location-specific competitive advantages, but it identifies the importance of location based on upward and downward linkages that stimulates the competition which in turn strengthens productivity and economic growth. Hill and Brenan (2000) also identified cluster as a geographical concentration of competitive firms within the same industry, that have closer ties and perform selling and buying activities to other industries, use resources together, and share common technologies to gain a competitive advantage over other firms located at distant locations

Porter’s framework of cluster highlights the nature of demand that pushes companies to develop new and better products and services. Exposure to more demanding customers can enable companies to develop distinct advantages relative to their rivals, increasing the value they are able to generate. Moreover, the role of related and supporting industries are explicitly acknowledged within the cluster. Related and supporting industries contribute to the productive capability of a firm by giving it ready access to specialized inputs and services without having to face the different types of transaction costs associated with sourcing from other locations.

Many previous studies (Porter, 2000; den Hertog et al., 2001; Lang, 2009; Sheffi, 2013; Chhetri et al., 2014; Rivera Virgüez, 2014) have identified the effect of the cluster on firms' performance, economic prosperity and inter-firm collaborative practices. However, it has not been empirically evaluated if the cluster enhances inter-firm competition specifically in port-centric logistics cluster. Hence, the next section develops the framework based on Porter's cluster model that reflects the impact of clustering on competition and Five Forces model of competition that describes the factors affecting the inter-firm competition.

3.3 DEVELOPMENT OF THE THEORETICAL FRAMEWORK

This section develops a theoretical framework to examine the relationship between the clustering process and competition using the Five Forces model (Porter, 1979). Earlier studies were limited to studying the impact of clustering on collaboration, offering more value-added services, gaining innovation capabilities, and increased productivity (Sheffi, 2013; Chhetri et al., 2014; Rivera Virgüez, 2014); yet the effect of clustering of logistics firms around the port on inter-firm competition remained underexplored. This proposed research model builds on (1) Porter's (1998) cluster model that considers cluster to stimulate inter-firm competition (2) Porter's Five Forces model (1979), that discusses the dimensions to measure the inter-firm competition within and outside the port-centric logistics cluster. The proposed research model is presented in Figure 3.2 that explains how these relationships between the key dimensions of competition and port-centred logistics cluster are theorised and empirically tested.

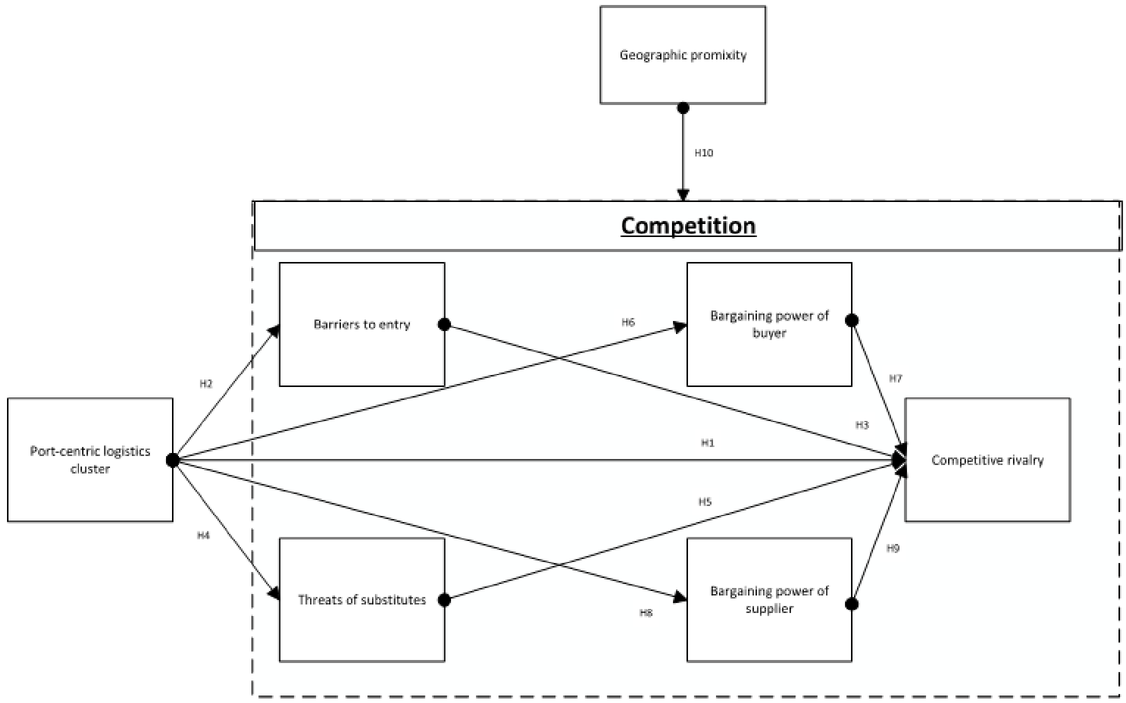


Figure: 3.2 Theoretical Model and Hypotheses

The impact of industrial clustering on the competitiveness of the region which forms the basis of today's competitive environment in regional economies is widely investigated. The proposed theoretical framework is founded on Porter's model which seeks to explore the dynamics of industrial clustering in the context to competition and collaborative environment generated due to localization of similar and complementary economic activities (Porter, 1993; Porter, 1998).

The spatial adjacency and the colocation play an important role in competition because they provide an environment that stimulates rivalry due to the proximity of buyer and supplier, their easy accessibility and abundantly available resources (Porter, 2000; Johansson and Quigley, 2004; van den Heuvel et al., 2013). Porter (2008) acknowledged that in a geographically concentrated area, which he referred to as a cluster, the competition will be relatively intense in comparison to a non-clustered environment. The outcomes of cluster-led competition are productivity enhancement and increased innovation capabilities of firms

(Porter, 2000). To determine the strength of competition in a cluster, Porter (2008) developed a Five Forces model. He identified that the competitive rivalry, barriers to entry, bargaining power of supplier, bargaining power of buyer, and threats of the substitutes largely determines the inter-firm competition.

The key dimensions of Five Forces model, developed by Porter, have been used by several studies in various contexts and for different industries to examine the industry's competitive positioning and to evaluate the strength of competition through competitive rivalry. Slater and Olson (2002) identified that the collective strength of these five forces will determine the strength of the competition between the firms within the cluster. Scholes et al. (2002) identify that the Five Forces model is a tool to determine where power lies in the system and the way micro-environment drives the competition that impacts the overall success of an industry. In addition to this Mohapatra (2012) states that the macroeconomic environment and government decisions also influence these five forces individually and collectively. The idea behind using the Five Forces model is to evaluate the attractiveness of industry by defining the rivalry among the firms within the cluster that dictates the profitability (Slater and Olson, 2002). Porter's Five Forces shape the industry structure and establish the rules for competition and also help to assess the underpinning cause of profitability (Magretta, 2011). Thompson et al. (2006) stated that the industries are different on their surface, but the drivers of profitability are similar. Thus, to understand the competition and profitability, the underlying structure of the Five Forces model needs to be analyzed. Grundy (2006) in his research further developed this model stating that Porter's five forces should be called "competitive pressures" because the competitive rivalry is the central box of the model and five forces are more of a checklist discussing the environment they offer their services in. Narayanan and Fahey (2005) examined that rivalry in the industry is shaped by the economic forces that are explained by Five Forces model. He identified the model based on three sets of elements, which Porter in his study explained using five forces, that includes:

I. Bargaining power of buyer and supplier;
II. The capital requirement that reflects entry and growth in the operation;
III. Rivalry driven from incumbents, substitutes, and entrants.

3.3.1 Competitive rivalry

Competitive rivalry defines the extent of competition among firms. The rivalry can be triggered through the reduction in price, the introduction of a new product, rigorous marketing campaigns, and service enhancement (Porter, 2008). It can also be accentuated with a higher concentration of competing firms that correspond to the intensity of competition. According to Ferrier and Lee (2002), competitive rivalry is the action taken against other companies to defend their position and the market share. Kirzner (2015) noted that the competitive rivalry is rooted back to Schumpeter's *theory of creative destruction* (Schumpeter, 1942) in which he defined the rivalry as head to head race between firms to keep ahead of one another. Competitive rivalry between the firms is a subset of competitive dynamics which is defined as the firm's actions and reaction describing the market process of competition (Connelly, 2008). The companies that work in the same sector naturally develop the tendency to compete with other companies (Markoulakis, 2012) that limits profitability due to consistent competition (Ural, 2014). To enhance competitive rivalry and to stay competitive, firms can use non-destructive competitive weapons such as marketing campaigns (Slater and Olson, 2002).

Numerous factors that affect the competitive rivalry are noted by various authors (see Table 3.3) that include innovation, product differentiation, promotion wars, size and the number of competing firms. Higher the number of similar-sized competing firms, lesser is the power lies with the suppliers to quote their own prices (Porter, 1979). Based on Porter's argument that industrial clustering affects competitive rivalry therefore, it can be argued that port-centric logistics agglomeration stimulates the inter-firm competitive rivalry.

H1: Port-centric logistics cluster has a positive and significant effect on competitive rivalry.

Table 3.2 – Factors affecting competitive rivalry

Factors affecting competitive rivalry	**(Slater and Olson, 2002)**	**(Auh and Menguc, 2005)**	**(Porter, 2008)**	**(Tsaur and Wang, 2011)**	**(Markoulakis, 2012)**	**(Dälken, 2014)**	**(Ural, 2014)**
Number of competitors							
Size of competitors		×	×	×	×		×
Industry growth			×		×	×	
Exit barriers			×		×	×	×
Identical product/services/product differentiation	×		×		×	×	
Product perishability			×				
Power of competitors				×			×
Fixed cost					×	×	
Price cutting techniques					×		
Switching cost between competitors						×	
New product development	×		×				
Innovation	×						
Promotion wars		×					
Imitation		×					

3.3.2 Barriers / Threats to entry

Barriers or threats to entry are defined as the threats posed by new entrants to the existing resident firms. New industries within the location bring new capacity, cash flow, capabilities and desire to gain the market share by competing with the existing industry (Sheffi, 2013). The direct effect of new firms on already established entities is exerting pressure to perform better on price, quality and product differentiation (Porter, 1998).

The barriers to entry may be caused due to high initial capital investment, limited access to distributional channels, high technological know-how, proprietary materials, and advanced Information technology, or it can be imposed by the government to regulate the industry (Porter, 2008). Restrictive government policies such as licensing, restrictions on foreign investments, and regulated industries such as liquor retailing, and taxi can hinder new entrants. The logistics industry in recent decades is increasingly becoming deregulated (Bowen, 2002; Williams, 2017). Thus, the government-imposed policies are not seen as a severe hindrance. Moreover, the capital requirement for resource acquisition in the logistics industry is minimal, especially in short-haul trucking. This results in an increased number of firms to provide logistics services and enhance competition. In addition, unequal access to the distributional channels among already existing companies and potential entrants represents high entry barriers due to the high investment required for the new rival to establish their own distribution channel. However, the logistics firms could have their own online portal as a distributional channel.

Higher barriers will deter the new entrants to immediately gain an advantage over their competitors and also will face retaliation from incumbents. On the flip side, the low entry barrier favors high competition among the firms which also leads to reduced profitability in the industry (Ural, 2014). McIvor (2005) explains that the decision to enter into the industry as a new competitor and taking market share lowers the profit that was already received by the existing companies. Moreover, he identified that the threat is posed from both the sides that are from new entrants and the existing firms. Scholes (2002) mentioned that the existence of higher barriers to entry limits the competitive rivalry among the firms. Different factors that affect the entry barriers noted by various authors are identified in Table 3.4.

The question which needs to be investigated is whether the port-centric logistics industry reflects low threats of entry barriers due to the deregulated logistics industry, low capital requirement for new business and the availability of multiple modes of transportation that results in easy switching from one to another supplier. Porter (1998) argues that the low entry barriers increase competitive rivalry among the companies and that to happen more within the clustered environment, which drives the formulation of two hypotheses H2 and H3.

H2: Port-centric logistics cluster has a negative and significant effect on barriers to entry.

H3: Barriers to entry have a negative and significant effect on competitive rivalry.

Table 3.3 – Factors affecting threats to entry

Factors affecting threats to entry	**(McIvor, 2005)**	**(Porter, 2008)**	**(Markoulakis, 2012)**	**(E. Dobbs, 2014)**	**(Ural, 2014)**	**(Dälken, 2014)**
Supply-side economies	×	×	×	×	×	×
Demand-side benefits		×		×		
Customer switching cost/ customer loyalty	×	×	×	×		
Capital requirement	×	×	×	×	×	×
Incumbency advantages		×		×		
Unequal access to distribution channels	×	×		×	×	×
Restrictive government policy	×	×		×	×	×
Cost disadvantage	×				×	×
Product differentiation	×		×		×	×

3.3.3 Threats of substitutes

The threat of substitutes is the ability of a buyer to choose an alternative to the service at a competitive price. It also means how easy is for the customer to switch the product or services to another provider. If the substitute services are of cheaper value, the tendency of the customer to forgo the existing services is higher (Porter, 2008). However, the substitute product or service must offer the same functionality and value that is provided by an existing product or a service.

The presence of substitute products fosters competition but highly dependent upon the opportunity and convenience of accessing the substitute product (Markoulakis, 2012). Hitt (1995) acknowledged that the substitute products might put the ceiling on the price that the industry can charge due to similar functional attributes of the substitute. Hubbard et al. (2011) identified two main factors that influence the threat of substitutes that include buyer's switching cost, and the buyer's willingness to search for different options. Many options are available in the port-centric logistics industry, such as different modes of transportation, and freight forwarding services that influence the buyers to show their interest in trying other options. Key factors that affect the threats of substitutes noted by various authors are listed in Table 3.5.

If any industrial sector is unable to keep customers away from the substitute product through consistently improved product or service at competitive prices, then industry profitability descends. However, Porter (1993, 1998) identifies that the firms working in a cluster create an environment that offers more substitute services due to the accessibility of larger resource base and higher innovation capabilities that in turn enhances rivalry among incumbents which become the basis for formulating the following two hypotheses H4 and H5.

H4: Port-centric logistics cluster has a positive and significant effect on threats of substitutes.

H5: Threats of substitutes has a positive and significant effect on competitive rivalry.

Table 3.4 – Factors affecting threats of substitutes

Factors affecting threats of substitutes	**(Slater and Olson, 2002)**	**(Porter, 2008)**	**(Markoulakis, 2012)**	**(Ural, 2014)**	**(Dälken, 2014)**
Competitive price	×	×	×	×	×
Switching cost			×	×	×
Buyer's addiction to buying substitute					×
Digitalization					×
Price ceiling		×			
Product differentiation		×	×	×	
Product improvement Capabilities		×	×	×	
Innovation	×				

3.3.4 Bargaining power of buyers

The bargaining power of buyers refers to the power of the customer to drive the decision on prices and service quality set by the supplier. Porter (2008) found that the high bargaining power of buyers will intensify competition. Ural (2014) identified that the buyers use their power to push the prices down to seek a better-quality product or service that leads to enhanced rivalry among suppliers. According to Markaulakis (2012), the expectation of buyers determines the profitability of the industry as this expectation may be used as a derivative to bring the cost down. Different factors that affect the bargaining power of buyers noted by various authors are mentioned in Table 3.6.

According to Porter (1993, 1998), the cluster provides an environment that shifts the power to decide the price and quality to the buyer. He identifies that cluster offers more choices for buyers to choose the services from, which, in turn, stimulates the competitive rivalry among the suppliers to hold their market position. A cluster is also characterized by similar and complementary industries where services offered are easily available and accessible which thus increases the inter-firm competition to retain the customers (Porter, 2008). Moreover, today's buyer is more conscious, well-informed regarding the services available which enable the customer to potentially search the market for substitute services before deciding any company as their service provider. This drives the setting up of two hypotheses H6 and H7.

H6: Port-centric logistics cluster has a positive and significant effect on the bargaining power of the buyers.

H7: Bargaining power of the buyers has a positive and significant effect on the competitive rivalry.

Table 3.5 – Factors affecting the bargaining power of buyers

Factors affecting the bargaining power of the buyer	**(Slater and Olson, 2002)**	**(Porter, 2008)**	**(Markoulakis, 2012)**	**(Ural, 2014)**	**(Dälken, 2014)**
Large volume buyer		×	×	×	×
Undifferentiated products	×	×	×		×
Backward integration		×	×		
Buyer is price sensitive	×	×			×
Buyer's expectation on quality	×			×	
Number of buyers				×	×
Fragmented buyer			×		
Profit potential	×		×		
Product is an essential aspect of buyer purchases			×		
Information technology		×			×

3.3.5 Bargaining power of suppliers

The bargaining power of suppliers denotes the power of suppliers to decide the price and profitability of the product/service and is exactly opposite to the bargaining power of the buyer. If the supplier offers specialized products or services, that need heavy investment in ancillary equipment, makes it harder for the customers to switch to other suppliers, thus reducing the competition (Porter, 2008). However, the logistics industry is not capital intensive such as the manufacturing industry thus heavy investment is not required for the cluster members. Instead, majority of the investment in infrastructure is government driven. Moreover, the supplier lines that are located near to the buyer provide monetary and accessibility gains to the buyers, in turn, does not allow the buyer to switch to another supplier too easily.

According to Hitt et al. (1995), influential suppliers affect the industry by controlling the price and quality which in turn dampens the competition within the industry. Markoulakis (2012) recognized that competition in the industry is determined by the market share of dominant suppliers. Slater and Olson (2002) stated that the power of the supplier is same that leads to the power of the buyer. Powerful suppliers will retain more profit for themselves by increasing the price of the product and shifting the cost to industry partakers. Major factors that affect the bargaining power of suppliers identified by various authors are listed in Table 3.6.

According to Porter (1993, 1998), the firms operating in a cluster demonstrate lesser capabilities to decide the higher price of product or service as the buyers exhibit more control. This results in providing an environment where competition is a fundamental criterion to stay in the business and outperform others by offering differentiated services at affordable prices. If the supplier is more concentrated than the firms it is supplying the products to, create a monopoly in providing the product or services will inhibit the competition which is not the case in the port-centric logistics cluster due to the firms offering similar services to a larger market. The port-centric logistics industry, being largely service-oriented sector, has lesser power in maximizing the profit and market share due to less use of capital-intensive resources which forms a fundamental building block in the manufacturing sector. This drives the two hypotheses H8 and H9.

H8: Port-centric logistics cluster has a negative and significant effect on the bargaining power of suppliers.

H9: Bargaining power of suppliers has a negative and significant effect on the competitive rivalry.

Table 3.6 – Factors affecting the bargaining power of suppliers

Factors affecting the bargaining power of suppliers	**(Slater and Olson, 2002)**	**(Porter, 2008)**	**(Markoulakis, 2012)**	**(Ural, 2014)**	**(Dälken, 2014)**
Supplier concentration	×	×	×	×	×
Switching cost		×		×	
Differentiated products	×	×	×	×	×
Substitute products		×	×	×	
Dominant suppliers	×			×	×
Forward integration			×	×	
Revenue generation				×	×
Number of suppliers	×				

3.4 SPATIAL CLUSTERS AND COMPETITION

A spatial cluster is a group of organizations in a geographical area with an aim to achieving enhanced productivity and innovation capabilities through inter-firm collaboration and competition (Karlsson, 2010). Although globalization has caused many of the economic activities to disperse over a larger market space, the importance of location is still fundamental to the competition (Porter, 2000). There are two competing economic forces in the modern era 'globalization', which seems to have increased the geographic extent of economic activities, and 'localization' which brings the inter-related industries within a geographically contained area. The industrial activities are more inclined towards spatially concentrated areas and this trend supports the revival of localized spatial growth (Gordon and McCann, 2000). This spatial concentration enables the firms to use the resources collaboratively but in the more competing environment thus enhancing the growth of the region (Porter, 1998). Moreover, the tendency of the firms to cluster around strategic economic nodes such as ports, airports, and transport networks is higher due to the competitive and comparative advantage of these areas (Chhetri et al., 2014).

The increasing world trade enhanced global network, and rapidly integrated distribution centres have refined the structural and functional roles of ports (Hummels, 2007). The contemporary ports act as value-added affiliations in the global supply chain through providing a range of services such as light manufacturing, cross-docking, postponement, exporting, importing, freight forwarding and stevedoring. As an effect of accentuated globalization, the firms providing these services tend to cluster around ports as the ports act as connecting nodes in international trade and the first entry point to the country.

Previous studies have discussed the benefits of firms' clustering associated with higher inter-firm collaboration (Sheffi, 2013; Rivera Virgüez, 2014), increased productivity (Porter, 1998; Chhetri et al., 2014), and augmented innovation capabilities (Sanchez and Omar, 2012). The access to these benefits within the cluster attracts other firms to collocate their operations within the cluster. The collocation results in more number of firms operating from defined vicinity thus increase the number of competitors hence inter-firm competition. Porter (1998) identified that the main cause of higher competition is driven from creating internal pressure for improvement because of constant comparison and presence of equal circumstances such as accessibility, labour, and resources. Furthermore, cluster shortens the process of spillovers effect, which is as an outcome of the competition, that helps foster local supplier development and gives rise to new competitors. The by-product of this competition is knowledge creation, a pool of technology and reputation of cluster location and other advantages. As cluster stimulates inter-firm competition hence it drives the development of the final hypothesis H10.

> *H10: The firms within the port-centric logistics cluster demonstrate higher inter-firm competition through competitive rivalry than the firms away from the port-centric logistics cluster.*

3.5 SUMMARY

This chapter developed the conceptual framework (see Figure 3.2) for PCLC and its impact on inter-firm competition in which location plays an important role. The conceptual framework developed in this study is founded on Porter's cluster model and Five Forces model which consists of six factors/constructs (PCLC, competitive rivalry, threats of substitutes, barriers to entry, bargaining power of buyer and bargaining power of supplier). The first part of the chapter details various perspectives of explaining cluster leading to the discussion of the more recent theory of Porter which states that the cluster enhances inter-firm competition in a defined locale and the strength of competition can be evaluated from Porter's Five Forces model. The literature review identified a significant relationship between clustering and co-location, and their impact on inter-firm competition. Chapter 4 presents the research methodology to empirically evaluate the theoretical model and test the research hypotheses in the later chapters.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

Chapter 4 describes the research methodology used to formalise the conceptual framework developed in chapter 3. This chapter discusses the study context (Melbourne), describes the data set and develops a methodological framework. A quantitative approach is used in this study to evaluate the impact of clustering on inter-firm competition.

Specifically, this chapter addresses the following questions:

- What are the methodological considerations in modelling the inter-firm competition in PCLC?
- How to develop a methodological framework to quantify inter-firm competition within and outside a PCLC?

4.2 STUDY CONTEXT

Melbourne area is selected as a study context to analyse PCLC and its effect on inter-firm competition. In recent times, ports act as strategic transportation nodes that integrate logistics services in the globalised supply chain and provide value-added services. Port of Melbourne is the nation’s largest general cargo and container port that connects the Australian industry to the international market. The reason for choosing the Melbourne port as a pivot of the PCLC and Melbourne area as a context is discussed in the next section.

4.2.1 Growth in international trade and port throughput

An increase in international trade is witnessed across the world due to globalization, where Australia is not an exception. For instance, gross international trade in goods and services grew from A$799bn in the year 2017-18 to A$891bn in the year 2018-19, which represented an increase of 11.6 per cent whilst five years trend shows an average growth of 5.7 per cent (BITRE, 2018). Due to the growth in international trade, the role of Australian ports is becoming more important as most of the freight is moving through them. The total freight movement through Australian ports in the year 2015-16 was 597 million tonnes of cargo which registered 3.1 per cent increase from the previous financial year whereas the average growth over the period of five years from 2010-11 was witnessed around 8.7 per cent (BITRE, 2018).

Port of Melbourne is considered to be the trade gateway to the state of Victoria with a turnaround of 3100 ships per year (Port of Melbourne, 2017-18). In the year 2017-18, the total container throughput of Port of Melbourne was 2.93 million TEU which was 8.6 per cent higher than last year as depicted in Figure 4.1 (Port of Melbourne, 2017-18). Port of Melbourne handles around 36 per cent of the total containers in Australia. The economic contribution of the Port of Melbourne is around $2.5 billion annually (Port of Melbourne, 2017-18).

Port of Melbourne is an important logistics hub to move the freight in Victoria and South Australia with its access to the national distributional network. The logistics activities in or near the port generate enormous employment opportunities. For example, Port of Melbourne generates around 15,700 full-time equivalent jobs that in turn contributes to an annual house hold income of A$950 million. Port of Melbourne contributes a value of around $1.8 bn to the Victorian economy annually (Port of Melbourne, 2017-18; Port of Melbourne, 2018).

Additionally, the logistics and transport industry is strongly connected with other industries such as manufacturing, agriculture, construction and retail. The product and services are required to be efficiently delivered in the most cost-effective way to stay competitive. Efficient logistics services enable higher competition amongst the firms where the location also plays a significant role such as near transport hubs. Previous studies (Sheffi, 2013; Chhetri et al., 2014; Singh et al., 2016) have found that the logistics cluster near transport hubs provides a competitive and collaborative environment to the firms. This environment enables more firms to collocate their operations within the cluster, in turn, provide more employment opportunities and an impact on the region's growth.

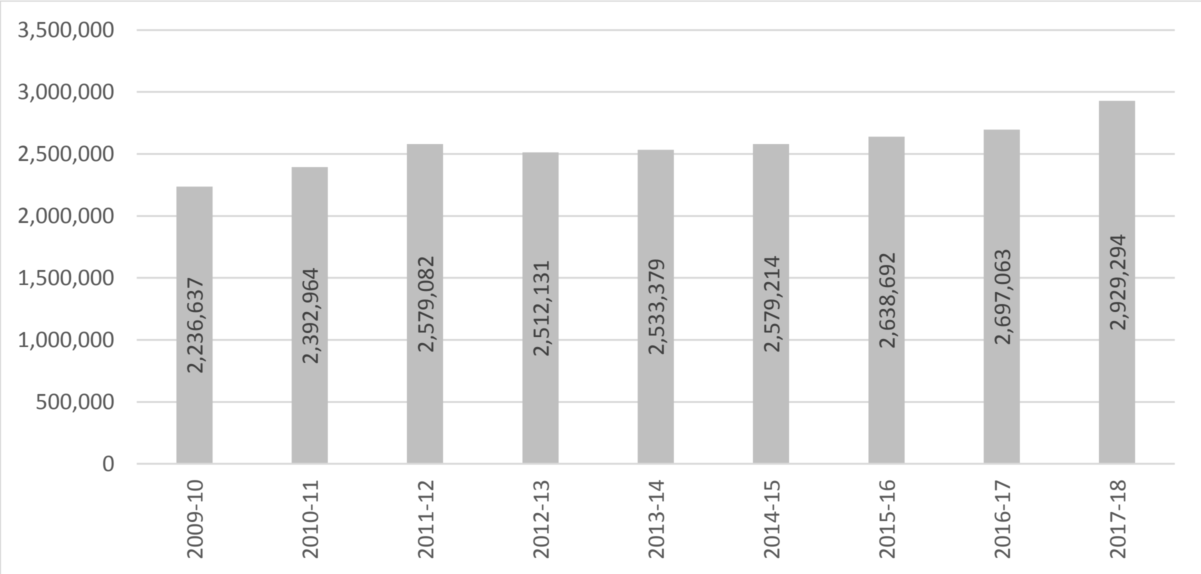


Figure 4.1: Total container throughput of Port of Melbourne – (source: (Port of Melbourne, 2019)

4.2.2 Supply bottlenecks / Logistics inefficiency

Victoria is one of the states in Australia that is situated in the south-east of Australia. It is the twelfth largest economy in the world capturing 3 per cent of the total landmass while contributing to a quarter of the national economy (Department of Economic Development, 2018). Victoria is also known to be the freight and logistics capital of Australia as it provides employment to around 260,000 and the sector itself contributes to $21 billion to the Victorian economy (Department of Economic Development, 2018). Victoria is also one of the largest exporters of agricultural commodities and a hub of manufacturing in Australia (Department of Transport, 2019). To facilitate the global and local distribution of these commodities, the ports act as substantial nodes. Port of Melbourne is one of the largest general cargo and container ports of Australia. The value of the goods that are exported from Victoria is around $26 billion each year (Department of Economic Development, 2018).

The freight volume is expected to increase from 360 million tonnes in 2014 to approximately 900 million tonnes by 2051 with a growth rate of 1.5 per cent per year in regional Victoria and 2.6 per cent per year in metropolitan such as in Melbourne (Department of Economic Development, 2018). Moreover, Victoria being a centre of manufacturing is required to collect the commodities off the factory gates and deliver across the state. This increase in freight movement brings the need for efficient delivery and to make better freight connections in the domestic and global marketplace that can contribute to the success of Victorian businesses and producers, where port centric logistics cluster plays a significant role. Previous studies (Sheffi 2013; Chhetri et al. 2014) have found a significant impact of spatial logistics clusters on increased production, higher innovation capabilities, and increased transportation efficiencies. Without achieving logistics efficiencies it is impossible to seamlessly connect global to the local market and gain production possibilities (Chhetri et al., 2014).

4.2.3 Population distribution and growing demand

The population in Victoria is expected to grow more than 10 million and in Melbourne more than 8 million by 2050, which will increase the demand for goods and services from overseas. The higher demand and changing buying patterns such as online buying increases the need for time-efficient and cost-effective distribution. However, higher population growth in the southeast suburbs of Melbourne poses uneven distribution patterns. This will result in rise of the empty container movement on road, in turn, increase the logistics and transportation cost. Previous studies (Chhetri et al., 2014; Singh et al., 2016) have found a significant role of logistics clusters around the ports to reduce empty container movement through consignment consolidation, shared facilities and working in collaboration.

Finally, the increase in freight volume, rise in demand, role of ports to connect the global manufacturing network to domestic transportation and distribution, and the changing role of ports to offer competitive and collaborative environment to support business growth has led us to consider Melbourne port and Melbourne area to conduct this study. The formation of spatial logistics cluster around Melbourne port may enable logistics efficiency and without achieving logistics efficiency the production and product distribution may not be viable.

4.3 RESEARCH DESIGN

Research design is a plan of how to answer the research questions (Leavy, 2017). It involves in specifying the data required, constraints to consider (such as time, money and location), ethical consideration, data collection techniques and analysis of data to answer research questions. The research design varies based on the method adopted to analyse the data (Bryman and Bell, 2011). A quantitative method is used in this study to analyse the data and examine the relationships. Figure 4.2 illustrates the research design of this study that includes the research paradigm, data used, primary data collection process, survey items testing and the method used to analyse the data.

4.3.1 Research Paradigm

The research paradigm guides the way any phenomenon is examined or research should be performed (Saundars, 2011). Several research paradigms have been discussed in the literature however this study adopts the positivist paradigm to carry out the research. The purpose of selecting the research paradigm forms the basis of selecting appropriate data collection methods and analysis techniques. A research paradigm related to three fundamental aspects that include the ontological aspect, the epistemological aspect and the methodological aspect (Creswell, 2009). These three aspects will define the way the world is viewed by the researcher and then conduct the research accordingly.

Ontology is a belief system that informs the researcher about what he thinks/senses about the social world and what and how he can learn about it (Creswell, 2009). Ontology guides the researcher in identifying if there exists a single reality or not. Guba and Lincoln (1998) described ontology as “what is the form and nature of reality and, therefore what is there that can be known about it". The ontological assumptions explain that the phenomenon under investigation has an objective reality that is independent of the researcher bias and external to the researcher or it has a subjective reality that is based on human assumptions that can be biased and is socially constructed (Collis & Hussey, 2003).

Epistemology is a belief system that explains the way knowledge is obtained and how the research proceeds (Guba and Lincoln, 1994). In epistemology, the researcher can take a stance to understand the relationship between him and the research participants. It determines how the researcher approaches and interacts with the participants to examine the phenomenon that may include close interactions or maintaining distance to exclude biasness. There are different epistemological paradigms such as positivism, interpretivism, transformative and pragmatism (Mertens, 2007). The research that reflects a positivist paradigm prefers working with an observable social reality that can later be generalised (Saundars, 2011). In the positivist approach, the propositions and hypothesis are driven from an existing theory which is tested empirically. Therefore, the positivist paradigm dictates that the reality exist that can be studied and explored (Persson, 2010). The interpretivist paradigm is based on an empathetic stance in which the phenomenon being studied is described from the participant’s view (Leavy, 2017). The third paradigm is the transformative paradigm that believes in the existence of multiple realities that are socially created (Mertens, 2007). The pragmatic paradigm dictates that the ontology and epistemology are determined from the research question. The view of the pragmatic paradigm is ‘study what interest you and has some value to you. The study can be conducted in different ways that deem more appropriate to the researcher and use the results that provide a positive outcome to your value system (Tashakkori and Teddlie, 2011). All these paradigms guide the researcher to view the world differently and conceptualise the problem that forms the basis to use appropriate methodology to answer the research question (Sethi, Smith and Park, 2001)

The positivist view is frequently used because of quantifiable observations and ease of replication as it uses a highly structured methodology (Healy and Perry, 2000). Further in this view, the research problem is divided into propositions and hypotheses that are tested empirically (Creswell, 2009). The current research has adopted a positivist view because the objective of this study is to investigate the relationships between port-centric logistics cluster, inter-firm competition and various dimensions of inter-firm competition that are based on Porter’s cluster model and Five Forces Model. Structural Equation Modelling is used to examine the relationships that are hypothesised in chapter 3. The investigation of the study using SEM can ascertain that the model is consistent with the data but can result in claiming that the model is proven (Kline, 2015). In saying that it depicts that if the model is consistent with the reality then data will be consistent and will support the model however if the data is consistent with the model that does not reflect that the model matches the reality (Bollen, 1989).

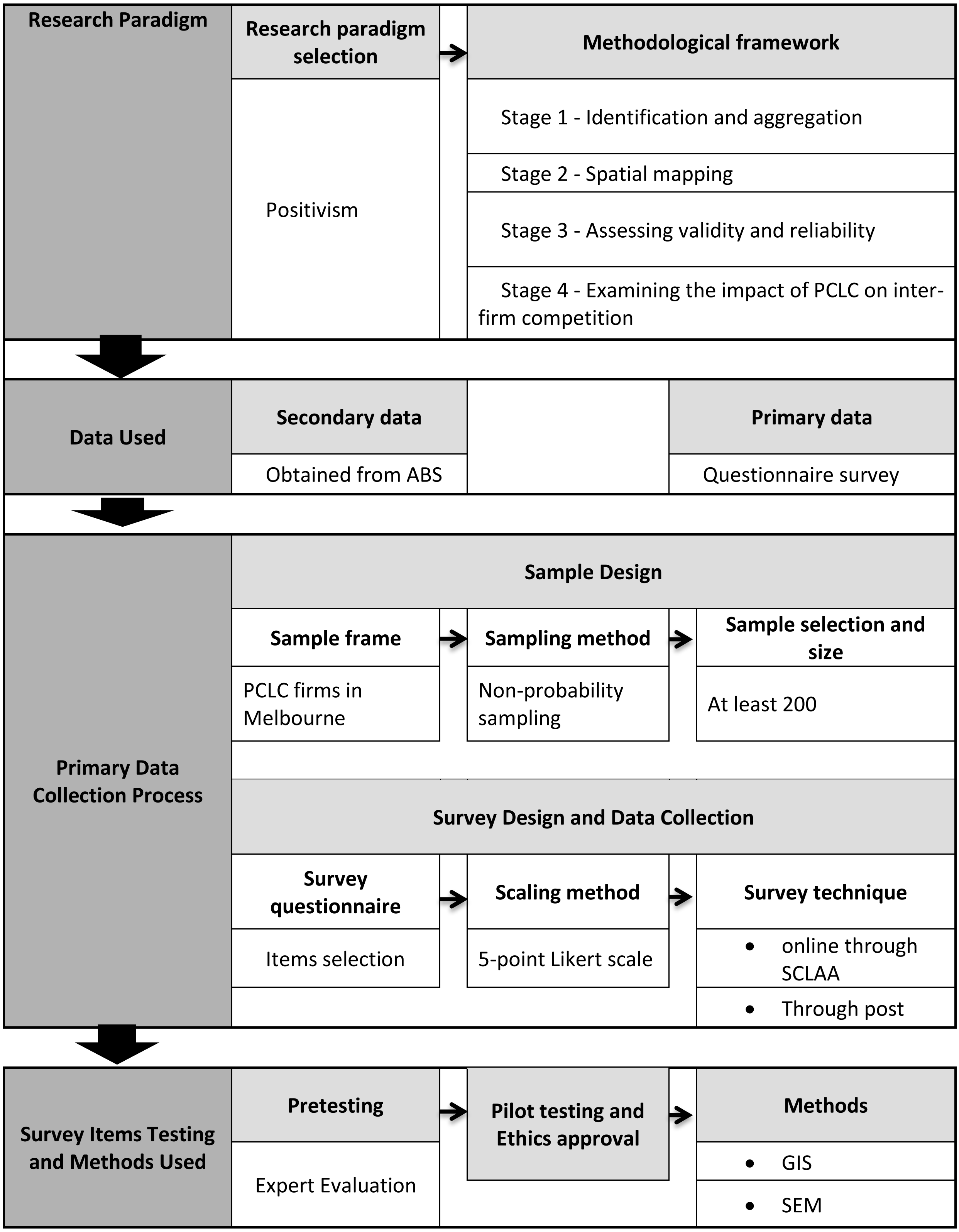


Figure 4.2: Research design

4.4 METHODOLOGICAL FRAMEWORK

As a part of phase 2 (see Figure 1.2) a four-stage methodological framework is developed in this study (see figure 4.3). In the first stage, the industries that represent PCLC are identified and aggregated. The second stage explains the methods to delineates the boundary of PCLC in Melbourne. The third stage discusses the validation process of the conceptual model and examines the reliability of the measurement model. The final stage details the process to examine the effect of PCLC on inter-firm competition within and outside the clustered area. Brief detail on these four stages is discussed in the next section.

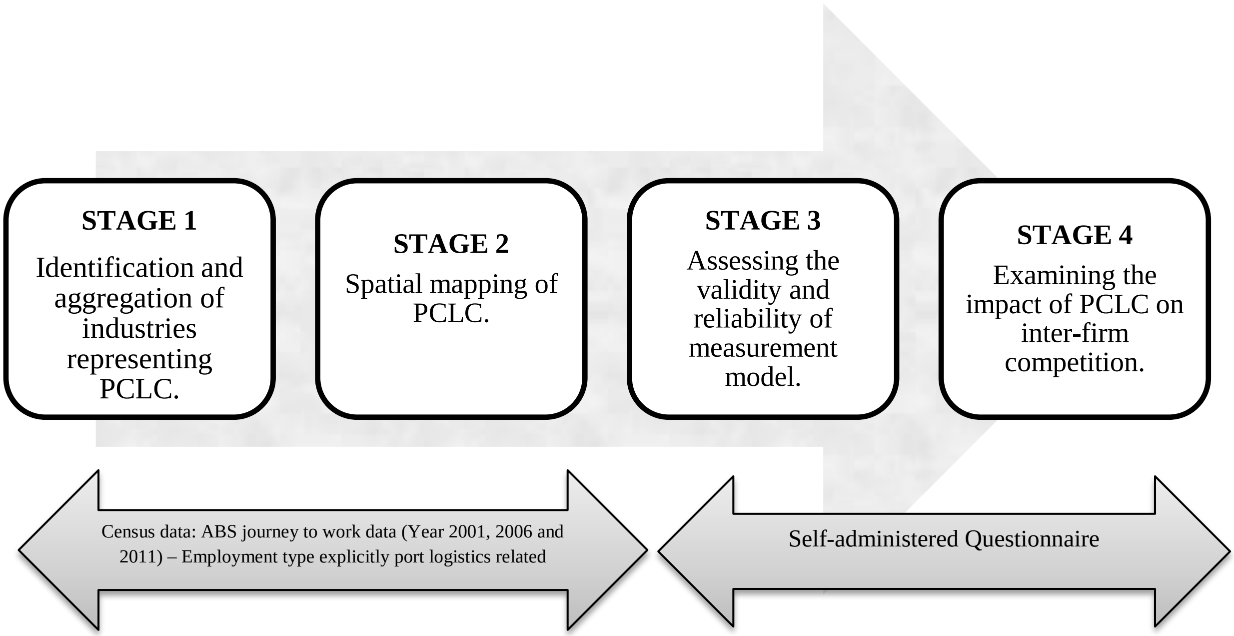


Figure 4.3 – Research stages

4.4.1 Stage 1 - Identification and consolidation of the port-centric logistics firms

The first stage of the study identifies the logistics industries, which are directly or indirectly related to support the port operations and management. The industries which are marginally related to logistics have been excluded from the study. For example, people employed as logisticians or on supply chain roles in manufacturing units or retail sectors, linked to port management were excluded. The component of passenger movement has also been excluded from this study. Therefore, this study focusses on any activity that relates to the movement, and storage of freight only.

4.4.2 Stage 2 - Mapping of the PCLC

The second stage maps the geographic extent of the PCLC using statistical location areas. A statistical location area (SLA) is the area that consists of one or more collection districts as defined by Australian Standard Geographical Classification (ASGC) (ABS, 2006). It is similar to the suburb that represents the whole Australia without gaps or overlaps when aggregated. SLA as a unit of analysis is chosen because of two key reasons. Firstly; it is the second lowest level of spatial object and is similar to the suburb in Victoria followed by Census Collection District. The collection district units are relatively small to be considered for a local labour market area with few employments. Secondly; Local Government Area (LGA) is larger than SLA, which is, at times, can be too large and varied to be considered as a homogenous unit. The aggregated port-centric logistics-related employment will be mapped using Geographical Information System (GIS) at the SLA level to delineate the boundary of PCLC.

4.4.3 Stage 3 - Assessing the reliability and validity of measurement model

The third stage assesses the validity and reliability of the measurement model, which is conceived to test the conceptual model (see Figure 3.3). This stage, therefore, compares Porter's theory against using its key constructs and the hypotheses established using survey data. This stage conducts a range of reliability and validity tests to assess if the items that measure the underlying construct manifest an internal consistency and how well the theoretical latent constructs reflect the items designed to measure it. The reliability of constructs is measured using Cronbach's alpha, and test-retest method whereas validity is tested in different measures such as face validity, content validity and construct validity. A detail of these measures is discussed, including their threshold values, in chapters 6 and 7 during data analysis.

4.4.4 Stage 4 - Examining the impact of PCLC on inter-firm competition

This stage examines the effect of PCLC on various constructs representing inter-firm competition that include bargaining power of buyers and suppliers, threats of substitutes, barriers to entry and competitive rivalry. These effects are estimated for various hypotheses established in the conceptual model which theorises the relationships between cluster and competition (see Table 3.7). Moderating effects of geographical proximity on enhanced inter-firm competition will also be estimated.

4.5 DATA SET USED

Two datasets are used in this study that includes Journey to work (JTW) data obtained from the Australian Bureau of Statistics (ABS) and primary survey data that are collected from logistics firms in Melbourne using online and postal methods. The details of the datasets used are as follows:

4.5.1 Australian Bureau of Statistics (ABS) data

The data set used to identify and aggregate port-centric logistics related employment (stage 1) and delineating the boundary of the port-centric logistics cluster in Melbourne (stage 2) is census JTW (Journey to work) data. The census JTW data capture a decadal change from 2001, 2006 and 2011 by industry at a statistical location area (SLA) level. Industries are classified by ABS using the Australian New Zealand Standard Industrial Classification (ANZSIC93).

This study considers the size of the employment as a proxy measure to estimate the scale of the port-centric logistics cluster. Many authors have used employment as a measure to define, identify and delineate the boundary of subcentres (Giuliano and Small 1991; Chhetri et al., 2014). Previous studies such as (Dunphy 1982; Bender and Hwang 1985; Gordon and Richardson 1996; Chhetri et al., 2014), have used employment data to measure levels of industry clustering as the data are readily available with sufficient details to differentiate industry classes. In addition to this, the census data is more reliable and provide accurate employment figures as it is based on a survey instead of estimates or approximations. This type of data can also be used as a comparison of clusters or pattern of change in cluster development (McDonald and McMillen, 1990). A study conducted in Cleveland used census data of employment to identify clustering of specialized industries using location quotient (Bogart and Ferry, 1999).

This study uses the industry-based employment data to identify PCL firms, in Melbourne. JTW data is best suited to analyse the changing patterns of employment distribution in hierarchically structured census units. JTW data provides information regarding where people reside, where they work and which mode of transport they use to reach their workplace. This employment JTW data contain the number of people employed in each industry by SLAs. Other absolute measures can also be used such as a number of organizations or the turnover of the companies however these measures will pose a problem of the disproportionate size of businesses. Some of the companies may consist more than 500 employees whereas some of the logistics companies, in specific freight transport companies in Melbourne, are owned by the single owner which will make it difficult to generalize the results and can also potentially under-estimate or over-estimate the size of the cluster.

There are 17 broad divisions in ANZSIC, which are denoted by codes such as A- Agriculture, Forestry and Fishery, B- mining and so on. These divisions are further divided into subdivisions, groups, and classes. Each division is characterized by one-digit code, a subdivision by two-digit code, a Group by three-digit code and a Class by a four-digit code. This study has used the Class that is represented by four-digit code to identify individual sub-industry type representing the PCL industry. The detail of this classification used in this study is illustrated in Figure 4.4.

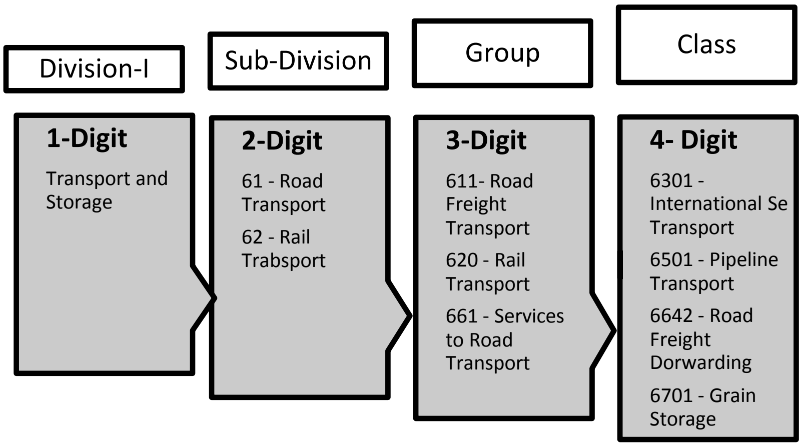


Figure 4.4: Hierarchical structure of industry: Australian - New Zealand Standard Industrial Classification (ANZSIC)

4.5.2 Approach adopted

There are two common approaches used to collect data and report information that includes qualitative and quantitative approaches. However, another approach known as the mixed-method approach is also used where both quantitative and qualitative data is collected and analysed. The qualitative approach focuses on understanding the concept in a profound and inclusive manner as data is collected through interviews, group discussions, and observations. The quantitative approach, on the other hand, analyse a phenomenon over a larger sample that offers an opportunity of examining the characteristics across groups. A quantitative approach is used in this study to test the conceptual model and theorized relationships. This approach is used mainly due to three reasons. These include:

- Firstly, a quantitative approach is an objective way of testing the theorized relationships as the data collected is based on facts and observation and is measurable. As the data is collected from a large sample, therefore, it provides an unbiased and balanced statement to present the facts and findings (Hair et al., 2006). In the quantitative approach, the data is collected in numeric form therefore the association of variables can be explored using statistical techniques.
- Secondly, it is not only able to identify the effect of PCLC on inter-firm competition, but it can also assess the extent of the effect. The data is collected for each latent construct that represents inter-firm competition (such as a competitive rivalry, bargaining power of buyers and suppliers, threats of substitutes and barriers to entry) therefore the direct and indirect effect of PCLC on different constructs can be measured using multivariate data analysis techniques.
- The inferences in quantitative studies are data driven and if the sample is a true representative of population then it may help in generalising the effect within broader context (Tabachnick and Fidell 2007; Meyers et al., 2016). Due to the objectivity of quantitative data the statements can be rechecked and verified.

4.6 DATA COLLECTION PROCESS

Data collection is a process of gathering information from the target population, which is port-centric logistics firms in Melbourne. The logistics firms in Melbourne, that are directly or indirectly associated to assist port operations and management, were approached to collect the data. A questionnaire was distributed to the firms online and through mails. This collected information is then analysed to test the hypothesis to make inferences. The data collection process includes sample design, and survey design and data collection as illustrated in Figure 4.5. The following section discusses these processes in detail.

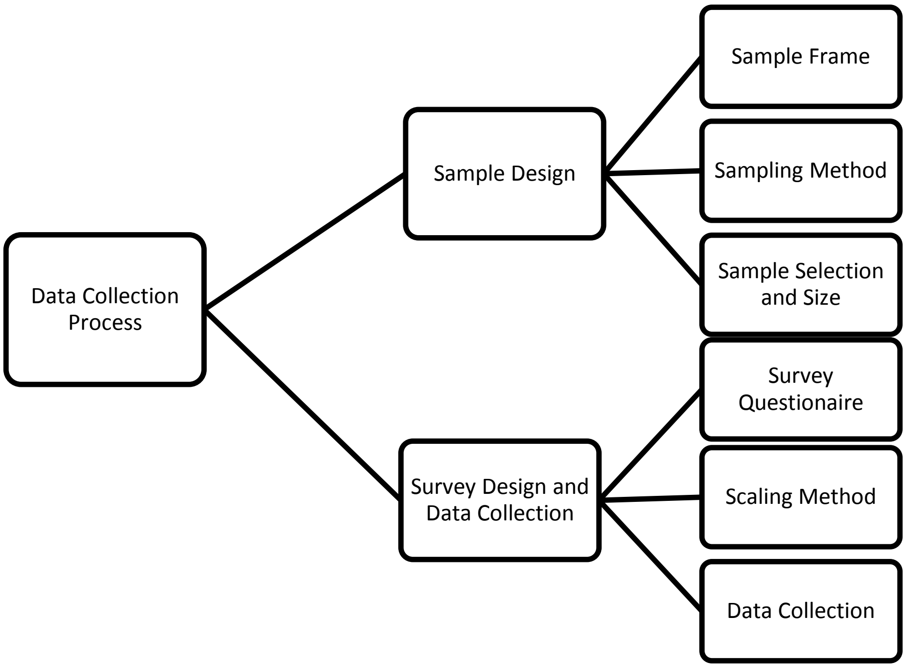


Figure 4.5: Data collection process

4.6.1 Sample design

Sample design is the process of selecting a sample of respondents from the larger population (Bell et al., 2018). The sample is a subset drawn from the population to evaluate the traits where these observations can be generalized for the entire population. Because of the availability, time and the cost, the entire population sometimes is hard to be surveyed. Thus, the representative sample is used to signify the entire population in this study. There are four considerations of what entails the representative sample that comprises of sample frame, sampling method, sample selection criteria and sample size. These are discussed below.

4.6.1.1 Sample frame

The sampling frame is the batch of the sample drawn from the population. The population in this study is logistics firms located in Melbourne which are directly or indirectly involved in port operation and management. Sample from the larger pool of logistics firms near and away from the Melbourne metropolitan area are extracted, using online resources, and yellow pages.

4.6.1.2 Sampling method

The sampling method is a procedure for selecting a sample from the population (Cavana et al., 2001). Selecting an appropriate method of sampling is imperative to avoid bias in the selection process. Moreover, a suitable method is also essential to be chosen to reduce the cost and efforts in collecting the data. Broadly, sampling methods can be divided into two categories, which are probability sampling and non-probability sampling (Bell et al., 2018).

In probability sampling, every element has an equal likelihood of being selected from the population whereas in non-probability sampling the elements are selected non-randomly. The advantage of using probability sampling is that sampling error can be calculated and reported while making the inferences for the entire population to give actual results; whereas, in non-probability sampling, the sampling errors are not known and not included in making the inferences (Cooper et al., 2006). It is therefore hard to generalize the results over the entire population in non-probability sampling. The non-probability sampling method is used where it is difficult to identify a representative sample and the cost of collecting data is relatively high (Blaikie, 2009).

Since there is no access to a comprehensive database of logistics companies in Melbourne and the sample can be any businesses located within a cluster that relates to logistics operation. It is therefore difficult to differentiate different firms operating their business in Melbourne. The non-probability sampling method is therefore used in this study where a maximum number of logistics firms have been targeted using databases such as yellow pages and a membership base of Supply Chain and Logistics Association of Australia (SCLAA).

4.6.1.3 Sample selection and size

The target population of this study represents the logistics companies in Melbourne that are involved in port operation and management. Only one representative, as a respondent, from each firm, was selected. If a single respondent is considered from each organization then the nominated person should be knowledgeable and aware of the key issues in the industry (Huber and Power, 1985). Therefore, middle to higher management representative was targeted to respond to the survey questionnaire.

The size of the sample is driven from the statistical technique used, Structural Equation Modelling (SEM), to analyse the data. Kotrlik et al. (2001) have identified that one should consider population size, a statistical method to be used and the desired accuracy level to ascertain the size of the sample. It is also imperative to determine the minimum returned sample size and initial sample size (Kotrlik and Higgins 2001; Bell et al., 2018). This study follows Hair et al. (2006) recommendation, which states that the sample size should be selected based on a data analysis technique. This study intends to use exploratory factor analysis (EFA) using Statistical Package for Social Sciences (SPSS), and confirmatory factor analysis (CFA) using Analysis of Moment Structure (AMOS) which requires minimum sample size of 200 (MacCallum et al., 1996; Lewis et al. 2005; Hair et al., 2006). Another study conducted by Byrne (2009) suggests that a sample of 400 would be sensitive to estimate the goodness of fit.

After ascertaining the minimum returned sample size as suggested by various authors, the next step is to estimate an appropriate initial sample size considering the risk of non-response in any of the survey-based research. To obtain a minimum sample of 200 usable responses, 1340 logistics companies from Melbourne were randomly contacted in the survey.

4.6.2 Survey design and data collection

A survey questionnaire was developed to collect the data on the key constructs in the conceptual model. This sub-section describes the development of instruments in the survey questionnaire, scaling method, and data collection process.

4.6.2.1 Survey questionnaire

The questionnaire (see appendix 1) is divided into two broader sections. The first section contains the questions to capture information on the respondent's characteristics, PCLC, information about their organizations such as size, category and respondent's role in the organization. The second section consists of survey items that measure various constructs that represent inter-firm competition such as competitive rivalry, bargaining power of buyers and suppliers, threats of substitutes and barriers to entry. These survey instruments were developed using previous literature as listed in Table 4.1, considering the constructs in this study and how appropriately the items reflect the construct (Jaworski and Kohli, 1993; Porter, 2000; Slater and Olson, 2002; Porter, 2008; Tsaur and Wang, 2011, Dälken, 2014; Rivera Virgüez, 2014; Ural, 2014). Five constructs, each having a minimum of 3 questions, are included which is a threshold to predict any construct (Hair et al., 2006).

Table 4.1: Items for PCLC and constructs of competition

Variable	Item	Source	Factor Loading	Comment	Adjusted Item
Competitive rivalry	Firms compete intensely	(O'Cass and Weerawardena , 2010)	0.76	Adjusted	There are numerous competitors in your industry.
	In our industry, price competition is highly intense	(Pecotich et al., 1999)	0.86	Adjusted	Providing competitive prices
	Level of product differentiation	(E. Dobbs, 2014)	Not reported	Own	Your company competes on the basis of customized services offered in comparison to your competitors.
	Anything that one competitor can offer, others can match readily	(Jaworski and Kohli, 1993)	Not reported	Own	Your company provides customised service to the customer.
	In our industry, competitive moves from one firm have noticeable effects on other competing firms and thus incite retaliation and counter moves	(Pecotich et al., 1999)	0.65	Adjusted	To have lower time to market than your competitors.
Barriers to entry	New firms entering our industry must spend a large amount of capital on risky and unrecoverable up-front advertising and /or for R&D	(Pecotich et al., 1999)	0.55	Adjusted	Initial capital required in your company.
	Established firm have substantial resource used to prevent the new entrants	(O'cass and Ngo, 2007)	0.75	Own	There is a need to use advanced technology in your industry, by new entrants
	Level of government regulations	(E. Dobbs, 2014)	Not reported	Adjusted	Government policy is not a barrier for new entrants to enter and compete in the business.
	New entrant firms in our industry will find it difficult to persuade distribution channels to accept their products	(Pecotich et al., 1999)	0.47		Accessing distribution channels are easy for your company.
Threats of substitutes	Our industry makes products for which there are a large number of substitutes	(Pecotich et al., 1999)	0.35	Adjusted	Your competitors offer many substitute services.
	Substitute products limit the profitability of this industry	(Pecotich et al., 1999)	0.51	Adjusted	Your business is affected by the substitute services offered by your competitors.

	Strong competition from substitutes	(O'Cass and Weerawardena , 2010)	0.76	Adjusted	How would you rate the extent to which the substitute services are of equal or superior quality?
Bargaining power of buyers	Buyers are more powerful	(O'Cass and Weerawardena , 2010)	0.84	Adjusted	Buyers have more power to control the cost than the seller.
	The buyers of our industry's products are in a position to demand concessions.	(Pecotich et al., 1999)	0.73	Own	Buyers have more options to get the services from your competitors at a lower price than yours.
	Buyer price sensitivity is high	(E. Dobbs, 2014)	Not reported	Adjusted	Buyers are price sensitive.
	Firms in our industry are not well informed about their suppliers' demand/sales figures, profitability and cost structure.	(Pecotich et al., 1999)	0.34	Own	Buyers are well-informed regarding the services.
	Many viable options of supplier substitutes	(E. Dobbs, 2014)	Not reported	Own	Substitute services are easily available.
	Buyer backward integration is not feasible.	(E. Dobbs, 2014)	Not reported	Adjusted	Threat of backward integration is high.
Bargaining power of suppliers	Level of buyer switching cost	(E. Dobbs, 2014)	Not reported	Own	Buyers can conveniently switch the supplier
	The suppliers can raise prices easily or threaten to reduce the quality of products	(O'cass and Ngo, 2007)	0.64	Adjusted	Your competitors influence the price of your services
	All firms in the industry are aware of the strong competition from substitutes	(O'cass and Ngo, 2007)	0.77	Adjusted	Your company struggles to sell the services because of the availability of substitute services.
PCLC				Own	Your business is driven directly or indirectly from the port?
				Own	Your customers are near to your proximity/business?
				Own	Your suppliers are near to your proximity/business?
				Own	Your company deals directly or indirectly with the companies near to you.
				Own	The reason of chosen location of your business is due to easy accessibility to the suppliers?
				Own	The reason of chosen location of your business is due to easy accessibility to the customers?

4.6.2.2 Scaling method

This study has used a 5-point Likert scale to capture the responses pertaining to the impact of PCLC on inter-firm competition from the logistics firms in Melbourne that are associated to perform the port-related functions. The scale ranges from 1 = Strongly disagree, through to 5 = Strongly agree. In addition to this, multiple choice type questions were asked in the questionnaire survey regarding the questions related to the respondent's characteristics, information about their organizations such as size, category, and their role.

4.6.2.3 Data collection

The questionnaire-based surveys can be conducted in many ways such as online, face to face, postal deliveries and hand-delivered. The respondents for this research are sourced from a wide variety of the companies providing logistics services locally, nationally and internationally. The organizations were divided into nine categories for respondents to select. These include road freight transport services, postal services, storage and warehousing, water transport services, courier services, rail transport, freight forwarding, custom agencies, port operators and othersThis research has used two approaches to contact the target population which includes online and via mail. A web page for an online survey was created on Qualtrics.

The survey was distributed to the target population by sending an email with the survey link to the respondents. The address of the organizations was retrieved from yellow pages and from the member database of the Supply Chain and Logistics Association of Australia (SCLAA) Around 1340 companies were contacted initially by sending an introductory email and asking for a key person's email and phone number. Upon receiving the information, the link to the questionnaire survey was sent to the relevant addresses. The web-based survey is a convenient and more efficient way to distribute to a larger audience. A postal survey involves sending the survey together with a self-addressed postage paid return envelope to the target population. This method has also been used to contact the organizations whose email IDs could not be supplied by the firms.

Only one questionnaire was distributed to each organization. The online survey link was sent to 980 firms; whilst the hardcopy survey, via mail, was sent to 360. Two reminder emails were sent to the respondents by SCLAA. After a period of around 6 months, 345 responses were received electronically, and 61 number of responses were received through the mail. This resulted in 406 responses received in total which was 30.2 per cent of the return rate, of which 27 responses were incomplete. The missing data in these responses have not shown any specific pattern but are not filled in by the respondents.

4.7 PRE-TESTING

Pretesting is an essential step to increase the validity and reliability of survey evidence as it is impossible to design a perfect survey (Reynolds et al., 1993). Pre-testing determines the strengths and weaknesses of the survey and also suggests that if the questions are comprehensible and measuring what they intend to measure. This, in turn, allows the researcher to make necessary changes.

The methods of pretesting involve reporting the origin of each item, expert evaluation and pilot study (Converse and Presser, 1986). To test the validity of the measures, an expert evaluation, and the pilot study was conducted in Melbourne. A comprehensive evaluation was conducted by the area expert and a practitioner in the industry. The purpose of this evaluation was to understand the contextual appropriateness and clarity of the content. The experts were asked to provide feedback on the difficulties they confronted in answering or understanding the questions. Table 4.2 presents the list of deleted or modified questions at the end of pre-testing based on the experts' feedback.

Table 4.2: Deleted items from the constructs (Expert evaluation)

Construct	Survey items	Adjusted items	Action taken
Competitive rivalry	Your company provides customized service to the customer	Your company competes on the basis of the quality of the services provided in comparison to your competitors.	Redundant Item deleted
	Providing competitive prices	Your company competes on the basis of prices with your competitors.	Redundant Item deleted
	To have lower time to market than your competitors	Your company takes an initiative to offer new service to the market quickly in comparison to your competitors.	Item deleted
Barriers to entry	Initial capital required in your company	Your company requires high initial capital investment	Modified
	Accessing distribution channels are easy for your company		Item deleted as respondents may not understand the meaning of accessing distribution channels
	How would you rate the extent to which the substitute services are of equal or superior quality?	Your competitor offers equal or superior substitute services than offered by your company.	Modified
Bargaining power of buyers	Threat of backward integration is high		Item deleted as respondents may not understand the meaning of backward integration

4.8 PILOT TESTING

Pilot testing is a dry run to assess the usability of measures. The survey questionnaire was administered to a sample of respondents to assess the reliability and determine if the measures are correlated to each other representing the construct (Cavana et al., 2001).

The questionnaire obtained after the expert evaluation was pilot tested with a sample of 25 respondents from the sample population, which was logistics firms within and outside the port-centric periphery in Melbourne. A web link of the survey was provided to them and was advised to complete the survey. On average, the survey took around 20 minutes to complete and the valuable feedback was also provided by the respondents in terms of clarity and understanding of the questions.

To assess the reliability of construct measures, Cronbach's Alpha (coefficient of internal consistency) was used (Churchill Jr, 1979; Field, 2013). The internal reliability was found to be above 0.7 for all the measured items in this study, which is within the threshold (Hair et al., 2006). Finally, 30 measured items were retained for the final survey including 5 questions pertaining to the characteristics of respondents and the firms. 25 items aimed to collect the data on PCLC and inter-firm competition among the logistics organisations were retained. These items represent six questions for PCLC, five questions for competitive rivalry, three questions for threats of substitutes, bargaining power of supplier and barriers to entry, and five questions for the bargaining power of the buyers. Table 4.3 lists the final measurement items for each construct.

Table 4.3: Measurement items for the constructs

Construct	Survey items
Port-centric logistics cluster	Your business is driven directly or indirectly from the port?
	Your customers are near to your proximity/business?
	Your suppliers are near to your proximity/business?
	Your company deals directly or indirectly with the companies near to you.
	The reason for the chosen location of your business is due to easy accessibility to the suppliers?
	The reason for the chosen location of your business is due to easy accessibility to the customers?
Competitive rivalry	There are numerous competitors in your industry?
	Your company competes on the basis of prices with your competitors?
	Your company competes on the basis of customized services offered in comparison to your competitors?
	Your company competes on the basis of the quality of the services provided in comparison to your competitors?
	Your company takes an initiative to offer new service to the market quickly in comparison to your competitors?
Barriers of entry	Your company requires high initial capital investment?
	There is a need to use advanced technology in your industry, by new entrants?
	Government policy is not a barrier for new entrants to enter and compete in the business?
Threats of substitutes	Your competitors offer many substitute services?
	Your business is affected by the substitute services offered by your competitors?
	Your competitor offers equal or superior substitute services than offered by your company?
Bargaining power of buyer	Buyers have more power to control the cost than the seller?
	Buyers have more options to get the services from your competitors at a lower price than yours?
	Buyers are price sensitive?
	Buyers are well-informed regarding the services?
	Substitute services are easily available?
Bargaining power of	Buyers can conveniently switch the supplier?
	Your competitors influence the price of your services?

supplier	Your company struggles to sell the services because of the availability of substitute services?

4.9 ETHICS APPROVAL

The research was undertaken in accordance with RMIT's ethics guidelines. The ethics approval (project number – CHEAN B 20654-02/17) was granted to conduct the study in Melbourne for the period March 28th, 2017 to October 31st, 2017 (Appendix 2 - ethics approval letter) and later extended until February 1st, 2018 (Appendix 3 - ethics approval letter for extension). The participants were provided with information about the data collection process. They were also provided with the information that their identity will not be disclosed at any stage of data collection, processing and interpretation. The personal information regarding names and any other forms were not collected. Data are reported as an aggregate and no individual information was revealed.

4.10 METHODS

This study uses two methods that include a Geographical information system (GIS) to delineate the boundary of PCLC using census data and Structural Equation Modelling (SEM) to analyse primary data collected through surveys. These two methods are discussed as follows:

4.10.1 Geographical information system (GIS)

Geographical information system (GIS) is used in this study to delineate the boundary of PCLC. The spatial extent of logistics-related employment clustering in and around the Port of Melbourne is examined using JTW data. Previous studies (Chhetri et al., 2014; Singh et al., 2016) have measured the spatial employment concentration as the accumulation of logistics employment within a spatial unit. It is measured as the total number of logistics related employment per square kilometre or as the percentage of logistics related employment in an area compared to the total employment in that area.

In this study, a port-centric logistics cluster is defined as the area of higher concentration of logistics employment surrounded by the neighbouring areas which are high in logistics employment. A new method is developed which identifies a spatial logistics cluster having adjacent neighbours with high logistics employment. The process of delineation of boundary of the port-centric logistics cluster is driven by three key principles that determine whether spatial units are amalgamated or not. These principles include:

- **Principle of concentration –** Concentration is a measure of disproportionate distribution of a phenomenon. In this study, it is simply measured as a proportion of the port logistics related employment to total employment. If it is equal to or greater than Australia's average logistics employment, which is 5.1 per cent in 2019 (Parliament of Australia, 2019) then only the area is merged in a cluster. Therefore, a cluster is considered to be the spatial agglomeration of logistics employment in this study. In this thesis, the PCLC is delineated based on two concepts: a spatial logistics employment concentration and a spatial logistics employment clustering. Figure 4.6 illustrates these two concepts graphically. The spatial concentration is an accumulation of logistics related employment within a spatial unit (local area). This can be measured as an absolute (i.e. total number of port logistics employment), relative value (i.e. a percentage of port logistics employment to total employment) or through location quotient. While the spatial logistics employment clustering is defined as the area having a higher concentration of logistics employment surrounded by a higher level of logistics employment areas, together form a logistics cluster.

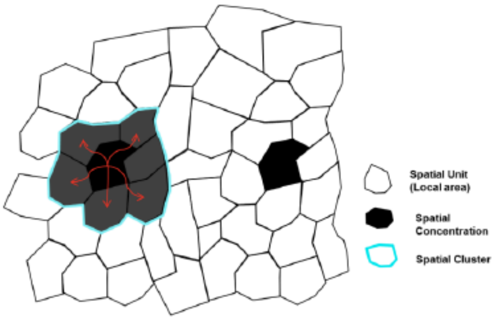
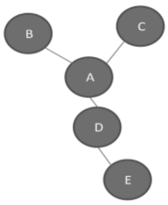


Figure 4.6: Spatial concentration and spatial cluster

- **Principle of spatial adjacency** – Adjacent spatial units are more likely to be related than those which are further apart. Adjacency is calculated by creating a binary connectivity matrix that assigns whether the areas are neighbours or not. Areas with common borders are allocated 1 and 0 not within the border. Non-adjacent areas are not incorporated in cluster formation. Areas within the vicinity of Port of Melbourne which are spatially adjacent therefore are merged to create the cluster. Figure 4.7 shows that the two spatial units such as A and B have common borders and non-zero length so that are neighbours whereas B and C have zero length therefore there are not connected.



	A	B	C	D	E
A	0	1	1	1	0
B	1	0	0	0	0
C	1	0	0	0	0
D	1	0	0	0	1
E	0	0	0	1	0

Figure 4.7: Binary connectivity matrix

Figure 4.7 demonstrates that the local areas that have employment above nation’s logistics employment average (principle of concentration) and are adjacent to the areas that have high port logistics-related employment will form PCLC. The local area in Figure 4.8 which is displayed red with 6 per cent of logistics-related employment does not become a part of PCLC despite having PCL employment of more than Australia’s average logistics employment. This is because of the non-adjacency of the local area.

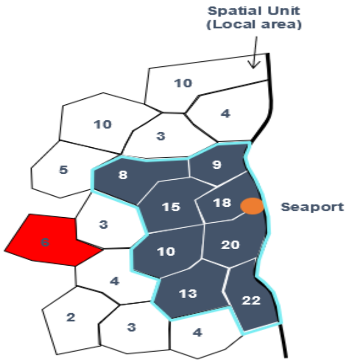


Figure 4.8: Principle of spatial adjacency

- **Principle of distance decay:** The impact of distance on a phenomenon diminishes with distance. A buffer with a radius of 50 kilometres from the port is created and then intersected with SLAs to create the cluster. The cluster can extend up to fifty miles from the core such as a CBD or Port (May et al., 2001). Similarly, Puga (2010) identified that localization mostly takes place within close distances that are often less than 50 km. This study considers 50 km distance from the core, Port of Melbourne in this study. Figure 4.9 illustrates that the level of interaction diminishes as the distance between the local areas increases.

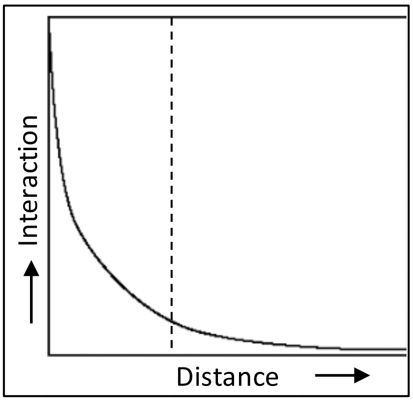


Figure 4.9: Principle of distance decay

These three-principles work on conjunction where the local areas or SLAs that are adjacent to each other and have a concentration of PCL employment of more than 5.1 per cent

(Australia's average logistics employment) are considered to form PCLC. Furthermore, the boundary of PCLC can extend up to 50 km from the Port of Melbourne.

4.10.2 Structural Equation Modelling (SEM)

This study applies the Structural Equation Modelling (SEM) technique for data analysis. SEM is a multivariate technique that examines a series of interrelated dependence relationships among constructs (Hair et al., 2006). This technique is widely used to test the construct validity and quantify hypothesized relationships (Hair et al., 2006; Kline, 2015). These relationships are represented by a series of multiple regression equations, which in turn explains the relationships among the constructs, that may be dependent or independent variables.

SEM integrates two multivariate techniques that are factor analysis and multiple regression (Hair et al., 2006). One of the advantages of using SEM is the use of a visual portrayal of the model to conceptualize the theory and describe the associations of the constructs (Bentler, 1995). The hypothesized model thus can be tested to determine the extent to which it fits well with the data. While comparing the model to the empirical data, if the goodness of fit (GOF) is achieved that means specified hypothesized model supports the relationship among the latent constructs and in case of the badness of fit the hypothesized model rejects the existence of the relationship (Byrne, 2016).

There are many features in SEM that sets it apart from other multivariate techniques. Firstly, it allows the examination of interrelated questions in a single and systematic way by modelling the dependent and independent relations simultaneously (Gefen et al., 2000; Steinmetz et al., 2009). SEM thus can handle multiple independent and dependent variables in the conceptual model. For example, it is hypothesized that the clustering of firms affects the "threats of the substitutes" and "threats of the substitutes" affects the competitive rivalry.

Therefore, “threats of substitutes” act as both dependent and independent variable in subsequent dependence relationships.

Secondly, using Analysis of Moment Structures (AMOS) which is a graphic interface the researcher can draw the path diagram including the causal relationships instead of regression equations. It is easier and quicker to specify and modify the model.

Thirdly, latent constructs can’t be measured directly as these are hypothetical. To measure the latent constructs, items are identified and selected that explain the latent construct more closely and appropriately. For example: competitive rivalry is a latent construct in this study and there are measurement items to measure it. Modelling of the constructs can’t be done using Ordinary Least Square (OLS) method and can easily be conducted using SEM.

Fourthly, the measurement errors are accounted for each latent construct as each latent construct captures the shared variance with its measured items. That in result partials out the measurement error (Hox and Bechger, 2013). For example: SEM estimates the true structural coefficient rather than an estimated one. Therefore, unless the reliability is 100 per cent the estimated and true relationship will differ (Hair et al., 2006). SEM corrects for measurement error and estimates what will be the relationship if there were no measurement error.

Finally, SEM is capable of modelling the direct, indirect and total effects of the latent variables and their relationships. This enables it to estimate the mediating and moderation effects, if exists.

4.11 SUMMARY

This chapter has developed the methodological framework to delineate the boundary of PCLC and model inter-firm competition within and outside PCLC using SEM. A GIS based method is developed with three conditional criteria to map PCLC in Melbourne using ABS

Census data; whilst SEM is proposed to model the relationships between firms' clustering behaviour and competition between them within and outside the cluster. As this study has considered both secondary data (employment data from ABS) and the primary data therefore methodological considerations for both the data sets have been accounted in provide detailed examination at a finer spatial granularity and at the firm level.

An overview of methodological concerns including sample design, instrument design, data collection process, and instrument validation process have been discussed and the techniques to address them were highlighted. The next chapter will discuss the data collection process, pre-processing and cleaning of primary data.

CHAPTER 5

DATA PRE-PROCESSING AND CLEANING

5.1. INTRODUCTION

This chapter explains the data processing and testing to meet the requirements of the statistical techniques used in this study. These include routine tests such as data normality assessment, identification of outliers, missing data, unengaged responses, a test of measurement instrument's reliability, non-respondent bias and common method bias. In addition, it also presents the results of descriptive statistics including the demographic profile of the respondents such as the firm's size, respondent characteristics.

5.2 DATA COLLECTION AND SCREENING

The data were collected from the firms which are directly dependent on the Port of Melbourne via an online and paper-based questionnaire survey (See Appendix 2). The survey questionnaire was sent to 1340 logistics firms in Melbourne which were sourced from the membership base of Supply Chain and Logistics Association of Australia and yellow pages A Qualtrics link was sent to all members in September 2017. A hard copy survey was also sent to the firms, which didn't nominate representative, via post with a return envelope. To increase the response rate, a reminder was sent (via email, phone call and in-person) in February 2018. After a period of around 6 months (from September 2017 to February 2018), 406 responses were received (30.2 per cent return rate).

From these 406 surveys, 256 surveys were received from the firms within the port-centric logistics cluster and 150 from outside. Only 238 responses received from firms within the port cluster were usable; whilst 18 had missing or incomplete data. 141 surveys from outside the cluster were used because 9 surveys had incomplete and missing data. 379 questionnaire surveys were found to be valid with complete information to be used for further analysis. In addition to five non-metric variables, the total number of metric variables are 25 which represents the key constructs in the model (survey questions).

5.3 MISSING DATA

Missing values refer to the situation in which the values in one or more variables are lost or intentionally or unintentionally left blank (Hair et al., 2006). It is important to treat missing data as they can be compounded with variates which in return may create substantial effects on results. This was carried out by examining whether the missing data is scattered throughout the observations or they exhibit any particular pattern. Furthermore, the prevalence of missing data is also examined to decide if it can be remedied. In case of missing data, the remedies can be applied otherwise the data needs to be excluded from the analysis.

It is important to identify missing data, the extent of missing data and available remedies for missing data for multivariate analysis. This includes the missing data caused due to the research design and patterns of missing data. Since the missing data is found to be under 10 per cent and occur in a specific non-random manner therefore as a rule stated by Hair et al. (2006), these responses were deleted from the data set. This solution of deleting the case is found to be most efficient where missing data is in non-random pattern. The decision is also driven by theoretical and empirical considerations such as minimum data required for a specific statistical method. The variables or the cases with more than 50 per cent of missing values are also deleted.

Diagnosis of the randomness of missing data is also conducted using missing at random (MAR) and missing completely at random (MCAR). This decision is based upon if the data is

MAR or MCAR followed by deciding the value to impute, which can be estimated based on valid values of other known variables or the values calculated from the valid data.

From the pattern of missing data, it becomes evident that a substantial amount of data can be remedied by deleting 27 cases that have too much of missing data and if imputed might inflate or represent wrong results. Hair et al. (2006) suggested that if the missing data per case is less than 10 per cent then it can be ignored. As total number of variables to be answered was 25 in this study so if missing data for each case is equal to or more than 5 (that is around 20.8 per cent) then that case warrants deletion and the cases with less missing data such as one missing or two missing can be remedied by imputing the data. After examining the data, 27 cases have been deleted with the missing data of equal to or more than 5 case-wise. It is important to note that among those 27 cases, the missing data had no specific pattern but seem to be random. The deleted cases represent 6.6% of the total responses which won't impact much on the final model (Hair et al., 2006).

5.4 IDENTIFICATION OF OUTLIERS

Outliers are the variables or the cases which are significantly different from the sample population (other observations) (Hair et al., 2006; Byrne, 2016). The presence of outliers can have a substantial effect on the analysis. A multivariate outlier detection procedure was followed in this research due to SEM-based multivariate analysis. This method detects the extreme scores on two or more variables whereas univariate examines on one variable (Kline, 2015).

A widely known method to detect multivariate outliers is the Mahalanobis D^2 measure (Hair, et al., 2006), which has been applied in this study. In this method, the distance of each observation is measured in multidirectional space from all observations mean center that provides a single value without taking the number of variables into consideration (Mahalanobis, 1936). The higher value of D^2 reflects the value is farther from the mean in multidirectional space.,

If the D^2/df value is higher for a bigger sample size (>200) typically 3 or 4 that represents an outlier. Whereas for small samples a value of D^2/df exceeding 2.5 is considered to be an outlier. The sample size in this study is 379. The value of D^2/df exceeding 3 or 4 was considered a multivariate outlier. The dataset (379 cases and 25 metric variables) were examined to detect the presence of outlier using D^2 as a measure of distance and then computed D^2/df. The observations of D^2/df have been presented in appendix 4. As shown in appendix 4, the D^2/df values of case no: 139 are exceeding three, suggesting that as an outlier case. Due to the larger sample size in this study, this case (case no: 139) has not been dropped and taken for further analysis.

5.5 TEST FOR MULTIVARIATE NORMALITY

Assessment of multivariate normality is a pre-requisite for applying a maximum likelihood estimation technique. The sample size in this study is 379 which is significantly large enough to validate the point that univariate normality is sufficient to estimate the data to be normal (Arbuckle, 1997; Hair et al., 2006). With large data, the effect of non-normality is less detrimental. As a result, univariate normality is assessed for the metric variables (that is, 25 variables of 379 cases).

Normality is evaluated graphically, by plotting a histogram with a normal probability distribution (Field, 2013). Skewness and kurtosis were also conducted. These measures represent the shape of the distribution. Kurtosis refers to "peakedness" or "flatness" of the distribution whereas skewness shows the orientation of the distribution. It is to evaluate whether the data is skewed to the left or right or symmetrical. A negative skew means the data is shifted to the right and positive skew represents the data is skewed to the left. A flatter distribution results in negative kurtosis whereas positive kurtosis reflects the taller distribution (Hair et al., 2006). Assessing kurtosis is more important in tests of variance and covariance whereas skewness effects the tests of the means (Byrne 2016). The critical values of Zskewness and Zkurtosis are +/- 2.58 (.01 significance level) and +/- 1.96 (.05 significance level). Additionally, Kline (2010) suggested the values between +10 to -10 for kurtosis can be accepted. Another tolerant measure suggested a range that is commonly used is ±4 (Tabachnick and Fidell, 2007). Table 5.1 presents the values of skewness and kurtosis of variables in this study. The variables CLU represents the 'cluster' construct, COR signifies '*competitive rivalry'*, BTE is used for '*barriers to entry'*, TOS is used for '*threats of substitutes'*, BPB represents '*bargaining power of the buyers'* and BPS characterises '*bargaining power of suppliers'*.

Table 5.1: Normality test results

Variables	N Valid	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis	Zskewness	Zkurtsis
CLU1	379	-0.493	0.125	-0.402	0.250	-3.94	-1.61
CLU2	379	-0.382	0.125	-0.496	0.250	-3.05	-1.98
CLU3	379	-0.496	0.125	-0.273	0.250	-3.96	-1.09
CLU4	379	-0.877	0.125	0.512	0.250	-7.00	2.05
CLU5	379	-0.375	0.125	-0.438	0.250	-2.99	-1.75
CLU6	379	-0.791	0.125	0.142	0.250	-6.31	0.57
COR1	**379**	**-1.175**	**0.125**	**0.749**	**0.250**	**-9.37**	**3.00**
COR2	**379**	**-1.253**	**0.125**	**1.132**	**0.250**	**-10.00**	**4.53**
COR3	379	-1.014	0.125	0.637	0.250	-8.09	2.55
COR4	379	-0.927	0.125	0.246	0.250	-7.40	0.98
COR5	379	-0.708	0.125	-0.408	0.250	-5.65	-1.63
BTE1	379	0.545	0.125	0.527	0.250	4.35	2.11
BTE2	379	0.619	0.125	-0.323	0.250	4.94	-1.29
BTE3	379	0.662	0.125	-0.028	0.250	5.28	-0.11
TOS1	379	-0.679	0.125	0.490	0.250	-5.42	1.96
TOS2	379	-0.680	0.125	0.502	0.250	-5.43	2.01
TOS3	379	-0.579	0.125	0.331	0.250	-4.62	1.32

BPB1	379	-0.781	0.125	-0.172	0.250	-6.23	-0.69
BPB2	379	-0.816	0.125	0.047	0.250	-6.51	0.19
BPB3	379	-0.666	0.125	-0.161	0.250	-5.32	-0.64
BPB4	379	-0.727	0.125	-0.034	0.250	-5.80	-0.14
BPB5	379	0.154	0.125	-0.550	0.250	1.23	-2.20
BPS1	379	-0.527	0.125	0.097	0.250	-4.21	0.39
BPS2	379	-0.512	0.125	0.141	0.250	-4.09	0.56
BPS3	**379**	**-0.806**	**0.125**	**1.289**	**0.250**	**-6.43**	**5.16**

the standard error for skewness is 0.125 which is the square root of (6/379 = N value) and the standard error of kurtosis is 0.250 which is the square root of (24/379 = N value). So, to get respective Zskewness and Zkurtosis each skewness and kurtosis value is divided by their respective standard error.

** Bold variables represent deviation from normality

Three variables COR1, COR2, and BPS3 show a deviation from the normality with values higher than the critical thresholds of +/- 2.58 which are with values 3.0, 4.54 and 5.16 (as shown in Table 5.1). In fact, the test for normality of the measurement items remaining in the final model shows no sign of kurtosis in the data; the only couple of the items appear to have a moderate-high value of kurtosis as shown in Table 5.1. Given the large sample size of 379, the effect is most likely to be insignificant (Hair et al., 2006; Byrne, 2016). Three variables that show a high Zkurtosis value, this study uses the bootstrap procedure in AMOS as a precaution which makes an adjustment for both chi-square test and the standard errors estimate to account for non-normal data in multivariate analysis (Byrne, 2016). The main advantage of bootstrapping is that it assesses the stability of the parameter estimates and presents their value with a higher degree of accuracy. This study uses Bollen-Stine bootstrap probability (p) to evaluate the model fit. The Bollen-Stine bootstrap method is used to adjust distributional misspecification in case the multivariate normality deviates for large data. (Yung and Bentler 1996)

5.6 ESTIMATING NON-RESPONSE BIAS

Non-response happens when there is a significant difference between the survey respondents, who did not participate in the survey or late participants. It is also known as participation bias where the results of the survey become non-representative because the participants reflect certain individualities that are inconsistent in turn affects the outcome (Armstrong and Overton, 1977). Hence, non-response has been estimated for the sample size (Cooper et al., 2006; Bell et al., 2018). The method to examine the non-response bias is to compare the responses of early respondents of the survey to the ones who responded to the survey late (Armstrong and Overton, 1977). According to the literature (Lewis-Beck et al., 2003; Collis and Hussey, 2013), the respondents who are more interested would likely to respond the survey earlier than the respondents who had no interest.

The non-response bias was examined by comparing the pattern of responses by early and late respondents. To differentiate the survey responses the date was mentioned when the surveys were received. Non-response bias is estimated based on comparing the means of all the variables in the model of those who responded earlier with those who responded late. As per the non-response rate estimated by Bell and Bryman (2018), this research considered 20 per cent (75 surveys) early responses and 20 per cent (75) late samples for independent sample t-test to investigate the difference (see Table 5.2).

The p-value for the F-test (Levene's test of equality of variances) indicates non-significance between two groups for most of the variables except for CLU1, BPB1, BPB2, BPB3, and BPB4. The variance between the two groups is assumed to be equal. The p-values for the t-test also suggest non-variances between two groups except COR2, COR4, BPB1, BPB2, BPB3, BPB4, and BPB5. The further examination identifies that the survey respondents' location for the first 75 respondents was from within port-centric periphery and the last 75 were outside the port-centric clustered environment.

Table 5.2: Independent sample T-test for non-response bias

			t-test for Equality of Means						
	Levene's test for equality of variances							**95% Confidence Interval of the Difference**	
Variable	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CLU1	6.112	0.015	1.328	148	0.186	0.160	0.120	-0.078	0.398
CLU2	0.710	0.401	0.200	148	0.842	0.027	0.133	-0.237	0.290
CLU3	1.147	0.286	0.732	148	0.465	0.093	0.128	-0.159	0.345
CLU4	0.364	0.547	0.513	148	0.608	0.053	0.104	-0.152	0.259
CLU5	2.377	0.125	1.582	148	0.116	0.213	0.135	-0.053	0.480
CLU6	0.001	0.980	-0.117	148	0.907	-0.013	0.113	-0.238	0.211
COR1	0.007	0.933	0.510	148	0.611	0.067	0.131	-0.192	0.325
COR2	0.057	0.812	2.383	148	0.018	0.293	0.123	0.050	0.537
COR3	1.895	0.171	-1.083	148	0.281	-0.147	0.135	-0.414	0.121
COR4	0.926	0.338	2.761	148	0.006	0.387	0.140	0.110	0.663
COR5	1.729	0.191	0.177	148	0.859	0.027	0.150	-0.270	0.324
BTE1	0.421	0.517	0.985	148	0.326	0.120	0.122	-0.121	0.361
BTE2	0.004	0.949	0.180	148	0.857	0.027	0.148	-0.265	0.319
BTE3	0.313	0.577	1.798	148	0.074	0.240	0.133	-0.024	0.504
TOS1	0.309	0.579	0.000	148	1.000	0.000	0.115	-0.228	0.228
TOS2	0.477	0.491	-0.855	148	0.394	-0.093	0.109	-0.309	0.122
TOS3	0.079	0.780	-1.577	148	0.117	-0.173	0.110	-0.391	0.044
BPB1	17.117	0.000	2.447	148	0.016	0.293	0.120	0.056	0.530
BPB2	8.574	0.004	1.944	148	0.054	0.267	0.137	-0.004	0.538
BPB3	8.126	0.005	5.012	148	0.000	0.720	0.144	0.436	1.004
BPB4	10.522	0.001	2.397	148	0.018	0.293	0.122	0.051	0.535
BPB5	0.497	0.482	5.277	148	0.000	0.680	0.129	0.425	0.935
BPS1	0.458	0.500	0.798	148	0.426	0.093	0.117	-0.138	0.324
BPS2	0.544	0.462	1.568	148	0.119	0.187	0.119	-0.049	0.422
BPS3	1.881	0.172	1.069	148	0.287	0.120	0.112	-0.102	0.342

5.7 TEST FOR COMMON METHOD BIAS

Common method bias (CMB), which is also known as common method variance, is a bias in the dataset which is external to the measures (Podsakoff et al., 2003). It is due to the constructs that the measures represent. Harman's single-factor test is widely used among several methods proposed in the literature to test the CMB (Podsakoff et al., 2003). In this approach, all the measurement items are loaded onto one factor to compute the total variance explained. If a single factor accounts for more than 50 per cent of the variance explained, during exploratory factor analysis (EFA) using an unrotated factor solution then data deem to have CMB.

Table 5.3 presents the results where the variance explained by one factor is 27.43 per cent, thus one factor did not account for a large proportion of the variance (significantly below 50 per cent). Moreover, a single factor also did not appear to represent the variance among all the measurement items. Hence, common method bias is not an issue in this study.

Table 5.3: Test for Common Method Bias – Total Variance Explained

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6.858	27.432	27.432	6.858	27.432	27.432
2	3.22	12.879	40.311	3.22	12.879	40.311
3	2.625	10.5	50.811	2.625	10.5	50.811
4	2.106	8.425	59.236	2.106	8.425	59.236
5	1.94	7.758	66.994	1.94	7.758	66.994
6	1.282	5.129	72.124	1.282	5.129	72.124
7	0.859	3.436	75.56	0.859	3.436	75.56
8	0.706	2.825	78.385	0.706	2.825	78.385
9	0.588	2.353	80.738	0.588	2.353	80.738
10	0.533	2.131	82.868	0.533	2.131	82.868
11	0.471	1.883	84.752	0.471	1.883	84.752
12	0.444	1.776	86.528	0.444	1.776	86.528
13	0.392	1.568	88.095	0.392	1.568	88.095
14	0.38	1.518	89.613	0.38	1.518	89.613
15	0.361	1.443	91.057	0.361	1.443	91.057
16	0.323	1.291	92.348	0.323	1.291	92.348
17	0.312	1.247	93.595	0.312	1.247	93.595
18	0.272	1.087	94.681	0.272	1.087	94.681
19	0.25	1	95.682	0.25	1	95.682
20	0.23	0.918	96.6	0.23	0.918	96.6
21	0.205	0.822	97.422	0.205	0.822	97.422
22	0.2	0.801	98.223	0.2	0.801	98.223
23	0.167	0.666	98.889	0.167	0.666	98.889
24	0.141	0.564	99.453	0.141	0.564	99.453
25	0.137	0.547	100	0.137	0.547	100

5.8 SAMPLING FRAME AND ORGANIZATIONS' PROFILE

The sample frame of this study is restrained the survey to the logistics firms that are directly or indirectly related to the port operation. Moreover, the firms that are surveyed are from the Melbourne area. The firms are divided into two categories based on the geographical location of their operation which is within the PCLC and outside the port-centric area. The representative of the company, who participated in the survey, hold a senior position. There were 9 broad categories of the firms that were surveyed however only 8 industry types participated in the survey. The survey analysis shows that around 65.7 per cent of respondents were from within the PCLC and 34.3 per cent outside the clustered vicinity.

Table 5.4 shows the profile of the organizations and the type of firms. The road freight transport services contributed around 43.77 per cent of the total within both the locations. In addition to this, the number of organizations was also higher in road freight transport services as compare to other industry types followed by freight forwarding (13.53 per cent) and courier services (11.94 per cent). The participants, who responded to the survey, were found to be higher within the cluster (248 respondents) compare to outside the cluster (131 respondents). The reason for higher participation from within the cluster is due to the fact that more number of logistics-related industries are located within the port periphery that includes the areas such as Altona, Williamstown, Laverton, Footscray, Sunshine, Hobsons Bay and Brimbank.

Table 5.4: Organization types

Organization Type	**Within Cluster**	**Outside Cluster**	**Total**	**% of Total**
Road freight transport services	98	69	165	43.77%
Freight forwarding	37	14	51	13.53%
Courier services	31	14	45	11.94%
Storage and Warehousing	28	6	34	9.02%
Postal Services	16	11	27	7.16%
Custom agency	14	12	26	6.90%
Rail transport	18	2	20	5.31%
Water transport services	7	2	9	2.39%
Port operators	-	-	-	-
Total	248	131	379	

Table 5.5 presents the frequency of the firms that directly or indirectly assist port operations. It has been found that companies within the PCLC deal quite frequently with the port. Around 57.8 per cent of companies within and outside the cluster draw their business from port whereas only 6.6 per cent of industries stated that they have no business relationship with the port. It is also interesting to conclude that there were 11 industries within the cluster who had not dealt with the port. The likely reason for this tendency may be due to the companies working as sub-contractors.

Table 5.5: Business dealing with port

Company Dealing	**Within Cluster**	**Outside Cluster**	**Total**	**% of Total**
very frequent	161	58	219	57.78%
sometimes	76	59	135	35.62%
never	11	14	25	6.60%
Total	248	131	379	

Table 5.6 presents the frequency distribution of the firms' sizes. Most of the firms that participated in the survey were small-sized enterprises having less than 20 employees. Around 70 per cent of the firms that participated in the survey had less than 50 employees. Only 6.33 per cent were large firms that have more than 500 employees.

Table 5.6: Organization size

Number of Employees	**Within Cluster**	**Outside Cluster**	**Total**	**% of Total**
Less than 20	90	53	143	37.73%
20 to 50	84	42	126	33.25%
51 to 100	28	15	43	11.35%
101 to 500	29	14	43	11.35%
More than 500	17	7	24	6.33%
Total	248	131	379	

5.9 SUMMARY

This chapter presented the preliminary analysis of survey data including missing values, outliers, departure from normality, non-response bias, common method bias. The test of normality revealed that the data lacks in multivariate normality due to skewness. The study did not find any departure with respect to kurtosis which is relevant to the covariance-based analysis. The test of non-respondent bias and CMB did not find any issue which may affect SEM analysis. In addition, the organisation profile is also presented that reflected that most of the firms that participated in the surveys were from PCLC, related road freight transport and freight forwarding services, and of small to medium size.

The next chapter discusses the results of the final stage and the descriptive findings of the constructs.

CHAPTER 6

INSTRUMENT VALIDATION AND MEASUREMENT MODEL

6.1 INTRODUCTION

This chapter presents the findings of the analyses that were carried out in the first three stages of model development. It commences with the identification and aggregation of the sub-industries that represent the port-centric logistics sector. It then identifies the SLAs that collectively form Port-centric logistics cluster (PCLC), by delineating the geographic boundary within which the cluster exists. This is followed by the validity and reliability results of the measurement model, which is developed to formulate the relationships between PCLC and the constructs that represents inter-firm competition.

Specifically, this chapter addresses the following questions:

- What sub-industries typically constitute a PCLC?
- Which SLAs represent the PCLC in Melbourne?
- How well the model fits the data which is estimated?

6.2 STAGE 1 - IDENTIFICATION OF PCL SUB-INDUSTRIES

The first step is to identify the sub-industries that comprise the PCL sector. Based on Australian New Zealand Standard Industrial Classification -ANZSIC93 data at a 4-digit level, a total of 633, 719 and 720 sub-industries are identified in the census periods of 2001, 2006 and 2011 respectively. This total number of sub-industries also include '*adequately described*', and '*not stated*' in the data set. The purpose of this inclusion is to provide an approximate count of employment. Otherwise the exclusion of these sub-industries (*'adequately described'* and *'not stated'*) will inflate the total employment because the number in these sectors is significantly high. Few new sub-industries were added in 2006 that were not listed in 2001. In addition to this, some industries have been bundled into one category such as; *transport, postal and warehousing division* in 2006 was *transport and* *storage/warehousing* as individual sector in 2001. Among all sub-industries, 29 sub-industries in 2001, 26 in 2006 and 25 in 2011 have been identified that represents the PCL sector.

Table 6.1 lists the sub-industries that represent the PCL sector at a 4-digit level. Logistics is a broader term that spans across many functions making the identification and characterization of the logistics industry unclear (Chhetri et al., 2014). However, this study uses the term port-centric logistics that incorporates the logistics firms that are directly or indirectly associated to assist and manage the port functions and management. PCL differentiates the logistics functions from an array of logistics activities that are used in other industries such as the manufacturing and retail sector.

Table 6.1: Industries representing PCLC

Shipbuilding	Transport Equipment Manufacturing
Water Transport, undefined	Transport and Storage, undefined
International Sea Transport	Road Freight Transport
Coastal Water Transport	Rail Transport
Inland Water Transport	Other Transport, undefined
Stevedoring	Pipeline Transport
Water Transport Terminals	Road Transport
Port Operators	Services to Transport, undefined
Freight Forwarding (Except Road)	Services to Road Transport, undefined
Customs Agency Services	Services to Road Transport,
Storage, undefined	Services to Water Transport,
Grain Storage	Other Services to Transport, undefined
Storage	Road Freight Forwarding
Postal Services	Services to Transport,
Courier Services	Postal and Courier Services, undefined

6.2.1 Comparative analysis of the years 2001, 2006 and 2011 data

Table 6.2 presents the PCL employment statistics in the census periods 2001, 2006 and 2011. The results show an increase in the number of sub-industries from 2001 to 2006 but remains unchanged from 2006 to 2011. The number of PCL industries however has decreased from 29 to 26 and then to 25 over these three census periods. Few new industries are included in the year 2006 that are not stated in the year 2001; whilst few industries are bundled into a single category. An employment count is also increased by 0.8 million from the year 2001 to 2006 and by 0.9 million from the year 2006 to 2011. It is interesting to note an increase in the percentage of PCL employment; that is from 3.28 per cent to 3.38 per cent from 2001 to 2006. However, it drops down to 3.33 per cent in 2011. The plausible reason of this per cent decline in employment relates to the increase in an absolute number of jobs from the years 2001 to 2006 to 2011. However, a significant increase is noticed if employment is examined by the number of employees in the PCL sector.

A state-wise analysis across three census periods shows relatively a higher concentration of PCL employment in New South Wales, followed by Victoria. In the years 2006 and 2011, *road freight transport, postal services, other warehousing, and storage services* are identified as major employers in the PCL sector whereas in the year 2001 *rail freight transport* replaces the position of *other warehousing and storage services* in the year 2006 and 2011. *Road freight transport* is found to be a growing sector due to growing volume of inbound freight requirements within states. Moreover, road transport provides door to door service which other mode of transport are unable to provide.

The result of SLA wise employment, in Victoria, indicates that the PCL employment is highest in Melbourne (C) remainder in the year 2001 and 2006 but Wyndham (C) North reflects the highest PCL employment in the year 2011. However, these ranking of SLAs changes significantly when the absolute number of jobs are converted into the percentage of PCL employment to the total employment. Hobsons Bay (C) – Altona holds the top position in Victoria in the year 2001 whereas South Barwon – Inner and Falls Creek Alpine Resort are the top SLAs consisting of highest PCL employment in the year 2006 and 2011 respectively. The reason for these SLAs to have higher PCL employment is partly because of low total employment.

Table 6.2: Comparative analysis of PCL sector in 2001, 2006 and 2011

	Year 2001	**Year 2006**	**Year 2011**
Total Sub-industries	633	717	717
PCL related industries	29	26	25
Total Employment	8297561	9104187	10058333
Total PCL Employment	272261	308085	334993
% PCL employment	3.28%	3.38%	3.33%
Top 3 industries with highest PCL employment wise	Road freight transport, Postal services, Rail transport	Road freight transport, Postal services, Other warehousing and storage services	Road freight transport, Postal services, Other warehousing and storage services
Cumulative % PCL employment to the total PCL employment of top 3 sub-industries	65.77%	72.09%	69.70%
Top 2 states with highest PCL employment	NSW, Victoria	NSW, Victoria	NSW, Victoria
% PCL employment to total PCL employment in AUS' in top 2 states	33.57% & 24.50%	30.34% & 24.44%	28.68% & 23.52%
Top 3 SLAs in Victoria with highest PCL employment	Melbourne (C) - Remainder, Melbourne (C)-inner, Port Phillip (C)-west	Melbourne (C) - Remainder, Wyndham (C)-North, Greater Dandenong (C) Bal	Wyndham (C)-North, Brimbank (C)-Sunshine, Brimbank (C)-Keilor

Top 3 SLAs in Victoria by % of PCL employment to total employment in that SLA	Hobsons Bay (C) - Altona, Wyndham (C)-North, Hume (C)-Broadmeadows	South Barwon - Inner, Falls Creek Alpine Resort, Hobsons Bay (C)-Altona	Falls Creek Alpine Resort, Melton (S) Bal, Greater Geelong (C) -Pt C

6.2.2 SLA-wise Statistics in 2001

Table 6.3 lists the top ten SLAs in Victoria by total PCL employment and by the percentage of PCL employment to the total employment. The results show that Melbourne (C) Remainder and Melbourne (C) Inner are ranked on top positions as total PCL employment is highest in these areas as compared to other SLAs, in Victoria. The situation alters when it is observed from the percentage of PCL employment to total employment in the corresponding SLAs because both of these SLAs don't even appear in the top ten positions. The top two positions are retained by Hobsons Bay (C) – Altona and Wyndham (C) – North with 11 per cent and 10.75 per cent of PCL employment to total employment respectively. The reason for higher employment in these areas is due to their geographic proximity to the Port of Melbourne. The main sub-industries that provide employment in these areas are road freight transport, postal services and freight forwarding services (see Table 6.5). When the SLAs that reflect high per centage of PCL employment to total employment are closely analysed, it was found that some of the areas have low employment in absolute number. For example, French Island has 8.11 per cent (see Table 6.3) of PCL employment however it had an employment of only 37 in total and 3 out of that was classified as PCL employment.

Table 6.3: SLA-wise statistics of PCL employment in 2001

Top 10 SLAs in Victoria	Total PCL Employment	Top 10 SLAs in Victoria	% of PCL Employment to Total employment in that SLA
Melbourne (C) - Remainder	5252	Hobsons Bay (C) - Altona	11.00%
Melbourne (C) - Inner	3755	Wyndham (C) - North	10.75%
Port Phillip (C) - West	3020	Hume (C) - Broadmeadows	8.30%
Hume (C) - Broadmeadows	2843	French Island	8.11%
Wyndham (C) - North	2619	Hume (C) - Craigieburn	7.37%
Gr. Dandenong (C) Bal	2198	Gr. Dandenong (C) Bal	6.83%
Kingston (C) - North	2044	Casey (C) - Hallam	6.58%
Hobsons Bay (C) - Altona	1954	Port Phillip (C) - West	6.53%
Maribyrnong (C)	1472	Corio - Inner	5.72%
Hume (C) - Craigieburn	1317	Wellington (S) - Rosedale	5.62%

6.2.3 SLA-wise statistics in 2006

Table 6.4 provides a list of PCL employment in the year 2006. Melbourne (C) Remainder and Wyndham (C) - North takes the top position in employing the highest number of people related to the PCL sector in comparison to other SLAs in Victoria. Whereas the situation varies when it is observed from the percentage of PCL employment to total employment in the corresponding SLAs because Melbourne (C) Remainder loses its top position to South Barwon and doesn't even appear in the top ten positions. The top two positions are captured by South Barwon – Inner and Falls Creek Alpine Resort with 29.45 per cent and 21.22 per cent respectively. However, Hobsons Bay (C) – Altona follows these two SLAs with the PCL employment of 16.27 per cent. Melbourne (C) remainder and Altona are within the proximity of Port of Melbourne that's why the employment related to the PCL sector is higher. Road freight transport, warehousing and freight forwarding services sectors were found to be biggest employers of PCL employment in these SLAs (see Table 6.5).

Table 6.4: SLA-wise statistics of PCL employment in 2006

Top 10 SLAs in Victoria	**Total PCL Employment**	**Top 10 SLAs in Victoria**	**% of PCL Employment to Total employment in that SLA**
Melbourne (C) - Remainder	5209	South Barwon - Inner	29.45%
Wyndham (C) - North	3921	Falls Creek Alpine Resort	21.22%
Gr. Dandenong (C) Bal	3262	Hobsons Bay (C) - Altona	16.27%
Hobsons Bay (C) - Altona	3241	Hume (C) - Craigieburn	12.39%
Hume (C) - Broadmeadows	3172	Wyndham (C) - North	12.11%
Melbourne (C) - Inner	3048	Campaspe (S) - South	12.06%
Hume (C) - Craigieburn	2791	Boroondara (C) - Kew	10.50%
Brimbank (C) - Sunshine	2441	Brimbank (C) - Sunshine	9.16%
Kingston (C) - North	2040	Hume (C) - Broadmeadows	8.80%
Port Phillip (C) - West	2028	Gr. Dandenong (C) Bal	8.64%

Moreover, there are few SLAs, such as South Barwon-Inner and Falls Creek Alpine Resort, which have higher percentage of PCL employment, yet they reflect low total employment (see Table 6.4). Both of these SLAs had a total of 764 and 542 employment in which 225 and 115 were classified as PCL employment.

Table 6.5: SLAs with high PCL employment

SLAs	**Main sectors with high PCL employment**		
Melbourne (C) - Remainder	Road Freight Transport	Postal Services	Freight Forwarding Services
Melbourne (C) - Inner	Postal Services	Road Freight Transport	Transport Support
Wyndham (C) - North	Road Freight Transport	Postal Services	Courier Pick-up
Hobsons Bay (C) - Altona	Road Freight Transport	Warehousing	Freight Forwarding Services
Hume (C) - Broadmeadows	Road Freight Transport	Freight Forwarding Services	Warehousing

6.2.4 SLA-wise statistics in 2011

Table 6.6 lists the top ten SLAs that have the highest PCL employment in the year 2011. The analysis found that Wyndham (C) - North and Brimbank (C) - Sunshine scored top positions with the highest number of PCL employment in Victoria. The ranking of these SLAs, however, changes when it is evaluated on the percentage of PCL employment as shown in Table 6.6. Both of these SLAs ranked low in the ranking. The top two SLAs include Falls Creek Alpine Resort and Melton (S) Bal which hold 12.93 per cent and 8.23 per cent of PCL employment to total employment respectively. However, Greater Geelong (C) - Pt C follows these two SLAs with an employment percentage of 7.82 per cent. Upon analysing these SLAs that have higher percentage of PCL employment it has been found that the total employment number in these SLAs is very low in comparison to other suburbs. For example, Falls Creek has a total employment count of only 1926 where 192 are classified as PCL employment. On the other side, the areas that are closer to the Port of Melbourne such as Wyndham and Altona represent higher PCL employment in both absolute and percentage terms. However, some south-eastern suburbs of Melbourne such as Cranbourne and Berwick also show higher PCL employment because of their proximity to manufacturing/logistics hubs (Chhetri et al., 2014).

Table 6.6: SLA-wise statistics of PCL employment in 2011

Top 10 SLAs in Victoria	**Total PCL Employment**	**Top 10 SLAs in Victoria**	**% of PCL Employment to Total employment in that SLA**
Wyndham (C) - North	3164	Falls Creek Alpine Resort	12.93%
Brimbank (C) - Sunshine	2296	Melton (S) Bal	8.23%
Brimbank (C) - Keilor	2183	Greater Geelong (C) - Pt C	7.82%
Hume (C) - Craigieburn	1894	Wyndham (C) - West	7.22%
Melton (S) - East	1835	Wyndham (C) - North	6.84%

Melton (S) Bal	1834	Hume (C) - Broadmeadows	6.66%
Casey (C) - Cranbourne	1829	Hobsons Bay (C) - Altona	6.47%
Casey (C) - Berwick	1565	Melton (S) - East	6.47%
Hobsons Bay (C) - Altona	1519	Hume (C) - Sunbury	6.11%
Hume (C) - Broadmeadows	1424	Brimbank (C) - Sunshine	6.10%

6.3 STAGE 2 - MAPPING THE PORT-CENTRIC LOGISTICS CLUSTER

The second stage delineates the geographic boundary of the port-centric logistics cluster in Melbourne. A port-centric logistic cluster is defined as a geographic construct which is generated through a process of spatial partitioning of space. Three key criteria are employed to identify the PCLC, which include levels of employment concentration, spatial contiguity, and proximity to the Port of Melbourne. These criteria would also help reflect the spill-over effect and the process of agglomeration of firms near the port. This also affirms the Tobler's (Miller, 2004) first law of Geography that argues "everything is linked to everything, but spatially closer functions are more connected to each other. As the distance increases the hindrances between the functions also increase. The amalgamation of SLAs is presented as an iterative process whereby SLAs are merged with the Port of Melbourne if it fulfils those three criteria.

The map in Figure 6.1 shows the geographic extent of the Port of Melbourne, which is generated as a result of iterative process of amalgamation. Melbourne PCLC is anchored on Melbourne CBD and other surrounding SLAs are amalgamated if they fulfil the required thresholds. The emergent PCLC shows west-ward extension with greater concentration of PCL in Altona, North Melbourne, Laverton, and Footscray. These SLAs are both functionally and spatially dependent on Port of Melbourne. They provide logistics infrastructure and functions which are needed to operate the port. The development of this cluster is also supported by land-use policy that has changed the planning scheme to allow industrial land use zoning. These SLAs have higher concentration of warehousing facilities, transport companies, freight forwarding companies, and courier companies.

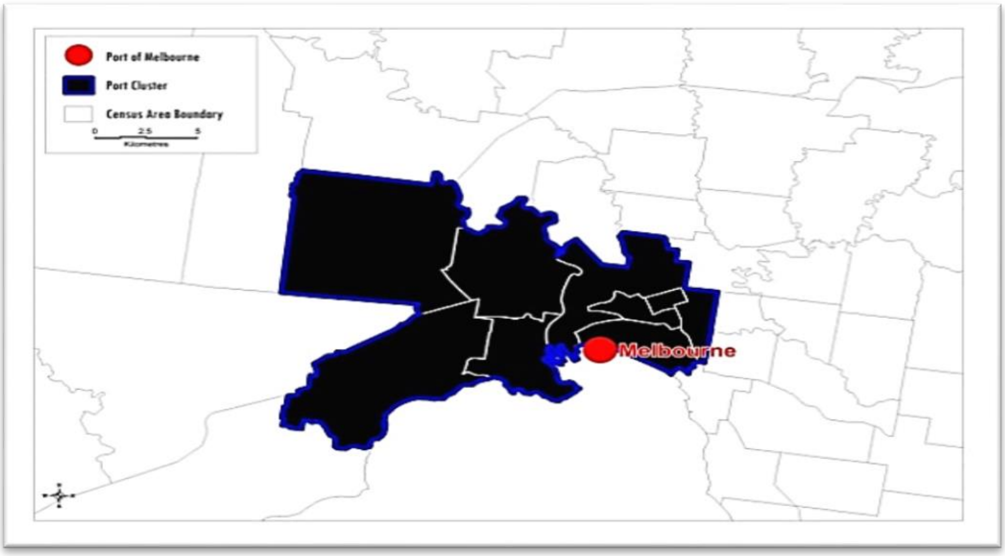


Figure 6.1: PCLC - Melbourne

6.4 STAGE 3 – ASSESSING THE VALIDITY AND RELIABILITY OF MEASUREMENT MODEL

Stage 3 develops a measurement model to examine the effect of PCLC on inter-firm competition through assessing the validity and reliability of the model. The results of the validity and reliability of the measurement model are presented below. Figure 6.2 illustrates multi-step validation process of measurement model. These steps are as following.

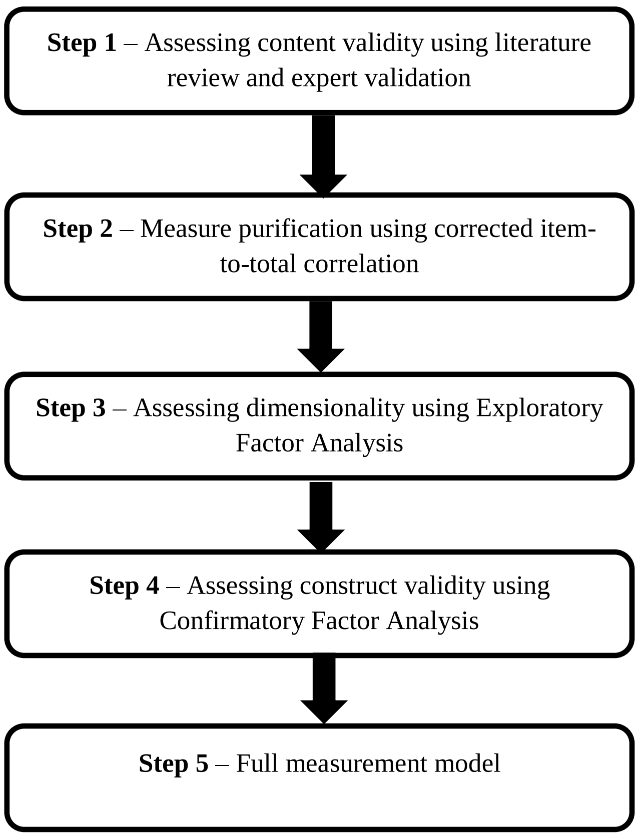


Figure 6.2 Instrument development and validation process

6.4.1 Step 1: Assessing content validity

Content validity refers to the extent to which the measurement items of the latent construct represent the domain, which the test is seeking to measure (Gefen et al., 2000). It assesses to the extent of similarity and consistency of the items which are used to represent the latent construct (Hair et al., 2006). Failure to ascertain content validity can result in potential bias as the test instruments may measure something else to what they are designed to measure.

Constructs representing inter-firm competitions were developed through in-depth literature review and reinforced by experts' judgement. An area expert from academia and practitioner from the industry were selected to validate the content. This is in line with the guidelines suggested by Straub et al. (2004), who identified that the study area experts should be consulted to validate the measurement items and the content before starting the final data collection. Pre-testing is conducted to ensure that there are no abnormalities in the instruments and the measurement items are well understood by the respondents (Haynes et al., 1995). The pilot test was conducted by running the survey to a small sample of the population. A pilot test was conducted with five respondents from the logistics firms within and outside the port periphery. This helped in identifying any issues and flaws in the measurement instruments and understanding the logic. The instruments were then purified, and wording of the survey was also altered after receiving the suggestions from the respondents.

6.4.2 Step 2: Measure purification and items reliability

The purpose of measure purification is to eliminate the items that are inconsistent with other items in the construct. The most common statistic for evaluating internal consistency reliability is the coefficient of internal consistency (Cronbach's Alpha) (Straub et al., 2004).

The values of Cronbach's alpha ranges from 0 (completely unreliable) to 1 (totally reliable). A value of more than 0.6 is considered acceptable for exploratory and further analysis but higher is preferred (Hair et al., 2006; Bell et al., 2018). Item-to-total correlation is also computed to explain how each item correlates with other items in the construct. A low value of item-to-total correlation reflects that the item belongs to some other construct and can potentially produce measurement error, therefore, it should be deleted. An optimal threshold for item-to-total correlation is 0.3 or more (Field, 2013).

Table 6.7 presents the results of the initial reliability test, which suggests that all the items have achieved internal consistency. This is indicated in higher Cronbach's alpha values which are more than 0.6 and the item-to-total correlation is more than 0.3. Only one item BPB5 has a lower value of alpha and item-to-total correlation as compared to other items in the construct yet it not significantly low from the threshold values. Therefore, no item is deleted at this stage and all the items are considered for further analysis.

Table 6.7: Cronbach's alpha and Item-to-total correlation values

Construct	Cronbach's Alpha	Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Cluster	0.936	CLU1	17.1689	18.956	0.784	0.633	0.928
		CLU2	17.1398	18.639	0.835	0.704	0.921
		CLU3	17.1319	18.739	0.84	0.73	0.921
		CLU4	16.9551	18.969	0.862	0.761	0.919
		CLU5	17.277	18.497	0.83	0.706	0.922
		CLU6	17.0844	19.374	0.719	0.529	0.936
Competitive Rivalry	0.862	COR1	16.1979	10.937	0.693	0.51	0.83
		COR2	16.2137	10.671	0.738	0.561	0.819
		COR3	16.3351	10.483	0.751	0.569	0.815
		COR4	16.4459	10.581	0.677	0.481	0.833
		COR5	16.5172	11.007	0.56	0.34	0.866
Barriers to Entry	0.847	BTE1	4.0264	2.375	0.773	0.598	0.747
		BTE2	3.8813	1.925	0.713	0.531	0.801
		BTE3	4.1293	2.266	0.684	0.484	0.814
Threats of Substitutes	0.888	TOS1	7.7995	2.134	0.709	0.504	0.904
		TOS2	7.8259	1.959	0.828	0.714	0.8
		TOS3	7.7942	2	0.812	0.699	0.815
Bargaining Power of Buyer	0.745	BPB1	13.1214	7.038	0.505	0.316	0.703
		BPB2	13.066	6.326	0.56	0.367	0.681
		BPB3	13.2612	6.627	0.507	0.267	0.702
		BPB4	13.19	6.63	0.567	0.345	0.679
		BPB5	13.5673	7.304	0.411	0.221	0.735
Bargaining Power of Supplier	0.906	BPS1	7.8971	2.204	0.811	0.66	0.866
		BPS2	7.8338	2.081	0.827	0.685	0.853
		BPB3	7.7784	2.305	0.801	0.642	0.876

6.4.3 Step 3: Assessment of dimensionality using EFA

Step 3 explores and determines the dimensions and sub-dimensions beneath the theoretical constructs using exploratory factor analysis (EFA). EFA is conducted to understand if the construct is unidimensional or multidimensional (Holmes-Smith, 2007; Raykov and Marcoulides, 2012). EFA is an unrestricted method of exploring the number of factors without any prior knowledge about which items to load to which factor.

To establish the appropriateness and the factorability of data, the sample size is checked. The factorability of the data is tested using the Kaiser-Meyer-Olkin measure of sampling adequacy (KMOMSA) and Bartlett's test of sphericity (BTOS) (see Table 6.8). The possibility of factorability is assessed and established if the KMOMSA value ranges between 0.5 to 1.0 and the BTOS is significant (that is below 0.05) (Hair et al., 2006). Table 6.8 shows the factorability is possible for all the constructs, in turn, supports running EFA.

Table 6.8: KMOMSA and BTOS of the latent constructs

Construct	No of Items	KMOMSA	BTOS	Comments
Cluster	6	0.890	0.000	EFA supported
Competitive Rivalry	5	0.849	0.000	EFA supported
Threats to Substitute	3	0.725	0.000	EFA supported
Barriers to entry	3	0.719	0.000	EFA supported
Bargaining power of buyer	5	0.874	0.000	EFA supported
Bargaining power of supplier	3	0.754	0.000	EFA supported

Once the factorability is established the following rules Costello and Osborne (2005) are followed to conduct EFA:

- The factors are extracted using a maximum likelihood method with the Promax rotation. the maximum likelihood is the best choice when data is normally distributed as it allows to compute a wide range of goodness of fit indices, permits statistical significance testing of factor loadings and correlations among the factors and computing confidence interval (Fabrigar et al., 1999). The maximum likelihood method is followed because in further analysis, such as Confirmatory Factor Analysis (CFA), the maximum likelihood method is used. Thus, it won't inflate or deflate the results and there will be consistency in using the method in both EFA and CFA (Costello and Osborne, 2005). Gorush (2013) proposed that the varimax rotation method should be used for uncorrelated factors, and the Promax rotation method should be considered for correlated factors. The data is normal in this study (refer chapter 5) and the factors are correlated therefore maximum likelihood method is a more appropriate choice.

- Factors are extracted using eigenvalues (latent root criterion). Eigenvalue of greater than 1 is to be used when there are less than 40 variables Hair et al. (2006). This criterion is also known as Kaiser’s criterion which produces the most accurate factor structure with fewer variables (Kaiser, 1960). This study incorporates 25 variables making it suitable for using this method
- The minimum factor loading that is used as a minimum threshold is 0.5 (Field, 2013). This minimum is allocated to consider improved ‘within factor correlation’ and reliability. Hair et al. (2006) identified that for a small sample size a higher factor loading is advised whereas a factor loading of 0.4 is accepted for the sample size above 200. The sample size is 379 in this study, therefore, a factor loading of 0.5 was set as a threshold value and the factor loading below 0.5 was deleted (Lewis et al., 2005). The procedure was followed until a clear factor structure was established.

The initial pattern matrix of EFA extracted six factors, which explained 66.7 per cent of the variance (see Table 6.9). The KMOMSA for all six factors is 0.853 which is acceptable as it is higher than the threshold value of 0.7 and BTOS is significant too. Factor loading for each item on its corresponding factor has high loading on a single variable except one measurement item which is CLU6 that does not load on any factor. Furthermore, the loading value of CLU5 is also not calculated. In addition, COR5 does not load on any of the factors extracted and also does not have the loading value.

Moreover, checking their communalities under the extraction column, the value for CLU6 was 0.030 and 0.289 for COR5 (see Table 6.9). The communality is defined as the amount of the variance that an instrument has in common with its corresponding construct (Hair et al., 2006). The meaning of communality is the same as squared multiple correlation measure in CFA analysis (Hair et al., 2006). All other measurement items show communalities of 0.3. This value is desirable as with the larger sample size the convergence and model stability are more even if the communality is just above 0.3 but with the small sample size, it should be above 0.5 (Hair et al., 2006). Therefore, these 2 measurement items (COR5 and CLU6) were dropped and EFA was conducted again.

Table 6.9: Initial EFA pattern matrix and communalities

	Factor						Communalities	
	1	**2**	**3**	**4**	**5**	**6**	**Initial**	**Extraction**
CLU4	0.948						0.767	0.822
CLU5	0.901						0.699	0.723
CLU2	0.872						0.723	0.732
CLU3	0.813						0.755	0.759
CLU1	0.711						0.720	0.727
COR5							0.362	0.289
BPB2		0.911					0.747	0.784
BPB3		0.891					0.687	0.739
BPB1		0.877					0.703	0.734
BPB4		0.840					0.737	0.763
BPB5		0.518					0.461	0.410
COR3			0.847				0.626	0.694
COR2			0.825				0.627	0.682
COR1			0.766				0.604	0.613
COR4			0.763				0.539	0.588
CLU6							0.060	0.030
BPS2				0.911			0.742	0.835
BPS1				0.879			0.706	0.767
BPS3				0.846			0.676	0.730
TOS3					0.917		0.746	0.845
TOS2					0.895		0.763	0.844
TOS1					0.781		0.578	0.594
BTE1						0.913	0.641	0.816
BTE2						0.769	0.601	0.639
BTE3						0.761	0.528	0.578

The final output of the EFA matrix (see Table 6.10) is re-generated, after dropping the 2 items (that are CLU6 and COR5), which explained 71.37 per cent of the variance. All the items load well to their respective constructs and no cross-loadings are found in this pattern matrix. Moreover, all the loadings are above 0.5. Only BPB5 has a loading of 0.518 which is still above the threshold of 0.5 but may not load well in further analysis. However, it has been retained in the analysis at this stage. The KMOMSA after removing CLU6 and COR5 is 0.850 which is above the threshold of 0.7, whilst BTOS presents a significant value of 0.000. The communalities of all the instruments are above 0.3 as shown in Table 6.10.

Table 6.10: Final EFA pattern matrix, Cronbach's Alpha and communalities

	Factor						**Communalities**		
	1	**2**	**3**	**4**	**5**	**6**	**Initial**	**Extraction**	**Cronbach Alpha**
CLU4	0.942						0.766	0.823	0.932
CLU5	0.894						0.697	0.721	
CLU2	0.868						0.722	0.734	
CLU3	0.808						0.754	0.761	
CLU1	0.705						0.715	0.724	
BPB2		0.911					0.743	0.786	0.906
BPB3		0.889					0.686	0.738	
BPB1		0.876					0.702	0.734	
BPB4		0.837					0.737	0.762	
BPB5		0.517					0.429	0.405	
COR3			0.832				0.612	0.68	0.875
COR2			0.819				0.622	0.681	
COR1			0.770				0.599	0.624	
COR4			0.762				0.538	0.593	
BPS2				0.910			0.739	0.834	0.911
BPS1				0.879			0.703	0.768	
BPS3				0.845			0.676	0.73	
TOS3					0.920		0.746	0.847	0.896
TOS2					0.895		0.761	0.842	
TOS1					0.783		0.575	0.594	
BTE1						0.912	0.639	0.816	0.852
BTE2						0.769	0.598	0.639	
BTE3						0.761	0.526	0.578	

The internal reliability (Cronbach's alpha) of the constructs was checked with and without the deleted instruments (CLU6 and COR5). They are found to be within the acceptable range. Cronbach's alpha values for all the constructs are more than a threshold of 0.75 (Litwin and Fink, 1995). Table 6.11 presents a summary of the EFA representing the number of items during the initial EFA and the dropped items with their descriptions. Finally, six constructs are retained with the measurement items, after dropping COR5 and CLU6 that did not load on any of the factors.

Table 6.11: Summary of EFA output

Construct	**No of items before EFA**	**Dropped Items**	**Reason to drop**	**Number of items after EFA**
Cluster	6	CLU6 – reason of location is due to accessibility to the customer	The item did not load on any construct	5
Competitive rivalry	5	COR5 – firm offer new service to the market quicker to the competitors	The item did not load on any construct	4
Threats of substitutes	3	unchanged	unchanged	3
Barriers to entry	3	unchanged	unchanged	3
Bargaining power of buyer	5	unchanged	unchanged	5
Bargaining power of supplier	3	unchanged	unchanged	3

The next section conducts further tests for construct validity through confirmatory factor analysis (CFA) using Analysis of Moment Structures (AMOS).

6.4.4 Step 4: Assessment of construct validity through CFA

Step 4 assesses the construct validity through Confirmatory Factor Analysis (CFA) by evaluating how well the measured instruments represent the underlying latent construct. before

Convergent and discriminant tests are computed to provide validity of the theoretical constructs (Brown and Moore, 2012). Convergent validity means the items (used to measure latent constructs) should share a high proportion of variance in common. The convergent validity is checked by the combination of following measures (Gefen et al., 2000; Hair et al., 2006);

- Goodness of Fit measures,
- Squared multiple correlation (SMC),
- Average variance extracted (AVE), and
- Construct reliability (CR).

Whereas the Discriminant validity is the representation of cross loading which means the extent to which one construct is different from another (Holmes-Smith, 2007). It also shows that the individual item explains the same construct, not another. The discriminant validity can, more rigorously, be assessed through comparing AVE values for each factor with the squared inter-factor correlation estimates, where AVE values should be higher than squared inter-factor correlation, for the discriminant validity to be supported (Gefen et al., 2000; Hair et al., 2006).

The construct validity test is conducted initially on the individual factor model (single factor congeneric model) and then finally on full measurement model. To test the convergent validity of the model, the goodness of fit (GOF) measures are checked. Most of the authors (Lomax and Schumacker, 2004; Hair et al., 2006; Kline, 2015) suggest that at least three to four different types of fit indices are required to support the model fit.

Table 6.12 provides the guidelines for fit indices considering the sample size. Based on Hair et al. (2006) instructions this study reports chi square, degree of freedom, RMSEA, SRMR, CFI and PNFI as the goodness of fit measures. The next section discusses the single factor congeneric models and final measurement model and reports the fit measures for the convergent validity.

Table 6.12: Guidelines for Fit Indices

Type	Name of GOF statistics	Abbreviation	Acceptable level	Reference
Chi-square	Chi-square (with df, p)	x2 (df, p*)	p-value can be less than .05	(Hair et al. 2010, 666; Holmes-Smith 2010, 5, 7)
Absolute fit indices	Normed chi-square	x2 /df	Value between 1 and 5	(Bagozzi et al. 1991, as cited in Lewis et al. 2005; Hair et al. 2010, 668)
	Root mean-square error of approximation	RMSEA	Values < .08/.10	(Lewis et al. 2005; Hair et al. 2006, 748; Hair et al. 2010, 672)
	Root mean-square residual and standardised RMR	RMR, SRMR	Values < .09	(Hair et al. 2010, 672)
Incremental fit indices	CFI, Tucker Lewis index, Incremental fit index	CFI, TLI, IFI	Values >= .92	(Hair et al. 2010, 672)
Parsimony fit indices	Parsimony normed fit index (PNFI), Parsimony comparative fit index (PCFI)**	PNFI, PCFI	Values >= .5	(Hair et al. 2010, 672)

6.4.4.1 Single-factor measurement model of cluster

This section presents the results of the single-factor congeneric measurement model, which presents the hypothesised measurement model that consist of six unidimensional constructs, based on the model on this study, with all cross loadings constrained to zero. The theoretical framework supported by EFA output results in six factors, which are port-centric logistics cluster, *competitive rivalry, bargaining power of buyer, bargaining power of suppliers, threats of substitutes, barriers to entry*.

The port-centric logistics cluster measures the ability of a firm to draw its business from the port. The logistics firms that assist the operation and management of Port of Melbourne are considered to be working within PCLC. The cluster construct was hypothesized to consist of six items where one item CLU6 was dropped in EFA analysis as it did not load on any of the factors. The proposed one-factor congeneric measurement model based on CFA for the port-centric logistics cluster with five items is presented in Figure 6.3. The loadings are presented just above the line and the SMC values are displayed at the end of the arrow in the figure.

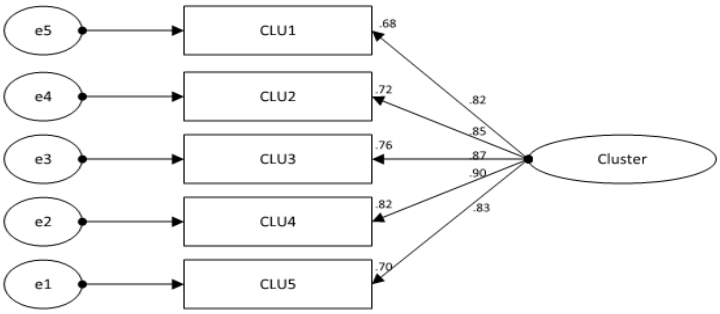


Figure 6.3: One-factor proposed congeneric model of PCLC

As shown in Table 6.13, the proposed model has an acceptable p-value and is admissible. All the factor loadings are above 0.7 and SMC values are above 0.5. the value of χ^2/DF is 3.092, which is just above the threshold. Other GOF indices are well supported and are consistent with the model fit, hence, no adjustments are done with the model. The measurement model fits the data well.

Table 6.13: Statistics for proposed single-factor congeneric model for PCLC

Construct	Chi-Square	Degree of freedom	χ^2/DF	Absolute Fit Indices		Incremental fit index	Parsimony fit index
Cluster	χ^2	DF		RMSEA	SRMR	CFI	PNFI
	15.46	5	3.092	0.126	0.027	0.98	0.59
Factor Loadings							
Item	Estimate		C. R	P	SMC	Comments	
CLU1	0.822		12.509	***	0.676		
CLU2	0.847		10.208	***	0.717		
CLU3	0.873		11.515	***	0.762	Convergent validity holds	
CLU4	0.903		12.233	***	0.816		
CLU5	0.834		12.723	***	0.695		
(P < 0.001***, P < 0.01**, P < .05*)							

6.4.4.2 Single-factor measurement model of competitive rivalry

The competitive rivalry measures the extent of competition among the firms. The competitive rivalry was theorised through five measurement items. However, one item COR5 was dropped in EFA extraction because it did not load on any constructs. The CFA of the proposed one-factor congeneric model of competitive rivalry is presented in Figure 6.4.

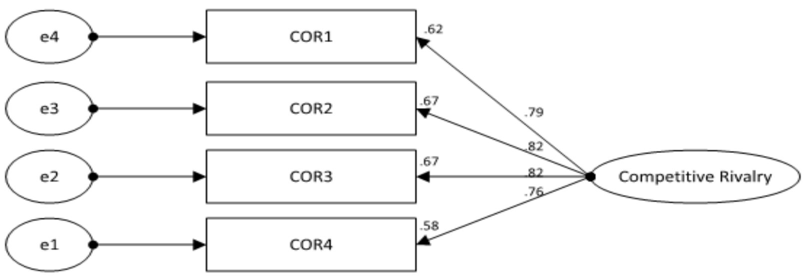


Figure 6.4: Proposed one-factor congeneric model of competitive rivalry

Table 6.14 suggests that the proposed model has an acceptable p-value and is admissible. All the standardised factor loadings and SMC values are above 0.7 and 0.3 respectively, which are above threshold. The normed chi-square value is 2.305, which is within the acceptable range. The incremental index, CFI, is above 0.9. The absolute fit indices, root mean square error of approximation (RMSEA) and standardised RMR (SRMR) values are below the recommended threshold. All GOF indices are well supported and in consistent with the model fit, thus model fits the data well.

Table 6.14: Statistics for proposed single-factor congeneric model for competitive rivalry

Construct	**Chi-Square**	**Degree of freedom**	**χ^2/DF**	**Absolute Fit Indices**		**Incremental fit index**	**Parsimony fit index**
Competitive Rivalry	χ^2	DF		RMSEA	SRMR	CFI	PNFI
	4.61	2	2.305	0.008	0.01	0.93	0.67
Factor Loadings							
(P < 0.001***, P < 0.01**, P < 0.05*)							
Item	Estimate		C. R	P	SMC	Comments	
COR4	0.761		11.917	***	0.579		
COR3	0.821		10.423	***	0.673		
COR2	0.819		10.371	***	0.671	Convergent validity holds	
COR1	0.789		11.917	***	0.622		
(P < 0.001***, P < 0.01**, P < 0.05*)							

6.4.4.3 Single-factor measurement model of bargaining power of buyer

The bargaining power of buyer measures the buyer power/authority to control the prices, quality and the impact it has on the services. It was theorised to have five measurement items. The CFA of the proposed single factor congeneric model is presented in Figure 6.5.

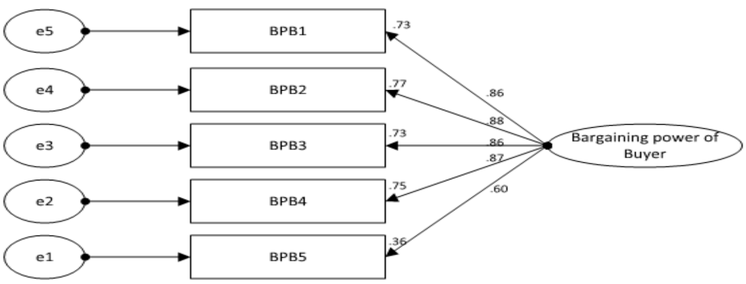


Figure 6.5: Proposed one-factor congeneric model of bargaining power of buyer

The EFA extraction did not detect any abnormality though loading of BPB5 was just above 0.5. The examination of GOF statistics in Table 6.15 suggests that the proposed model has acceptable p-value and is admissible. All the factor loadings and SMC values are above threshold except BPB5, for which the SMC value is 0.36. Moreover, χ^2/DF value is 5.945 and PNFI value is 0.490 which reflects poor model fit. Hence, BPB5 was removed from the proposed model and a re-specified model is provided below in Figure 6.6.

Table 6.15: Statistics for proposed single-factor congeneric model for bargaining power of buyer

Construct	**Chi-Square**	**Degree of freedom**	**χ^2/DF**	**Absolute Fit Indices**		**Incremental fit index**	**Parsimony fit index**
Bargain power of buyer	χ^2	DF		RMSEA	SRMR	CFI	PNFI
	29.724	5	5.9448	0.105	0.026	0.964	0.49
Factor Loadings							
Item	Estimate		C. R	P	SMC	Comments	
BPB1	0.856		14.232	***	0.732		
BPB2	0.879		11.151	***	0.773		
BPB3	0.857		11.493	***	0.735		
BPB4	0.867		10.684	***	0.752		
BPB5	0.603		11.533	***	0.363	DROPPED	
(P < 0.001***, P < 0.01**, P < 0.05*)							

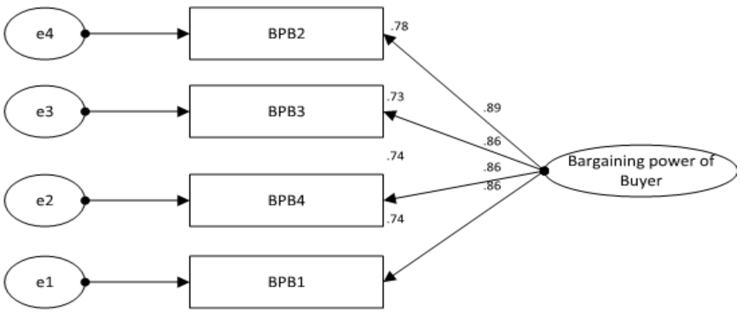


Figure 6.6: Final one-factor congeneric model of bargaining power of buyer

Figure 6.6 demonstrates that all of the factor loadings are above 0.7 and all SMC values are above .50. Table 6.16 also shows that all GOF indices are consistent with the good model fit. The normed chi-square is 4.67 which is within the acceptable level whereas in the previous model it was 5.94. It is also obvious from the absolute fit measures, incremental fit index and parsimony fit index that the model has an acceptable fit. Thus, the measurement model fits the data very well.

Table 6.16: Statistics for final single-factor congeneric model for the bargaining power of buyer

Construct	Chi-Square	Degree of freedom	χ^2/DF	Absolute Fit Indices		Incremental fit index	Parsimony fit index
Bargain power of buyer	χ^2	DF		RMSEA	SRMR	CFI	PNFI
	9.34	2	4.67	0.05	0.019	0.989	0.63

6.4.4.4 Single-factor measurement model of threats of substitutes

The threats of substitutes measure the effect of available substitute services upon logistics companies. It was theorised to have three indicators. The three-indicator rule is not violated as the construct has three measurement items. However, as the degree of freedom will be zero and this model is considered to be just identified model, hence, tau equivalence assumptions have been considered where all the factor loadings on the factor are constrained to be equal to 1 and then model is run (Hair et al., 2006). The CFA of the proposed one-factor model of threats of substitutes is presented in Figure 6.7.

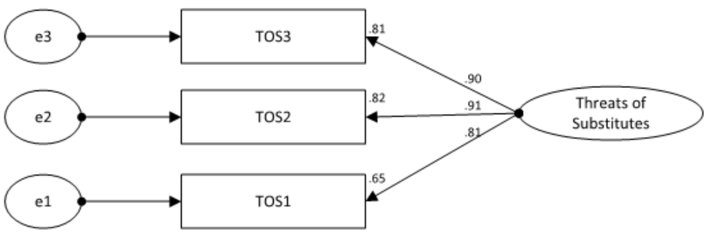


Figure 6.7: Proposed one-factor congeneric model of threats of substitutes

Examination of GOF statistics in Table 6.17 indicates an admissible model fit in terms of the p-value, chi-square, normed chi-square, and RMSEA. Further, the factor loadings and SMC are above threshold. Therefore, both Table 6.17 and Figure 6.7 conclude that the model has an acceptable fit and all the instruments display convergent validity.

Table 6.17: Statistics for proposed single factor congeneric model for the threats of substitutes

Construct	Chi-Square	Degree of freedom	χ^2/DF	Absolute Fit Indices		Incremental fit index	Parsimony fit index
	χ^2	DF		RMSEA	SRMR	CFI	PNFI
Threats to substitutes	8.16	2	4.08	0.07	0.03	0.983	0.654
Factor Loadings							
Item	Estimate		C. R	P	SMC	Comments	
TOS1	0.809		12.395	***	0.654		
TOS2	0.906		8.410	***	0.822	Convergent validity holds	
TOS3	0.9		8.808	***	0.811		
(P < 0.001***, P < 0.01**, P < 0.05*)							

6.4.4.5 Single-factor measurement model of barriers to entry

The barriers to entry measure the difficulty for the logistics firms to initiate services in an already existing sector, which is port-centric logistics in this study. It was theorised to have three measurement items to explain the construct. The model is just identified based on three indicator rule. The tau equivalence assumptions are considered, as the degree of freedom is zero, by constraining all the factor loadings to be equal to 1 before running the model (Hair et al., 2006). The CFA of the proposed one-factor model of barriers to entry is presented in Figure 6.8.

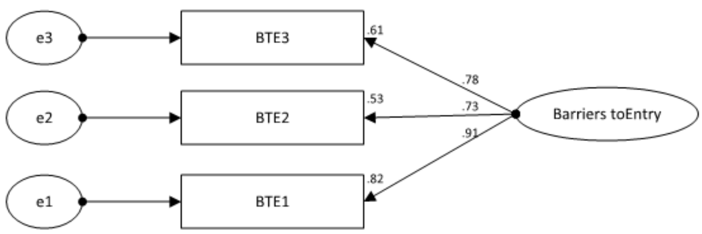


Figure 6.8: Proposed one-factor congeneric model of barriers of entry

The examination of GOF statistics in Table 6.18 indicates the admissible model fit in terms of the p-value. The normed chi-square is 3.8 which is well below the threshold of 5. The absolute fit indices represented by SRMR and RMSEA have values 0.08 and 0.03 respectively which reflects the values to be within the acceptable range. Further, the factor loadings and SMC are above threshold. Thus, both the Table 6.18 and Figure 6.8 show that the model has an acceptable fit and all the items exhibit convergent validity.

Table 6.18: Statistics for Proposed Single Factor Congeneric Model for Barriers of Entry

Construct	**Chi-Square**	**Degree of freedom**	**χ^2/DF**	**Absolute Fit Indices**		**Incremental fit index**	**Parsimony fit index**
	χ^2	DF		RMSEA	SRMR	CFI	PNFI
Barriers to entry	7.752	2	3.876	0.08	0.03	0.99	0.658
Factor Loadings							
Item	Estimate		C. R	P	SMC	Comments	
BTE1	0.906		6.175	***	0.82		
BTE2	0.73		12.591	***	0.533	Convergent validity holds	
BTE3	0.779		11.622	***	0.606		
(P < 0.001***, P < 0.01**, P < 0.05*)							

6.4.4.6 Single-factor measurement model of the bargaining power of suppliers

The bargaining power of supplier measures that how difficult it is for the suppliers to control the price and the market. It comprised of three survey items explaining the underlying factor. Similar to the previous couple of models, a three-indicator rule is not violated for this construct, but the model is just identified with zero degrees of freedom. Consequently, *tau* equivalence assumptions have been considered where all the factor loadings on the factor are constrained to be equal to 1 before running the model (Hair et al., 2006). The CFA of the proposed one-factor model of the bargaining power of suppliers is presented in Figure 6.9.

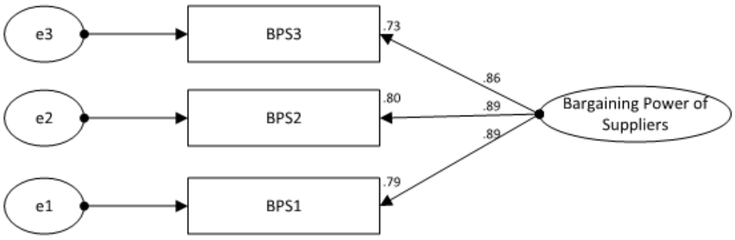


Figure 6.9: Proposed one-factor congeneric model of bargaining power of suppliers

The specified measurement model has an acceptable fit against all the selected fit measures and all the measurement items meet minimum threshold values of GOF statistics, as presented in Table 6.18. Therefore, single factor congeneric model for the bargaining power of supplier is acceptable and the instruments show convergent validity.

Table 6.19: Statistics for proposed single factor congeneric model for the bargaining power of suppliers

Construct	Chi-Square	Degree of freedom	χ^2/DF	Absolute Fit Indices		Incremental fit index	Parsimony fit index
Bargaining power of	χ^2	DF		RMSEA	SRMR	CFI	PNFI
buyer	4.73	1	4.73	0.08	0.01	0.996	0.61
Factor Loadings							
Item	Estimate		C. R	P	SMC	Comments	
BPS1	0.888		9.877	***	0.788		
BPS2	0.895		7.414	***	0.801	Convergent validity holds	
BPS3	0.857		10.68	***	0.734		
(P < 0.001***, P < 0.01**, P < 0.05*)							

The next stage investigates the construct validity of the full measurement model. The importance of gaining GOF of full CFA measurement model is to avoid any chance of possible poor fit during structural model.

6.4.5 Full measurement model

The discussion thus far has been focused on ensuring the unidirectionality and construct validity of each construct. This section discusses the full measurement model for all six constructs together that include PCL, competitive rivalry, bargaining power of buyers, bargaining power of suppliers, threats of substitutes and barriers to entry. The full measurement model presents how these six constructs are operationalised by the set of measurement items and evaluates the relationships between the constructs and measured items.

To validate the full measurement goodness of fit measures and discriminant validity is checked. The results of the measurement model are presented in five steps that include model specification, model identification, model estimation, model testing, and model modification. These steps are discussed as follows.

6.4.5.1 Model Specification

The model specification is the way the latent constructs are operationalised by the set of measured variables (Hair et al., 2006). The first step of SEM begins with the estimation of model specification, where the model means a statistical statement about the relationships among the variables within a theoretical framework. Figure 6.10 illustrates twenty-two observed variables with six different latent constructs (factors). Each observed variable is hypothesized to measure only a single factor; thus, twenty-two factor loadings are hypothesized for twenty-two observed variables that load onto six latent constructs. The summary of the model variables is presented in Table 6.20. The correlation among the factors is hypothesized and the measurement error variances are not related (zero correlated measurement errors).

Table 6.20: Summary of model variables

Cluster	Competitive Rivalry	Bargaining power of supplier	Threats of Substitutes	Barriers to Entry	Bargaining Power of Buyer
Observed Endogenous Variables					
CLU1	COR1	BPS1	TOS1	BTE1	BPB1
CLU2	COR2	BPS2	TOS2	BTE2	BPB2
CLU3	COR3	BPS3	TOS3	BTE3	BPB3
CLU4	COR4				BPB4
CLU5					
Unobserved Exogenous Variables (Measurement Residuals)					
e1,e2,e3,e4,e5	e6,e7,e8,e9	e10,e11,e12	e13,e14,e15	e16,e17,e18	e19,e20,e21,e22
Variable Counts					
Number of variables in the model					50
Number of observed variables					22
Number of unobserved variables					28
Number of exogenous variables					28
Number of endogenous variables					22

Note: CLU = items measuring cluster, COR= items measuring competitive rivalry, BPS = items measuring bargaining power of supplier, TOS = items measuring threats of substitutes, BTE = items measuring barriers to entry, BPB = items measuring bargaining power of the buyer.

Table 6.20 lists the variables in the full measurement model, accompanied by their categorization as either the total number of variables, observed or unobserved variables, and endogenous or exogenous variables. The observed variables are treated as dependent variables (endogenous) in the model whereas the error terms and the constructs operate as independent variables (exogenous). Table 6.20 also lists the number of items within each factor. There are some fixed parameters, and others are free to be evaluated. For example, CLU4 is considered to be fixed and allowed it to load only on ‘cluster’ not on any other factors. Cluster is considered to be the free parameter. There are 44 regression weights, 28 out of which are fixed and 16 are estimated. The fixed weights constitute 6-factor loadings (fixed at 1) and there are 22 error terms (fixed at 1). There are also 28 variances and 15 covariances. Therefore, in total, there are 87 parameters from which 28 are fixed and 59 parameters are free to be estimated.

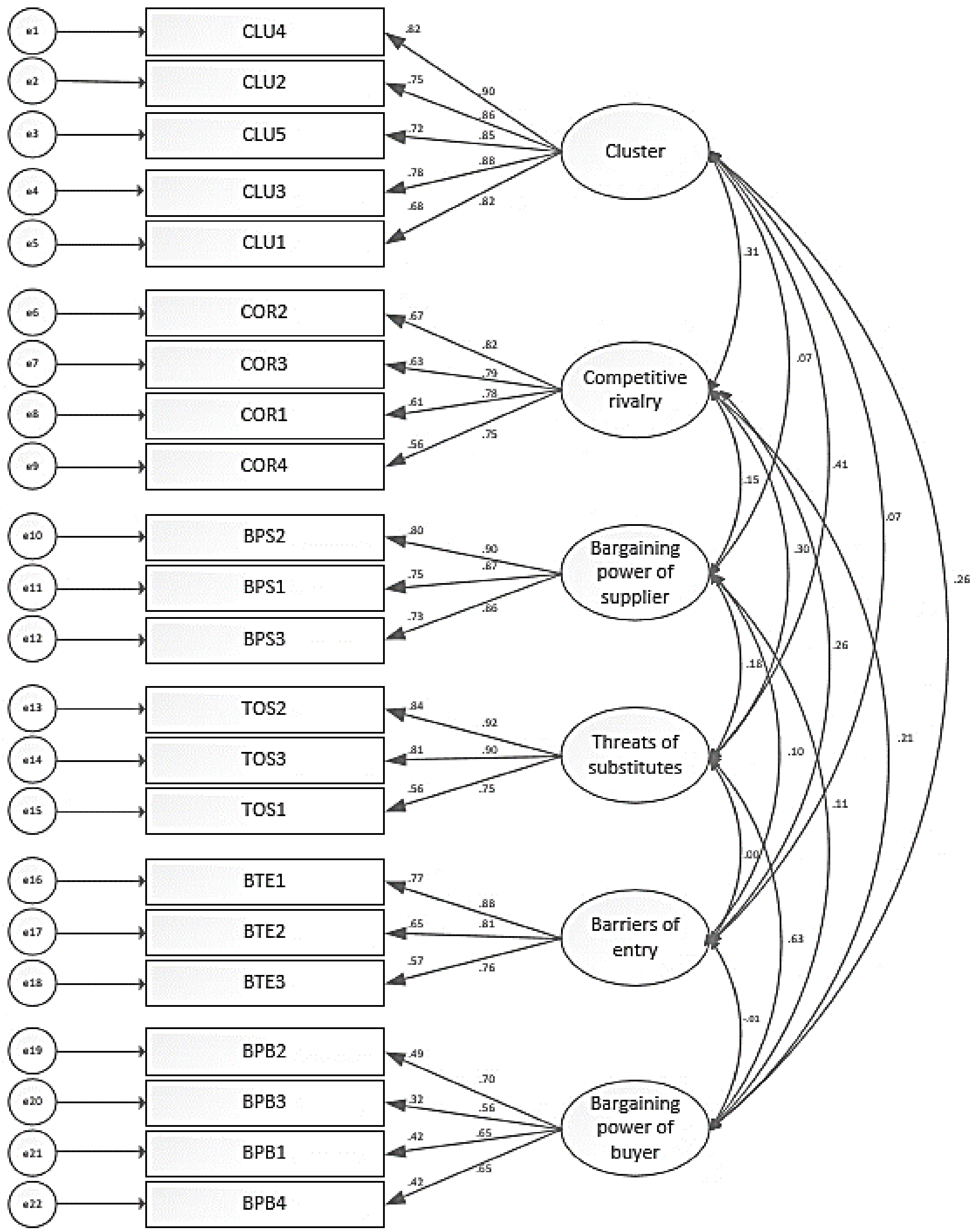


Figure 6.10: Initial full measurement model of inter-firm competition in PCLC

6.4.5.2 Model Identification

The model identification stage addresses that if a single unique value for each free parameter can be obtained from the sample data (Hair et al., 2006). This step discusses if a unique parameter estimate can be found on the basis of the sample covariance matrix (*S*) and the theoretical model, obscured by the population covariance matrix (σ). The guidelines for identification have two basic rules which are *'order condition'* and the *'three indicator rule'*:

I. Meeting the order condition

The order condition refers to the requirement of the model having a degree of freedom more than zero. It is anticipated that the difference between the number of variances and covariances from the free parameter estimates to be positive. In the measurement model (see Figure 6.10), a total of 59 parameters are freely estimated and the number of fixed parameters is 28 (i.e. 6-factor loadings and 22 error terms). The number of distinct values in the matrix *S* (sample covariance matrix) is equal to:

$p (p+1) / 2 = 22 (22+1) / 2 = 253$

where the value of p represents the observed variables in the sample variance-covariance matrix. The number of values in *S* (sample covariance matrix) is 253, which is greater than the number of free parameters, that are 59, therefore the degree of freedom is positive (253 - 59 = 194). It fulfils the order condition as the model is over-identified. In the model, if the degrees of freedom are zero then the model is said to be just-identified and if the degrees of freedom are negative the model is under-identified. However, the necessary condition of the model to be over-identified is met with the degree of freedom to be 194 in this model.

II. The three-indicator rule

The guidelines of the three-indicator rule are that all single-factor congeneric models should have at least three indicators. As proposed by Hair et al. (2006) even factor with two measurement items two indicators can be identified if these items have a relationship with the same factor. In this study, all single-factor congeneric models have at least three indicators that represent the underlying factor.

6.4.5.3 Model Estimation

In this step, the actual covariance matrix is compared with the estimated covariance matrix (Hair et al., 2006). The intent here is to estimate the parameters in which the sample covariance matrix S is as close to implied matrix σ. If the difference between the elements of S and σ is 0, then the chi-square value = 0, which implies a perfect model fit to the data. To estimate the model, three criterions are considered; *feasibility*, *statistical significance*, and the *appropriateness of standard error*.

Feasibility of Parameter Estimates

All the estimated standardised path coefficients and the standardised correlation between the factors are less than 1; whilst the loadings should be more than 0.5 but higher than 0.7 is preferred (Hair et al., 2006). Higher loadings represent that the instruments load heavily on the construct. Table 6.21 presents the standardised factor loadings of all the items to their respective constructs and found that all the estimates are well above 0.5. The instruments to measure the bargaining power of buyer especially BPB1, BPB3, and BPB4 have comparatively lower loadings, 0.648, 0.562 and 0.646 respectively, than other measurement items but still within the threshold values.

Table 6.21: AMOS output for measurement model: Parameter estimates and SMC

Standardised regression weights between items and constructs			**Estimate**	**C. R**	**P**	**SMC**
CLU4	<-	CLU	0.905	9.734	***	0.819
CLU2	<-	CLU	0.864	11.133	***	0.747
CLU5	<-	CLU	0.848	11.489	***	0.719
CLU3	<-	CLU	0.883	10.593	***	0.780
CLU1	<-	CLU	0.822	11.916	***	0.676
COR2	<-	COR	0.821	9.393	***	0.674
COR3	<-	COR	0.791	10.239	***	0.626
COR1	<-	COR	0.783	10.433	***	0.613
COR4	<-	COR	0.751	11.048	***	0.565
BPS2	<-	BPS	0.896	7.509	***	0.803
BPS1	<-	BPS	0.869	8.980	***	0.755
BPS3	<-	BPS	0.856	9.556	***	0.733
TOS2	<-	TOS	0.918	6.173	***	0.843
TOS3	<-	TOS	0.898	7.488	***	0.806
TOS1	<-	TOS	0.747	12.146	***	0.558
BTE1	<-	BTE	0.88	5.950	***	0.775
BTE2	<-	BTE	0.806	9.101	***	0.650
BTE3	<-	BTE	0.757	10.613	***	0.573
BPB2	<-	BPB	0.703	9.870	***	0.494
BPB3	<-	BPB	0.562	11.940	***	0.316
BPB1	<-	BPB	0.648	10.891	***	0.419
BPB4	<-	BPB	0.646	10.910	***	0.418

Statistical significance of parameter estimates

Each estimated coefficient should be statistically significant. If any item is non-significant then the measurement item should be dropped (Hair et al., 2006). As shown in Table 6.21 that all the estimated coefficients are statistically significant at $p<0.001$. Only significant loading does not reflect if the item is performing adequately. This is because the loading can be significant at $p<0.001$ level, yet the path coefficient can be lower than the absolute value of

0.5. However, in this study (see Table 6.21) loadings are significant and also the path coefficient is higher than 0.5.

Squared multiple correlation (SMC)

SMC represents the total variance of the measured variable that is explained by the underlying latent factor (Field, 2013). SMC is also sometimes known by different terms such as item reliability, communality, or the variance extracted. The value of SMC above 0.3 is accepted (Hair et al., 2006). Table 6.21 presents the values of SMC of all the measurement items to their constructs and found that all the values are above the required threshold. It has also been observed that the same measurement items, which have loadings of less than a value of 0.7 that are BPB1, BPB3, and BPB4, have lower values of SMC as well but are within the acceptable range. However, BPB3 has the lowest value of SMC which is 0.316 among all the measured variables but not to that values which may warrant it to be dropped.

Appropriateness of standard error

In the measurement model, no negative standard error is observed, which is presented in Table 6.21, which reflects that the parameter has been estimated with precision.

6.4.5.4 Model Testing

Model testing determines how well the data fit the theoretical model or in other words how the theoretical model is supported by the observed data. (Hair, Black et al. 2006). Results from the multifactor measurement model, using confirmatory analysis, are presented in Figure 6.10. All the items loadings are statistically significant at the level of 0.01. The constructs are found to be inter-related, as presented in Table 6.23, with the highest correlation between threats of a substitute and the bargaining power of buyer ($r = .628$, $p<.01$) and weakest between threats of substitute with barriers to entry ($r = .00$, $p<.01$). The chi-square value of this full measurement model is 504.2 with the degree of freedom 194 at a probability level of .000.

Table 6.22: Statistics for Initial Full Measurement Model

Chi-Square	**Degree of freedom**	**χ^2/DF**	**Absolute Fit Indices**		**Incremental fit index**	**Parsimony fit index**
χ^2	DF		RMSEA	SRMR	CFI	PNFI
504.2	194	2.598	0.065	0.053	0.939	0.76

Table 6.23: Inter-Correlations between Constructs

	COR	**BPS**	**TOS**	**BTE**	**BPS**
CLU	0.313	0.069	0.412	0.067	0.453
COR		0.154	0.298	0.259	0.211
BPS			0.180	0.096	0.114
TOS				0.003	0.628
BTE					-0.013

The convergent validity statistics of the measurement model are presented in Table 6.22. The value of RMSEA is 0.065, which is acceptable. Another absolute fit index that is normed chi-square is supported with a value of 2.5989 though the value of less than 2 would be considered better. Moreover, the value of CFI is 0.939 which is greater than the threshold 0.90 yet higher than 0.95 is better.

6.4.5.5 Model Modification

This step examines if the measurement model needs to be further improved. In case the data does not fit the theoretical model well, the model needs to be modified to examine the possibility of a new model. The modification search can be conducted to find the model that fits better with the sample variance-covariance matrix (Lomax and Schumacker, 2004; Hair et al., 2006).

The initial CFA of the full measurement model provides a reasonably good fit, making it suitable to carry out further analysis. However, scrutiny of modification indices and standardised residual covariances provides an opportunity for better model fit. The standardised residual covariance of BPB4 is high (see Table 6.24) and also SMC is 0.418 whereas BPB3 has SMC value of 0.316 (see Table 6.21) but examining the standardised residual covariance, it is not significantly higher as compare to BPB4 (see Table 6.24). Moreover, as shown in Table 6.24 the modification index of error variance of BPB4, which is e22, is higher.

Table 6.24: Standardised residual covariance of BPB4 and Modification Indices

Standardized residual covariances		**Modification indices**					
Items	**Bargain_BUyer4**		**Covariances**			**M.I.**	**Par Change**
BPB4	0		e22	<-->	BTE	11.699	-0.083
BPB1	-1.412		e22	<-->	Cluster	25.382	0.144
BPB3	1.163		e19	<-->	e21	11.203	0.09
BPB2	-0.985		e17	<-->	e22	15.022	-0.09
BTE3	-1.684		e14	<-->	COR	13.644	0.06
BTE2	-4.145		e14	<-->	e16	12.466	0.034
BTE1	-1.418		e10	<-->	e20	13.476	0.071
TOS1	0.27		e8	<-->	e18	12.195	-0.069
TOS3	0.759		e6	<-->	e22	12.301	-0.084
TOS2	1.067		e2	<-->	e17	16.509	0.071
BPS3	-0.437		e1	<-->	e22	11.445	0.059
BPS1	-2.025		e1	<-->	e10	10.299	-0.035
BPS2	-1.226						
COR4	1.315						
COR1	-0.01						
COR3	-1.469						
COR2	-1.693						
CLU1	3.647						
CLU3	2.579						
CLU5	1.691						
CLU2	2.044						
CLU4	3.075						

Hence, BPB4 was dropped to further examine if a better model fit was established. By removing BPB4, from the initial model, the chi-square value has dropped from 504.22 to 388.94. The CFI value also improved from 0.939 to 0.956. All absolute fit indices, incremental and parsimony fit index meet the threshold and the model is acceptable in terms of CFI, PNFI, RMSEA, and SRMR (see Table 6.25).

Table 6.25: Statistics for Initial Full Measurement Model

Chi-Square	**Degree of freedom**	**χ^2/DF**	**Absolute Fit Indices**		**Incremental fit index**	**Parsimony fit index**
χ^2	DF		RMSEA	SRMR	CFI	PNFI
388.94	174	2.235287356	0.06	0.042	0.956	0.77

The specified measurement model has an acceptable fit against all the selected fit measures and all the measurement items meet minimum threshold values of GOF statistics. Therefore, the full measurement model (see Figure 6.11) is acceptable.

The full measurement model is further tested for its reliability, convergent validity, and discriminant validity. Table 6.26 below shows that composite reliability (CR) values of all the factors are above 0.6 which is the threshold for the construct reliability to validate (Hair et al., 2006). Convergent validity is also supported by all the Average variance extracted (AVE) values and is above 0.5 which is the threshold. The discriminant validity provides evidence that the factors are unique and captures different phenomenon from other constructs. The discriminant validity is supported because, for all the factors, the AVE values were greater than the inter-factor squared correlation coefficients (see Table 6.26) (Hair et al., 2006; Holmes-Smith, 2007).

Table 6.26: Statistics of convergent and Discriminant Validity

Factors	**CR**	**AVE**	**CLU**	**COR**	**BPS**	**TOS**	**BTE**	**BPB**
CLU	0.937	0.748	0.865					
COR	0.867	0.619	0.313***	0.787				
BPS	0.906	0.764	0.069	0.154**	0.874			
TOS	0.892	0.736	0.412***	0.298***	0.180**	0.858		
BTE	0.856	0.666	0.066	0.258***	0.096†	0.003	0.816	
BPB	0.704	0.527	0.355***	0.220**	0.142*	0.573***	0.063	0.669

Significance of Correlations: † $p < 0.100$, * $p < 0.050$, ** $p < 0.010$, *** $p < 0.001$

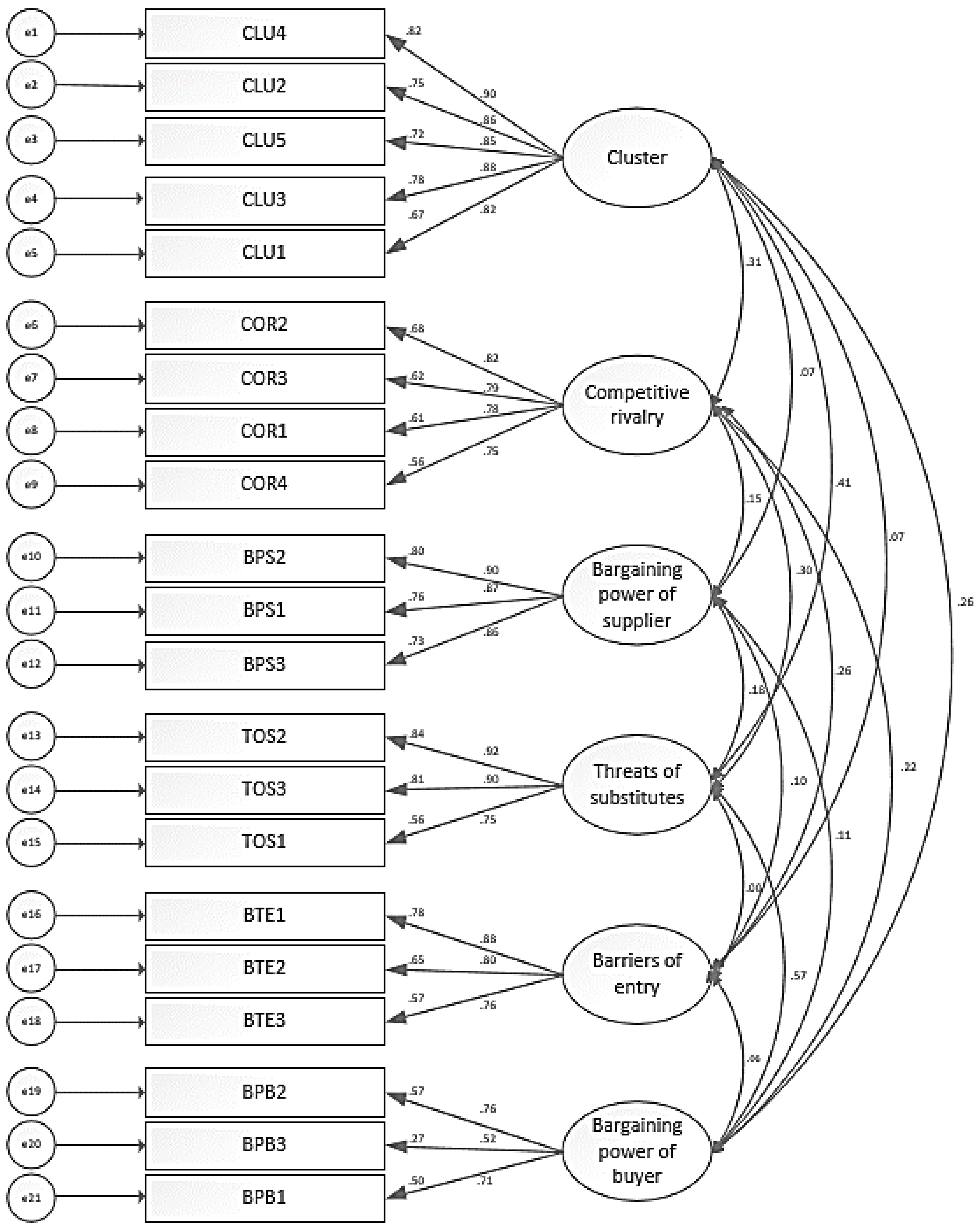


Figure 6.11: Final full measurement model of inter-firm competition in PCLC

6.5 MEASUREMENT MODEL INVARIANCE (CFA)

The next section examines the similarity and/or difference between different groups of respondents. The purpose here is to compare same model across the groups and find the similarity or difference. The invariance at the measurement model level is pre-requisite to compare the model at the structural level. The thesis hypothesises that the measurement items of the constructs (i.e. PCLC, *competitive rivalry, barriers to entry, bargaining power of buyer, bargaining power of supplier, and threats of substitute*) are invariant across the logistics firms that work within and outside the port cluster. This reflects that the measurement items measure the same underlying constructs across two different groups that are within and outside Port of Melbourne vicinity (Byrne, 2016).

In seeking the multi-group invariance, this study seeks to answer two questions:

- Do the measurement instruments of the constructs (PCLC, *competitive rivalry, barriers to entry, bargaining power of buyer, bargaining power of supplier, and threats of substitute*) operate in a similar way across these groups; that is the firms within or outside the port-centric logistics cluster?
- Is the factorial structure of single item or of the theoretical construct (e.g., PCLC) equivalent between two groups (i.e. within the clustered and non-clustered environment)?

6.5.1 Establishing the baseline model

To test measurement instrument invariance the respondents are divided into ‘within cluster’ and ‘outside the cluster’ based on their location and distance from Port of Melbourne as centre: 248 firms are classified within PCLC and other 131 firms operate away from the port. The final modified model established during the CFA is considered to be the baseline model and is run for firms within the PCLC and outside the PCLC. The findings of the baseline model yield model fit which means it is identical across both the groups.

6.5.2 Testing configural invariance

Configural invariance is a measure of the equality of the base factor structure that exists among groups (Byrne, 2016). Hair et al. (2006) proposed that after dividing the data into groups of within and outside the clustered environment, an appropriate level of model fit, and the construct validity is required to be shown by the groups. This is also known as totally free multiple group model. Here all free parameters are estimated freely, hence they are free to take different values between the groups (Hair et al., 2006).

Configural model is also considered to be the baseline model (Byrne, 2016). As it is a baseline model, the overall model fit is therefore to be assessed. The goodness of fit with multigroup parametrization is good too as evident in Table 6.27. The normed chi-square value is 2.04, which is within the threshold value. Other measures of fit indices such as absolute fit indices, incremental fit indices, and parsimony fit indices are also within the acceptable range.

Table 6.27: Statistics of Fit Indices of Configural Model

Chi-Square	**Degree of freedom**	**χ^2/DF**	**Absolute Fit Indices**		**Incremental fit index**	**Parsimony fit index**
χ^2	DF		RMSEA	SRMR	CFI	PNFI
712.42	348	2.047184	0.053	0.059	0.917	0.706

6.5.3 Testing metric invariance

Metric invariance establishes that in addition to latent factors be measured by the same measurement items, the factor loadings of the items must be equivalent across the groups (Byrne, 2016). The invariance at this stage suggests that the construct has the same meaning across the group. The significant difference between factor loading arises from the differences among the underlying construct that is being assessed by the measurement instruments. In order to assess the metric invariance, a chi-square difference test is conducted between configural model, which is a baseline model, to the model where factor loadings are constrained to be equal across the groups (Hair et al., 2006). The metric invariance is tested by constraining the factor loadings to be equal between the groups, that are within PCLC and outside port cluster.

No significant difference of chi-square difference test is found; hence the factor loadings are similar across both groups (see Table 6.28). The metric invariance indicates that group comparisons of factor variance and covariances are defendable but unable to justify comparisons of group means (Hair et al., 2006).

Table 6.28: Model Comparison of Configural and Metric Invariance

Model Tested	**Model Fit Measures**				**Model Differences**			**Comments**
	χ^2	DF	RMSEA	CFI	Difference of χ^2	Difference in degree of freedom	*p*	
Configural Invariance	712	348	0.053	0.947				
Metric Invariance	726	369	0.048	0.939	14	21	0.4	Not Significant

Hair et al. (2006) identified that in the metric invariance, the difference in chi-square and degree of freedom is taken from the previous model, which is configural model. The chi-square difference is 14 and the degree of freedom difference is 21, which indicates the non-significant difference. Hence, the metric invariance test holds true for this model.

6.6 SUMMARY

The chapter presented the results of first three stages of research framework. The first stage identified the sub-industries that represent PCLC. The main sub-industries with high PCL employment include road freight, postal services, warehousing and freight forwarding services. A new method is developed to delineate the geographic boundary of PCLC, which was anchored on Melbourne CBD using three key principles of concentration, spatial contiguity and distance decay. The PCLC is mapped which shows a larger concentration of PLC employment in the western part of Melbourne such as Altona, North Melbourne, Laverton and Footscray.

This chapter also presented the approaches adopted to validate the research items and full measurement model. The model fits the data well. Measurement items are invariant across the groups at both configural and metric level. This concludes that the measurement items represent same construct within and outside port-centric logistics cluster at measurement model level.

The next chapter will discuss the descriptive findings of key constructs used, the fourth stage of this study and discussion on hypothesis testing.

CHAPTER 7

RESULTS, ANALYSIS AND DISCUSSION

7.1 INTRODUCTION

This chapter presents and discusses the key findings of the analyses carried out in this study. Findings of the results of the structural model are examined to compare the theory tested against the empirical data collected. In particular, the hypotheses that are established to evaluate the theory of clustering, are tested for their ability to explain the effect of spatial clustering on various facets of inter-firm competition. Finally, a multi-group analysis is conducted to examine inter-firm competition between firms located inside and outside the port-centric logistics cluster through competitive rivalry. This chapter specifically addresses the following question:

- Do the effects of PCLC on inter-firm competition through competitive rivalry exhibit strongly, when firms are clustered around the port?

7.2 KEY FINDINGS

This research has developed a method to delineate the boundary of of PCLC in Melbourne and empirically examined the relationship of PCLC with the inter-firm competition. The key findings of this study that includes descriptive results, structural model and the moderating effect of port on inter-firm competition through competitive rivalry are discussed as follows.

7.2.1 Levels of inter-firm competition

Figure 7.1 presents an overview of the mean scores of the dimensions of inter-firm competition. To measure the survey responses a 5-point Likert scale (1 = strongly disagree through to 5 = strongly agree) was used.

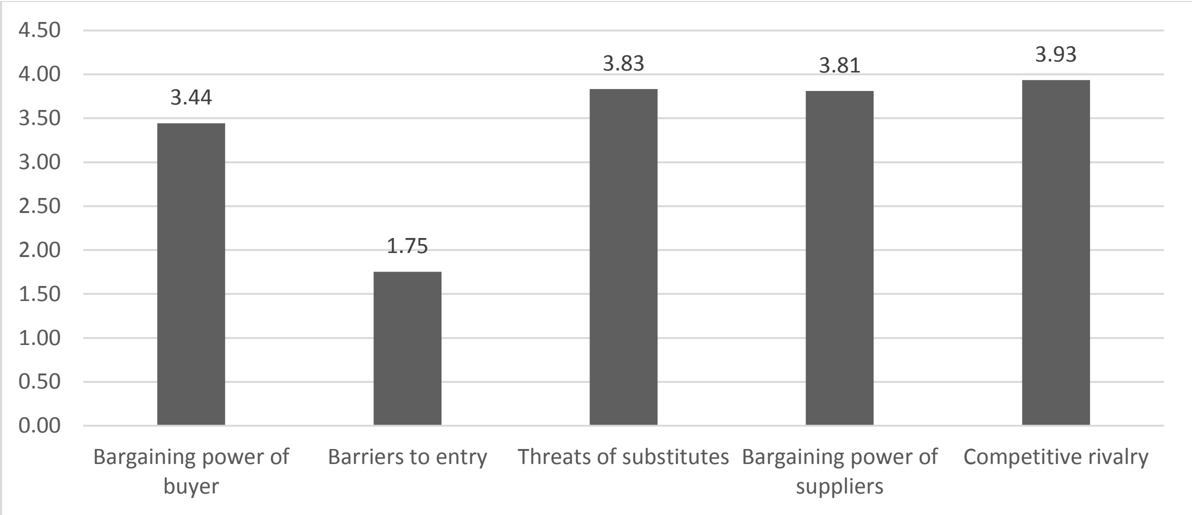


Figure 7.1: Overview of mean scores of inter-firm competition dimensions

The results indicate that five constructs that represent inter-firm competition have shown a high degree of competition except for '*barriers to the entry'*. The mean values of '*competitive rivalry'* and '*threats of the substitutes'* are relatively higher when compared to '*bargaining power of supplier'* and '*threats of substitutes'* for all the firms that are surveyed. The '*barriers to entry'* are perceived to have shown the lowest score which indicates that the logistics firms in Melbourne have relatively an ease to set up their business. This may be because of the low capital investment required in the logistics industry as compared to other industries such as manufacturing. Moreover, logistics being a deregulated sector has fewer government regulations that hinder the businesses that operate within this sector. This might have resulted in lower levels of '*barriers to entry'* for the businesses.

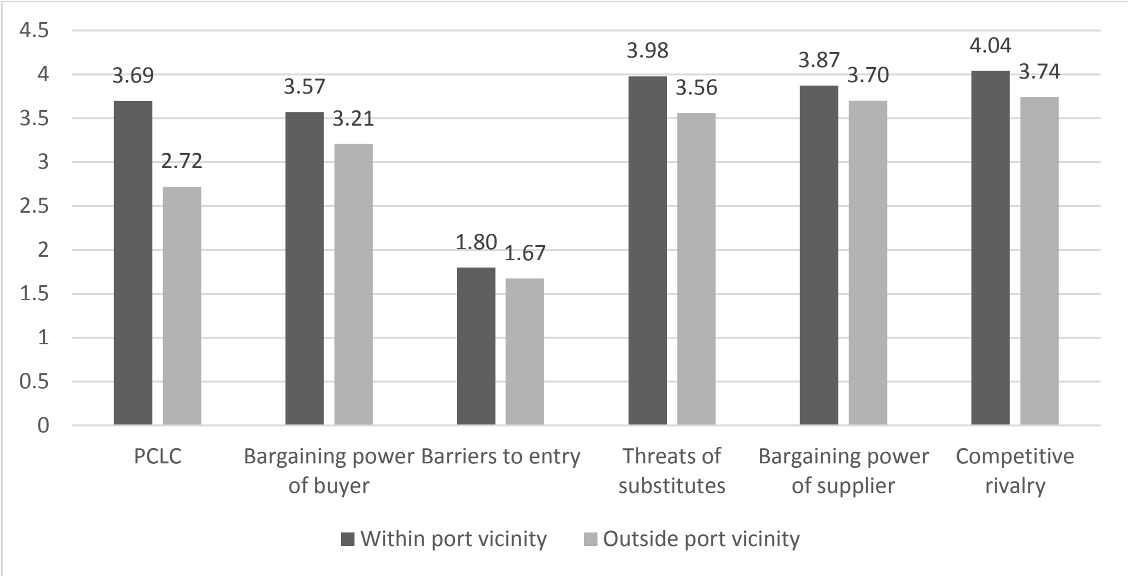


Figure 7.2: The effect of port geography on the constructs

When these mean scores are compared between the two groups (i.e. within and outside PCLC), the results clearly show (see Figure 7.2) the effect of port geography on various constructs of inter-firm competition among logistics firms. Logistics firms, when located within the port proximity, are more likely to attain a higher mean score for all the constructs than those located away from the port cluster. As shown in Table 7.1, the results of t-test also show that the differences in mean scores on inter-firm competition constructs within and outside the cluster are statistically significant ($p<.05$).

Table 7.1: Independent Sample t-test on firms' location (within or outside the port-centric cluster)

Constructs	**Mean**	**t**	**p**	**Mean Difference**	**Std Error**
PCLC	3.36	11.977	0.000	0.97	0.081
Bargaining power of buyer	3.44	4.93	0.000	0.36	0.073
Barriers to entry	1.75	1.982	0.050	0.12	0.062
Threats of substitutes	3.83	5.688	0.000	0.42	0.074
Bargaining power of supplier	3.81	2.057	0.041	0.17	0.083
Competitive rivalry	3.93	3.288	0.001	0.29	0.09

The difference in the mean scores could be attributed to greater access or availability of resources, easy access to suppliers and the customers, a higher tendency of inter-firm interaction, and knowledge sharing for firms within-cluster near the port when compared to those located at a distance. Gaining scale economies due to firms' proximity to the port is the key benefit for firms, which is often not viable to gain in isolation (Chhetri et al., 2014; Singh et al., 2016).

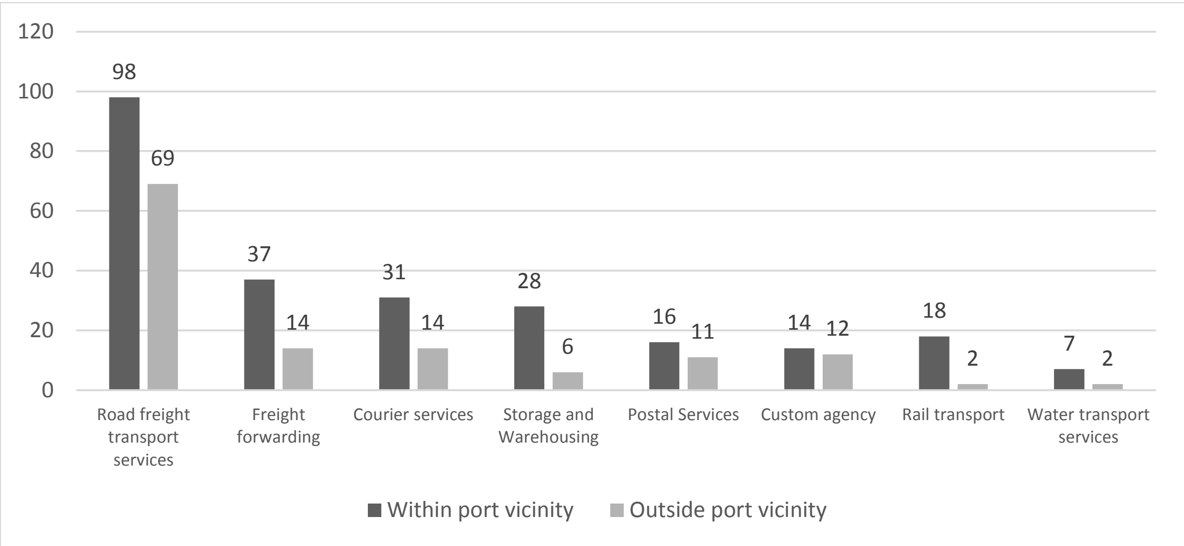


Figure 7.3: Organization Types

Figure 7.3 shows the number of organizations types that participated in the survey representing the port-centric logistics cluster. Most of the firms represent road freight transport followed by the freight forwarding sector. Around a total of 43.4 per cent of the firms that were surveyed in Melbourne represent road freight transport services. Higher participation within the port vicinity is also evident from Figure 7.3. The increasing trade volume and the growing throughput of Port of Melbourne may be the reason for logistics firms clustering around the port. This agglomeration of logistics firms happens in order to assist an easy and efficient movement of freight to and from the Port of Melbourne.

Figure 7.4 shows that most of the firms that participated in the survey in Melbourne are small and small to medium industries with an employee count of less than 50. Further, it is observed that the size of most of the road freight transport firms in Melbourne is small which is validated in this study through the survey findings (see Figure 7.4). Only a few industries were large industries having more than 500 employees.

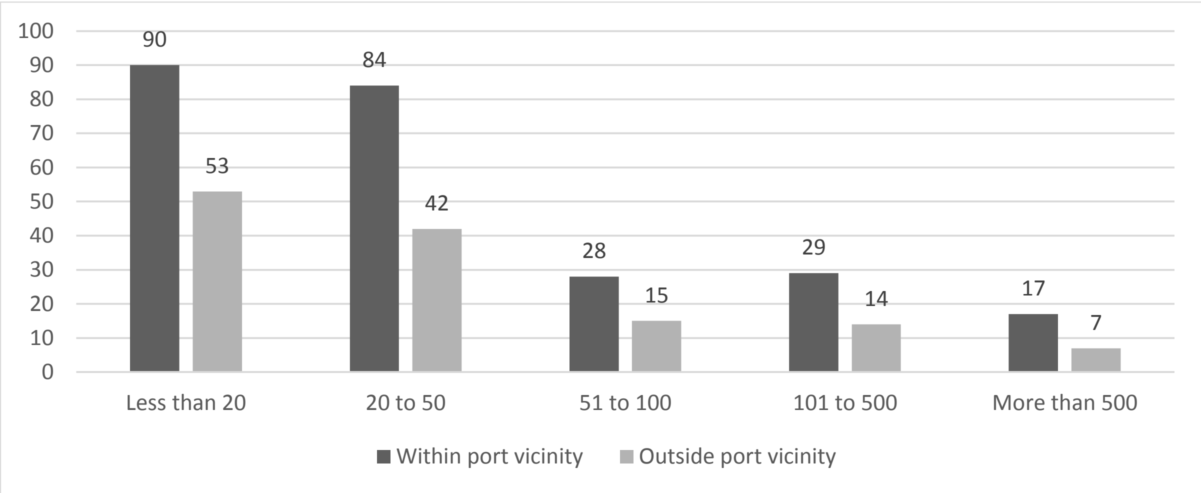


Figure 7.4: Size of organizations

Port-centric logistics cluster

As shown in Figure 7.5, more than 53 per cent of the firms involved in port-related activities and their businesses are somewhat affected by the proximity factor. A large proportion of customers are found to be closer to the supplier's business locations. 54 per cent of the firms reported that the suppliers they are dealing with are relatively nearer to the location from where they operate their business. Further, 65.9 per cent of the firms respond that their companies involve in having a transactional/business relationship with the firms that are closer to them. Around 46.7 per cent of the respondents indicate that the reason for choosing their business location is due to the proximity and easy access to their suppliers. This shows a tendency for creating an ecosystem of firms which co-locate with other interrelated and interdependent businesses to gain the benefits of accessibility and availability of resources, easy communication, and reduced transaction cost due to proximity. The finding, therefore, attests to the tendency of logistics firms to fetch/draw their business from the port and operating within the port vicinity.

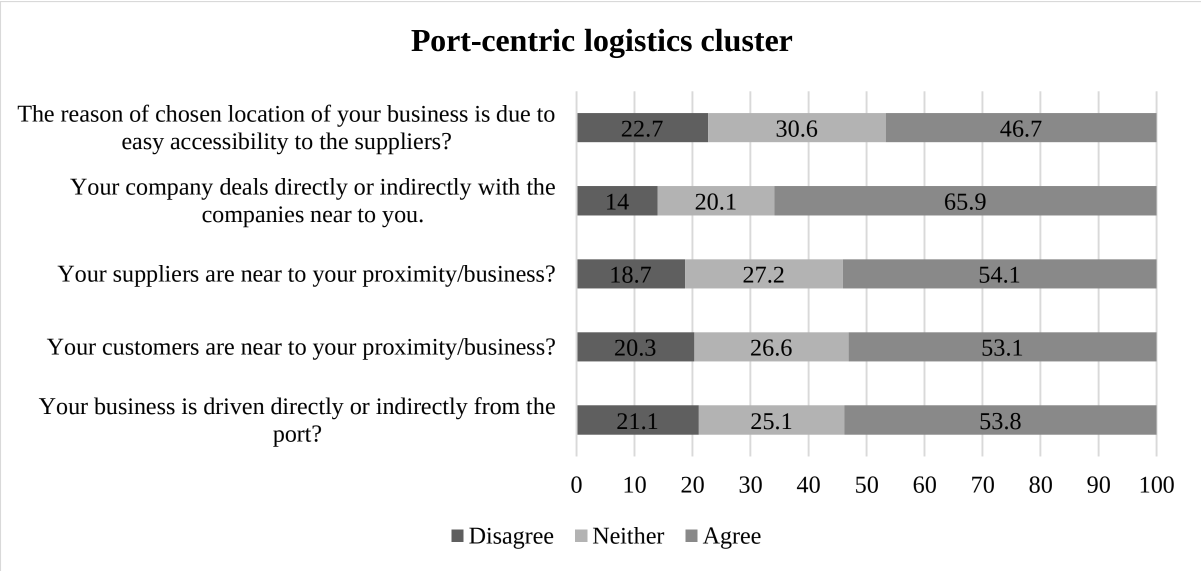


Figure 7.5: Port-centric logistics cluster

Competitive rivalry

The items to measure the competitive rivalry among port-centric logistics firms are presented in Figure 7.6. Around 80.4 per cent of the respondents reported in the survey that there are numerous firms that offer similar services in Melbourne. A total of 81.6 per cent of firms indicate that they compete with other businesses on the basis of the cost of services that they offer; while 73.8 per cent of firms responded that they compete on the basis of the quality of service they provide. Further, 75.7 per cent of the respondents specify that they compete based on the customised services that they offer as compare to their competitors. The results show that the intensity of the competition among the port-centric logistics firms is affected by the number of firms that offer similar services at competitive prices. It is also found that competition is further intensified if the firms provide customised services.

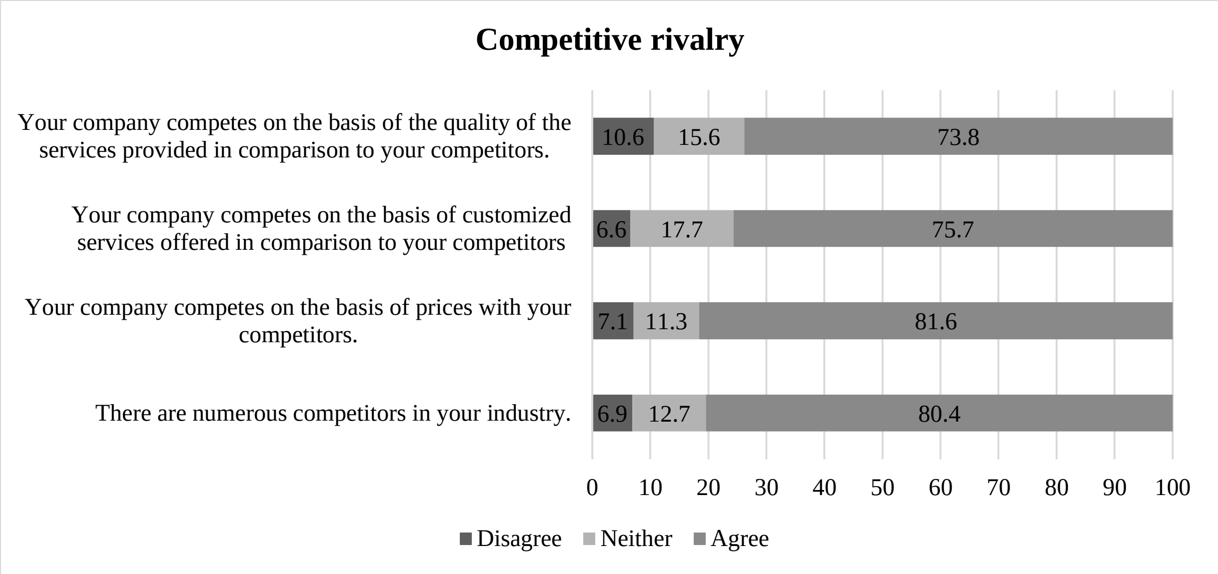


Figure 7.6: Competitive rivalry

Barriers to entry

The measurement items to examine the *barriers to entry* among the port-centric logistics firms and their results are shown in Figure 7.7. Around 19.5 per cent of the survey respondents indicate that government policies are not a barrier to enter into the port-centric logistics industry. 29 per cent of the firms, however, acknowledged that there is a need to use advanced technology by the new entrants to enter into the logistics sector to improve their competitiveness. Only 18.5 per cent of the respondents report that a new company needs high investment to start their business. Overall, the survey result indicates that most of the respondents believe that the government policies, high capital investment and advanced need of technology are not the major hurdles to enter into the logistics business. It is implied that it is relatively easy for a new firm to start a business in port-centric logistics industry. They are less likely to be influenced by the *barriers to entry* including government policies, use high tech instruments and high capital cost.

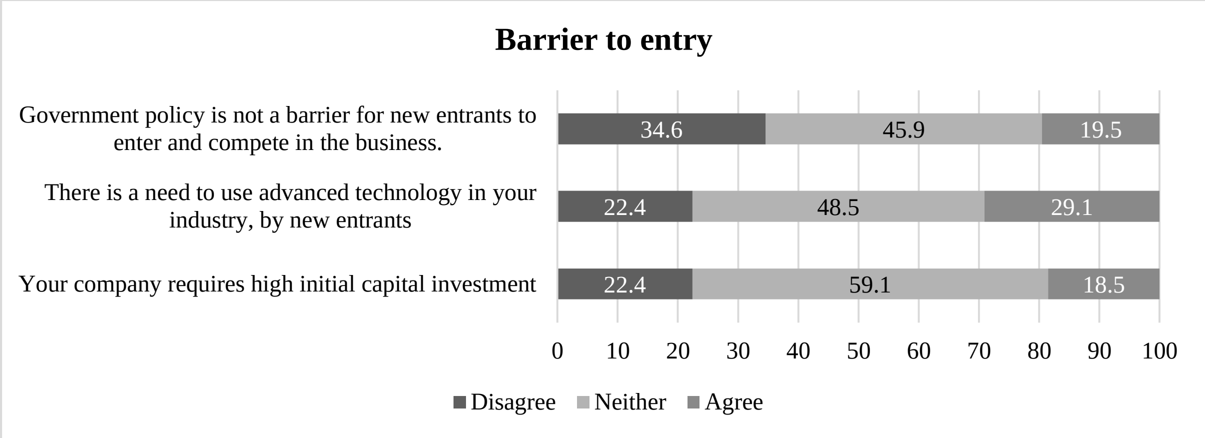


Figure 7.7: Barriers to entry

Threats of substitutes

As shown in Figure 7.8, the survey respondents state that their competitors offer many substitute services (78%) and their business is affected by the services offered by their competitors (77.3%). Further, 77 per cent of the firms suggest that their competitors offer equal or better services as compare to their services. The overall survey result indicates that more than 75 per cent of the respondents report that their businesses are affected by the substitute services that are offered by other companies in the port-centric logistics sector. This shows high levels of *threats of substitutes* in the PCL sector whereby their businesses are likely to be severely impacted by the substitute services.

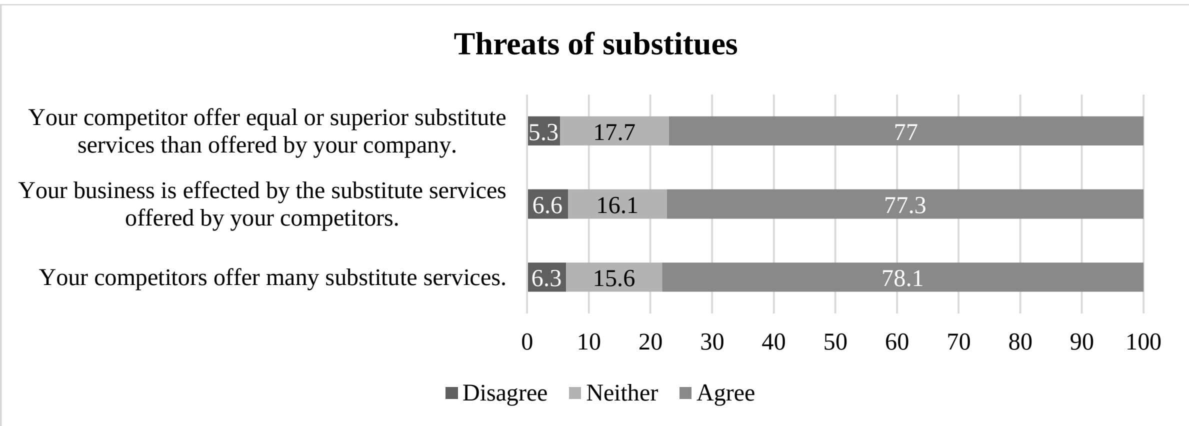


Figure 7.8: Threats of substitutes

Bargaining power of buyer

The measurement items that are used to represent the bargaining power of buyer are shown in Figure 7.9. 83 per cent of the firms understood the fact that the power to control the price of the services lies with the buyers. Buyers have more options to access the services from their competitors at a lower price (81.5%). This is because of the availability of numerous suppliers that offer similar services in the logistics sector. Moreover, buyers are highly price-sensitive, which drives them to find competitively priced services (79.7%). Overall, the results show a high *bargaining power of buyers* in PCL industry whereby buyers have more control over the price of the services.

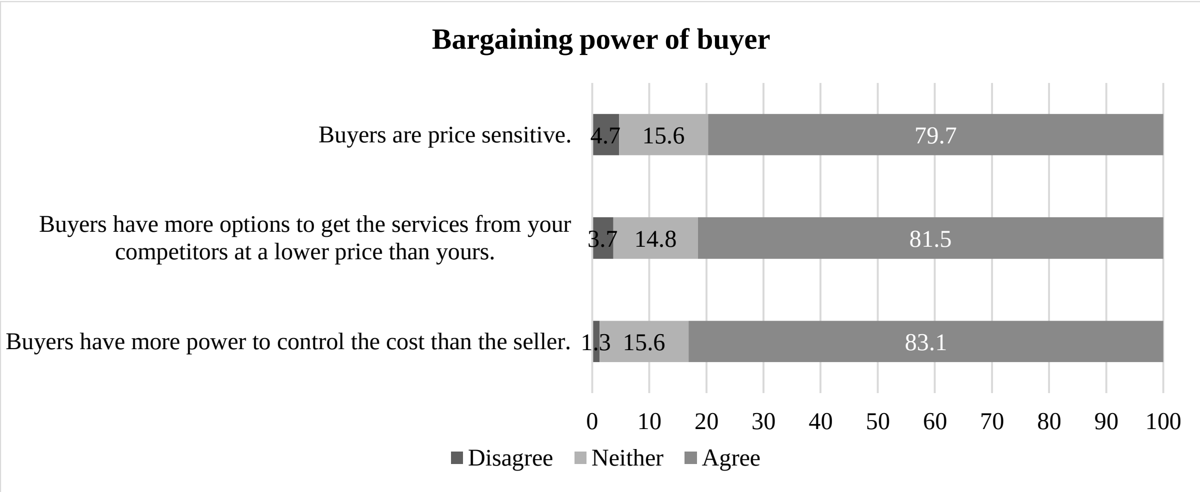


Figure 7.9: Bargaining power of buyer

Bargaining power of suppliers

There are three items to measure the bargaining power of buyer which are presented in Figure 7.10. 73.6 per cent of the respondents indicate that the buyers can easily switch suppliers as they have access to numerous suppliers that offer similar services. Further, 72.5 per cent of the firms believe that their competitors influence the price of the service they offer. 80.7 per cent of the firms claim that they struggle to sell their services because of the substitute services available and their easy accessibility to buyers. Overall, the survey result indicates a low *bargaining power of suppliers* and have relatively lesser power to control the price of the services they offer.

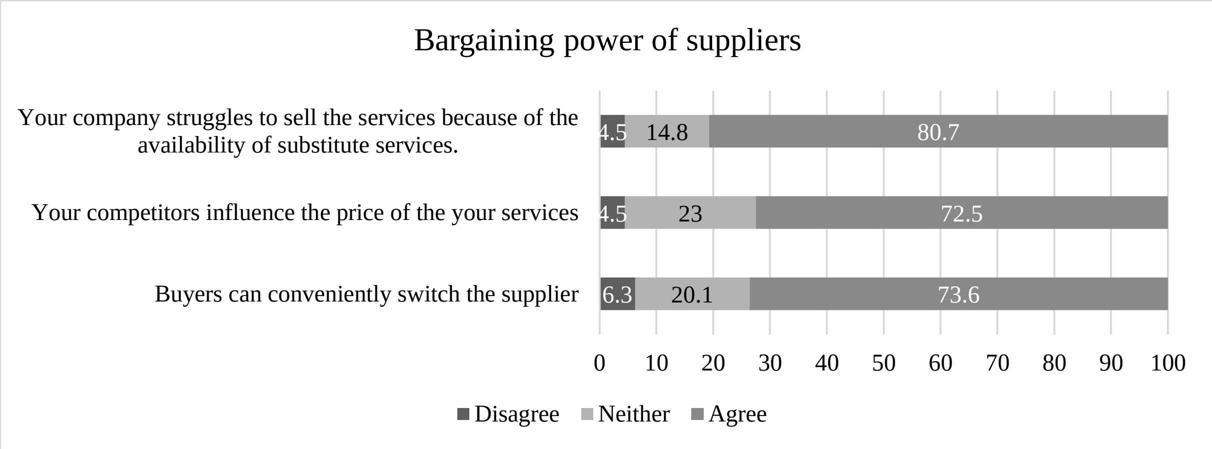


Figure 7.10: Bargaining power of suppliers

Overall, the survey results indicate that the PCL industry reflects a high level of competitive rivalry, threats of substitutes and bargaining power of buyers. Whereas, a low level of barriers to entry and bargaining power of suppliers are exhibited in the PCL sector, in Melbourne.

7.3 THE STRUCTURAL MODEL: RESULTS AND ANALYSIS

This section presents the key findings of the structural relationships between the constructs by utilising the measurement model. The full measurement model is tested by checking the validity and reliability of the model. The correlational relationships that were created during CFA are changed to dependence relationships in the structural model.

There are two ways to design the structural model in SEM (Hair et al., 2006). These are as follows:

I. First is to keep the factor loading, and error variances fixed for the structural model, which are obtained from the measurement model. This means loading estimates are no longer be free parameters;

II. Second is to allow the factor loadings and error variances to be freely estimated.

The rationale of the first approach is, as the values are known so should not be subjected to change in the structural model because of the change in the nature of relationships. However, even if they change that will be the case of interpretational confounding which means the loadings of one construct are affected by the relationship pattern between the constructs, but loadings should not change. The disadvantage of this method is that the change in fit between CFA and the structural model is due to the measures instead of the structural model. The second approach is simple as it provides interpretational confounding by comparing the loading estimates of CFA with the structural model. Small fluctuation is expected (0.05 or less) (Hair et al., 2006). Another advantage of the second approach is the convenience of comparing the model with the original CFA model fit to assess the fit for the structural model. The second approach is the most commonly used approach (Hair et al., 2006; Kline, 2015). Therefore, this study uses the second approach of comparing the structural model with CFA fit.

7.3.1 Assessing validity of Structural Model

The validity and acceptability of the structural model can be evaluated in terms of

(1) model fit, that is, GOF indices;

(2) comparing factor loadings of the structural model to that of the underlying measurement model;

(3) the magnitude of variance explained, that is, R^2; and

(4) the size, direction, and significance of the estimated structural parameters (Hair et al., 2006).

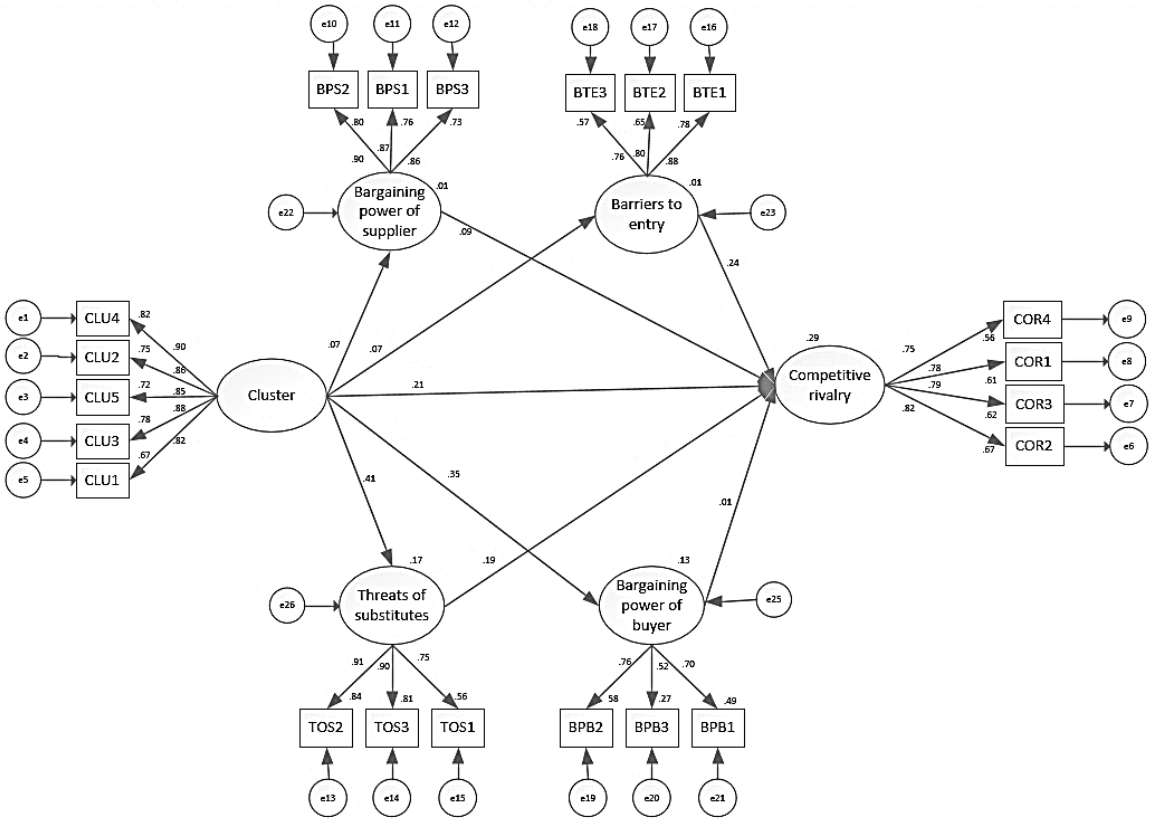


Figure 7.11: Structural model of the effect of PCLC on inter-firm competition

The structural model is shown in Figure 7.11. The structural model is evaluated on the basis of four criteria that are mentioned above. ***The first step*** compares the structural model fit against the CFA model. The fit indices of the structural model, do not show any significant deviation from the measurement model. The structural model's normed chi-square (χ^2/DF) is within the acceptable range. Both the incremental fit indices, which are CFI and TLI, meet the threshold of 0.92 and above. The model's absolute fit indices values, as reflected by RMSEA and SRMR, are less than 0.08 which is within the acceptable range.

Table 7.2: Comparison of model fit between CFA and structural model

Model Fit Measures			
Statistics	**Abbreviation**	**CFA Model**	**Structural Model**
Chi-Square	χ^2	388.94	401.808
Degree of freedom	DF	174	179
χ^2/DF		2.235	2.245
Absolute Fit Indices	RMSEA	0.06	0.057
	SRMR	0.042	0.043
Incremental fit index	CFI	0.956	0.955
	TLI	0.946	0.946
Parsimony fit index	PNFI	0.77	0.77

There is a slight difference in absolute fit indices between measurement and structural models, but it is not statistically significant. Weston and Gore (2006) argued that the difference between SRMR values of measurement and structural model can go as high as 0.15 if the model has less than 30 measurement items and a sample size of less than 500. Both of these are applicable in this study, which indicates the model provides a good fit. The difference between the chi-square value is 12.88 but there is also a difference of 5 in the degrees of freedom between two models, in turn, reflecting no significant difference between normed chi-square values. The absolute fit indices, RMSEA and SRMR, show a slight difference between CFA and structural model with little higher values in the structural model (see Table 7.2) but these are within the acceptable range (Hair et al., 2006). All the measures are within the threshold range, in turn, reflect the goodness of fit. Moreover, the structural model did not change from the CFA model. Hence, the full structural model is supported and accepted.

The second step is to investigate the difference of loading estimates of the structural model with the CFA model which is shown in Table 7.3. The structural model is expected to have the same factor loadings as in the CFA model. The results show that most of the loadings remained unchanged in the structural model. However, a small change is noted in some factor loadings (see Table 7.3) but they are not significant and also not above the acceptable threshold of 0.05 (Hair et al., 2006).

Table 7.3: Standardised regression weight difference between CFA and structural model

Standardized Regression Weights of the measured variables					
Items		**Construct**	**CFA Model**	**Structural Model**	**Difference**
CLU4	<-	CLU	0.905	0.905	0
CLU 2	<-	CLU	0.865	0.865	0
CLU 5	<-	CLU	0.849	0.849	0
CLU 3	<-	CLU	0.884	0.884	0
CLU 1	<-	CLU	0.821	0.821	0
COR2	<-	COR	0.822	0.821	0.001
COR3	<-	COR	0.79	0.79	0
COR1	<-	COR	0.783	0.782	0.001
COR4	<-	COR	0.752	0.751	0.001
BPS2	<-	BPS	0.896	0.896	0
BPS1	<-	BPS	0.869	0.869	0
BPS3	<-	BPS	0.856	0.855	0.001
TOS2	<-	TOS	0.914	0.914	0
TOS3	<-	TOS	0.902	0.902	0
TOS1	<-	TOS	0.747	0.746	0.001
BOE1	<-	BTS	0.882	0.883	-0.001
BOE2	<-	BTS	0.804	0.804	0
BOE3	<-	BTS	0.758	0.756	0.002
BPB2	<-	BPB	0.763	0.763	0
BPB3	<-	BPB	0.521	0.522	-0.001
BPB1	<-	BPB	0.706	0.7	0.006

The ***third step*** is to examine the variance explained of the ultimate dependent (endogenous) variable that is the competitive rivalry. As noted in Figure 7.11, the model explains 29 per cent of variance in competitive rivalry which is acceptable (Cohen, 1988; Falk and Miller, 1992; Chin, 1998). This result supports the validity of the structural model.

The ***fourth step*** of establishing the validity of the structural model is to investigate the size, direction, and significance of the parameter estimates. Table 7.4 presents the structural path estimates.

Table 7.4: Structural path estimates

Size, Significance, and Direction of the Structural Path						
Constructs			**Estimate**	**S.E.**	**C.R.**	**P**
BTE	<--	CLU	-0.05	0.042	1.171	0.242
BPS	<--	CLU	0.065	0.049	1.334	0.182
BPB	<--	CLU	0.31	0.054	5.731	***
TOS	<--	CLU	0.343	0.044	7.789	***
COR	<--	CLU	0.196	0.056	3.497	***
COR	<--	TOS	0.217	0.083	2.629	0.009
COR	<--	BPB	0.008	0.085	0.098	0.922
COR	<--	BTE	-0.294	0.07	4.224	***
COR	<--	BPS	0.092	0.057	1.612	0.107

As shown in Table 7.4, four paths are found to be significant at a 99 per cent confidence level. These include:

- cluster to *bargaining power of buyer* with the standardised estimate of 0.31,
- cluster to *threats of substitutes* with the standardised estimate of 0.343,
- cluster to *competitive rivalry* with the standardised estimate of 0.196, and
- *barriers to entry* to competitive rivalry with the standardised estimate of 0.294.

These path estimates show significant t-values, which are represented as C.R in Table 7.4. Four paths are found to be statistically insignificant include cluster to *barriers to entry* with standardised estimate of 0.05, cluster to *bargaining power of supplier* with standardised estimate of 0.065, *bargaining power of buyer* to *competitive rivalry* with standardised estimate of 0.008 and *bargaining power of supplier* to *competitive rivalry* with standardised estimate of 0.092. *Threats of substitutes* to *competitive rivalry* has emerged significant at a 90 per cent confidence level with standardised estimate of 0.217. This provides further support to the structural model.

7.4 MULTIGROUP ANALYSIS (STRUCTURAL INVARIANCE)

The structural model invariance is tested following the same steps that are used to test measurement model invariance in chapter 6. To investigate the structural model invariance firstly, at least partial metric invariance should be met for the measurement model to ensure that the constructs can be compared (Hair et al., 2006). The reason for this is to ensure that whether the difference in the structural parameters is due to group peculiarity or if they are truly different at their structural relationship (Hair et al., 2006). The structural model comparison is most commonly used to test the moderation effect. Moderation assesses the difference in the structural relationship between the groups when the third variable is introduced. It can investigate the difference in the structural relationships on the entire model or any particular relationship between the groups.

In this study, the firms which are surveyed are divided into two groups based on their geographical location of the main operation; that are 'within the port-centric logistics cluster' and 'outside the port-centric area'. This is to evaluate the effect of the port geography on inter-firm competition among the port-centric logistics firms. The pre-requisite of measurement invariance has been achieved across the groups in chapter 6 (section 6.7).

After the groups are divided, the combined fit is assessed using model fit indices. The fit of the combined model is acceptable (χ^2=729.7, df=340, $p < 0.05$, CFI=0.915), which suggests configural invariance is achieved. This serves as the base model (model M1) for subsequent comparisons with other constrained models as presented in Table 7.5.

The model M2 is created by adding the equality constraint to the factor loadings estimates across the groups, which are created in model M1 (i.e. within and outside port vicinity). The chi-square difference between the groups M2 and M1 is found to be insignificant ($\Delta\chi2$=26.7, df=25, $p > 0.05$). This supports the measurement invariance because by adding the equality constraint the model fit did not loss. This concludes that the measurement items convey the same meaning across both groups. For example; the meaning of five measurement items that are used to examine competitive rivalry reflects the same meaning between the logistics firms that operate within and outside the port periphery. Measurement invariance needs to be established before testing the structural invariance (Blunch, 2008).

The model M3 represents the added equality constraints on all the unidirectional path estimates across the groups in the model M2. Hence, the constraints that are added in model M3 are in addition to model M2. The result of the chi-square difference between the models M3 and M2 is significant ($\Delta\chi2$=23.3, df=17, $p<0.05$). This suggests that there may be a difference of one or more structural path estimates within and outside PCLC.

To examine which particular path is not invariant across the groups each of the structural path equivalence is separately estimated, which is mentioned in the models from M3a through to M3I presented in Table 7.5. The paths which are statistically significant reflect non-invariance between the groups (within and outside PCLC)

By applying the equality constraint across each path, it was found that the models M3a, M3c, M3d, M3e, and M3g were statistically significant (see Table 7.5). All these models reflected significantly higher effect for logistics firms that are within the proximity of Port of Melbourne than those that are away. The negative path direction in model M3a reflects that the *barriers to entry* are lower within the PCLC as compared to outside. Further model M3c indicates higher levels of inter-firm *competitive rivalry* within PCLC whereas rivalry weakens as firms are spatially away from the cluster. It was also found that more power lies with the buyers to decide the price as compared to suppliers within PCLC, as revealed in model M3d. A statistically significant result of model M3e reflects a higher effect of *threats of substitutes* when logistics firms cluster around port than those operate away from the port. It is further noted that the impact of the *bargaining power of buyer* has a higher impact on *competitive rivalry* within PCLC. Whereas other paths such as M3b, M3f, M3h, M3I, when constrained to be equal, are not statistically significant which shows that the effects are not different within and outside the cluster.

In summary, the results show a statistically significant chi-square difference between the groups when paths are constrained to be equal from PCLC to *competitive rivalry*, PCLC to the *bargaining power of buyers*, PCLC to *threats of substitutes* and *bargaining power of buyer* to *competitive rivalry*. All other paths are statistically insignificant. It is therefore concluded that location, a port in this study, play an important role to stimulate inter-firm competition. This is because of the numerous competitors/firms that provide similar services that force the firms to outperform to gain a bigger market share. Moreover, the availability of resources, easy accessibility to suppliers and buyers, opportunities to work in collaboration, benefits of spill over effects and reduced transaction cost can also some of the benefits gained when firms operate their businesses near the port vicinity (Chettri et al., 2014; Singh et al., 2016).

Table 7.5: Structural Invariance

Model Tested	**Model Fit Measures**				**Model Differences**					
	X2	DF	X2/DF	CFI	Difference of X2	Difference of degree of freedom	*p*	Comments	Outside Cluster	Within Cluster
Configural Invariance *(M1 - Baseline)*	729.7	340	2.146176	0.915						
Measurement Invariance *(M2-Equal Loadings)*	756.4	365	2.072329	0.915	26.7	25	0.371			
Structural Invariance; *M3 - Equal Loadings, Structural path estimates*	779.7	382	2.041099	0.915	23.3	17	0.001	Significant		
M3a. PCLC to Barriers to entry	733.6	359	2.043454	0.915	22.8	6	0.001	Significant	-0.105	-0.132
M3b. PCLC to Bargaining power of supplier	749.1	359	2.08663	0.915	7.3	6	0.294	Non-significant	-0.033	-0.038
M3c. PCLC to Competitive Rivalry	736.2	359	2.050696	0.915	20.2	6	0.003	Significant	0.018	0.341
M3d. PCLC to Bargaining power of Buyer	734.9	359	2.047075	0.915	21.5	6	0.001	Significant	0.272	0.288
M3e. PCLC to Threats of Substitutes	734.2	359	2.045125	0.915	22.2	6	0.001	Significant	0.256	0.38
M3f. Threats of Substitutes to Competitive Rivalry	748.4	359	2.08468	0.915	8	6	0.238	Non-significant	0.209	0.237
M3g. Bargaining power of buyer to Competitive Rivalry	743.2	359	2.070195	0.915	13.2	6	0.037	Significant	0.007	0.106
M3h. Barriers of Entry to Competitive Rivalry	751.5	359	2.093315	0.915	4.9	6	0.557	Non-significant	0.158	0.295
M3I. Bargaining power of supplier to Competitive Rivalry	751.7	359	2.093872	0.915	4.7	6	0.583	Non-significant	0.06	0.076

7.5 HYPOTHESIS TESTING

The results of the final model are presented in Table 7.6. The standardised coefficients show whether the hypotheses established earlier are supported or rejected. Table 7.6 reveals the positive effect of PCLC on *bargaining power of buyer* (β = 0.31; t = 5.731, $p<0.01$), PCLC on *threats of substitutes* (β = 0.343; t = 7.789, $p<0.01$), PCLC on *competitive rivalry* (β = 0.196; t = 3.497, $p<0.01$) and the *threats of substitutes* to *competitive rivalry* (β = 0.2171; t = 2.629, $p<0.05$). These support the argument that the clustering of logistics firms has exerted a positive impact on the *bargaining power of buyers, threats of substitutes and competitive rivalry*. Thus, it is concluded that when the logistics firms operate within a clustered business environment, the *threats of the substitutes* are higher, and the buyers have more power to control the prices. This may be because more firms offer similar or alternate services within a clustered environment, resulting in buyers having more options to choose the services from. It is also evident that the firms within PCLC demonstrate higher *competitive rivalry* due to the existence of numerous firms around them which might have created a competitive environment to outperform to gain access to a larger market share.

Table 7.6: Structural path of the full structural model

Structural Parameter estimates of Impact of PCLC on inter-firm competition through competitive rivalry					
	Estimate	S.E.	C.R.	P	Hypothesis
PCLC to Barriers to Entry	-0.05	0.042	1.171	0.242	Not Supported
PCLC to Bargaining power of supplier	0.065	0.049	1.334	0.182	Not Supported
PCLC to Bargaining power of Buyer	0.31	0.054	5.731	***	Supported
PCLC to Threats of Substitutes	0.343	0.044	7.789	***	Supported
PCLC to Competitive Rivalry	0.196	0.056	3.497	***	Supported
Threats of substitutes to Competitive Rivalry	0.217	0.083	2.629	0.009	Not Supported
Bargaining power of buyer to Competitive Rivalry	0.008	0.085	0.098	0.922	Not Supported

Barriers of Entry to Competitive Rivalry	-0.294	0.07	4.224	***	Supported
Bargaining power of Supplier to Competitive Rivalry.	0.092	0.057	1.612	0.107	Not Supported
Logistics firms within port-centric logistics cluster demonstrates higher inter-firm competition through higher competitive rivalry than the firms outside the port-centric periphery	Yes				

The results also indicate a negative impact of '*barriers of entry'* on '*competitive rivalry'* (β = -.294; t = 4.224, p<0.01). This suggests that a reduction in entry barriers tends to intensify *competitive rivalry* among firms. This supports the hypothesis that if the barriers of entry are relaxed, then the firms might more likely to create higher competition through *competitive rivalry.* This is mainly because of the new businesses having easy access to operate from an established sector where many firms have already captured a big market share. This is unlike a monopoly structure where the market is characterised by a sole seller who has control over the market, where the substitutes products are not availab le and the entry barriers are higher. Port-centric logistics industry is characterised to have lower *barriers to entry* because of logistics being a deregulated sector where the government-imposed policies do not become a hindrance to set-up a new business. These low *barriers to entry* indicate that there is a higher tendency of the firms to offer similar services in this sector, therefore, there are numerous competitors offering alike services and compete against each other to gain a bigger market share that results in the higher *competitive rivalry*. A greater number of firms operating within the cluster, therefore, are more likely to enhance inter-firm competition. In other words, the logistics firms that are clustered around port exhibit higher levels of competitive rivalry than those located at a distance from the port.

Relationship between PCLC to *barriers of entry* (β = -0.05; t = 1.171, p>0.01), cluster to *bargaining power of supplier* (β = 0.065; t = 1.334, p>0.01), *bargaining power of buyer* to *competitive rivalry* (β = 0.008; t = 0.098, p>0.01), and the *bargaining power of supplier* to *competitive rivalry* (β = 0.092; t = 1.612, p>0.01) are found to be insignificant. Hence, it is concluded that the structural relationships between these, as proposed in the theoretical framework, are not supported in this research context.

7.6 DISCUSSION

The role and significance of PCLC are increasing due to the growth in globalization led international trade. This growth requires an efficient logistics system to deliver the products as the production facilities are spatially dispersed and concentrated in developing countries. To achieve logistics efficiencies the companies tend to work in freight villages to conduct the activities relating to transport, logistics, and distribution of the goods and services for both national and international accounts (Mangan et al., 2008b). These freight villages have been labelled with other names such as Distriparks (van Horsen, 1991; Eller, 1995; Nam et al., 2011), Districenters (De Langen, 2004), Dry ports (Raso et al., 2009; Monios and Wilmsmeier, 2012), and Logistics Clusters (Sheffi, 2013; Chhetri et al., 2014). This study posits the empirically grounded concept of port-centric logistics cluster (PCLC) that represents the aggregation of logistics firms that collaborate and compete to support the port operation and management. The evolution of port-centric logistics as an emerging discipline has resulted, to a large extent, from the increasing demands of shippers, customers and the rapidly changing role of ports in the context of supply chains. Therefore, the aim of this study is to examine the type of industries that represent PCLC in Melbourne, spatial spread of port-centric logistics cluster in Melbourne followed by empirically examining the effect of PCLC on inter-firm competition through competitive rivalry. This spatial agglomeration of port-related logistics activities is captured in Melbourne, Australia.

7.6.1 Identification of PCL industry in Melbourne

The surge of transnational companies and the requirement of a responsive supply chain have transformed the way how ports operate nowadays. The modern ports act more as logistics hubs where logistics firms are agglomerated to provide value-added services than offering just the traditional services in the global network. Port of Melbourne is a trade gateway of state of Victoria and is one of the busiest container ports in Australia (Department of Transport, 2019) from where a number of logistics firms provide differentiated and value-added services to support port operation and management. This study found that the services offered from PCLC in Melbourne consist mainly of road freight transport, postal services, freight forwarding, warehousing, and courier services.

This study observed that among all other types of firms, road freight transport was found to be the biggest employers of PCL employment. This may be due to the increased throughput of Port of Melbourne which was estimated to be 3.02 million TEU in the year 2018-19 which was 3.1 per cent higher than last year (Port of Melbourne, 2018-19). This increase in container throughput needs an efficient door to door delivery in which road freight transport is the most suitable mode of delivery. Based on this outcome the policies can be formulated that support the collocation of other road freight transport or supporting industries, by giving some incentives through lower taxes or monetary benefits. Busan Port is such an example where government support is available for the firms that work within-cluster near port proximity (PortNews, 2017). This collocation will further strengthen the cluster through the collaborative use of resources which may help to reduce the transport cost and congestion along the corridor (Monios and Wilmsmeier, 2012; Sheffi, 2013; Singh et al., 2016).

However, the effect of this collocation on the firm's collaboration, reduction in transport cost and congestion issues needs further investigation. Zhu et al. (2002) claim that this development of a logistics hub around the port may help in offering integrated logistics services which will impact the economic growth of the region. The world-renowned ports such as Singapore Port, London Port, Busan Port, and Port of Rotterdam are few examples where logistics firms work in an integrated fashion around the port.

To support the growth and progress of the maritime sector in Australia "The Maritime Workforce Development Forum" was established in early 2012. One of the strategic recommendations put forward was to establish an Australian maritime cluster (Maritime Workforce Development Forum, 2013). This strategy with some other important strategies like a target on training new entrants, monetary support from the government for training, and collaboration with other sectors, was made to secure the future of the Australian maritime and port logistics industry. To take an initiative in this path the shipping reform (Tax incentives) Act 2012 has started encouraging commercial companies to perform cluster related activities (form and work in a cluster) to be eligible for tax exemptions.

7.6.2 Changing role of ports and mapping the PCLC in Melbourne

The evolution and transformation of ports have been witnessed over time in terms of functionality, external environment, spatial and port organization, and strategic direction. Nam and Song (2011) identified that the contemporary ports attempt to offer differentiated services to add value in the final product to serve the customer better than ever. Whereas Flynn and Lee (2011) noted that the modern ports are becoming more customer-centric which they discussed by identifying the generations of the port from first through to the fifth generation. They further added that the fifth-generation ports tend to offer the services that are more integrated, lean, responsive, external environment focussed and designed to cater to the individual customer based on their requirement. However, there seems a lack of studies that explicitly discussed the role of the port in providing the environment that is more competitive for logistics firms that are clustered around it.

Porter (2000) identified that the clustered environment provides an opportunity to the firms, that work within, to enhance their performance through high collaboration and inter-firm competition. This inter-firm competition helps in increasing the productivity of the region and also provides efficiency gains. This study fills the gaps by empirically examining the effect of PCLC on inter-firm competition which is found to be higher within-cluster environment. However, the effect of this higher inter-firm competition on productivity, performance and innovation capabilities needs to be empirically evaluated.

It is argued in this study for the existence of a port-centric logistics cluster in Melbourne based on three criteria that include the principle of concentration, the principle of spatial adjacency and the principle of distance decay using JTW census data. Many authors have used employment as a measure to define, identify and delineate the boundary of subcentres (Giuliano and Small, 1991). Research led in the United States (US) used employment density, commute time and distance from the CBD, as proxies or thresholds for conceptualizing Activity Centres impacts (Gordon and Richardson, 1996). Dunphy (1982), in Washington DC, used the data at block level to demarcate the boundary of activity centres based on employment densities. A study conducted in Cleveland used census data of employment to identify clustering of specialized industries using location quotient (Bogart and Ferry, 1999). Our findings suggest that the PCLC in Melbourne discerns more towards the western suburbs that include Altona, Footscray, Sunshine, and Laverton. Chhetri et al. (2014) identified a few suburban spatial employment logistics clusters that have evolved towards the south-east of

Melbourne. The existence of these suburban clusters may be due to increasing city congestion, and higher demand due to population growth in these areas.

The effective freight distribution requires easy connectivity and locational proximity to the customer base which are also termed accessibility and centrality (Robinsons and Bamford, 1978). Port of Melbourne may serve as a central location for freight distribution activity because of the easy accessibility and links to high-quality roads. Falker (2006) identified that the port-centric approach is a strong case to be developed because the maritime freight has to pass through ports and ports provide an opportunity to offer value-added services on-site that may include consolidation, postponement, light manufacturing and break bulk. The operational efficiencies can be gained by providing these services around the port within a clustered environment because the scale economies can be ascertained (Pettit and Beresford, 2009). Whereas, suburban logistics clusters may increase the freight miles, in turn, increase the transport cost. The ports tend to offer the best location for setting up the distribution centre by the retailers and manufacturers which in turn may offer more employment opportunities and help them bring their supply chain cost lower through the reduction in last-mile problem and resource sharing among the partners (Mangan et al., 2008).

Our findings suggest that the PCLC in Melbourne can be considered as a functional node for agglomeration of economic activities that can form a focus of innovation (Rodrigue and Hesse, 2007). The firms when collocate within-cluster increases the scope of activities to offer value-added services in addition to conventional services (Mangan et al., 2008; Sheffi, 2013). Hence, the logistics agglomeration around the key strategic hubs such as ports may significantly contribute to the regional economy and encourage other firms to collocate their business within the cluster. The spatial concentration of logistics firms around the Port of Melbourne may help optimising the logistics services, minimizing the transport cost, reduction in lead time and lower transactional cost through the collaborative use of resources and higher inter-firm competition. The higher competition within-cluster is driven from increased competitive rivalry among the logistics firms through the low bargaining power of suppliers and threats of substitutes and via high bargaining power of buyers and threats of substitutes (Porter, 1979).

7.6.3 Effect of PCLC on Inter-firm competition using the Five Forces model

A cluster provides a competitive environment that results in generating opportunities for the firms to increase their productivity, innovation capabilities and business growth (Porter, 2000). Porter (2000) further identified that the spatial clustering of the firms promotes competition and collaboration, and both can coexist as they operate on different scales. To examine the extent of inter-firm competition, industry's competitive position, and the strength of competition through competitive rivalry many earlier studies have used the key dimensions of Porter's Five Forces model in various contexts and for different industries.

Slater and Olson (2002) acknowledged that the Five Forces model determines the strength of inter-firm competition when the firms are agglomerated. Narayan and Fahey (2005) noted that the Five Forces model explains the extent of *competitive rivalry* in the industry. Grundy (2006) mentioned that to understand the competition and profitability of industry Five Forces model needs to be analysed. Magretta (2011) identified that the industry structure is shaped by Porter's Five forces that establish the rule for competition. O'cass and Ngo (2007) used the Five forces model to examine the relationship between competitive intensity, strategic types, firm characteristics, and brand performance. A weak covariance among these five constructs of competitive intensity was found because distinct forces characterise industry structure and they may necessarily not be correlated. However, they found a strong competitive intensity in the food industry but weak competition among the PC manufacturing industry. Their study found that buyer power is a common trait in all different types of industries whereas other forces (such as *competitive rivalry, bargaining power of supplier, threats of substitutes* and *barriers to entry*) were apparently unequal. Pecotich et al. (1999) developed and validated the instruments to measure the industry perception which they defined as *INDUSTRUCT* based on Porter's Five Forces model. They found that all the industries should display the same industry structure as described by Porter's Five forces however the reality that is perceived by the managers representing different industries may vary significantly. Whereas, this study focusses on using the Five Forces model in the PCL industry to examine the inter-firm competition.

Our findings suggest that the port-centric logistics industry reflects low *barriers to entry* due to the availability of different modes of transportation, deregulated sector and low capital requirement. The low *barriers to entry* open more opportunities for the firms to compete in the market, in turn, increases the *competitive rivalry* among the companies. Porter (1979) identified two ways to enhance *competitive rivalry* that include price competitive tactics and non-price competitive tactics. Price tactics include price wars whereas non-price competitive tactics include advertising and new product development through innovation. This study found that the logistics firms compete based on cost, quality and offering customised services to the customers. This suggests that the PCL industry does not solely compete on price which may be detrimental for the industry profitability as noted by Porter (1979) but provide value-added services through non-competitive tactics too.

Furthermore, the PCL industry provides similar services, which can easily be matched by competitors which signify that *threats of substitute* services are higher. This study found that the substitute services are easily available and accessible within the cluster which stimulates inter-firm competition with an aim to retain the customers. It was also noted that the business profitability is affected by the substitute services that are offered within PCLC. Narayan and Fahey (2005) found that the availability of substitute services affects *competitive rivalry* that in turn enables competitive advantage. Dulcic et al. (2012) noted that technological development and changing demand pattern contribute to an increase in the availability of substitute services.

The buyers who avail logistics services are well-informed regarding the services available in the market. In addition to that, they are also high in number due to the changing and increasing demand pattern. This enables the buyers to search for alternative services that may be more cost-effective and customised to their needs. Porter (1979) identified that the *competitive rivalry* is significantly affected if the buyers are large in number, well informed and the product demand is higher. Oslon and Slater (2002) found a significant influence of the *bargaining power of buyer* on industry profitability. They noted that a large number of available substitute services provides the buyer with more power because of their tendency to switch to other services. Dyer and Singh (1998) claimed that the unavailability of crucial resources required to gain a competitive advantage for the firm may suggest linking upstream to a bigger network of relationships with other suppliers and buyers or collaborate with the competitors to gain mutual benefit. This study observed that the port-centric logistics industry constitutes numerous substitute services that match the expectation of end buyers that in turn exert more pressure on the firms to perform better hence increases *competitive rivalry* among the firms. This suggests that the high *bargaining power of buyers* and low *bargaining power of suppliers* foster inter-firm competition through high *competitive rivalry*.

7.6.4 Effect of location (ports) on Inter-firm competition

The study also investigated whether the logistics firms that are clustered near port vicinity exhibit higher inter-firm competition through competitive rivalry than the firms that are away from the port. Previous literature (Brülhart, 1998; Porter, 2000; Chen, 2001; Sheffi 2013) reveals that the role of geographical location, spatial proximity, and clustering of firms are critical to gain competitive advantage due to various benefits such as easy access to customers and suppliers, lower transaction cost, resource sharing, and knowledge spillover.

A multigroup analysis conducted in this study found a statistical difference between inter-firm competition near and far port vicinity. The results indicate that the PCL firms that are clustered around the port reflect higher inter-firm competition through competitive rivalry than the firms that don't become part of PCLC. This signifies that the importance of location is fundamental to the competition which is similar to the notion that some places are more productive than others such as high performing auto companies in South Germany, fashion companies in Italy, and IT companies in Silicon Valley (Porter, 2000).

The spatial dispersion of production activities has resulted in the changing logistics landscape in Australia. The logistics services need to be time-efficient and add more value to the supply chain due to the rising and changing demand pattern. This can be attained when the firms work within locational proximity and near to the major transport hubs such as ports or airports (Sheffi, 2013).

It is argued in this study that port location plays an important role in enhancing inter-firm competition when the firms are clustered around it. This is primarily due to a large number of firms offering similar services from the defined vicinity which tend to match the quality and cost offered by their competitors. Further, the firms choose to operate near ports due to the availability of a large supplier and customer base around the port. The survey results found that most of the firms strongly agreed that the reason for working near the port is due to easy accessibility to their customers and suppliers. Roso et al. (2009) and Bergqvist (2012) claimed that the logistics activities spanned near to the ports have a high impact in terms of easy and efficient distribution, inland connection and resource-sharing (Roso et al., 2009; Bergqvist, 2012). Bichou and Gray (2004) acknowledged that the agglomeration of logistics activities not only helps in regional growth through productivity increase but also augment the port performance, efficiency and effectiveness. Porter (1993) ascertained that the competitive advantage of a region is significantly influenced by the clustering of the firms in which location is an important dimension to consider as it provides the environment which is conducive to business growth.

In summary, it can be concluded that the clustering of logistics firms around the port boosts the competitive rivalry, which is a determinant of the region's competitive advantage, as identified by Porter (1990). The PCLC may tend to attract other firms to collocate their functions within, which makes it easier for them to offer coordination between product and service, in turn, creating internal pressure for improvement because of constant comparison and presence of equal general circumstances such as accessibility, labor, and resources. Porter (2000) noticed that cluster nurtures co-location that shortens the process of spillovers effect, which is as an outcome of the competition, that helps foster local supplier development and gives rise to new competitors. The by-product of this competition is knowledge creation, the pool of technology and reputation of cluster location and other advantages. However, these advantages of cluster and competition can be empirically assessed and quantified in future studies.

7.7 SUMMARY

This chapter presents the results of the structural model. The results of the structural model reveal a positive and significant effect of PCLC on the *bargaining power of buyers*, *threats of substitutes* and *competitive rivalry*. Whilst a negative and significant effect of *barriers to entry* on *competitive rivalry* was observed. All other hypotheses that were presented in this study were not supported. A multigroup analysis reveals that there is a significant difference between the impact of logistics firms clustering on the competitive rivalry at the group level. The results indicate that the logistics firms that are clustered around the port exhibit higher inter-firm competition through competitive rivalry than the firms that don't operate within the cluster near the port.

The next chapter discusses the research questions followed by limitations and future direction of the study.

CHAPTER 8

CONCLUSION AND LIMITATIONS

8.1 INTRODUCTION

This chapter aims to highlight the key findings of this study. This chapter presents the concluding remarks based on the data analysis that is conducted in earlier chapters. The research questions, that are presented in chapter 1, will be addressed and analysed also. The implications of the research are discussed which are further divided based on theoretical and practical implications. Finally, the chapter discusses the limitations of the study that leads to future research directions followed by the conclusion of this study.

8.2 RESEARCH QUESTIONS REVISITED

This study aims to develop a model, based on Michael Porter's cluster model (1998), to estimate the impact of spatial clustering of port-centric logistics firms on inter-firm competition through competitive rivalry. To accomplish this aim, three research questions were developed in this study that were based on an in-depth literature review, the Five Forces Model, and the rationale presented in chapter 1. These research questions are as follows;

- What industries typically constitute a port-centric logistics cluster within a geographically bounded area?
- How to delineate the boundary of port-centric logistics cluster in Melbourne
- Do port-centric logistics firms exhibit more inter-firm competition through higher competitive rivalry than those located away from the port area?

To answer the first two questions, Journey to Work (JTW) data from the Australian Bureau of Statistics (ABS) was used. However, to investigate the last question a survey was conducted to the logistics firms in Melbourne. A theoretical model was developed (see Figure 8.1) using Porter's cluster model (Porter, 1998) and the Five Forces model (Porter, 1979). Based on other studies and the gap analysis, the research hypotheses were presented to test the impact of the clustering of the logistics firms on inter-firm competition. Further, a moderation effect of the port vicinity on inter-firm competition among logistics firms was also examined in this study.

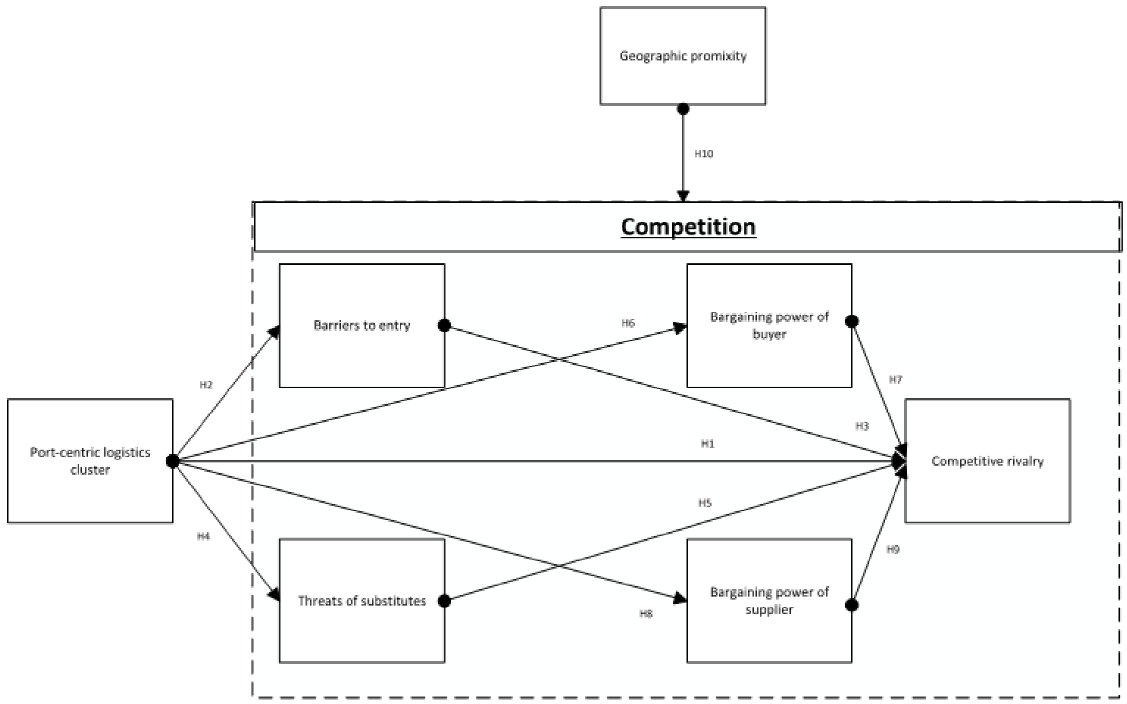


Figure 8.1 – Full Research Model

The full research model and relevant hypothesis are presented in Figure 8.1. A total of 10 hypotheses were presented and supported by a 95 per cent confidence interval (see Table 7.6 – last chapter). The role of geographical proximity was also tested using multi-group analysis in this study to compare if the inter-firm competition is accentuated near port-centric vicinity. This framework has helped to answer these three research questions, which are discussed as follows.

8.2.1 What industries typically constitute a port-centric logistics cluster within a geographically bounded area?

This research question was answered in stage 1 of methodological framework that was discussed in chapter 6 (see section 6.2). The results indicate that a total of 633 sub-industries in 2001, 719 sub-industries types in 2006 and 720 sub-industries in 2011 were identified. Among these total number of industries 29 sub-industries in 2001, 26 sub-industries in 2006 and 25 sub-industries in 2011 were selected that represent the PCL sector (see Table 6.1). The Census JTW data by industry in statistical location areas (SLA) was used to identify the industrial activities that define and characterize PCLC. This study found that PCL employment in Australia contributes to around 3.28 per cent, 3.38 per cent and 3.33 per cent in the years 2001, 2006 and 2011 respectively. The percentage drop in employment is due to the increase in an absolute number of jobs from 2001 to 2006 to 2011, therefore, if examined by the number of employees in the PCL sector, a significant increase was observed. A previous study conducted in Melbourne by Chhetri et al (2013) found 28 sub-industries that characterized the logistics cluster sector in which they included road-centric, rail-centric, port-centric, and airport-centric logistics sectors. They used census data of 2006 only whereas this study uses the data over a period of 15 years which reflects the changes in sub-industries due to some inclusions, exclusions, and amalgamation of a few industrial sectors.

It was observed that the concentration of PCL industries was higher in NSW as compared to Victoria when the data was analysed state wise. It was found that in the year 2001 *road freight transport, postal services and rail transport* were the major employment providers in the PCL industry contributing around 65.77 per cent cumulative percentage employment to total PCL employment. However, in 2006 and 2011 two sectors remained the same to offer the highest employment which were *road freight transport and postal services* but the third position was replaced by *other warehousing and storage services*, with a cumulative contribution of these three sectors to be approximately 72.09 per cent in the year 2006 and 69.70 per cent in 2011.

This study also found that *road freight transport* is a growing sector because the majority of the freight is distributed locally after receiving it. Moreover, it is also economical to distribute the freight within Victoria using road transport because using other modes, such as rail, may not be a viable option to offer end to end solutions (door to door deliveries). Therefore, this study answers this question.

8.2.2 How to delineate the boundary of port-centric logistics cluster in Melbourne?

This research question was answered in stage 2 of methodological framework that was discussed in chapter 6 (see section 6.3). The logistics firms were aggregated, to form logistics cluster in Melbourne, that are directly or indirectly involved in port operations and management. The map presented (see Figure 6.1) in chapter 6 shows the existence of a spatial logistics cluster around the Port of Melbourne. This study found that Melbourne PCLC is anchored on Melbourne central business district (CBD) with a large concentration of logistics employment vis-à-vis industries in the west of Melbourne such as Altona, North Melbourne, Laverton, and Footscray. The PCLC in this study is defined and delineated based on the areas that have a higher concentration of aggregate logistics employment, having the port as an anchor, and that are surrounded by other high logistics employment concentrated areas.

This concludes that there is a higher concentration of spatial logistics employment related to the port operation and management that largely discerns towards the western suburbs of Melbourne.

8.2.3 Do port-centric logistics firms exhibit more inter-firm competition through higher competitive rivalry than those located away from the port area?

This research question was answered in stage 3 and 4 of methodological framework in chapter 6 and 7 (see sections 6.4 and 7.4). A multigroup analysis was conducted using SEM to test the effect of PCLC on inter-firm competition through competitive rivalry. The chi-square difference was conducted for the measurement weight and measurement intercept. It was found that two groups were significantly different at a p-value of <0.05 (see Table 7.5). Therefore, this study is consistent with the argument proposed by Porter (1998) that the clustering of the firms increases inter-firm competition and location plays a significant role in stimulating the competition. Porter (1998) has affirmed that the firms that operate within a cluster collaborate in order to compete. Furthermore, the firms within a cluster reflect more competitive rivalry than the firms outside the cluster.

This research reveals that the clustering of logistics firms increases 'threats of substitutes' due to the availability of multiple services within the cluster. A positive effect of PCLC on the 'bargaining power of buyers' was also found which shows that more power lies with the buyers to control the prices when logistics firms are clustered. This study also found that the clustering of the firms increases 'competitive rivalry' due to numerous firms offering similar services that provide more opportunities for the buyers to choose the services from. The results also indicated a negative impact of 'barriers to entry' on 'competitive rivalry' which suggests that as entry barriers are relaxed, such as government policies and capital requirement, the competitive rivalry increases

The positive and a higher impact of clustering of logistics firms around the port on inter-firm competition through competitive rivalry has been proven and the research question can be answered as: the PCLC reflects higher inter-firm competition through competitive rivalry when firms operate near port vicinity.

8.3 RESEARCH CONTRIBUTIONS AND IMPLICATIONS

In recent years the focus of ports operation is more towards linking the global operations and to provide value-added services along the supply chain. Rapidly changing logistical environment that is characterised by agility in the supply chain, results in the need of changing ports operation in line with the strategic goals of a company and to fulfil the diverse/complex demand of the customer. Moreover, the growth in international trade, as a consequence of globalization, is increasing the dependence of ports as ports act as an important logistical node in the global supply chain by seamlessly connecting the global suppliers with the local customers. Thus, the increasing importance of the ports results in the firms collocating their operation near to port vicinity and work in a clustered environment to attain a number of benefits that may include higher inter-firm collaboration and competition, knowledge creation, productivity enhancement, and resource sharing. This study makes several theoretical and methodological contributions as well as practical implications that are discussed as follows.

8.3.1 Theoretical contributions

Theoretically, this study provides new knowledge on the identification of the firms that characterise PCLC. This adds to the body of literature as previous similar studies have discussed spatial logistics cluster (Chhetri et al., 2014), port-centric logistics (Mangan et al., 2008), logistics agglomeration (Rivera et al., 2014) and logistics clusters (Sheffi, 2013; Rivera et al., 2014). This study attempted to identify firms that are directly or indirectly involved in port operations and management.

This study developed a new theoretical framework that integrates the cluster model with the Five Forces model to examine the effect of port-centric logistics cluster on inter-firm competition. The tested scales used in this study can be adopted in future research to explore different relationships among the variables and their mediating effect. The results indicate that the clustered logistics firms around the port demonstrate higher inter-firm competition than the firms away from the port. This suggests a significant role of the geographical proximity on higher inter-firm competition.

This study conceptualises the formation of cluster from a spatial perspective where logistics industries spatially agglomerate around the port. This is because of the changing role of the ports from a simple transhipment hub to an integrated node in the global supply chain. This study can be used as a case to explore the existence of PCLC and the way firms interact within PCLC in other countries. The geostrategic position of PCLC can serve as a potential hub to serve large areas and connect to other suburban clusters through the design of the 'hub and spoke' network. It implies that the PCLC can act as an anchor with transport linkages to other suburban clusters.

8.3.2 Methodological contributions

Methodologically, this study developed a new method that identifies a spatial port-centric logistics cluster having adjacent neighbours with high logistics employment. The process of delineation of the boundary of the port-centric logistics cluster is driven by three key principles that determine whether spatial units are amalgamated or not. These three principles include the degree of concentration, spatial adjacency, and distance decay. These three-principles work in conjunction where the local areas or SLAs that are adjacent to each other and have a concentration of PCL employment of more than the country's average logistics employment are considered to form PCLC. Furthermore, the boundary of PCLC can extend up to 50 km from the Port of Melbourne.

Five validated measurement items were developed to examine if the logistics firms operate within port-centric logistics cluster or away. These measurement items show the tendency for creating an ecosystem for the firms which co-locate with other interrelated and interdependent businesses to gain the benefits of accessibility and availability of resources, operating in closer proximity to their suppliers and buyers, and mainly dependent upon port operation.

8.3.3 Practical Implications

This study provides significant practical implications that may be used by practitioners and the policymakers to create an environment where logistics firms can co-locate near the port to gain locational benefits.

First, our findings suggest that there are numerous logistics firms mainly *road freight transportation*, *warehousing and distribution services, freight forwarding services, and postal services* that are clustered in the western parts of Melbourne. The accumulation of diversified logistics services around the Port of Melbourne can offer higher economic vibrancy through closer proximity of the firms to their suppliers and customers, easier communication, transactional benefits, higher freight volume and capabilities, and provide value-added service that can be underscored in the geographical proximity. For example, the distriparks such as in the Netherlands, Singapore, Dubai, Shanghai and many more where logistics services are clustered around the port to offer postponement services at the end of the supply chain such as cross-docking, break and create bulk, and product customization. Therefore, the Port of Melbourne can act as a strategic functional node to attract more firms to collocate looking at the added benefits of working within the cluster near to the port.

Second, the identification of sub-industries and mapping the boundary of PCLC in Melbourne may also empower the firms that work within it to control the freight and regulate the distribution. This is because as the cluster, especially around the port, can act as a national and international gateway for the freight to move in and out from the country for example as in the case of major hubs such as Singapore, Rotterdam, and Antwerp. Further, the policies regarding transportation planning and urban land use can also be formulated by considering these spatial clusters because these clusters act as high activity nodes. The argument to support these policy formulations is recognized in government reports such as *The Cluster Policies White Book* (Andersson et al, 2004) and *A Cluster Initiative Greenbook* (Solvell et al., 2003). As this study identifies the firms that characterize the PCL and maps the cluster boundary in Melbourne, this helps for the policymakers to plan the policies strategically to create a competitive environment and offer facilities that may give additional benefits to the firms to operate from the cluster. For example, a number of multinational logistics corporations gain benefits from operating from Busan New Port Distripark where the South Korean government has opened 16 container berths and 1,204,000m2 logistics facility zone (Andersson et al, 2004). The firms gain benefits such as increased cooperation, sharing resources, and easy access to the suppliers and buyers.

Third, the study found that the ‘threats of substitutes’ and ‘bargaining power of buyers’ are higher within PCLC due to a higher number of competing firms that offer similar or complementary services. This results in enhanced competitive rivalry among the logistics firms that work within the proximity in a clustered environment. Considering the proximity of firms within PCLC and its effect on higher competitive rivalry, a policy can be formulated and implemented based on the results of this study to further foster the linkages between the firms, develop a protocol to access and share the data, provide training to upgrade skills to compete in the international market, and to promote international linkages. According to Porter (1998), the government can play an important role to support the industry through subsidies, creating constructive competition, investing in R&D and infrastructure development. The government can also create capabilities through the creation of knowledge centres by collaborating with educational institutions as developed between Zaragoza and MIT Institute of Transportation and Logistics where capabilities of the local workforce are enhanced by offering specialized training within the cluster and degrees to the aspirants (Sheffi, 2013).

Fourth, this study found that the clustering of logistics firms around the Port of Melbourne enhances inter-firm competition. This enhanced competition may help to increase productivity and efficiency (Porter, 2000) which in turn are the growth derivative of a region. This makes the PCLC an attractive place for other firms to collocate. This collocation of the logistics firms may further help in the reduction of empty container movement since the carrier loads can be shared among the firms (Sheffi, 2013; Chettri et al., 2014; Singh et al., 2016). Moreover, sharing the load can significantly reduce the cost to the companies by achieving economies of scale as a consequence of operating from the same geography. The in-depth literature and the analysis used in this study can form a basis for the firms to decide if they want to operate within the cluster or in isolation. Furthermore, the frequency of in and out freight movement from the cluster is higher. The collective higher volume load (in terms of a full container) can be sent out of the cluster as companies can cooperate to send a full container to avoid the higher cost of delivery per unit in partially filled containers.

Fifth, the existence of PCLC in Melbourne can act as a functional node for the clustering of logistics firms that can form the focus of innovation and high productivity area by devising cluster-based policies. Porter (2000) identified that little competitive rivalry refers to low productivity and innovation. However, this study noted a higher competitive rivalry among the logistics firms in PCLC than the firms that are away. Therefore, PCLC in Melbourne can act as a growth pole to support the regional economy through the creation of logistics hubs where more value-added services can be provided. This may help in achieving economies of scale and scope in logistics to help increase productivity and innovation8 capabilities as manufacturing is offshored due to cost competitiveness (Sengpiehl, 2010; Sheffi, 2013). Other service industries such as retail and tourism might use the results from this study to develop and implement appropriate strategies to enhance inter-firm competition.

Sixth, Port of Melbourne may serve as a central location for freight distribution activities due to the presence of cluster around it and easy accessibility to other distribution networks such as suburban spatial logistics clusters as identified by Chhetri et al. (2014) in Melbourne south-east. The effective freight distribution requires proximity and accessibility which may best be served around the Port of Melbourne. This spatial concentration of logistics firms around the Port of Melbourne may help to minimize transport cost, reduction in lead time and lower transaction cost.

Finally, the outcome of this study can be used by managers of the companies who are looking to make the locational decision for their operation. The PCLC can be considered as a potential location by looking at the operational benefits such as easy accessibility of supplier and customers, spillover effects of the cluster, operational cost reduction, and an easy search of talent within the cluster. Moreover, the area development authorities can also aim to attract the companies within the cluster by offering a collaborative and competitive environment within the cluster. The natural competition and collaboration among the neighbouring companies within the cluster improve efficiency and quality of service which in turn can be passed onto the customer through offering the services at a competitive price.

8.4 LIMITATIONS AND FUTURE RESEARCH

This study contains few limitations that can be considered for future studies.

First, the data used in this study is the *journey to work* data that does not reflect the employment type, an exact number of employees in the company, and the company productivity level which may relevant to study the cluster and its impacts. However, no other data set that represents employment at a spatial level is available in Victoria to consider for cluster formation. Future research may consider capturing the data on firm size, productivity, and employment status. By capturing the detailed data may yield more meaningful results.

Second, this study has not considered inter-firm interaction and collaborative practices to measure the spillover effect of the competition. Porter (2000) identified that firms collaborate in order to compete in a clustered environment. Therefore, future studies may consider examining the impact of clustering on inter-firm collaboration and the nature of collaboration among clustered firms followed by comparing the effect within and outside the cluster. This would form the basis to understand the business relationship within the PCLC. For example, do the logistics firms within the PCLC share resources such as transport means and information technology, align incentives, jointly plan and create an environment to offer supply chain visibility.

Third, this study has also not considered the comparison of growth of logistics employment near and away from the port. Many small spatial logistics clusters in Melbourne have evolved over time as discussed in the empirical study conducted by Chhetri et al. (2014). To answer the question of whether logistics firms tend to cluster or disperse, there is a need to examine the trend over time. Hence, it will be thought-provoking to examine if the trend of logistics employment growth is higher around the port or in other areas that form small spatial logistics clusters due to the increased congestion around the port and comparatively higher real estate prices.

Fourth, this study uses a quantitative approach, therefore, it may have a limitation of the limited outcome. This is because the questions asked in the quantitative method are structured and close-ended which leaves no opportunity for the respondents to explain the reason for the situation/response. Thus, using a mix method approach may yield different results and allow a comprehensive approach to data interpretation.

Finally, this study is based on data collection from Melbourne only. Future research may consider comparing the data from two different cities or even two different countries to validate the results as it will allow a better understanding of the impact of the cluster on logistics firms around the port.

8.5 CONCLUSION

This study bridged the gap by developing a conceptual framework to investigate the role of PCLC on inter-firm competition among the logistics firms. This was done by integrating the Cluster model with Five Forces model. Three research questions were answered in this study that were based on existing literature and the theoretical framework.

Hence, towards the final conclusion, this study presents the identification of industrial sectors that demonstrate PCLC followed by delineating the boundary of PCLC around the Port of Melbourne. *Road freight*, *postal services*, and *rail freight* were the main industries that offered a majority of the employment in PCLC sector. The study concluded that the PCLC in Melbourne discerns towards the west of Melbourne such as Altona, North Melbourne, Laverton, and Footscray.

The empirical results provided in this research indicate that the clustering of the logistics firms positively impacts inter-firm competition through higher competitive rivalry. Moreover, the location plays a significant role, port area in this study, in enhancing the competitive rivalry. However, a future investigation may be needed to evaluate the collaborative practices that lead to higher competitive rivalry such as information exchange, knowledge sharing, infrastructure sharing, and trust.

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Appendix 1: Invitation to participate in this research

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

PARTICIPANT INFORMATION

Project Title: *"Melbourne Port-Centric Logistics Cluster: Collaborative and/or Competitive Pathway?"*

Investigators:

(1) Prof. Rajiv Padhye, Ph.D., E: rajiv.padhye@rmit.edu.au *P: +613-99255803*

(2) Prof. Prem Chhetri, Ph.D., E: prem.chhetri@rmit.edu.au P: +613-*99251392*

(3) Amanpreet Singh, MBA, B.Tech,, P:+61-99259163

Dear Participant,

You are invited to participate in a research project being conducted by RMIT University. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators.

Who is involved in this research project? Why is it being conducted?

My name is Amanpreet Singh and I am doing a Ph.D. research in the School of Fashion and Textiles, RMIT University, Melbourne. My supervisors are Prof. Padhye and Prof. Chhetri. This project has been approved by the RMIT Human Research Ethics Committee. The research seeks to compare the collaboration and competitiveness between clustered and non-clustered port-centric logistics firms in Melbourne

Why have you been approached?

This survey is to be completed by the employees working in logistics organizations who are directly or indirectly involved in providing services to the seaport. If you are over 18 years of age and a logistics employee working on a middle to higher management role then you are invited to participate in this Ph.D. research project being conducted through RMIT University.

What is the project about? What are the questions being addressed?

About 200 logistics companies within the cluster and 200 companies outside the cluster will be recruited for the study. The purpose of this research is to investigate whether the companies within the cluster collaborate and compete more or less than the companies outside the cluster which might help the companies to make a strategic decision to collocate their operation within the cluster or not, if they don’t operate in a cluster. The participants will be asked to share their knowledge about their organization's ability to compete and collaborate with other organizations.

If I agree to participate, what will I be required to do?

If you decide to participate, you will be asked to complete a questionnaire which will take approximately 20 minutes to complete. You will be provided with a web link to access the questionnaire online (e.g., via PC or tablet using a secure online server). This questionnaire includes questions about the impact of the presence of other organization on your competitive and collaborative position. Prior to completing the questionnaire, you will also be asked for some demographic details. We will not collect any identifiable information.

What are the benefits associated with participation?

Studying the port-centric logistics cluster in Melbourne can help the companies to make a strategic decision whether the collocation of their operation will be beneficial for them in terms of their profitability. This will also help in policymakers to draft the policies accordingly and plan the area keeping special needs of logistics sector in mind which in turn can help in an economic growth of the companies as well as well the city.

What will happen to the information I provide?

The responses you provide to the survey will be stored on RMIT University server. Once we have completed our data collection and analysis, we will import the data to the RMIT server where it will be stored securely for a period of five years. Data will be reported as an aggregate data. Therefore, individuals will not be identified. Your privacy and confidentiality will be strictly maintained in such a manner that you will not be identified in the thesis report or publication. As participants' details are not recorded, any information that you provide can be disclosed as an aggregate data only if (1) it is to protect you or others from harm, (2) if specifically required or allowed by law, or (3) you provide the researchers with written permission. Data will be only seen by the researcher and supervisors who will also protect you from any risks.

At the conclusion of the project, a summary of the results and associated reports will be made available should you request for it. The contact details will be used strictly for the dissemination of results and will not be passed to the third party and will be purged once the objective is met. The final results will also be reported in a thesis to be submitted for Mr. Amanpreet Singh's Ph.D. degree, and as appropriate, in papers for presentation at conferences or for publication in scientific journals. Because of the nature of data collection, we are not obtaining written informed consent from you. Instead, we assume that you have given consent by your completion and return of the questionnaire.

What are my rights as a participant?

As a participant, you have the right to withdraw at any time and to have any questions answered at any time. Your participation in this research will help identify the role of clusters in creating more competition and collaboration which can be used by the logistics companies to foster their market presence and to enhance overall performance.

What are the possible risks or disadvantages? Whom should I contact if I have any questions?

There are no anticipated risks associated with participation. However, if you are unduly concerned about your responses to any of the questionnaire items or if you find participation in the project distressing, you should contact *the Ethics Officer, Research Integrity,* *Governance and Systems, RMIT University, GPO Box 2476V VIC 3001. Tel: (03) 9925 2251 or email* human.ethics@rmit.edu.au as soon as convenient. The Ethics Officer will discuss your concerns with you confidentially and suggest an appropriate follow-up, if necessary.

Security of the website

Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user's transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects.

Security of the data

This project will use an external site to create, collect and analyze data collected in a survey format. The site we are using is https://www.qualtrics.com. If you agree to participate in this survey, the responses you provide to the survey will be stored on a host server that is used by Qualtrics. No personal information will be collected in the survey so none will be stored as data. Once we have completed our data collection and analysis, we will import the data we collect to the RMIT server where it will be stored securely for five (5) years. The data on the Qualtrics host server will then be deleted and expunged.

Thank you for your assistance and for giving us your time to participate. We value your contribution to this research.*Yours sincerely,*

Amanpreet Singh, Prof. Rajiv Padhye, & Prof. Prem Chhetri.

If you have any concerns about your participation in this project, which you do not wish to discuss with the researchers, then you can contact the Ethics Officer, Research Integrity, Governance and Systems, RMIT University, GPO Box 2476V VIC 3001. Tel: (03) 9925 2251 or email human.ethics@rmit.edu.au

Appendix 2: Survey questionnaire

<u>Survey Questionnaire</u>

This questionnaire is addressed to the employees in the logistics industry.

Please answer ALL question by filling in the blank spaces provided or by checking (✓) the number of the item that BEST describes your situation.

Section A: Background information:

1. Name of your organisation:

   ____

2. Location (address with postcode) of your organisation:

   ____

3. What are the main products or services of your organization?
   - ☐ Road freight transport services
   - ☐ Postal Services
   - ☐ Storage and Warehousing
   - ☐ Water transport services
   - ☐ Courier services
   - ☐ Rail transport
   - ☐ Freight forwarding
   - ☐ Custom agency
   - ☐ Port operators
   - ☐ Other ______________________

4. Number of employees working in your organization
   - ☐ Less than 20
   - ☐ 20 -50
   - ☐ 51-100
   - ☐ 101-500
   - ☐ 500 and Above

5. How often does your company deal with port related operation?
    - ☐ Very frequent
    - ☐ Sometimes
    - ☐ Never

Port-centric logistics cluster

To what extent do you agree/disagree with the following statements?	**Strongly disagree**	**Disagree**	**Neither Agree Nor disagree**	**Agree**	**Strongly agree**
Your business is driven directly or indirectly from the port?					
Your customers are near to your proximity/business?					
Your suppliers are near to your proximity/business?					
Your company deals directly or indirectly with the companies near to you.					
The reason of chosen location of your business is due to easy accessibility to the suppliers?					
The reason of chosen location of your business is due to easy accessibility to the customers?					

Section B:

Determinants to measure Competition of the firms in port-centric logistics cluster in Melbourne

MEASURING INTER-FIRM COMPETITION:

1. Competitive Rivalry

To what extent do you agree/disagree with the following statements?	**Strongly disagree**	**Disagree**	**Neither Agree Nor disagree**	**Agree**	**Strongly agree**
There are numerous competitors in your industry.					
Your company competes on the basis of prices with your competitors.					
Your company competes on the basis of customized services offered in comparison to your competitors.					
Your company competes on the basis of the quality of the					

services provided in comparison to your competitors.					
Your company takes an initiative to offer new service to the market quickly in comparison to your competitors.					

2. Barriers to Entry

To what extent do you agree/disagree with the following statements?	**Strongly disagree**	**Disagree**	**Neither Agree Nor disagree**	**Agree**	**Strongly agree**
Your company requires high initial capital investment					
There is a need to use advanced technology in your industry, by new entrants					
Government policy is not a barrier for new entrants to enter and compete in the business.					

3. Threats to Substitutes

To what extent do you agree/disagree with the following statements?	**Strongly disagree**	**Disagree**	**Neither Agree Nor disagree**	**Agree**	**Strongly agree**
Your competitors offer many substitute services.					
Your business is effected by the substitute services offered by your competitors.					
Your competitor offers equal or superior substitute services than offered by your company.					

4. Bargaining Power of the Buyers

To what extent do you agree/disagree with the following statements?	**Strongly disagree**	**Disagree**	**Neither Agree Nor disagree**	**Agree**	**Strongly agree**
Buyers have more power to control the cost than the seller.					
Buyers have more options to get the services from your competitors at a lower price than yours.					
Buyers are price sensitive.					
Buyers are well-informed regarding the services.					
Substitute services are easily available.					

5. Bargaining Power of Supplier

To what extent do you agree/disagree with following statements?	Strongly disagree	Disagree	Neither Agree Nor disagree	Agree	Strongly agree
Buyers can conveniently switch the supplier					
Your competitors influence the price of your services					
Your company struggles to sell the services because of the availability of substitute services.					

Appendix 3: Ethics Approval

RMIT
UNIVERSITY

College Human Ethics Advisory Network (CHEAN)
College of Design and Social Context
NH&MRC Code: EC00237

Notice of Approval

Date:	**28 March 2017**	
Project number:	**CHEAN B 20654-02/17**	
Project title:	***Melbourne Port-centric Logistics Cluster: Collaborative and/or Competitive Pathway?***	
Risk classification:	**Negligible risk**	
Chief investigator:	**Professor Rajiv Padhye**	
Status:	**Approved**	
Approval period:	From: **28 March 2017**	To: **31 October 2017**

The following documents have been reviewed and approved:

Title	Version	Date
Risk Assessment and Application form	3	7 March 2017
Participant Information Sheet	3	7 March 2017
Sample Questionnaire	3	7 March 2017
Sample Recruitment Email	2	7 March 2017
Certificate of Completion Competition and Consumer Protection Module	1	23 March 2017
Response to Committee	1	28 March 2017

The above application has been approved by the RMIT University CHEAN as it meets the requirements of the *National statement on ethical conduct in human research* (NH&MRC, 2007).

Terms of approval:

1. **Responsibilities of chief investigator**
   It is the responsibility of the above chief investigator to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by CHEAN. Approval is valid only whilst the chief investigator holds a position at RMIT University.
2. **Amendments**
   Approval must be sought from CHEAN to amend any aspect of a project. To apply for an amendment use the request for amendment form, which is available on the HREC website and submitted to the CHEAN secretary. Amendments must not be implemented without first gaining approval from CHEAN.
3. **Adverse events**
   You should notify the CHEAN immediately (within 24 hours) of any serious or unanticipated adverse effects of their research on participants, and unforeseen events that might affect the ethical acceptability of the project.
4. **Annual reports**
   Continued approval of this project is dependent on the submission of an annual report. Annual reports must be submitted by the anniversary of approval of the project for each full year of the project. If the project is of less than 12 months duration then a final report only is required.
5. **Final report**
   A final report must be provided within six months of the end of the project. CHEAN must be notified if the project is discontinued before the expected date of completion.

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College Human Ethics Advisory Network (CHEAN)
College of Design and Social Context
NH&MRC Code: EC00237

6. **Monitoring**
   Projects may be subject to an audit or any other form of monitoring by the CHEAN at any time.
7. **Retention and storage of data**
   The investigator is responsible for the storage and retention of original data according to the requirements of the *Australian code for the responsible conduct of research* (section 2) and relevant RMIT policies.
8. **Special conditions of approval**
   Nil.

In any future correspondence please quote the project number and project title above.

Dr Marsha Berry
Chairperson, College Human Ethics Advisory Network (CHEAN B)
RMIT University

cc: Dr David Blades (CHEAN secretary), Mr Amanpreet Singh.

Appendix 4: Ethics approval extension

RMIT UNIVERSITY Design and Social Context College Human Ethics Advisory Network (CHEAN)
Sub-committee of the RMIT Human Research Ethics Committee (HREC)

Notice of Approval

Date:	**17 October 2017**
Project number:	**CHEAN B 20654-02/17**
Project title:	**'Melbourne Port-centric Logistics Cluster: Collaborative and/or Competitive Pathway?'**
Risk classification:	**Negligible Risk**
Investigator:	**Professor Rajiv Padhye, Mr Amanpreet Singh, Professor Prem Chhetri**
Approved:	**From: 17 October 2017 To: 1 February 2018**

I am pleased to advise that your extension request has been granted ethics approval by the Design and Social Context College Human Ethics Advisory Network (CHEAN), as a sub-committee of the RMIT Human Research Ethics Committee (HREC). Ethics approval is extended until 1 February 2018.

Terms of approval:

1. **Responsibilities of investigator**
   It is the responsibility of the above investigator/s to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by the CHEAN. Approval is only valid whilst the investigator/s holds a position at RMIT University.
2. **Amendments**
   Approval must be sought from the CHEAN to amend any aspect of a project including approved documents. To apply for an amendment please use the 'Request for Amendment Form' that is available on the RMIT website. Amendments must not be implemented without first gaining approval from CHEAN.
3. **Adverse events**
   You should notify HREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
4. **Participant Information Sheet and Consent Form (PISCF)**
   The PISCF and any other material used to recruit and inform participants of the project must include the RMIT university logo. The PISCF must contain a complaints clause.
5. **Annual reports**
   Continued approval of this project is dependent on the submission of an annual report. This form can be located online on the human research ethics web page on the RMIT website.
6. **Final report**
   A final report must be provided at the conclusion of the project. CHEAN must be notified if the project is discontinued before the expected date of completion.
7. **Monitoring**
   Projects may be subject to an audit or any other form of monitoring by HREC at any time.
8. **Retention and storage of data**
   The investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Please quote the project number and project title in any future correspondence.

On behalf of the DSC College Human Ethics Advisory Network, I wish you well in your research.

Dr David Blades
DSC CHEAN Secretary
RMIT University
E: dscethics@rmit.edu.au

Appendix 5: Multivariate outliers

Case	D2	D2/df (df=25)	Case	D2	D2/df (df=25)	Case	D2	D2/df (df=25)	Case	D2	D2/df (df=25)	Case	D2	D2/df (df=25)
1	22.68	0.91	77	17.05	0.68	153	36.62	1.46	229	22.88	0.92	305	22.27	0.89
2	7.39	0.30	78	16.52	0.66	154	39.77	1.59	230	20.43	0.82	306	27.41	1.10
3	24.76	0.99	79	20.36	0.81	155	32.28	1.29	231	22.48	0.90	307	24.07	0.96
4	15.33	0.61	80	20.58	0.82	156	14.64	0.59	232	22.23	0.89	308	10.95	0.44
5	28.45	1.14	81	11.74	0.47	157	28.08	1.12	233	30.12	1.20	309	13.96	0.56
6	22.76	0.91	82	24.75	0.99	158	39.48	1.58	234	45.03	1.80	310	14.16	0.57
7	15.03	0.60	83	5.39	0.22	159	29.50	1.18	235	18.02	0.72	311	38.71	1.55
8	14.40	0.58	84	32.20	1.29	160	34.56	1.38	236	14.59	0.58	312	11.78	0.47
9	23.76	0.95	85	13.92	0.56	161	51.97	2.08	237	21.84	0.87	313	30.74	1.23
10	20.54	0.82	86	17.05	0.68	161	51.97	2.08	238	19.67	0.79	314	30.39	1.22
11	29.43	1.18	87	12.48	0.50	162	28.25	1.13	239	27.47	1.10	315	28.44	1.14
12	13.17	0.53	88	10.82	0.43	**163**	**53.77**	**2.15**	240	50.51	2.02	316	28.08	1.12
13	24.11	0.96	89	15.87	0.63	164	24.02	0.96	241	22.30	0.89	317	8.91	0.36
14	23.87	0.95	90	24.33	0.97	165	36.06	1.44	242	28.82	1.15	318	34.86	1.39
15	29.79	1.19	91	11.18	0.45	166	16.11	0.64	243	51.14	2.05	319	19.56	0.78
16	23.51	0.94	92	29.36	1.17	167	42.33	1.69	243	51.14	2.05	320	14.37	0.57
17	28.24	1.13	93	7.99	0.32	168	25.61	1.02	244	40.34	1.61	321	30.80	1.23
18	24.64	0.99	94	26.38	1.06	169	22.12	0.88	245	23.53	0.94	322	20.96	0.84
19	8.01	0.32	95	9.69	0.39	170	45.03	1.80	246	24.38	0.98	323	24.81	0.99
20	21.03	0.84	96	18.78	0.75	171	18.02	0.72	247	20.54	0.82	324	20.65	0.83
21	14.37	0.57	97	28.95	1.16	172	14.59	0.58	248	20.97	0.84	325	29.07	1.16
22	25.12	1.00	98	22.76	0.91	173	21.84	0.87	249	36.29	1.45	326	30.96	1.24
23	21.03	0.84	99	20.72	0.83	174	14.16	0.57	250	36.44	1.46	327	25.04	1.00
24	17.98	0.72	100	13.46	0.54	175	38.71	1.55	251	34.38	1.38	328	35.90	1.44
25	22.00	0.88	101	20.53	0.82	176	11.78	0.47	252	32.34	1.29	329	23.60	0.94
26	21.85	0.87	102	11.61	0.46	177	30.74	1.23	253	5.83	0.23	330	29.12	1.16
27	19.51	0.78	103	49.84	1.99	178	30.39	1.22	254	13.45	0.54	331	41.31	1.65
28	27.49	1.10	104	18.67	0.75	179	28.44	1.14	255	31.39	1.26	332	23.78	0.95
29	13.92	0.56	105	15.80	0.63	180	28.08	1.12	256	39.16	1.57	333	17.05	0.68
30	21.24	0.85	106	12.81	0.51	181	16.47	0.66	257	23.59	0.94	334	26.89	1.08
31	25.25	1.01	107	16.49	0.66	182	50.51	2.02	258	21.13	0.85	335	19.67	0.79
32	16.42	0.66	108	5.72	0.23	183	24.96	1.00	259	24.73	0.99	336	27.47	1.10
33	34.45	1.38	109	17.09	0.68	184	28.31	1.13	260	32.33	1.29	337	50.51	2.02
34	34.53	1.38	110	16.23	0.65	185	25.26	1.01	261	18.48	0.74	338	22.30	0.89
35	15.70	0.63	111	24.36	0.97	186	32.13	1.29	262	25.61	1.02	339	28.82	1.15
36	33.91	1.36	112	32.09	1.28	187	17.15	0.69	263	22.12	0.88	340	51.14	2.05
37	25.29	1.01	113	11.72	0.47	188	22.48	0.90	264	45.03	1.80	340	51.14	2.05
38	24.15	0.97	114	11.03	0.44	189	22.23	0.89	265	18.02	0.72	341	24.96	1.00
39	26.10	1.04	115	22.27	0.89	190	30.12	1.20	266	14.59	0.58	342	28.31	1.13
40	25.00	1.00	116	27.76	1.11	191	27.64	1.11	267	13.38	0.54	343	25.26	1.01
41	28.15	1.13	117	22.32	0.89	192	12.86	0.51	268	22.27	0.89	344	32.13	1.29

42	26.07	1.04	118	7.20	0.29	193	7.67	0.31	269	27.41	1.10	345	27.05	1.08
43	25.30	1.01	119	13.96	0.56	194	25.36	1.01	270	24.07	0.96	346	22.48	0.90
44	20.54	0.82	120	19.19	0.77	195	31.84	1.27	271	10.95	0.44	347	25.10	1.00
45	10.42	0.42	121	14.00	0.56	196	21.13	0.85	272	13.96	0.56	348	31.44	1.26
46	31.86	1.27	122	12.30	0.49	197	24.73	0.99	273	24.78	0.99	349	24.24	0.97
47	16.81	0.67	123	11.57	0.46	198	32.33	1.29	274	15.19	0.61	350	26.84	1.07
48	34.54	1.38	124	30.87	1.23	199	18.48	0.74	275	22.51	0.90	351	23.51	0.94
49	19.32	0.77	125	23.68	0.95	200	21.24	0.85	276	27.45	1.10	352	29.81	1.19
50	5.83	0.23	126	12.93	0.52	201	26.92	1.08	277	23.60	0.94	353	28.62	1.14
51	24.98	1.00	127	32.71	1.31	202	30.67	1.23	278	29.12	1.16	354	22.53	0.90
52	17.39	0.70	128	14.18	0.57	203	27.26	1.09	279	41.31	1.65	355	23.55	0.94
53	**57.52**	**2.30**	129	22.56	0.90	204	30.59	1.22	280	18.78	0.75	356	24.04	0.96
54	24.57	0.98	130	51.14	2.05	205	13.53	0.54	281	40.80	1.63	357	33.90	1.36
55	12.20	0.49	130	51.14	2.05	206	8.91	0.36	282	36.29	1.45	358	37.55	1.50
56	23.24	0.93	131	40.34	1.61	207	20.65	0.83	283	36.34	1.45	359	33.91	1.36
57	19.01	0.76	132	22.15	0.89	208	19.56	0.78	284	16.89	0.68	360	35.31	1.41
58	42.46	1.70	133	24.38	0.98	209	14.37	0.57	285	20.53	0.82	361	33.54	1.34
59	23.08	0.92	134	23.23	0.93	210	24.32	0.97	286	20.97	0.84	362	26.23	1.05
60	14.86	0.59	135	15.42	0.62	211	20.96	0.84	287	36.29	1.45	363	33.44	1.34
61	14.55	0.58	136	14.51	0.58	212	13.76	0.55	288	36.44	1.46	364	31.66	1.27
62	19.43	0.78	137	31.21	1.25	213	14.30	0.57	289	34.38	1.38	365	31.51	1.26
63	15.19	0.61	138	15.54	0.62	214	33.64	1.35	290	32.34	1.29	366	23.74	0.95
64	26.90	1.08	**139**	**77.17**	**3.09**	215	36.44	1.46	291	5.83	0.23	367	28.63	1.15
65	18.95	0.76	140	13.45	0.54	216	28.34	1.13	292	15.91	0.64	368	32.65	1.31
66	18.88	0.76	141	31.39	1.26	217	27.38	1.10	293	23.39	0.94	369	29.88	1.20
67	27.07	1.08	142	39.16	1.57	218	18.30	0.73	294	8.91	0.36	370	27.96	1.12
68	32.06	1.28	143	23.59	0.94	219	17.79	0.71	295	39.62	1.58	371	18.88	0.76
69	22.84	0.91	144	32.35	1.29	220	29.78	1.19	296	25.56	1.02	372	49.99	2.00
70	17.05	0.68	145	7.17	0.29	221	27.26	1.09	297	33.94	1.36	373	17.99	0.72
71	24.81	0.99	146	19.67	0.79	222	29.50	1.18	298	14.00	0.56	374	21.70	0.87
72	18.76	0.75	147	27.47	1.10	223	34.56	1.38	299	15.33	0.61	375	32.58	1.30
73	13.68	0.55	148	50.51	2.02	224	37.66	1.51	300	32.21	1.29	376	28.98	1.16
74	24.23	0.97	149	22.30	0.89	225	28.25	1.13	301	32.20	1.29	377	17.14	0.69
75	17.47	0.70	150	38.82	1.55	**226**	**53.77**	**2.15**	302	25.80	1.03	378	25.47	1.02
76	28.89	1.16	**151**	**52.24**	**2.09**	227	24.38	0.98	303	11.72	0.47	379	52.08	2.08
			152	32.77	1.31	228	23.23	0.93	304	13.38	0.54			