Urban Distribution Centres: International Models

Applicability to the Inner City of Melbourne

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

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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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Reham Al-Hindawi 20/7/2019

Table of Contents

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Me

Abstract

Urban freight transport is an important aspect which focuses on the sustenance of life and economies of a given urban centre. It involves carriage of the waste which is generated in the cities as well as other goods. Despite the many benefits which are associated with this process, there exist various negative impacts such as emission of toxic gases. An example of this kind of gas includes greenhouse gas which is abbreviated as GHG. This leads to dire consequences which have huge negative impacts on the wellbeing of a city and lives of its residents. Melbourne City has been experiencing an accelerated rate of growth in the recent past and this has attracted more investors to venture into urban freight transport. This has contributed greatly in the development of new solutions in the industry Urban Distribution Centre (UDC) is viewed by many as a solution to address the environmental and liveability issues generated by freight transport in urban city centres. Some of these solutions include UDC which is a facility that deals with logistics and it is usually located close to a city, more specifically near the Central Business District (CBD) or a shopping centre that it serves. Several freight transport firms deliver goods to that facility and from which combined deliveries are executed within the city, CBD or shopping centre. Although the literature has identified sustainability as one of the key success factors for the implementation of UDC, limited research exists on developing a business model and a framework that considers sustainability issues associated with UDC. Therefore, the aim of this research is to develop a framework for an urban distribution centre that considers the sustainability aspect, particularly its applicability to Melbourne context.

To achieve the research aim, firstly the GHG emissions generated by different modes of transport are predicted using a data set of over 20 years via multivariate regression and double exponential smoothing model. The results show that the introduction of electric vehicles and plug-in hybrid vehicles can reduce significant GHG emissions. Secondly, from 77 UDCs', two UDCs cases (the City of London UDC and Paris-La Petite Reine) that have already been implemented in other countries were examined in order to discuss their potential applicability to Melbourne. By analysing two UDC experiences and discussing models and relevant features and elements that may be transferable to Melbourne context, found that certain business models would likely work best in Melbourne City than others. Finally, a business case model and a framework are proposed for the implementation of a successful UDC in Melbourne.

List of Figures

List of Tables

List of Abbreviations

GHG	Greenhouse Gas
CBD	Central Business District
UDC	Urban Distribution Centre
GDP	Gross Domestic Product
LSP	Logistics Services Providers
AIS	Advanced information systems
GPS	Global Positioning System
GIS	Geographic Information System
UCC	Urban Consolidation Centre
LUP	Logistics Urban Plan
SEStran	South East of Scotland Transport partnership
CDM	Clean Development Mechanism
JI	Joint Implementation
CO2	Carbon Dioxide
CRSC	Carbon Regulated Supply Chain
LAC	Latin American and Caribbean
FP	Fuel Price
FC	Fuel Consumption
FE	Fuel Efficiency
DES	Double Exponential Smoothing
VKT	Vehicle-kilometres travelled
NTV	Number of Transportation Vehicles
UN	United Nations
WEF	World Economic Forum
UFCCC	United Nations Framework Convention on Climate Change
US	United States
NATS	North American Transportation Statistics
ANOVA	Analysis of Variance
VIF	Variation inflation factors
NTC	National Transport Commission
MPS	Metropolitan Planning Strategy
VMT	Vehicle Miles of Travel
MCC	Micro-Consolidation Centre
COG	Centre of Gravity
BMC	Business Model Canvas
IOT	Internet of Things

List of Publications

Journal Articles:

1. NAHLEH, Y, KUMAR, A, DAVER, F, AND AL-HINDAWI, R, 'Decision Tree Modelling in Emergency Logistics Planning'. World Academy of Science, Engineering and Technology International Journal of Social, Management, Economics and Business Engineering Vol:8 No:6, 2014.
2. Alhindawi, R., Nahleh, Y.A., Kumar, A., Shiwakoti, N., 2018. Projection of Greenhouse Gas Emissions for the Road Transport Sector Based on Multivariate Regression and the Double Exponential Smoothing Model. Journal of Environmental Modelling and Assessment. (Under Review)
3. Alhindawi, R., Nahleh, Y.A., Kumar, A., Shiwakoti, N., 2018. Application of Adaptive Neuro-Fuzzy Technique for Projection of Greenhouse Gas Emissions for Road Sector. Journal of SN Applied Sciences. (Under Review)
4. Alhindawi, R., Nahleh, Y.A., Kumar, A., Shiwakoti, N., 2019. Urban Freight Consolidation Centre Efforts in City Logistics: International Case Studies - A review. Transport Reviews Journal. (In Progress)
5. Alhindawi, R., Nahleh, Y.A., Kumar, A., Shiwakoti, N., 2019. Business Modelling of a City Logistics: Melbourne (CBD) Case Study. Supply Chain Management: An International Journal. (In Progress)

Conference publications:

1. Alhindawi, R., Nahleh, Y.A., Kumar, A., Shiwakoti, N., 2016. A multivariate regression model to predict the GHG emission in urban logistics. 23rd ITS World Congress, Melbourne, Australia.
2. Alhindawi, R., Nahleh, Y.A., Kumar, A., Shiwakoti, N., 2016. A multivariate regression model for road sector greenhouse gas emission. 27th ARRB Conference – Linking people, places and opportunities, Melbourne, Victoria 2016.

CHAPTER 1

Introduction

This chapter starts with brief research about the area of study's background. Following this, is a discussion of research questions and objectives surrounding this area of study. This is further followed by an overview of the research structure that will be employed during the course of study as well as a brief description of the scope of this particular study. Finally, the outline of the thesis structure is illustrated.

1.1 Background and Introduction

Global urbanization has been on a rising curve and the population of many cities across the world has experienced exponential growth in the recent past. This has led to an increased influx of people towards urban areas. This has resulted in an immense increase in transportation services as noted by Browne et al. (Browne et al., 2012). In accordance with a report released recently by the United Nations (2014), it has been predicted that the population will continue to grow further in all urban areas. This report further indicated that the majority of the European cities are populated with about 73% of their country's overall population. It has also been approximated that this population residing in the European cities contribute about 85% of their states' Gross Domestic Product (GDP). About 81% of its total population of the United States resides in suburbs and cities. On the other hand, China had its urban population rising tremendously from about 26% to a figure around 53% within a period of three years (United Nations 2014). Following the global trend, Melbourne is also expanding in terms of population. Currently, Melbourne's inner-city population is estimated to be 155,527 residents. By 2037, this is expected to increase to around 266,455 residents (Melbourne, 2018). As a result of this huge population, it is predicted that goods and services will be in high demand. Additionally, there is a growing need for device delivery logistics that will ensure that goods will be delivered in a faster way. This has pushed Logistics Service Providers (LSP) to look for mechanisms which will ensure that goods are transported from one part of the Urban area to another using small vehicles (Taniguchi et al., 2003, McKinnon, 2010, McKinnon et al., 2015).

According to Quak (Quak, 2008), a good transportation system needs to be accompanied by a proper transportation system of freight. Development of a logistic system that is efficient leads to the creation of a competitive system of transportation that forms an important aspect of the economic system of a given urban city. The continued growth of the urban population has a corresponding increase in the number of services and goods that require transportation in order to meet both commercial and domestic needs (Browne et al., 2012). On the other hand, an increase in transportation services within the urban centres leads to an increased amount of waste. Cities should have a mechanism of controlling this amount of waste and ensure a friendly atmosphere is maintained across the whole city (Browne et al., 2012). This calls for an increase in vehicles which are aimed at helping in transportation of waste and goods in and out of the urban cities. Therefore, despite the many benefits associated with freight vehicles, the negative aspects are overshadowed and these vehicles are still part and parcel of pushing developments within the city (BESTUFS, 2007, Lindholm and Behrends, 2010, Allen et al., 2015).

Although freight transport distribution is one of the major drivers of the economic development of cities it is rarely a priority of city planners and decision-makers. As stated by Geoff Anson Consulting (Consulting, 2010), every day, individuals and businesses depend on goods and equipment moved on the freight network. So, delivery failures caused by congestion and delay is a paramount problem. (Crainic et al., 2004, Dablanc, 2008) state that goods transportation in urban areas has become an issue for many cities in the world due to traffic congestion which significantly affects logistics operations. Growth of the transportation sector calls for expansion of cities which will eventually result in an increase of adverse effects to the surroundings. Some of these effects include noise and air pollution, increased congestion and road accidents. Additionally, this will lead to more adverse effects such as global warming which is caused as a result of GHG emissions within the cities (Browne et al., 2012, Allen et al., 2015, Quak et al., 2014, Nordtømme et al., 2015).

During the last three decades, there has been tremendous growth in the e-commerce industry more specifically in the e-grocery and consumer product markets. This has led to an increased rate of delivery services between the consumers and product sellers. This growth is associated with major problems that affect the supply chain which majorly includes the suppliers and consumers (Gevaers et al., 2009). The last procedure of the supply chain is involved with the delivery of products directly to the consumers. This part depicts the actual physical transportation process of goods from the supplier to the final destination where the customer is located. This is a critical process which ensures the delivery of products to the consumers has been fulfilled (Aized and Srai, 2014).

With the expected increase of distribution and dissemination of goods within the major cities across the world, there need to be strategies that will help in reducing or eliminating the negative effects of this move. (Interface Transport, 2009) confirm this issue and state that the last mile delivery is the most expensive part of freight transport distribution in urban areas. According to Gevaers et al. (2009), the last part of the supply chain is considered to be one of the processes that account for most of the environmental solutions within the cities. Additionally, this last part of the supply chain process leads to a more expensive and inefficient process. Firstly, delivery of products to people's home has led to an increased failure of deliveries which has led to losses and incurrence of more money in order to cover the distance. Secondly, this has led to a high problem referred to as "empty running". Thirdly, security is another problem that which usually arises from discussions between the consignee and a supplier. Fourthly, the distribution of goods in some regions has been a huge challenge which has led to a small mass of goods that can hardly generate enough income which can sustain the routine plan. Lastly, most of the home-home deliveries are done using small vans which have led to a higher amount of carbon as opposed to the one that is generated by bigger trucks (Gevaers et al., 2009). Mayors of cities and governments are seeking to address this issue and related problems such as environmental nuisances through different measures. Many initiatives have been undertaken worldwide to solve the problem such as road space allocation, the road user charging, public transport development, parking taxes, urban land use, and road freight management, but the results are not all convincing. If we look at freight distribution into a city, some investigators such as Lindholm and Behrends (2010) point out that many significant obstacles such as the lack of global comprehension of the interactions of transport movement in urban areas make obtaining reliable achievements difficult. Similarly the Australian Transport Council (ATC, 2008) in its report related to “the improvement of urban congestion information for decision making” outlines the lack of understanding of transport movement generated by business as one of the major information limitations hindering decision-making. Freight transport distribution in urban area is a complex issue involving many stakeholders from the public and private sector which interact but do not necessarily cooperate (Lindholm and Behrends, 2010). As stated by Muñuzuri et al. (2005), the configuration of European city centres limits the possible expansion of freight and passenger transport and consequently is the cause of an increase in conflicting situations between freight carriers and other stakeholders.

1.2 City Logistics

There is a rising global trend whereby goods and services are in high demand within the cities. This calls for an improvement of logistic activities so that they can become more effective and efficient. Logistics is a term that has been used to describe the movement of goods from one point to another as a means of distribution (Johansson, 2018).

An increased rate of logistics in cities has led to diverse perspectives from various people. According to Thompson and Taniguchi (2001), city logistics has been defined as a process that involves transport and logistic activities which is optimized using collaborative effort by private establishments and information systems which have been optimized in order to reduce congestion and promote energy and safety mechanisms.

Another example is from Lindholm (2012) who has defined city logistics as activities associated with transportation management in an urban context. In this paper, ‘city logistics’ is used in a similar manner which is defined by Taniguchi et al. (2001). In his work he referred this term as a process that involves optimization of urban area activities by use of information systems which are advanced.

City Logistics aims at addressing negative effects in a congested urban area and try to devise innovative mechanisms that will promote quality life within the urban areas (Muñuzuri et al., 2005, Quak et al., 2014, Malhene et al., 2012). Rodrigue et al. (2013), discussed that city freight distribution systems include independent retailing, food deliveries, parcel and home deliveries, chain retailing, construction sites, and garbage collection and disposal. According to De Magalhães (2010), low commonality existing between the different freight distribution systems is the cause of heterogeneity and complexity of urban freight transport which make the relationships between stakeholders difficult. In accordance with Thompson and Taniguchi (2001), it has been noted that the four major stakeholders who are involved in urban freight transport include; Shippers who are also referred as receivers, residents, freight carriers and the government. All these stakeholders share different objectives and their behavior is totally different. Figure 1.1 shows the intertwined relationships between these groups and the potential conflicts within the system.

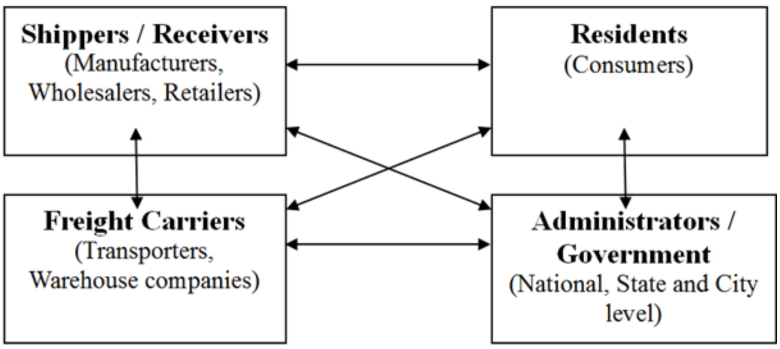


Figure 1.1: Key stakeholders in city logistics (Tseng et al., 2005)

Furthermore, Thompson and Taniguchi (2001) highlight that City Logistics must target three goals: mobility (ease and secure movement of goods in an urban area), sustainability (consideration of environmental issues and energy saving) and liveability for the residents. In fact, City Logistics aims to make a more efficacious and efficient logistics system within a city. This is achieved through consideration of benefits and costs of the set mechanisms towards some of the key stakeholders which include both the private and public sectors. As noted by Taniguchi and Van Der Heijden (2000), city logistics can be categorized as shown below:

- Advanced information systems (AIS) which include the use of Geographic Information System (GIS), and Global Positioning System (GPS)

- Cooperative freight transport system (integration of resources of cooperative companies),
- Public logistics terminal including freight villages, ***UDC***,
- Load factors control for the access to specific areas, and
- Underground systems of freight transport.

According to a report carried out in 2007, it was stated that there was an urgent need of developing a distribution system that could create an interface the transport system and the distributors who were involved in distribution processes within a given urban area. This report further suggested that the use of smaller vehicles which are environmentally friendly could be able to perform distribution tasks in a better way (Commission, 2007). According to BESTUFS (2007), developing a platform that could handle and manage freight system of a given city is also seen as a suitable alternative. Such a platform could lead to further advantages such as improved handling of the delivery of goods across the city. This would enhance efficiency and could make it easier to control and manage waste and returns. This thesis focuses on one of such platforms which is UDC and it has been highlighted from a report by BESTUFS.

1.3 Urban Distribution Centre

Urban Distribution Centres (UDCs) is also referred to as Urban Consolidation Centre (UCCs) in some publications, is a concrete application of public terminal freights which has been broadly developed in Europe over the last twenty years. Among the most studied initiatives of city logistics is UDC ((van Rooijen and Quak, 2010, Benjelloun and Crainic, 2008, Lagorio et al., 2016). In accordance with these publications, this has been established to be the case due to the ability and potential it has in reducing negative impacts which are usually related to the distribution of freight within the cities. It has been highly preferred to other systems due to the fact that it provides solutions in both environmental and social dimension. This helps in providing a desirable alternative which can be applied in distribution systems which are used today ((Browne et al., 2005, Nordtømme et al., 2015, Gammelgaard et al., 2016).

1.3.1 Definition of UDC

In accordance with Browne et al. (2005), UDC is a facility that deals with logistics which are closely located to a city, a CBD or a shopping centre and it involves many freight transport firms which handle the delivery of goods and from which combined deliveries are executed within the city, CBD or shopping centre. (Interface Transport, 2004), defines a UDC as being a nodal point which gathers and stops the flow of goods or services in order to organize and simplify delivery into a city centre. Figure 1.2 below illustrates UDC principle described both by (Browne et al., 2005, Interface Transport, 2004) by opposing a freight transport distribution in an urban area. It further provides two different scenarios which are used to depict the differences exhibited in the presence and absence of UDC. The system using UDC is referred to as a UDC system and involves various processes such as transportation into and out of the UDC until goods are received by the receiver.

In the figure shown below, the small yellow circles which appear at the outskirts of the urban city are used to depict the receivers of goods. On the other hand, the yellow circles which are shown located on the outer side of the urban area are used to depict shippers. In the first scenario, the style of lines is used to show the routes used by the shippers while in the second scenario, those lines represent the routes used by UDC operators.

Application of UDCs provides a couple of benefits to various stakeholders of the market. For instance, in the figure used below, a decrease in the number of vehicles offering freight services in the system can lead to improvement of the attractiveness of the city. This results in more positive impacts which are beneficial to the receivers and shippers located in the urban area. Despite the lucrative opportunities which can result from such a market scenario, this can also lead to negative effects as noted by (Johansson, 2018).

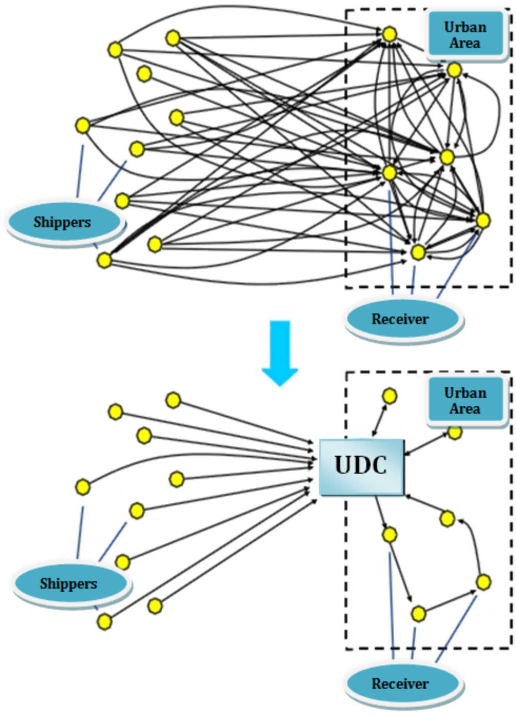


Figure 1.2: Two different scenarios, one with a UDC and one without: Adapted from (Interface Transport, 2004)

1.3.2 UDC Benefits

Some of the major benefits which are associated with a UDC system include improvement of the load factor of vehicles which are used in the transportation of goods. This yields more benefits to congested cities whereby the UDC system leads to a reduction of distance covered when making delivery of goods within the city. This, in turn, reduces GHG emissions as well as air pollutants in the city (Browne et al., 2005, van Rooijen and Quak, 2010, Panero et al., 2011, Gammelgaard et al., 2016).

In addition, the reduction of the distance covered by freight vehicles leads to a reduction of congestion and accidents on the roads. This promotes and enhances pedestrian safety and the overall security of other road users (Browne et al., 2005, Gonzalez-Feliu and Morana, 2010, Allen et al., 2012, Lebeau et al., 2013).

1.3.3 Financial aspect of UDCs

In accordance with papers published by various scholars have shown that acquisition of a fully functional UCD system is a costly venture(Browne et al., 2005, van Duin et al., 2010, Marcucci and Danielis, 2008, Olsson and Woxenius, 2014, Wolpert and Reuter, 2012)). However, some researcher argued that a UDC system which is viable should be able to sustain itself and this is well captured these research works, (Allen et al., 2007, Marcucci and Danielis, 2008).

Furthermore, there are other researchers who argued that in order to have a UDC system which is viable, it should have permanent safeguarding which can only be supported by subsidies offered by the government. (Browne et al., 2005, van Duin et al., 2010, Quak and Tavasszy, 2011, Van Duin et al., 2008). This was further supported by some piloting trials which were conducted by some researchers and proved that UDCs which depended on government collapsed immediately after withdrawal of the subsidies by the government. The main reason behind this was the inability to cover the running costs which were associated with the system (Browne et al., 2005, van Rooijen and Quak, 2010, Allen et al., 2012, Quak et al., 2014, Ville et al., 2013). Hence financial element remains to be a great challenge which is associated with UDCs.

In order to ensure the survival of a UDC, generation of revenue remains to be one of the major elements which cannot be overlooked. Therefore, a good UDC system should be able to set good prices for its services in order to generate an income which will be able to cover its running costs (Browne et al., 2005, van Rooijen and Quak, 2010, Allen et al., 2012, Van Duin et al., 2016, Aastrup et al., 2012). In order to achieve this, many researchers have highlighted the need to develop a business model which is well thought when coming up with a design of a UDC system. To achieve this process in an effective manner, there is a need to, first of all, gather knowledge about a UDC and have a comprehensive understanding of its financial aspect. This will help in developing a viable concept that will help in organizing a UDC in a way that it provides logistical and social value to all stakeholders (Browne et al., 2005, Allen et al., 2012, Quak et al., 2014, Nordtømme et al., 2015, Van Duin et al., 2016, Malhene et al., 2012).

1.3.4 UDC and Business model

In accordance with Quak et al. (2014), it has been noted that issues with urban logistics are common and there have been major efforts which have been applied and tested but proved to be unsuitable for implementation which are for long-term purposes. Majority of those tests have been able to focus on operational and technical feasibility aspect with little attention towards the economic feasibility aspect (Quak et al., 2014). Application of efforts towards these initiatives has been on a declining trend due to the uncertainty of the value of benefits associated with such moves (Quak et al., 2014). He further argues that development of freight systems which are more successful requires a feasible economic condition and a business model which is viable.

A business model has been defined by Osterwalder et al. (2010) as a model whereby an organization is able to offer value to its customers and be in a position to generate revenue which sustains the entire system and operations of the organization. It has also been described as a mechanism by which an organization is able to create, deliver and capture value.

Furthermore, the business model has also been described as a series of elements which involves a value proposition, a customer interface, a financial aspect and infrastructure management. Firstly, the customer interface entails channels, customer relationships, and segments. Secondly, the value proposition entails service and product offering. Thirdly, the infrastructure management involves management of key partners, resources and activities. Lastly, the financial aspect depicts the revenue model as well as the cost structure. There is another definition of a business model that was put forward by Afuah (2004). In his definition, a business model is referred to as money generating system. This is a set of activities carried out by a firm in order to offer their customers benefits while they earn a profit that promotes the sustenance of the entire system.

Urban logistics aims at helping cities in designing policies that assist in the development of business models that have consideration of the environmental implications. Some of these factors include; reduction of pollution and noise as well as reduction of the number of trips which are made by freight vehicles. Additionally, they also focus on social impacts and strives to promote and enhance the quality of life, working conditions as well as reducing congestion and accidents (TURBLOG, 2011).

There are several negative effects which are associated with urban freight transport which affects both the society and the environment. Hence, sustainable solutions are highly recommended for urban freight transport for cities with Melbourne being one of them. The main positive impact of the urban distribution centre is to decrease negative effects without having its sole goal of making a profit.

1.4 Objective and Research question

Although there have been some studies on city logistics and UDCs in Australian context, a comprehensive and systematic study on transferability of international models of UDC to Australia has been limited in literature. Therefore, this paper aims at studying the transferability of International models of UDC to Australia. Specifically, we examined the transferability of international models of UDC to Melbourne CBD. The main objectives include the following:

- *Research objective 1: E*xplore the interconnection between the framework factors (stakeholders, objective, descriptor and solution approach).
- *Research objective 2:* To understand the intrinsic and contextual factors for success of operational UDC internationally.

- *Research objective 3:* To examine the potential transposition of international models of UDC to Melbourne CBD through the analysis of selected case studies.
- *Research objective 4:* To propose a guideline which can be used in modelling an urban freight system which involves a combination of common activities and features such as stocking and ordering among others. This is achieved in form of data model that promotes object and data modifications.

This study proposes the following primary research question based on the research objectives. The research questions of this study are:

- *Research question 1:* Which option has the most potential to reduce GHG emissions resulting from urban transport modes? *(addressing objective 1)*
- *Research question 2:* What are the intrinsic and contextual factors and the common features and activities of success of operational UDC internationally? *(addressing objectives 2 and 3)*
- *Research question 3:* What are the impacts of making a guideline in the applicability of urban logistics at the Inner City of Melbourne? *(addressing objective 4)*

1.5 Research Framework

The methodology is designed according to the research objectives. Based on the nature of this study, the research approach is distributed into three stages:

First Stage:

- Conducting a literature review aiming to identify the key characteristics including business model and contextual features of active UDC implemented internationally.
- Identifying the current political, economic and social features of freight transportation in Melbourne CBD.
- Collecting data from different secondary sources

Analyse the data collected using statistical software (Minitab). This is further followed by application of statistical models such as Double Exponential Smoothing (DES) model as well as Multivariate Regression Model which are applied on the same variables in order to predict the GHG emissions.

Second Stage:

- Selecting urban logistics case studies and compare them to find the similarity between each model. So, we can start making urban logistics guideline.
- Develop a Decision Tree Analysis to select the suitable UDC.

Third Stage:

- Selecting internationally active UDC and examine the potential transposition of these international model of UDC in Melbourne CBD.
- Propose city logistics typology to be implemented in Melbourne CBD.
- Develop business model canvas for the city of Melbourne.

The research methodology is designed based on the research objectives. This is mixed-method study which includes three stages. Figure 1.3 shows the research methodology flow chart.

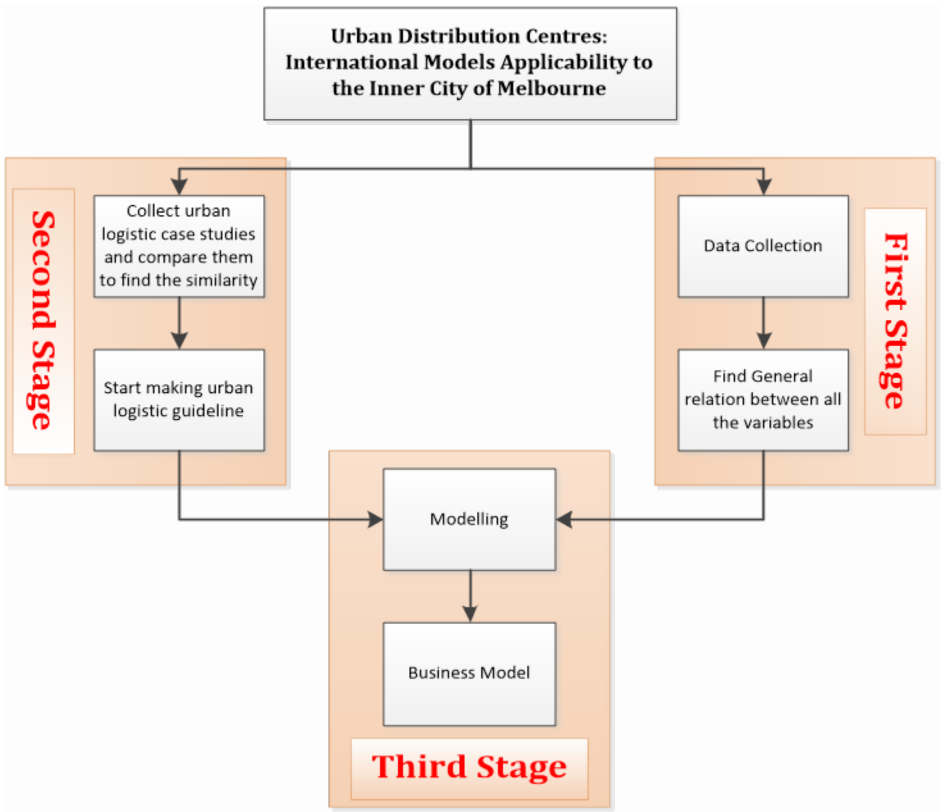


Figure 1.3: Research methodology flow chart

There are reliable studies which were conducted over the last twenty years aiming to list the essential features of successful UDCs. In this research, identification of key success factors of a sustainable UDC and in which economic, political and social context a UDC works the best is drawn on the results of previous dependable studies in this field.

Regarding the freight transport distribution in Melbourne CBD, the research aims to analyse current freight regulations and policies applied.

The potential applicability of the selected UDC in Melbourne CBD is analysed by identifying the potential issues related to their implementation. Each UDC will be assessed in terms of political (regulations, policies, stakeholders), economic (performances, deliveries) and environmental (polluting emission and congestion) aspects. Regarding the case studies, the criteria used to select them are as follows:

1. The UDCs are not in experimentation phase and are totally operational.
2. They operate permanently and are sustainable.
3. Data and information are available in English and enable to understand and compare the results obtained (economic, environmental and social aspects).
4. The UDCs are managed by private companies or private/public partnership.
5. Contextual features of these UDC are compatible with the configuration of Melbourne.
6. The types of model/method are available.

The UDC selection has to identify different cases being possibly transposable onto Melbourne in order to reduce traffic congestion in the CBD.

1.6 Research Scope

The research is limited to Urban Distribution Centres implemented for the delivery of goods (parcels, food and drinks, chilled and frozen) into the inner city and considering the different other types of urban logistics means aiming to enhance urban traffic or environmental issues. The motivation of the research is to examine the potential transposition of international UDC model to Melbourne CBD.

The purpose of the research is to examine the transferability of international models of UDC specifically to Melbourne CBD.

1.7 Thesis Organization

The whole paper consists of a total of seven chapters. Below is a brief overview of how the other chapters are structured and organized.

- *Chapter 2: Literature Review*

This chapter starts with a detailed review of literature which is relevant to the research topic. It comprises of research studies conducted over the last twenty years in relation to city logistics concept and more particularly UDCs. In order to facilitate the readings these studies were grouped in three categories:

- City logistics and urban freight models.
- Urban freight distribution centres: case studies.
- The Environmental Impacts in Urban logistics.

➢ *Chapter 3: Importance of the UDC to Reduce the GHG Emissions*

Shows the importance of the UDC in predicting the greenhouse gas GHG emissions.

➢ *Chapter 4: Guideline for choosing which model is suitable for UDC*

Shows the findings related to the key success factors of operational and sustainable UDCs, and describes the regulations and policies currently implemented in Melbourne CBD.

➢ *Chapter 5: Transferability of the selected UDC*

This chapter studies the UDC's transferability and presents a common transferability framework that was developed for these initiatives. The main objective is to establish a framework to assess the potential for transferability of urban logistics concepts, practices and models.

➢ *Chapter 6: Business Model*

This chapter presented a proposed business model on the feasibility and sustainability of starting a UCC initiative in Melbourne CBD. We have designed a business model, which represents receivers, carriers, the UCC, and the local government as stakeholders. The model is divided into four series of elements which include:

- Customer interface- This includes customer relationships, channels and segments
- Value proposition- This comprises of service and product offering
- Infrastructure- This consists of key resources, activities and partners
- Financial aspect- This section covers revenue streams, cost structure and results

- *Chapter 7: Conclusion & Recommendations*

This chapter concludes the thesis with the highlights of the contributions in this area. Limitation and constraints are also indicated. Furthermore, some recommendations for future research opportunities are suggested to researchers.

CHAPTER 2

Literature Review

This chapter describes the review of relevant literature on city logistics, urban distribution centre and environmental impacts of urban logistics. Following the literature review, the research gaps are analysed at the end.

There have been many studies conducted in the field of urban freight and transport planning that propose some measures to reduce traffic congestion and related problem such as environmental pollution (GHG emissions). In order to comprehend their contributions, those studies have been grouped into three categories as below:

- City Logistic and Urban freight Models
- Urban freight Distribution Centres: case studies
- The Environmental Impacts in Urban logistics

2.1 City Logistic and Urban Freight Models

In accordance with Boerkamps et al. (2000), urban freight domain can be classified into five components. All these components are part of the freight movement and they have four interacting markets. Based on the variety of market segments, there exist four main stakeholders who have a major implication towards the urban freight domain as shown in the figure below. They include carriers, customers, shippers, and administrators (See Fig. 2.1).

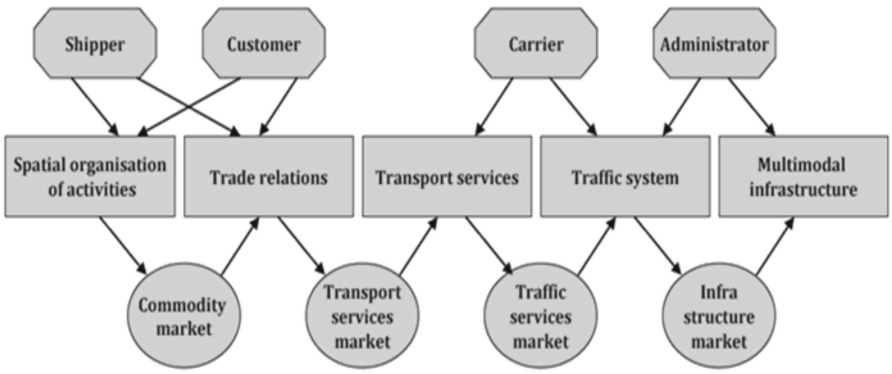


Figure 2.1: Urban freight domain (Boerkamps et al., 2000)

Browne et al. (2005), in their research, counted more than 67 relevant experiences related to the implementation of UDC in Europe, Japan, and the USA over the last thirty years. Panero et al. (2011), point out that among the 37 UDC cases that they studied in their research, about two-thirds of them are still operational today.

Over the last twenty years, many studies have been carried out to understand the causes of success or failure of these experimentations. Researchers focus on the key factors (strengths, weaknesses, threats, and opportunities) which make the development of an UDC successful. They also search to understand the economic, political and social context in which a UDC works the best and to define the preliminary conditions required in order to obtain agreement about the development of a UDC from stakeholders (shippers/receivers, freight carriers, residents and administrators/governments). Although numerous Australian experts such as Russel Thompson have studied city logistics problems only a few experiments have been conducted over the last twenty years in comparison with those performed in Europe.

The outcome which results from the interactions of stakeholders from both the supply and demand sides lead a scenario referred to as Urban freight traffic. Therefore, in order to have a better understanding of how goods are moved from one point of the urban area to another, there is a need to analyze the behavior and attributes of different stakeholders. (Anand et al., 2012). According to (Taniguchi et al., 2001), urban freight domain stakeholders can be classified into four broad categories.

Pre-selected parts of a system can be represented in a meticulous way which is commonly referred to as a modelling perpective. A perspective brings out the different visualization, dedication, focus and conceptualization of model representation. There exist various perspectives of the urban freight system which is dependant on the objectives for modelling, user and the available means of achieving the objectives. The movement of goods in urban areas can be analyzed from diferent perspectives which aim at fulfilling a common objective.

Some of the four common perspectives which are used in urban freight modelling include technology, planner, policy and behavior. However, some of the recent research efforts have established that there is a fifth novel perspective known as multiple actors perspective and has been highly considered lately (Anand et al., 2012).

ADEME (2004), highlights the comparative analysis of two UDC (La Rochelle and Monaco) with two main lessons. First, UDC should be located near the city and would receive goods by train or ship; furthermore, the use of big electric trucks should be recommended to deliver products into the city. Although this first remark seems a utopia it underlines the potential path for improvement of environmental efficiency of UDC. Second, the best environmental effects are obtained through a viable and efficacious functioning of UDC.

Gonzalez-Feliu and Morana (2010), show how the city logistics method can meet the objectives of sustainable development. They highlight through the case study of the City of Porto, the key factors of success of a sustainable urban distribution organisation. Panero et al. (2011), aim to analyse UDC model in order to identify the key features and contextual conditions that make them successful and to discuss the potential applicability to the New York Metropolitan region of three active UDC cases.

Thompson and Taniguchi (2001), give readers a detailed presentation of the city logistics concept and its involvement in freight transport. Wilson (2008) suggests that Japanese and European models of freight planning are a good standard that freight transport managers and planners should consider for Melbourne. In addition, he points out that city logistics concept could help to define strategies for sustainable transport into Melbourne city. Although much research about city logistics and UDCs have been conducted by Australian experts, only a few experimentations have been executed in Australia over the last twenty years in comparison with those performed in Europe.

2.2 Urban Freight Distribution Centres: Case Studies

Transportation of freight within the urban areas remains to be an integral part of the life of a city. This supports the movement of goods from various places such as industries and shops and ensures that the intended clients or businesses. This offers huge support to tenancy life and ensures that all operations of the city are running smoothly (Allen et al., 2000). However, urban freight transportation has many negative impacts on the environment. Vehicles which are involved in the transportation of these goods consume massive energy and this increases the emission of CO_2, NOx and noise which poses a huge threat to the people residing in the city. As the urban population continues to grow, there has been a rapid increase in the request of goods and services within the city. This massive increase in requests has resulted in commercial vehicles making more trips in order to meet the increased demand. This has consequently led to increases noise and air pollution, more jamming as well as reduced safety of the people living in the city. As a result of the increased freight deliveries in the city areas, more options on how to respond to such a scenario becomes an important aspect which cannot be overlooked (Anand et al., 2012). As we strive to make cities environmentally friendlier, it has been noted that the exploration of innovative approaches on how to manage the urban transport delivery system becomes very important. One of these approaches includes the coordination of various freight logistics. For instance, products belonging to different carriers can be grouped together and be delivered using small delivery vehicles to a particular part of the city. This is a strategy which is suitable when there are fewer vehicles which are tasked with the delivery of goods in a given city (Fossum, 2013).

Freight transport system plays an important role which helps in the economic vitality of a given city. It plays an integral role in ensuring there exist a linkage of all nodes within the city. This promotes the creation of a competitive region where different supply chains can be able to keep up with the commercial and industrial tasks as well as other functions. Despite all these benefits, urban freight movement has its own cons. For instance, it leads to increased noise, air pollution and traffic congestion. Additionally, it also leads to special losses which include extra labour and fuel costs which arises from traffic and penalties or fees which are gathered through legal or double-parking offences. It has always proved to be overwhelming when efforts are put forward in order to reduce the negative impacts which are associated with the delivery trips taking place in the city. As a result of the increased number of firms indulging in the transportation industry as well as the growth of urban population, this has resulted in a contradiction which inhibits the creation of a green city (Anderson et al., 2005).

Over the last ten years, there has been the development of various UCCs which are based on different operational structures with the aim of reducing negative effects related to the freight transportation system. This usually achieved by focusing on the last part of the freight transport system which focuses on how goods are moved from a supplier and get delivered to a client (Scott et al., 2009). UCC has been defined as an area of convergence of goods where products coming outside of the city are combined and then relayed to the intended client using small delivery vehicles. It has been noted that depending on the distance, the delivery process can either be done by foot or through the use of delivery vehicles (Browne et al., 2005). UCCs has enabled carriers, retailers and shippers to have a way which they can be able to consolidate deliveries from various clients with an aim of simplifying the distribution process as well as cutting cost by using fewer delivery trucks. This improves productivity and cuts down on operational costs leading into increased profit (Browne et al., 2005, BESTUFS, 2007).

The prime of UCCs is create a centre or a terminal where goods can be consolidated and combined together in order to improve conveyance and reduce the transportation costs. This yields more benefits such as reduced city congestion, parking issues as well as reduced number of large trucks manoeuvring in city which can lead to accidents. This leads to creation of a safer city to the residents. There has been application of more than sixty UCCs in Europe but the degree of accomplishment has varies in all centres (Browne et al., 2005).

Research of UCCs can be dated back in the mid-1970s where it started as an urban freight activity and since then it has been able to grow with a high level of enthusiasm in the past decade (van

Duin et al., 2010). There has been identification of major logistic centres in Germany and Netherlands which aims at helping in achievement of efficient logistics in cities. However, there has been a consideration of other cases from various countries which include, France, UK, Italy, Sweden, Portugal, Austria and Spain who have begun rolling out UCCs schemes (Browne et al., 2005, BESTUFS, 2007).

Application UCCs leads to some social advantages which include reduced congestion in cities and air pollution as well as enhancement of safety and easiness of accessing parking. Furthermore, depending on how a UCC is executed, there can be other benefits such as cost saving which results from maximization of load factor of the delivery vehicles, improvement of vehicle orientation as well as reduction of mileage which leads to overall improvement of operational efficiency (Panero et al., 2011).

(Interface Transport, 2004), conducted a study aiming to environmentally analyse and compare two UCCs located in La Rochelle (France) and Monaco, respectively after 4 and 14 years of operation. Focused on environmental issues such as pollutants ratio, local air pollution and urban congestion, this comparative analysis pointed out two main lessons:

- First, an UCC should be located near the city and would receive goods by train or ship, the use of big electric trucks with an optimised loading should be recommended to deliver products into the city. Although this first remark seems unrealistic it underlines the potential path for improvement of environmental efficiency of an UCC.
- Second, the best environmental effects are obtained through logistics performance.

This environmental research was conducted for both Monaco and La Rochelle by comparing the current operational UCC with a hypothetic situation without UCC defined by researcher team and validated through interviews of carriers and receivers. Unfortunately, the lack of data for the situation without UCC has led researchers to make many assumptions which can distort the results. Nevertheless, as the two analyses used the same process and assessment criteria, the comparison remains accurate. Furthermore, evaluation of the environmental impacts of the two UCCs was carried out by using a systemic approach based on the analysis of the UCC logistics chains instead of a geographical method limited to the area covered by the UCC. This approach guaranties that results are not impacted by environmental effects in relation to other nuisances in the geographical area. Albeit this comparative analysis and assessment is accurate and pertinent, it is difficult to take a global lesson from only two case studies' outcomes. Furthermore, it is regrettable, even if it is comprehensible, that economic, political and social aspects of the two UCC have not been considered in this research.

The viability of UCC after the experimentation phase is one of the main concerns of municipalities and logistics suppliers. (Browne et al., 2005) outline in their study related to the evaluation of 67 European UCC schemes that there is a lack of information in this field enabling local authorities or investors to make a decision based on evidence. However, before measuring the viability of a UCC it is crucial to identify the benefits, results and economic, social, and environmental effects of a UCC.

In **Error! Reference source not found.**, (Browne et al., 2005) brings an answer to this issue by summarising the logistics and prerequisite activities of a UCC as well as its benefits which are based on the following key features:

- Freight transportation
- Storage space
- Pre-retail services

Figure 2.2 revealed that a UCC which has been well defined can positively impact stakeholders in different fields: operations, results and economics, social and environmental effects.

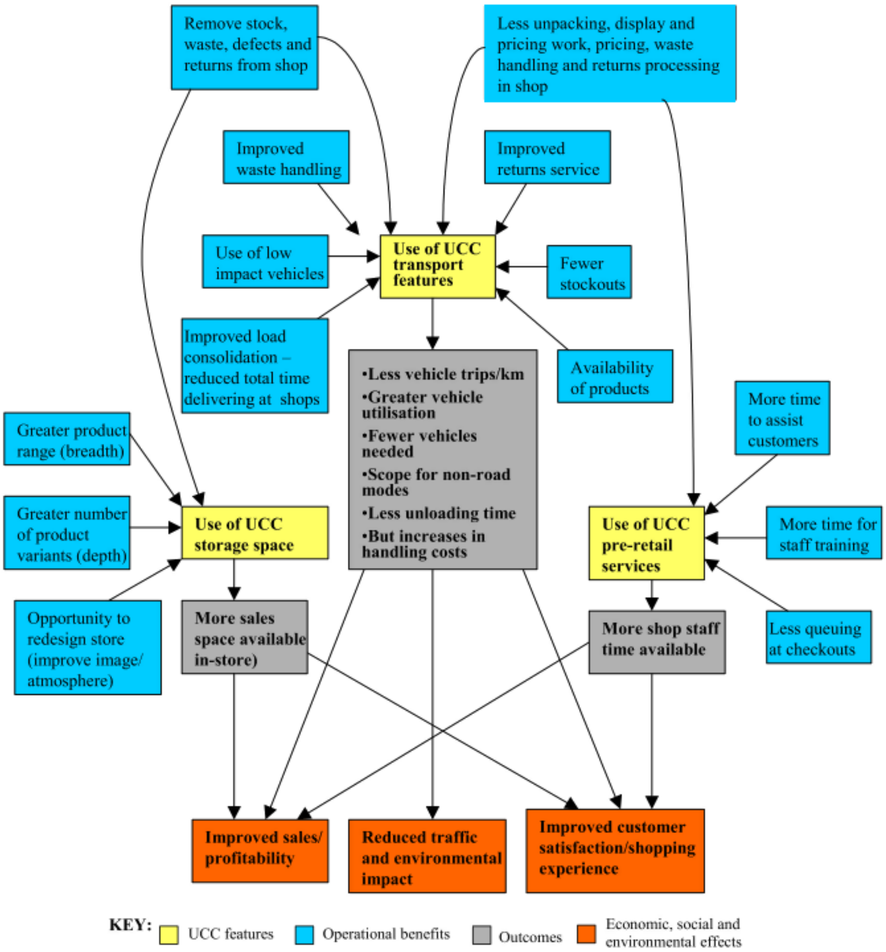


Figure 2.2: Range of potential logistics, prerequisite activities and possible benefits of at UCC system (Browne et al., 2005)

Another contribution of (Browne et al., 2005) is the development of a framework enabling to assess an UCC type through an accurate and consistent approach which includes the investigation of stakeholders' views (shippers/receivers, freight carriers, and governments policy makers) through interviews. Nevertheless, application of the assessment framework to operational UCC such as the Tenjin (Japan) or the Heathrow Airport retail consolidation centre showed that the lack of data, before the implementation of the UCC, was a major issue.

Consequently, measuring the real effect of an UCC implementation on environmental issues is a hard challenge, unless simulating a hypothetic situation without UCC, for the comparison as realised by (Interface Transport, 2004) in their study. To illustrate this point, over the 67 UCC analysed, solely 17 UCCs had contained data related to financial, logistics and environmental impact of UCCs. As a result, the evaluation of operational UCCs was limited to these 17 UCCs.

Nevertheless, findings provide relevant information about the likely beneficiaries of UCCs from a logistics perspective such as small and independent retailers, carriers making small and several drop deliveries and current share-user distribution operations. Major supermarkets and department stores are not interested in UCCs because they operate their own inventory stock consolidation and provide deliveries to their outlets. According to (Browne et al., 2005), allocation of costs and benefits between stakeholders involved in an UCC is a critical point in establishing the viability of an UCC initiative because parties are interested only by their costs and benefits, and rarely want to share improved results in the logistics chain. The last contribution of authors is the path for enhancement of viable and sustainable UCCs suggested through several recommendations for Government actions in regulation and policy field, existing and future UCCs initiatives and future research into UCCs.

Muñuzuri et al. (2005), suggest two levels of measures that local administration can implement to enhance freight deliveries in urban areas: specific solutions aiming to solve specific issues and combined solutions, involving the consolidation of several specific solutions, which make up the logistics strategic policy for the city. Table 2.1 succinctly presents the specific solutions suggested by (Muñuzuri et al., 2005).

Table 2.1: Classification of urban freight solutions for application by local administration (Muñuzuri et al., 2005)

Local administration solutions for urban freight		
Public infrastructure	Transfer points	City terminals Outskirts logistic centers Logistic improvement of terminals Use of rail or ship terminals Use of public parking lots
	Modal shift	Use of the train or underground system Shuttle train
Land use management	Parking	Load zone provision Parking space planning Hub areas Use of other reserved spaces
	Building regulations	Load/unload interfaces Use of private parking lots Mini-warehouse
Access conditions	Spatial restrictions	Access according to weight and volume Access to pedestrain zones Street blocking allowance Closing the center to private traffic Road pricing
	Time restrictions	Adequate rotation in load zones Night deliveries Double-parking short time restrictions Access time windows
Traffic management	Scope of regulations	Carrier classification Freight zone classification Harmonization of regulations Street classification
	Information	On-line load zone reservations

The study provides a useful glossary of applicable solutions including references of research conducted in this field and the expected effect of these measures by main theme. Furthermore, it underlines that these measures can be either enforced or promoted according to the objective targeted by local authorities.

The research of economic model enabling to perpetuate UCCs after the experimentation phase is one of (Gérardin and Conseil, 2007) objectives in his study related to the analysis and assessment of ten French UCC. Unfortunately, if the UCCs analysis is very well conducted, its utilisation, as indicated in the research objective, essentially focuses on the French national program "Merchandises en Ville". As a result, the lessons learned are not easily utilisable in another context. Nevertheless, amongst the general remarks made, those related to the difficulties to collect data, to coherently assess UCCs performance and to obtain consensual agreement from stakeholders is a recurrent criticism of researchers.

Another issue in logistics transport management is the lack of efficient Logistics Urban Plan (LUP) based on accurate information. (De Magalhães, 2010), reveals in his study of Belo Horizonte city (2.5 million of inhabitants, Brazil) that 30% of trucks circulating inside the city are empty, 35% are half loaded and large trucks are generally overloaded by 23%. These findings show that the development of LUP must not be based solely on trends of vehicles on the road but also on the potential improvement of traffic issues through implementation of measures related to urban land use and road freight management. However, the author does not explicitly explain the possible contribution of City Logistics concept in solving traffic congestion issues in Belo Horizonte city.

Gonzalez-Feliu and Morana (2010), show how City Logistics method can meet the objectives of sustainable development. Through the case study of City of Porto, the authors highlight the key factors for the success of a sustainable urban distribution organisation.

Stewart and Halliday (2010), in their report 'Sustainable Urban Distribution', provide an overview of sustainable urban distribution in the SEStran (South East of Scotland Transport partnership) area, and concentrate on UDC and the use of low carbon vehicles.

Panero et al. (2011), analysed UDC model in order to identify the key features and contextual conditions that make them successful and to discuss the potential applicability of UDC model to the New York Metropolitan region of three active UDC cases.

2.3 The Environmental Impacts In Urban Logistics

Distribution of goods, as well as urban freight transport, remain to be significant elements in the commercial, economic and environmental dimension of a city. Therefore, there has been a growing concern over the increasing environmental impacts which result from urban freight traffic more specifically air pollution and GHG emissions (Taylor, 2005).

Allen et al. (2007), in their book *Good Practice Guide on Urban Freight Transport* give advice to people seeking to implement initiatives aiming to enhance the flow of goods in urban areas while decreasing related environmental nuisances. De Magalhães (2010), shows that 30% of trucks circulating inside Belo Horizonte city are empty, 35% are half loaded, and large trucks are overloaded by 23%. He recommends implementing the concept of city logistics to manage the freight transport in Belo Horizonte metropolitan area.

In response to the growing pressure on companies to be more sustainable from external parties, there has been an increasing focus on carbon emission assessment and reduction. The field known as Green supply chain management has received more and more interest during the last few years.

20% of all emissions which are associated with GHG emissions are attributed to the transport system which comprises of both of passenger and freight transport. GHG emissions are increasing rapidly as a result of the growing transport system in cities and it is predicted that this could grow to a higher percentage by 2020 if there are no mitigative actions. Emissions resulting from freight transport system accounts for more than 30% of the total GHG emissions. More than 90% of the GHG emissions from the transport sector consist of CO_2. There have been mechanisms which have been developed in order to reduce emissions of carbon from operations related to the transport system. These initiatives have garnered a lot of attention from all parts of the world and this attention is expected grow more in the coming years. In order to meet reduction of GHG emission targets, the industry sectors will have to come up with decarbonisation strategies which can be employed in their logistics in the next coming years. Chemical industry contributes less than 9% of all total emission associated with the freight transport. This industry has adopted pro-active measures which are aimed at reducing environmental effects associated with logistic activities through a collaborative effort with the logistics service providers (ECTA, 2011).

In accordance with Kyoto Protocol in 1997, 83 countries together with the European Union signed a protocol which provides a baseline for reducing GHG emissions (Lenoble, 2014).

A carbon market has been created in order to ensure that the target of reducing carbon emission as stipulated in the Kyoto Protocol has been achieved. In addition, some strategies have been developed and they include Joint Implementation (JI), Clean Development Mechanism (CDM) and emission trading. JI allows the implementation of emission reduction projects in other Kyoto countries and this allows them to emit in their countries. CDM allows countries to be implement emission reduction projects in developing countries and this grants them a right to emit in their countries. Finally, emission trading allows countries which have been involved in carbon dioxide emission to emit and be able to sell a right to emit to other states (UNFCCC, 2009).

The transport sector has been established to be the second largest contributor of CO_2 emissions with a reported figure of about 23% of all total Carbon dioxide emissions in Europe in the year 2006.(Commission, 2011). According to Carbon Regulated Supply Chain (CRSC), more insights were provided on how carbon emission could be regulated as depicted by a study done by (Loo, 2009). This study further provides information that depicts the various calculation methods that can be applied in transportation.

The field of Green supply chain management has received a great interest during the last few years. Lenoble (2014), summarizes several practices done within the field of Green supply chain management through use of a SCOR model. The influences on the environment have become important criteria which must be considered by companies due to different forces. These forces are the pressure from public, laws and environmental standards; enterprises are required to focus on environmental management and the pressure from the partners among the supply chain. Furthermore, Customer awareness, economic and competitive pressure push companies to focus on environmental issues (Lenoble, 2014).

Kyoto Protocol became the first international agreement which was aimed at reducing GHG and it involved a collaborative effort of 83 countries and the European Union (UNFCCC, 2009). These countries came to agreement that could see them reduce their overall emissions by a minimum of 5% within a period of four years between the year 2008 and 2012 (UNFCCC, 1998). The prime goal for this protocol was to achieve a stable GHG concentration in the atmosphere and ensure that the climate system was free from dangers of anthropogenic interference (Wolfgang Schade, 2006).

In accordance with the International Transport Forum (OECD, 2010), 30% of the total CO_2 emissions come from the transportation after fuel combustion. In addition, this sector contributes to about 15% of the total GHG emissions. It was also noted that between the period of 1990-1997, global CO_2 emission was increased by 45%. This yields huge problems that affect operations of many companies (OECD, 2010). This justifies why calculation methods are used in order to provide relevant information on companies' performances.

With more and more LSP the problem of allocation between companies becomes more relevant. Also, calculation tools with allocation methodology had to be developed according to some regulation methodology in order to know which companies in which country contribute to the emissions (Lenoble, 2014).

In 1998, GHG protocol was developed and was an initiative that included many parties which included non-governmental organization, businesses and other institutes which aimed at developing an international accounting tool that could offer help to leaders. It could help to have a good understanding on how to manage and quantify GHG emissions. This protocol comprised of three scopes that aimed at achieving a higher level of accuracy and transparency in regard to the calculations (Lenoble, 2014). They include:

- Scope 1: Direct emissions
  This scope covers all emissions which come from sources that are controlled or owned by the reporting entity
- Scope 2: Indirect GHG emissions
  This refers to emissions that result from consumption of heat or steam which has been purchased.
- Scope 3: Other indirect GHG emissions
  These emissions are as result of production or extraction of materials or fuels which has been purchased.

In the past one decade, there has been a variety of literature work which has aimed at analysing emission of carbon by urban transport systems. Majority of these studies have focused on how the transportation system works and the various mechanisms which be put in place in order to minimise emissions which result from freight and people movements within cities. Recently, there has been a genuine focus on the environmental effects which are associated with movement of people and goods within cities. This move has been hugely influenced by the need to have an urban transport system which yields both social and economic benefits (Zanni and Bristow, 2010).

There has been lots of literature works from various scholars which are aimed at bolstering understanding of GHG emissions as well as depict the natural approaches which can be adopted by various nations. Several procedures and methodologies have been used in research with an aim of trying to develop strategies that can reduce CO_2 emissions caused transport activities. Generally, current literature which has been done on the transport sector and carbon emissions can be divided into four essential methods based on the methodological perspective:

- Bottom-up sector-based analysis
  According to van der Zwaan et al. (2013), an investigation has been carried out on how CO_2 emissions of transport division of Europe can be decarbonized. Additionally, other strategies which include COPERT III methodology has been used in the analysis of road transport emissions in Italy (Bellasio et al., 2007), This method has also been involved as a means of study of emissions associated with vehicles in urban areas (He and Chen, 2013, Dallmann et al., 2013, Sider et al., 2013).

- Decomposition analysis
  The emitted CO_2 has been is further implications which alters modal shift, fuel mix, population, economic growth, transportation energy intensity and emission coefficients. In accordance with Timilsina and Shrestha (2009), it has been established that the main variables of transportation energy intensity and economic growth results from CO_2 after conducting a decomposition analysis. Furthermore, it has been established that economic growth plays an integral part when it comes to contribution of CO_2 emissions in ASEAN-5 and EU27 economics (Andreoni and Galmarini (2012) and Chandran and Tang (2013).

- System optimization
  This method has been widely used in the forecasting of CO_2 emissions and energy demands (Si et al., 2012, Ahanchian and Biona, 2014, Motasemi et al., 2014). Additionally, it has been used in analysing strategies which can lead to better energy planning which promote sustainable development (Szendrő and Török, 2014). It has also been used in the process of planning networks that can help in energy supply activities (Kanzian et al., 2013).

- Econometric models
  This involves use of time series models that help in exploration of long run nexus between the emission of CO_2 by transport sector and economic growth in OECD nations, Saboori et al. (2014). There has been a substantial focus on predicting the trends that can be adopted in by the vehicle population in order to improve management of CO_2 emissions in Taiwan (Lu et al. (2009). Becerra et al. (2012), focuses on target set by EU countries towards

reduction of CO_2 emissions. Moreover, Meyer et al. (2007), provides an estimate of the demand of passenger cars in 11 world regions and the associated CO_2 emissions. Furthermore, panel data has been used by Tokunaga and Konan (2014) and Konur (2014), in order to provide estimations of CO_2 which are caused by the transportation sector.

After in-depth discussion about the factor which contribute hugely towards the emission of CO_2 in the transport sector, there are two shortcomings which have been established. Firstly, majority of these studies have been based on cross-sectional data or time series. After conducting a comparison between these two strategies with panel data, the latter has been established it provides better results in identification and measurement of impacts which is contrary to what is offered by the former two strategies. Secondly, most of these studies are biased towards the sole use of optimization and decomposition models in analysing effect which contribute to emissions of CO_2 (Xu and Lin, 2015).

In applicable literature, extensive steps were taken with an aim of bolstering emissions of GHG and natural approach arranging in various nations. Various demonstrating methodologies and procedures were utilized to research the affecting variables and decrease strategies that effect the CO_2 emissions development in different transport areas. In general, previous research made use of various strategies and models which include regression analysis, time series analysis, DES model, optimization and decomposition models.

Transportation sector has recently been getting huge interest from scholars and researchers as a result of its dominant effect of GHG emissions. In the recent decade, emission of CO_2 in the transport sector has been widely studied by researchers and scholars from many parts of the world. However, most of these studies have focused on how the transport systems and the mechanisms which can be developed in to reduce GHG emissions in urban areas. Road transport is a vital client of the restricted and compelled urban area (Muñuzuri et al., 2005).

After utilization of time series analysis, Sultan (2010) was able to find out that there existed a co-combination of fuel price (FP) and pay per capita on transport duel consumption (FC). There was also a discovery of a relationship between CO_2 discharges and vitality utilization as noted by (Wang et al., 2011). Begum et al. (2015), delved at the impacts of FC, populace development and

GDP on the emissions of CO_2. Ivy-Yap and Bekhet (2015), put forward recommendations that could help reduce CO_2 emissions which included use of low carbon advancements. By use of regression analysis, (Sadorsky, 2013, Sadorsky, 2014) looked into the relationship between GDP, salary, urbanization and vitality force and found that diminishment of CO_2 emissions could develop from increases fuel changing and fuel efficiency (EF) to renewable vitality. High population density which led to thick road networks in urban areas could create a better absorption of emitted CO_2 (Shu and Lam, 2011). Additionally, Xu et al. (2014), was able to come into a conclusion that there were effects of vitality structure, populace, vitality intensity and GDP on emanations of CO_2. GDP was found out to be the main driving force behind major emanations of CO_2 which take after by the scale of populace and vitality structure.

After application of decomposition analysis, Lakshmanan and Han (1997), populace and GDP were credited to be the cause of the imminent change of the CO_2 discharges in the transport segment. It was further noted that decayed CO_2 contributed to the outflow of development into sections which are associated with changes in emission coefficient, modal shift, transportation energy intensity and modal shift along with growth of GDP (Timilsina and Shrestha (2009).

In order to ensure, maintenance of vitality arranging as well as diminishment of CO_2 emanation, several optimisation models were created. By utilization of linear programming models, there was an exploration of benefits which are associated with making energy choices that could support reduction of CO_2 by industries(Börjesson and Ahlgren, 2012, Bai and Wei, 1996, Wang et al., 2008). Moreover, used a mixed integer linear programming model and contemplated on the effects of fuel switching and balancing on power generation (Hashim et al. (2005). This study established that fuel and FE switching were the best choices for decreasing discharges of CO_2. This was backed by a study by Tan et al. (2013) who used mixed integer linear programming to achieve a perfect arrangement of waste to vitality in order to ensure reduction costs related with CO_2 emissions and generation of electricity.

Outflows associated with GHG from the road transport sector have been able to show a pattern which can be used with statistical forecasting technique to make predictions. Addition of (Brown, 1957) and (Brown and Meyer, 1961) to the DES model has enabled calculation of mean and development of pattern. This was advanced further by (Goodman, 1974, Gardner, 1985) and (Gijbels et al., 1999) who worked on the DES model to upgrade and improve its exactness. (Gardner, 1985) gave general exponential smoothing consider regularity. Likewise, (Gijbels et al., 1999) contributed to the study and his knowledge enabled use of the existing exponential smoothing hypothesis by application of DES model inside of a nonparametric regression structure.

There are various studies which have demonstrated use of DES models in different fields which include ecological contamination. For instance, DES model was used in South Korea to anticipate the arrangement of ozone and how it contributes in air pollution (Oh et al., 1999). In England, DES model was used to gauge power request and help in minimizing the regular effects which are associated with utilization of power (Taylor, 2003). In china, DES model was used in creation of an indicator which was used in indication of defilement of stream water (Zheng-wen and Kai-yu, 2010). Furthermore, DES model was used in assessment of CO contamination by urban traffic road (Gupta et al., 2011). In the US, DES model was used to look to assess the diminishing pattern of CO_2 emissions as well as performing forecasts (Choi et al., 2014).

2.4 The Research Gaps

After a critical literature review has been completed, the following research gaps have been identified. Please note that the objectives and research questions identified in chapter 1 are consistent with the research gaps as presented below:

- Lack of study that has systematically explored the interconnection between the framework factors which include descriptor, solution, objective and stakeholders. All these factors aim at achieving a reduction of GHG emissions which result from urban transport models. Additionally, they depict the benefits associated with the prediction of GHG emissions in order to improve and enhance the quality of life. For example, information stored in a database depicting how various solutions to influence objectives of urban freight contributes to helping the selection of approaches used in creating solutions which can be used in future models. Similarly, associating descriptors, stakeholders and objectives can be beneficial in the process of selecting the correct stakeholders as well as activities that are suitable to a given model. *(addressing objective 1)*

- The urban freight transportation models experience underdeveloped standard framework which results from urban freight domain's dynamic nature as well as the variation of problems related from one city to another. However, a combination of common features and activities such as stocking and ordering can be used in providing guidelines that can be followed when creating an urban freight domain model. This description is used to provide a basic model which makes it easier and more possible to carry out some modification of data and object properties *(addressing objectives 2,3 and 4)*.

2.5 Summary

This chapter reviewed the body of knowledge relative to the analysis of city logistics through the application of a wide variety of urban freight concepts as well as the tools and methods used for this research. The following Tables 2.2, 2.3 and 2.4 illustrate the references used in the various parts of this research study.

While Table 2.2 summarizes some significant review of urban freight models and city logistics models according to the discussed framework, Table 2.3 gives a summary of methodologies which are adopted in order to perform GHG prediction in various sectors which includes the transport industry. On the other hand, Table 2.4 provides a list of factors which are used in GHG prediction. As depicted in Table 2.3, it has been established that recent studies have put a major focus on the energy sector while few research works have been done to address the road transport sector. Table 2.4 has further shown that previous studies have considered a variety of parameters which include FC, FP, road density and GDP. This study aims at utilizing the advantages of that kind of experiences and works towards offering other relevant variables which include the ratio between Number of Transportation Vehicles (NTV) and Vehicle-Kilometres Travelled (VKT) for various transportation modes.

Table 2.2: Summary of literature review on urban freight models and city logistics models

Author	Model	Urban Studies	Stakeholder					Objective								Descriptor															Solution			Perspective							
			Shipper	Carrier	Administrator	Receiver	Urban expressway operators	Economic	Efficiency	Road-Safety	Environment	Infr. & Mgmt.	Urban structure	Accessibility	Knowledge	Freight Generation	Commodity flow	Land use	Vehicle design	Vehicle loading	Location	Building and site design	Trip generation	Load factor	Modal transfer	Traffic design	Traffic flow	Pollution level	Cost	Industry structure	Planner	Policy	Technology	Planner	Behavioural	Policy	Technology	Multiple actors	Economic	Spatial	Temporal
(Southworth, 1982)	Planning model	Chicago			X							X						X			X										X			X							
(Young et al., 1983)	Elimination by Aspects model	Australia	X						X						X										X										X						
(Visser and Maat, 1996)	Simulation model, with the use of a GIS	Netherlands			X						X			X									X				X									X					
(Harris and Liu, 1998)	Input–output modelling	UK			X			X								X															X			X							
(Holguin-Veras, 2000)	Logistic information modelling	Guatemala City	X	X		X									X		X										X										X				
(Taniguchi and Van Der Heijden, 2000)	BOX model	Kobe City, Japan	X	X	X				X		X													X				X								X	X				
(Boerkamps et al., 2000)	Good Trip model	Groningen city, Netherlands	X	X	X	X			X		X					X	X			X			X				X			X	X	X			X	X					
(Russo and Comi, 2002)	A general multi-step model	France and Switzerland			X	X		X	X	X	X	X	X		X		X						X				X							X	X						
(Jinghua et al., 2003)	Dynamic Freight Traffic Simulation model	New England and New York State	X			X			X							X	X												X								X				
(Wisetjindawat and Sano, 2003)	Tokyo Model	Tokyo Metropolitan Area	X	X	X				X		X						X										X								X	X					
(Crainic et al., 2004)	Planning models	Rome		X	X				X			X								X	X					X					X			X							
(Holguín-Veras et al., 2004)	Statistical models	New York City metropolitan area	X	X		X									X					X			X							X					X						

(Taniguchi and Shimamoto, 2004)	Dynamic vehicle routing and scheduling model	Japan		X	X				X		X									X			X				X					X	X								
(Taniguchi and Tamagawa, 2005)	VRP-TW-F Model	Keihanshin area	X	X	X		X		X		X	X								X							X	X				X			X	X					
(Hensher and Puckett, 2005)	Economic-behaviour-based freight model	Australian cities	X	X	X	X			X			X															X			X		X			X	X		X			
(Friesz and Holguín-Veras, 2005)	Dynamic Game-Theoretic Models	New York City		X					X														X						X		X			X				X			
(Figliozzi, 2006)		United States		X					X																		X						X		X		X				
(Yannis et al., 2006)	SATURN Model	Athens, Greece			X						X	X															X	X				X		X		X					
(van Duin et al., 2007)	Simulation model of auctioning and route/delivery rescheduling in 'hybrid' freight markets.		X	X					X											X			X						X	X			X					X			
(Figliozzi, 2007)	Tour model	USA Canada, Japan, Australia, Germany, UK, Netherlands, France, and Switzerland			X				X														X				X					X				X					
(Hunt and Stefan, 2007)	Tour-based micro-simulation model	Calgary in Canada			X			X	X	X	X	X	X		X								X				X							X							
(Wisetjindawat et al., 2007)	Tokyo model	Tokyo Metropolitan Area	X	X	X				X						X	X	X			X			X				X			X											
(Routhier and Toilier, 2007)	A single model — FRETURB	City of Dijon, Town in France			X			X	X		X	X	X								X	X	X				X				X	X									
(WANG and Holguín-Veras, 2008)	Tour-based models	Denver metropolitan area			X			X	X	X	X	X	X		X								X											X							
(Kanaroglou and Buliung, 2008)	Integrated urban land use and transport model	Hamilton, Canada			X						X				X								X				X	X			X			X							
(Holguín-Veras, 2008)	An analytical model	New York City		X	X	X			X	X	X	X															X		X	X		X				X		X			

(Friesz et al., 2008)	Model of dynamic pricing of freight services in an urban environment		X	X		X			X							X							X						X	X								X			
(Muñuzuri et al., 2009)	Modelling approach consisting of a demand model	City of Seville, Spain			X			X	X	X	X	X	X		X	X	X										X							X							
(Crainic et al., 2009)	Modelling paper (Models for evaluating and planning city logistics systems)	The countries of the European Union and Japan		X	X				X											X	X						X				X			X							
(Gentile and Vigo, 2013)	Demand models	Emilia-Romagna Region in Italy			X							X			X	X	X						X				X							X		X					
(Donnelly et al., 2010)	A hybrid microsimulation model			X	X							X			X		X			X			X		X						X										
(Russo and Comi, 2010)	A modelling system	European city				X			X						X		X						X				X								X						
(Muñuzuri et al., 2010)	Demand model for B2B and home delivery during the morning peak hour	City of Seville, in Spain		X	X						X				X												X							X		X					
(Russo and Comi, 2011)	ex-ante model	Cities and town in southern Italy	X		X	X			X			X					X		X										X		X										
(Russo and Comi, 2012)	Simulation models	European city	X			X		X		X	X								X									X	X		X		X								
(Anand et al., 2014)	Logistic ontology Model		X	X	X	X		X	X	X	X	X					X				X						X	X				X			X						
(Nuzzolo and Comi, 2014b)	Simulation models	Rome			X						X																														
(Ville et al., 2013)	Urban consolidation model	Vicenza (Italy)	X	X	X			X			X	X				X			X	X	X						X	X				X					X	X			
(Nuzzolo and Comi, 2014a)	Freight Demand Models		X	X		X		X			X	X						X			X							X			X				X						

(Bozzo et al., 2014)	An ex-ante model	European city	X		X	X					X	X						X	X								X	X			X	X								X	
Nilesh Ananda*et al., (2014)	Agent-based model	City of Rotterdam	X	X		X		X			X									X	X							X	X	X			X	X		X						
(Diziain et al., 2014)		France and Japan	X	X							X				X			X																						X	
(Marciani and Cossu, 2015)	Governance model	Turin, Italy	X	X	X	X		X	X	X	X	X	X													X	X	X			X		X	X			X	X			
(Davydenko, 2015)	Logistics Chain Model	Netherlands, and the Randstad region			X			X			X	X				X												X				X								X	
(Morfoulaki et al., 2016)	Multi Criteria Analysis	Serres, Greece	X		X						X	X	X						X	X	X						X	X				X	X							X	X

Table 2.3: Summary of literature review outlining key features including methodology

Author / Year	Sector	Country	Time period	Methodology/approach																										
				Johansen co-integration	Cointegrated vector autoregression (CVAR)	Granger causality	Structural time series	Linear programming	Time series	Autoregressive distributed lag (ARDL) approach	fully modified OLS (FMOLS)	Long-range Energy Alternative Planning (LEAP)	Vector error correction model (VECM)	Motor Vehicle Emission Inventory (MVEI)	Intergovernmental Panel on Climate Change (IPCC)	Panel-pooled fully modified ordinary least square	Vector autoregressive (VAR) model	Autoregressive integrated moving average (ARIMA)	Seasonal autoregressive integrated moving average	Bai–Perron panel cointegration	Toda–Yamamoto	Mixed integer programming	Decomposition	Panel regression	Life cycle assessment approach (LCA)	Multi-objective optimization	Regression analysis	Multiple regression model	Double exponential smoothing	Non-parametric regression
Bai and Wei (1996)	Electricity	Taiwan	1990-2000					√																						
Lakshmanan and Han (1997)	Transport	USA	1970-1991																				√							
El-Fadel and Bou-Zeid (1999)	Transport	Lebanon	1997-2020											√	√															
Wu et al. (2005)	Energy	China	1985-1999																				√							
Hashim et al. (2005)	Electricity	Ontario	-																			√								
Ediger and Akar (2007)	Energy	Turkey	forecast 2005-2020															√	√											
Singh et al. (2008)	Transport	India	1980-2000						√																					
Ang (2008)	Energy	Malaysia	1971–1999	√																										
Wang et al. (2008)	Iron and Steel	Manufacturing	-																							√				
Kamarudin et al. (2009)	Transport	Malaysia	-																			√								
Bekhet and Yusop (2009)	Energy	Malaysia	1980-2005	√																										
Timilsina and Shrestha (2009)	Transport	Asian countries	1980–2005																				√							

Zhang and Cheng (2009)	Energy	China	1960-2007			√															√									
Sultan (2010)	Transport	Mauritius	-						√	√																				
Börjesson and Ahlgren (2012)	Transport	Sweden	1995–2051					√																						
Sharif Hossain (2011)	Energy	Newly industrialized countries	1971–2007	√		√							√																	
Pao and Tsai (2011)	Energy	Brazil	1980–2007	√		√							√																	
Pao et al. (2011)	Energy	Russia	1990–2007	√		√							√																	
Shu and Lam (2011)	Transport	Louisiana	2002-2006																									√		
Wang et al. (2011)	Transport	China	1995–2007																				√							
Jahangir Alam et al. (2012)	Energy	Bangladesh	1972–2006	√		√				√			√																	
Bekhet and Yasmin (2013)	Energy	Malaysia	1970-2011			√			√	√																				
Tan et al. (2013)	Waste	Malaysia	2011 -2025																			√								
Chandran and Tang (2013)	Transport	ASEAN	1971-2008	√		√							√																	
Sadorsky (2013)	Energy	76 developing countries	1980–2010																					√						
Sadorsky (2014)	Energy	16 emerging countries	1971–2009																					√						
Xu et al. (2014)	Energy	China	1995-2011																				√							
Ackah and Adu (2014)	Transport	Ghana	1971-2010				√																							
Choi et al. (2014)	Transport	USA	1960-2011																										√	
Apergis and Payne (2014)	Energy	Central American countries	1980-2010			√					√		√							√										
Baek and Pride (2014)	Energy	Major nuclear	1990–2011	√	√																									

		producing countries																												
Bella et al. (2014)	Energy	OECD countries	1965–2006										√																	
Ivy-Yap and Bekhet (2014)	Residential	Malaysia	1978-2011						√	√																				
Farhani et al. (2014)	Economic	Tunisia	1971–2008			√				√			√																	
Begum et al. (2015)	Energy	Malaysia	1970-2009						√	√																				
Xu and Lin (2015)	Transport	China	2000-2012																											√
Ivy-Yap and Bekhet (2015)	Residential	Malaysia	1978-2013						√	√																				
Alshehry and Belloumi (2015)	Energy	Saudi Arabia	1971–2010	√		√					√		√																	
Al-Mulali et al. (2015)	Energy	23 selected European countries	1990-2013						√				√			√	√													
Mustapa and Bekhet (2015)	Transport	Malaysia	1990-2013																									√		
Friedrich and Trois (2016)	Waste	South Africa	2012, 2014 and 2020																						√		√			
Alhindawi et al. (2016)	Transport	USA	1990-2012																									√		
Fan and Lei (2016)	Transport	Beijing	1995-2012																			√								
Alshehry and Belloumi (2017)	Transport	Saudi Arabia	1971–2011			√				√																				
Talbi (2017)	Transport	Tunisia	1980–2014				√										√													
Lin and Benjamin (2017)	Transport	China	1980-2010																								√			
Emodi et al. (2017)	Energy	Nigeria	2010-2040									√																		
Danish et al. (2018)	Transport	Pakistan	1990-2015							√			√																	

Table 2.4: Summary of literature review outlining main factors examined

Related factors of study

Author / Year	Gross domestic product (GDP)	CO2 emissions	Energy-related CO2 emissions	Electricity production	Fuel consumption (FC)	Fuel Efficiency	Income	Price	Human Capital	Efficiency	Optimization on CO2 emissions	Optimization on electricity production Cost	Renewable electricity consumption	Population	Export
Bai and Wei (1996)											√	√			
Lakshmanan and Han (1997)	√	√			√									√	
El-Fadel and Bou-Zeid (1999)		√			√	√								√	
Wu et al. (2005)	√		√												
Hashim et al. (2005)											√				
Ediger and Akar (2007)					√										
Singh et al. (2008)		√			√										
Ang (2008)	√	√			√										
Wang et al. (2008)											√				
Kamarudin et al. (2009)															
Bekhet and Yusop (2009)	√				√										

Author / Year	Import	Foreign direct investment (FDI)	Oil price	Coal prices	Fleet technology	Type of Vehicle	Number of vehicles	Employment	Optimization on economic cost	Electricity consumption	Trade openness	Fuel price (FP)	Foreign direct investment (FDI)	Distance travel (DT)	Energy consumption
Bai and Wei (1996)															
Lakshmanan and Han (1997)														√	
El-Fadel and Bou-Zeid (1999)					√	√									
Wu et al. (2005)							√							√	
Hashim et al. (2005)									√						
Ediger and Akar (2007)															
Singh et al. (2008)						√									
Ang (2008)															
Wang et al. (2008)															
Kamarudin et al. (2009)									√						
Bekhet and Yusop (2009)			√					√							

Author / Year	Energy intensity	Urbanization	Financial development	Road density	Per capita income	Fuel mix	Fuel Type	Modal shift	Emission coefficients	Optimization on production cost	Modal share	Transport intensity	Vehicle-kilometers travelled (VKT)	Number of Transportation Vehicle (NTV)	Transportation Mode
Bai and Wei (1996)															
Lakshmanan and Han (1997)															
El-Fadel and Bou-Zeid (1999)									√						
Wu et al. (2005)	√														
Hashim et al. (2005)															
Ediger and Akar (2007)															
Singh et al. (2008)							√		√						
Ang (2008)															
Wang et al. (2008)										√					
Kamarudin et al. (2009)															
Bekhet and Yusop (2009)															

Timilsina and Shrestha (2009)	√	√												√																	√					√		√	√						
Zhang and Cheng (2009)	√	√							√					√																√		√													
Sultan (2010)					√																						√								√										
Börjesson and Ahlgren (2012)											√													√																					
Sharif Hossain (2011)	√	√																								√				√		√													
Pao and Tsai (2011)	√	√																												√															
Pao et al. (2011)	√	√																												√															
Shu and Lam (2011)		√					√							√																		√		√											
Wang et al. (2011)		√			√																																				√	√			
Jahangir Alam et al. (2012)	√	√																							√																				
Bekhet and Yasmin (2013)	√	√			√										√	√																													
Tan et al. (2013)											√													√																					
Chandran and Tang (2013)	√	√																										√		√															
Sadorsky (2013)	√						√																								√	√													
Sadorsky (2014)	√						√																								√	√													
Xu et al. (2014)	√	√			√																										√														
Ackah and Adu (2014)					√		√	√	√	√																																			
Choi et al. (2014)		√			√																																								√
Apergis and Payne (2014)	√	√											√	√				√	√																										
Baek and Pride (2014)	√	√		√																																									
Bella et al. (2014)	√	√																							√																				

Ivy-Yap and Bekhet (2014)	√													√											√		√																		
Farhani et al. (2014)	√	√																								√				√															
Begum et al. (2015)	√	√												√																															
Xu and Lin (2015)	√	√			√									√																															
Ivy-Yap and Bekhet (2015)	√													√											√		√	√																	
Alshehry and Belloumi (2015)	√	√																√												√															
Al-Mulali et al. (2015)	√	√																														√	√												
Mustapa and Bekhet (2015)		√			√	√																					√		√																
Friedrich and Trois (2016)		√		√	√																																		√			√			
Alhindawi et al. (2016)		√																																									√	√	√
Fan and Lei (2016)	√	√												√																	√											√			
Alshehry and Belloumi (2017)	√	√	√																											√															
Talbi (2017)	√		√		√																									√	√	√													
Lin and Benjamin (2017)	√	√												√																	√	√													
Emodi et al. (2017)	√	√					√							√																√		√													
Danish et al. (2018)	√	√															√													√		√													

CHAPTER 3

Importance of the UDC to reduce the GHG emissions

The economic impact of air pollution has caused it to become a major concern in many countries. People have become more aware of this issue because of the available information on how it negatively affects human health and environmental sustainability. This chapter will highlight in detail its functionality in predicting GHG emissions. This will be achieved through the use of Vehicle-Kilometre and Number Transportation Vehicles (NTV) ratio for the six different modes of transportation. These include motorcycles, passenger cars, tractors, single-unit trucks, buses and light trucks.

3.1 Introduction

One of the most significant environmental issues in the world remain to be air pollution. This results from the high levels of GHGs concentration in the atmosphere (Pauzi and Abdullah, 2014). In the recent decades, climate change and GHG emissions have been subjects of interests worldwide. Various organizations which include the World Economic Forum (WEF) and United Nations (UN) have continuously worked towards developing remedies that could help in reduction and elimination of effects which area associated with climate change and global warming on the economy. One of these important remedies include the Kyoto Protocol which includes collaborative effort of many countries towards reduction of GHG emissions (Farhani et al., 2014).

One of the greatest contributors to the GHG emissions globally is the transportation sector. The increasing number of vehicles in the world has led to a tremendous rise of GHG emissions. In 2007, 23% of the total worldwide GHG emissions came from the transport sector. It was approximated that 73% of this was hugely from the road transport (Association, 2008).

According to statistics from Australia, transport sector ranks in the second place after electricity in the listing of GHG sources that lead to air pollution. This sector accounts for about 18% of the all GHG emissions in Australia. For instance, the light vehicles contribute to about 18% of these emissions. For a period of one year between 2016 and 2017, levels of GHG pollution caused by the transport system increased by 3.4%. Since 1990, this figure has continued to rise with an estimated increase of 62.9% which is a higher rate as compared to other sectors. Emissions of GHG in Australia by the transport sector have continued to grow and this trend is predicted to continue in the future (Henriques-Gomes, 2018).

In the United States, 18% of the total energy is utilized by the road transport sector which also contributes 22% of total GHG emissions. The transportation division aggregates 63% of the energy utilization which in return contribute to 73% of GHG emanations. As a result of the various activities such as GHG outflows, globalization, energy concerns, enhanced statistical models and vehicle innovations makes it ideal to pay attention to various elements such as VKT, GHG emissions and energy utilization (Rentziou et al., 2012).

In the recent past, there has been a huge concern to many individuals on the growing effects and implications of GHG emissions to our surroundings. These has led to development of many initiatives that aims at reducing the GHG emissions across the whole world (Loo, 2009).

Several approaches have been put forward in order to carry out predictions of GHG emissions. However, accuracy of these approaches has been hugely affected by the Lack of relationship of the non-linear variables hence affecting the desired outcome. It has also been noted that emission of emanating from road traffic, forest fires and industries are highly uncertain (Pokrovsky et al., 2002). Therefore, there is a need to put non-linear variables into consideration when developing GHG emissions prediction methods which are reliable.

Recent research has been mostly inclined on the effects of GHG emissions towards to the environment(San Choi and Abdullah, 2016). Majority of these research works have tried to put forward policies which can be used in reducing GHG emissions. These policies start from the road sector which includes activities such as fiscal measures that include vehicle and fuel taxes. Other policies include seeking voluntary agreements with vehicle manufacturers so that they can work towards reduction of fuel consumption by vehicles. Additionally, there has been a policy which focuses on carrying out campaigns that persuade people to purchase fuel-efficient vehicles. There has been introduction of usage charges which tries to encourage reduction of CO_2 emissions which is achieved through implementation of efficient use of transport vehicles (OECD, 2002). The impacts of various factors which include vehicle fuel consumption, traffic demand and traffic load can be predicted and evaluated using modelling and assessment procedures (OECD, 2002). Majority of these prediction models employ the use “top-down” and “bottom-up” methods which yields more reliable results that can result to cost-efficiency after reduction of CO_2 is achieved (OECD, 2002).

It is usually very complex to model environmental data because of the underlying correlation between many variables resulting to complex network relationships. Many researchers have been interested to improve forecasting tools for GHG emissions. Historical data has played an important role in making predictions. Besides this, there have been several approaches which have been suggested to aid in making predictions of GHG emissions. Based on the literature review, it has been established that majority of the prediction methods aim at improving accuracy of the results(Pauzi and Abdullah, 2014). Unavailability of some data such as the annual average distance and fuel consumption per vehicle have increased the number of constraints which affect forecasting of CO_2 emissions. The other criticism has involved development of many equations which are being used in satisfying many assumptions. Effective use of those equations has be proved to be difficult as a result of rigidity of assumptions and methodology (OECD, 2002).

The main aim of this chapter is to promote models that help in prediction of GHG emissions which are associated with the road sector. This is achieved through the use of ratio between VKT and NTV which considers the six modes of transport. It is to be noted that we used the data set from US to model the GHG emissions as the comprehensive data set for Melbourne or Australia were not available. Since the main focus is on the relative scenario analysis of different transportation modes in terms of GHG emissions and the relative impact of less carbon intensive transportation modes in the city area, it is assumed that the geographical bias may not be an issue. Additionally, DES models, as well as multivariate linear regression models, were developed in determination of the most suitable vehicle type that could fit UDC perfectly in order to reduce environmental impacts. This is well described in the following sections.

3.2 Predictions tools

There exist a variety of various methods which are used in computation of GHG emissions. However, there is a difference in their assumptions and scope since they are reliant on data gathered from various countries. As result of this disparity, there has been huge variations on the results obtained. Therefore, this leads to the urge of having robust and flexible approaches which uses substantial amount of data to ensure correct predictions of GHG emissions have been obtained. The prime goal of this chapter is to provide a general approach which can be used in analyzing and recognition of various factors that have an influence on the GHG emissions and forecasting that emanate from the road sector. Two models have been used in order to achieve this methodology process. These models have been made using data that has been collected over a span of twenty years on NTV and VKT from North America's road transport sector.

3.2.1 Multivariate Regression analysis (MRA) and the Double Exponential Smoothing (DES) Model

Definition of future energy needs in the road sector is dependent on the quantification process of GHG emissions. Currently, there are many ongoing studies which aim at developing models which can be used to predict emissions of GHG in the road transport sector. This study brings forward a proposition of applying DES and MRA models which can be used in the forecasting and investigation of the prime elements that have huge impacts on emissions of GHG which emanate from the road sector. Then MRA model utilises VKT to NTV ratios that include six transportation modes. Furthermore, it also uses data about vehicles which is extracted from the NATS online database collected over a period of more than 22 years. From the generated results, it has been established that the VKT to NTV ratio clearly shows that modes of transport have a high impact to the emissions of GHG. Hence, the MRA model can be used in predicting emissions of GHG and how this can be reduced in coming years. This is easily determined through the use of determination and adjusted coefficients ($R^2$and R^2) values of 89.46% and 91.8%, respectively. This paper has established NTV and VKT are the major elements which influence growth of GHG emission. This model which is being developed focuses on examination of various scenarios which can used in order to introduce hybrid electric vehicles as well as battery electric vehicles which can be used in future. If this move comes to fruition, CO_2 emission will reduce by 62.2%.

3.2.1.1 Variables

- ***Vehicle-kilometers traveled (VKT)***

This is an important metric which is used by researchers in order to measure how efficient is a fleet of vehicle which is expressed in terms of its volume of traffic and activity. VKT estimations prove to be important when carrying out estimations of vehicles emissions in order to aid in transport planning. It also provides additional information which can be used in decision making process of road safety policy and infrastructure investment. Hence, VKT estimates should be as accurate as possible (Bureau of Infrastructure, 2011).

- ***Number of Transportation Vehicles (NTV)***

This study includes various categories of vehicles include light trucks, tractors, combination trucks as well as passenger cars. (Bureau of Infrastructure, 2011). An increase of NTV will result in a higher GHG emissions.

3.2.1.2 Data Sources

The author of this paper used historical data which was collected between 1990 to 2012. This data was accessed from the official online database of North American Transportation Statistics (NATS) (North American Transportation Statistics, 2000). The collected data has been used in order to carry out analysis and identification of the various factors which influence emissions of GHG.

3.2.1.3 Data Limitations

The US Department of Transportation is in charge of the NTV data which is collected and stored in the database. This data covers all categories of vehicles which include combination truck tractors, light trucks and passenger cars. Data collected from the lights truck categories includes data of vans, pick-up trucks as well as sporty utility vehicles. The category of tractors also included data of tractors while on the other hand taxis were included under passengers' car category. Furthermore, local motor were included under bus category (North American Transportation Statistics, 2000).

On the other side, VKT data included motorcycles, light trucks and passenger cars. The Department of Transportation in the US gave an updated VKT data using a highway mode for a long period of time. It was noted there was a change where some vehicles had relocated from the passenger's category and moved to truck category (North American Transportation Statistics, 2000).

Hence, based on that observation, we need to understand time-series data is prone to discontinuities which can result into errors when we are performing estimation using our regression model. However, the proposed method to be used in this study as well as the generated results creates a room for further testing once a new, good and detailed dataset is obtained.

3.2.1.4 Model Development

The study process comprises of two sections:

1. A multivariate linear regression analysis (MRA).
2. A double exponential smoothing model (DES).

This model is constructed based on both NTV and VKT historical data which spans over a period of 20 years from the North America's transport sector.

In order to develop a good MRA model which can be used in emissions of GHG forecasting, it is important for each variable to have a predicted value. In this study, a forecasting tool which was based on DES technique was used in generating these predicted values. DES method has been highly recommended in the handling of historical data and it therefore proves to be an important tool in this study as noted by Sullivan and Claycombe (1977) and Hyndman et al. (2008).

Regression analysis has been generally used in examination of multifaceted information which is achieved through creation of mathematical statements that shows how a response is related to a set of independent variables or predictors. GHG emissions are used as the response variable in this model. The VKT to NTV ratios for the six transportation modes are used as the casual variables in this study. These modes are depicted as follows; Light Trucks (LT), Passengers Cars (PC), Tractors (T), Motorcycles (C), Single Unit Truck (SUT) and Buses(B). It should be noted that there could be other several casual variables, but due to data unavailability only the above parameters were considered in this study. Additionally, Aggregated data analysis has been conducted by the researchers rather than carrying out a disaggregation of data into multiple modules of transport. In order to avoid the average squared residual which is associated with a recent one-step-ahead during forecasting, exponential smoothing is done by specifying a smoothing factor. According to Hyndman et al. (2008) and Sullivan and Claycombe (1977), the equation and formula which are used in double exponential forecasting are as shown below:

$$F_{t+m} = a_t + b_t m \qquad (1)$$

Where:

- F_{t+m} this is the forecast's representation after performance of m of periods
- a_t this depicts the forecasted intercept while b_t is the forecasted slope.
- The intercept a_t and the slope b_t are approximated as shown in equations 2 to 4:

$$a_t = 2S'_t - S"_t \qquad (2)$$

$$b_t = \frac{\alpha}{1-\alpha}(S'_t - S"_t) \qquad (3)$$

$$0 \leq \alpha < 1 \qquad (4)$$

α is the smoothing constant which is used when weighing the past and current observations and it lies in this range; 0 < α < 1. When the value of α is less than one it is considered to have a less smoothing effect and this gives a greater weight the latest changes that has taken place in the data. When value of α is closer to 0 it is concluded to be having a greater smoothing effect hence it becomes less responsive to changes that have been conducted recently. The selection of have no specific formal procedure which is correct for DES and single values for time X_t, and t respectively. The values S'_t and $S"_t$ are computed using the formula shown below in equations 5 and 6.

$$S'_t = \alpha X_t + (1-\alpha)S'_{t-1} \qquad (5)$$

$$S"_t = \alpha S'_t + (1-\alpha)S"_{t-1} \qquad (6)$$

On the other hand, when α is higher it means that more weight has been given to the current observations which are most recent. Before one runs a model, you need to choose α first. This is followed by a computation of forecasts which is achieved by use of a variety of α values. The values which gives a small mean square error during the calculations is concluded to have shown the expected future growth has been selected. Besides the selection of α values approximates, S'_{t-1} and $S"_{t-1}$ values should be assumed with the values of t=1 since there are no values that exist at that period. This is achieved after consideration of the equality of both values when compared with the original set of historical data (Hyndman et al., 2008, Sullivan and Claycombe, 1977).

3.2.1.5 Data Sets

Tables 3.1, 3.2 and 3.3 show the complete set of the data used in this study.

Table 3.1: VKT Data Set for the Model

Year	GHG Emissions	VKT (Millions of vehicle-kilometres)					
		Passenger cars	Motorcycles	Light trucks	Bus	Single-unit trucks	Tractor
1990	1,235,100	2,266,384	15,381	924,682	9,215	83,527	151,827
1995	1,352,700	2,314,710	15,767	1,271,428	10,332	100,914	185,800
1996	1,388,200	2,365,501	15,965	1,314,094	10,562	103,114	191,349
1997	1,416,900	2,418,129	16,224	1,369,132	11,011	107,654	200,499
1998	1,461,200	2,493,802	16,549	1,397,353	11,277	109,469	206,574
1999	1,511,800	2,525,222	17,033	1,450,054	12,331	113,143	213,051
2000	1,521,500	2,575,412	16,848	1,485,519	12,215	113,459	217,294
2001	1,527,400	2,618,991	15,502	1,516,991	11,378	116,506	219,730
2002	1,562,500	2,669,055	15,372	1,554,681	11,016	122,094	223,276
2003	1,571,300	2,690,770	15,411	1,583,627	10,914	125,124	225,514
2004	1,604,400	2,735,708	16,290	1,653,060	10,945	126,239	229,122
2005	1,612,100	2,749,437	16,824	1,675,410	11,234	126,327	231,790
2006	1,609,800	2,720,651	19,392	1,742,099	10,917	129,301	228,799
2007	1,614,100	3,386,729	34,434	944,070	23,361	193,087	296,440
2008	1,540,100	3,258,530	33,492	974,387	23,855	204,153	295,839
2009	1,500,100	3,240,311	33,474	992,809	23,107	193,384	270,116
2010	1,509,000	3,260,887	29,724	1,001,844	22,200	178,185	283,217
2011	1,489,900	3,289,889	29,785	971,204	22,190	166,660	263,544
2012	1,487,100	3,320,643	34,275	967,355	23,745	168,916	262,899

Table 3.2: NTV Data Set for the Model

Year	GHG Emissions	NTV (Number of Vehicles/Equipment)					
		Passenger cars	Motorcycles	Light trucks	Bus	Single-unit trucks	Tractor
1990	1,235,100	133,700,496	4,259,462	48,274,555	626,987	4,486,981	1,708,895
1995	1,352,700	128,386,775	3,897,191	65,738,322	685,503	5,023,670	1,695,751
1996	1,388,200	129,728,341	3,871,599	69,133,913	694,781	5,266,029	1,746,586
1997	1,416,900	129,748,704	3,826,373	70,224,082	697,548	5,293,358	1,789,968
1998	1,461,200	131,838,538	3,879,450	71,330,205	715,540	5,734,925	1,997,345
1999	1,511,800	132,432,044	4,152,433	75,356,376	728,777	5,762,864	2,028,562
2000	1,521,500	133,621,420	4,346,068	79,084,979	746,125	5,926,030	2,096,619
2001	1,527,400	137,633,467	4,903,056	84,187,636	749,548	5,703,501	2,154,174
2002	1,562,500	135,920,677	5,004,156	85,011,305	760,717	5,650,619	2,276,661
2003	1,571,300	135,669,897	5,370,035	87,186,663	776,550	5,848,523	1,908,365
2004	1,604,400	136,430,651	5,767,934	91,845,327	795,274	6,161,028	2,010,335
2005	1,612,100	136,568,083	6,227,146	95,336,839	807,053	6,395,240	2,086,759
2006	1,609,800	135,399,945	6,678,958	99,124,775	821,959	6,649,337	2,169,670
2007	1,614,100	196,491,176	7,138,476	39,186,974	834,436	8,116,672	2,635,347
2008	1,540,100	196,762,927	7,752,926	39,685,228	843,308	8,288,046	2,585,229
2009	1,500,100	193,979,654	7,929,724	40,488,025	841,993	8,356,097	2,617,118
2010	1,509,000	190,202,782	8,009,503	40,241,658	846,051	8,217,189	2,552,865
2011	1,489,900	192,513,278	8,330,210	41,328,144	666,064	7,819,055	2,451,638
2012	1,487,100	183,171,882	8,454,939	50,588,676	764,509	8,190,286	2,469,094

Table 3.3: Ratio (Vehicle-kilometres Travelled by Mode (Millions of vehicle-kilometres) /Number of Transportation Vehicles/Equipment)

Year	GHG Emissions	Ratio (Vehicle-kilometres Travelled by Mode (Millions of vehicle-kilometres) /Number of Transportation Vehicles/Equipment)					
		Passenger cars	Motorcycles Ratio	Light trucks	Bus	Single-unit trucks	Tractor
1990	1,235,100	16,951.20	3,611.02	19,154.70	14,697.27	18,615.41	88,845.13
1995	1,352,700	18,029.19	4,045.73	19,340.74	15,072.14	20,087.70	109,567.97
1996	1,388,200	18,234.27	4,123.62	19,007.95	15,201.91	19,580.98	109,556.01
1997	1,416,900	18,637.02	4,240.05	19,496.62	15,785.29	20,337.56	112,012.62
1998	1,461,200	18,915.58	4,265.81	19,589.92	15,760.13	19,088.13	103,424.30
1999	1,511,800	19,068.06	4,101.93	19,242.62	16,920.13	19,633.12	105,025.63
2000	1,521,500	19,273.95	3,876.61	18,783.83	16,371.25	19,145.87	103,640.19
2001	1,527,400	19,028.74	3,161.70	18,019.17	15,179.82	20,427.10	102,001.97
2002	1,562,500	19,636.86	3,071.85	18,287.93	14,481.08	21,607.19	98,071.69
2003	1,571,300	19,833.21	2,869.81	18,163.64	14,054.47	21,394.12	118,171.31
2004	1,604,400	20,052.00	2,824.23	17,998.30	13,762.55	20,489.92	113,972.05
2005	1,612,100	20,132.35	2,701.72	17,573.58	13,919.78	19,753.29	111,076.55
2006	1,609,800	20,093.44	2,903.45	17,574.81	13,281.68	19,445.70	105,453.36
2007	1,614,100	17,236.04	4,823.72	24,091.42	27,996.16	23,788.94	112,486.14
2008	1,540,100	16,560.69	4,319.92	24,552.89	28,287.41	24,632.22	114,434.35
2009	1,500,100	16,704.39	4,221.33	24,521.05	27,443.22	23,142.86	103,211.24
2010	1,509,000	17,144.27	3,711.09	24,895.69	26,239.55	21,684.42	110,940.84
2011	1,489,900	17,089.15	3,575.54	23,499.82	33,315.12	21,314.60	107,497.11
2012	1,487,100	18,128.56	4,053.84	19,121.97	31,059.15	20,623.94	106,475.90

3.2.1.6 Results and Discussions

This section brings out a presentation and discussion of the main results which have been obtained after carrying out an analysis of a multivariate regression of the GHG emissions model.

Regression Analysis Results

Minitab software was used in analysis of this regression. It was also used together with the application of Analysis of Variance (ANOVA) test in order to check on how significant was the multivariate linear regression model.

Results which were obtained after conducting this analysis have been presented well in the table below. All co-efficient together with their expected signs have been well indicated. The negative sign shows that the predicted value of the dependent variable will be a value which is less than zero with a condition where the predictor values used are set to 0. This should always be the expectation in cases where the dependent variable has a negative mean value. It worth noting that it is the overall and general relationship among variables which forms one of the most significant part of the regression model.

This section utilizes some of the already mentioned six modes of transportation which are abbreviated as PC, LT, SUT, B, M and T. After standardization of all coefficients, PC has been established to have the largest absolute value and then it is followed by LT, B and SUT respectively. Hence, PC is established as the most important variable in this study. In order to establish the importance of variable in a given model, an estimation of the p-value is carried out. In this study, the p-values have been established and presented in the table as shown below. A consideration was given to the variables that had only a p-value of less than 0.05. The output below shows predictor values for LT, B, PC and SUT since their p-values falls within the range of 0.0 - 0.05. The p-values for the Tractors and Motorcycles were 0.317 and 0.693 respectively. Hence, they were in excluded from the model.

Table 3.4: Outputs of Regression for the GHG Emissions

Variables	Coefficient*	P-value	Variation inflation factors (VIF)
Constant	-1883476	0.000	
Passenger cars (PC)	121.50	0.000	4.1120
Light trucks (LT)	23.9988	0.009	7.612
Bus (B)	5.6932	0.011	3.245

Single-unit trucks (SUT)	26.335	0.004	2.7042

Note:

*****: R^2= 90.8%, Adjusted R^2= 89.46%, Predicted R^2= 84.88%.

Where, R^2 is the percentage of the response variable variation which shows how close the data fits the regression line. , and adjusted R^2 compares the explanatory power of regression models that contain different numbers of predictors.

*: Coefficients are important at the 0.05 level.

Checking of Model Adequacy

To ensure verification of the multivariate linear regression model, it is important to ensure that adequacy of the model has been checked. Regression analysis involves the use of an ANOVA tool that tests the importance and validity of the model. This is carried out on the basis of some few assumptions. These include the residuals having an even distribution and a constant variance. These assumptions are validated using a graph which analyses the residuals. In order to determine whether a small set of data are part of a given normal distribution, a plot showing normal probability is made. Since the straight line represents data points, it is concluded that the distribution is normal. This is well depicted in the figure 3.1 (a). The assumptions are checked further by plotting a residual vs fitted values as shown in figure 3.1 (b). According to these plots, a constant variance has been associated with errors. This has led to dispersion of the residuals being around zero. For instance, an increase or decrease of residuals in a pattern with the fitted values leads to errors which do not have a constant variance. This plot has points which seem to have a random dispersion around zero and this brings forward an idea suggesting the error to be having a mean of 0 which is reasonable. The fitted values do not appear to increase or decrease as a result of the vertical width of the scatter plot. Hence, the variance of the error is assumed to be constant (Rudy, 2011). Therefore, this analysis demonstrates satisfactory results which fall within the horizontal band. Secondly, in this model, there was no detection of influence or leverage points. Thirdly, multicollinearity was not also detected in this model. When large Variation Inflation Factors (VIFs), usually larger than 10 are detected, this means that there was poor estimation of the regression coefficients. This is normally caused by near-linear and multicollinearity dependencies among the regression variables hence leading to outcomes which are misleading. In this study, variables which have VIF that is less than 10 has been demonstrated in Table 3.4. These results can be translated to mean non-existence of multicollinearity in this model. Fourthly, the behavior of this data has been well represented by the model points. This as a result of the following coefficients which have the indicated value. As it is, it look like negative values:

- multiple determinations (R^2)- 91.8%
- adjusted R^2-89.46%
- predicted R^2 -84.88%

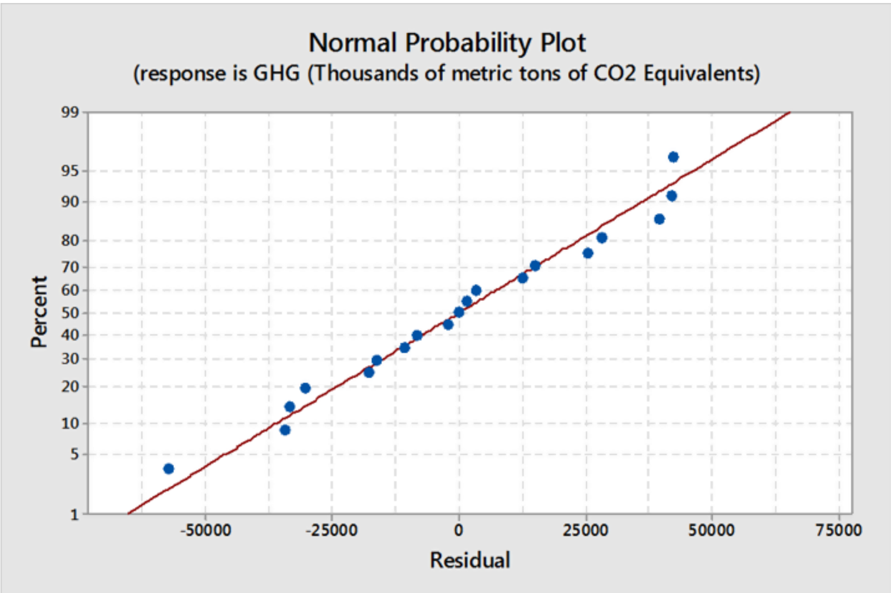
Finally, contribution of each vehicle category towards emissions of GHG is depicted by the last model (equation 7). Based on tests conducted previously, it can be concluded that the proposed model represents data accurately and has no violations towards the main assumptions. The equation for this model is as shown below in equation 7.

GHG Emissions= -1883486+26.34 Single-unit trucks+121.5 passenger cars+5.69 Bus+ 23.99 Light trucks (7)

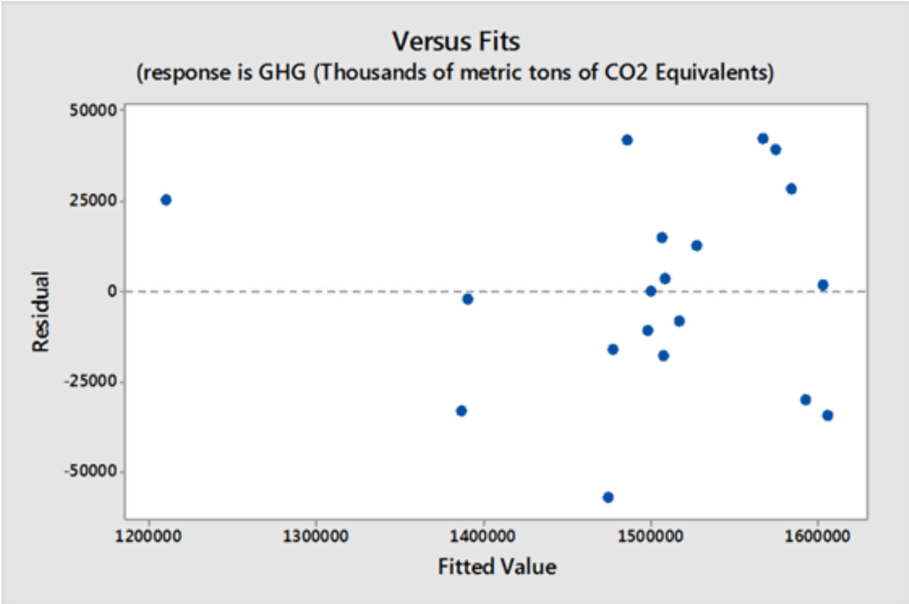
For example:

GHG Emissions (1990) = -1883486+(26.34×18615.41)+ (121.5×16951.2)+(5.69×14697.27) +(23.99×19154.7) = 1209563

$$\text{The Error\% (1990)} = \frac{\text{Predicted value} - \text{Actual value}}{\text{Actual value}} \times 100\% = \frac{1209563 - 1235102}{1235102} \times 100\% = 2.06\%$$



(a)



(b)

Figure 3.1: (a)Graph of Normal Probability and (b) Model of GHG Emissions graph of Residual versus Fitted Values

Table 3.5: Error Calculation

Year	Greenhouse Gas Emissions		Error %
	Actual	Predicted	
1990	1,235,102	1,209,563	2.06
1995	1,352,701	1,385,914	2.48
1996	1,388,203	1,390,246	0.14
1997	1,416,901	1,474,144	4.03
1998	1,461,203	1,477,173	1.08
1999	1,511,802	1,508,322	0.21
2000	1,521,502	1,506,371	0.98
2001	1,527,403	1,485,206	2.73
2002	1,562,501	1,592,653	1.92
2003	1,571,301	1,605,482	2.19
2004	1,604,404	1,602,626	0.14

2005	1,612,101	1,583,695	1.76
2006	1,609,801	1,567,259	2.69
2007	1,614,102	1,574,542	2.43
2008	1,540,106	1,527,431	0.81
2009	1,500,106	1,500,095	0.01
2010	1,509,004	1,517,266	0.52
2011	1,489,903	1,507,594	1.18
2012	1,487,101	1,497,834	0.75
Average of Error %			1.48

By application of Equation 7, there has been calculation of % error in order to draw a comparison between GHG real value and expected value. This has given a result value of 1.48% percentage error (Table 3.5).

Application of DES model which was described in equation (1), can be used to calculate GHG emissions forecasted variables over a long period of time which could even be from 1990-2060. This is made possible by the use of smoothing constants (α's) as depicted in Table 3.7. By using a predicted period of running 1990 to 2012, the resulting variables have been used in calculation of % error of projection which is clearly depicted in Table 3.6.

Table 3.6: % of projection error for the different variables

Transportation Mode	**Error %**
Passenger cars	2.38
Light trucks	5.03
Bus	7.74
Single-unit trucks	4.96
GHG error %	**1.94**

Table 3.7: Smoothing constants (α's) for the different variables

Transportation Mode	α%
Passenger cars	1.23692
Light trucks	1.21847
Bus	0.82999
Single-unit trucks	1.13279

A summary of GHG emissions predictions has been made using DES technique as shown in Figure 3.2. It has been predicted that by the year 2060, GHG emissions could rise to a figure around 2957400K Metric Tons (Scenario 1). This increase is expected due to the increased modes of transportation. According to Union of Concerned Scientist nationwide (Union of Concerned Scientists, 2016) GHG emissions for battery electric vehicles, the plug-in hybrids and gasoline vehicles are 144, 204 and 381 as depicted in table 3.8. These figures are measured in terms of grams of CO_2 per mile. Based on this data, table 3.9 presents five possible scenarios that could result from shifting from type vehicles to another as described below:

- Gasoline-Plug-in vehicles- This would lead to about 46.5% reduction of national CO_2 emissions (Scenario 2).
- Gasoline-battery electric vehicles- This would result in 62.2% decrease in CO_2 emissions (Scenario 3).
- Use of 50% of battery electric and 50% of plug-in electric hybrid vehicles- CO_2 emissions would reduce by 54.3% (Scenario 4)
- 25% plug-in electric, 50% gasoline, 25% battery vehicles- This would result in 27.16% reduction of 27.16% (Scenario 5)

Table 3.8: Average Emissions Nationwide (Union of Concerned Scientists, 2016)

Type of Vehicles	**GHG Emission (grams of CO_2 equivalents per mile)**
Gasoline vehicles	381
plug-in electric hybrids	204
battery electric vehicles	144

Table 3.9: The reduction value in GHG emissions for five scenarios

	Gasoline vehicles	plug-in electric hybrids	battery electric vehicles	GHG Emission
Scenario 1	100%			2957400K metric tons of CO_2Equivalents before 2060
Scenario 2		100%		46.5% decrease in CO_2 emissions
Scenario 3			100%	62.2 % decrease in CO_2 production
Scenario 4		50%	50%	54.3% reduction in CO_2 emissions
Scenario 5	50%	25%	25%	27.16% reduction in CO_2 emissions

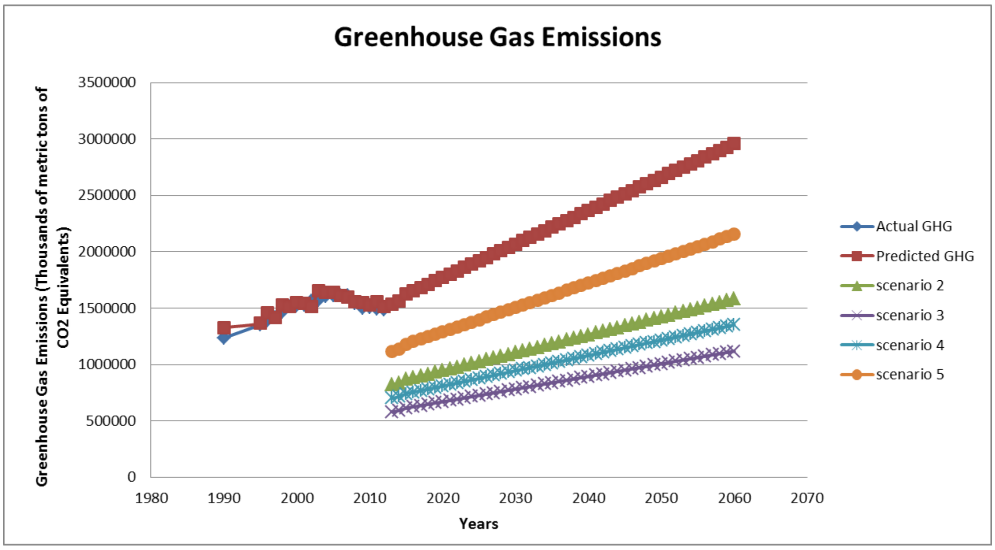


Figure 3.2: Real versus Expected values of GHG emissions for five scenarios

3.2.2 Conclusion

In majority of the developed nations, GHG emissions are mainly as a result of the road transport industry. In order to cut these emissions, all national efforts should have a major focus of reducing these emissions from the core which is the transport industry.

By use of multivariate linear regression model, this study was able to focus and carry out examination of GHG emissions factors which are associated with the road transportation sector. It made use of data collected in a span of 20 years. This period was between 1990-2012. From all six modes of transportation, the VKT to NTV ratios were identified. This was used to present the GHG emission factors which are considered to be significant. Based on the outcome, there is an indication that regression model can be used in modelling emissions of GHG in an adequate manner. This achieved by establishing adjusted R^2 coefficient of determination R^2 together with their values which are 89.46% and 91.8% respectively. This gives 1.48% error which is associated with the difference between actual value and the value which had been predicted. These results have also shown that the most crucial regression model variable is use of a personal vehicle.

This study made use of DES model in order to carry out predictions of variables which affects emission of GHG. This gave a 1.94% error between the real and the predicted value. From these results, it is predicted that by 2060, the emission of CO_2 will rise up to a figure around 2,957,400K metric tons. This will happen if we will continue using gasoline vehicle types only. A switch to battery electric would lead to a potential 62.2% decrease in emission of CO_2. If we shift from 50% use gasoline vehicles and 25% use of plug-in vehicles as well as 25% of battery vehicles, this will yield a decrease of CO_2 emission to 27.16%. Use of both battery electric and plug-in vehicles on a 50% basis will result in 54.3% reduction of CO_2 emissions.

In the process of developing efforts aimed at reducing CO2 emissions, a major focus should be on improving the efficiency of the transportation sector. This will help in reducing global warming as well climate change.

CHAPTER 4

Guideline for choosing which model is suitable for UDC

This chapter shows the findings related to the main key success factors of operational and sustainable UDCs, and describes the regulations and policies which currently implemented in Melbourne CBD.

4.1 Key Characteristics Of Active And Successful UDC

4.1.1 Key features of operational and successful UDC

(Stewart and Halliday, 2010), following a review of 14 European UDCs, have pointed out the following success factors for an implementation of a UDC:

- Located in industrial area with an easy and reliable access to the road network (highway and motorway) in order to collect goods to deliver,
- Using clean vehicles enabling to extend delivery hours in city centre and circulate in pedestrian areas,
- Developing a private/public partnership by attributing the management of the UDC to a private company (bidding),
- Financing the start of the project through local or national subsidies in order to evaluate the performance of the UDC before outsourcing its management,
- Suggesting and promoting new services to the community,
- Showing evidence that the UDC minimise the costs of transportation and environmental nuisances,

(Browne et al., 2005), outlines through the evaluation of 67 European UDCs that the success of a UDC is directly correlated to the followings points:

- Available and sufficient financing,
- Strong support of local administration through helpful regulations and policies,
- Considerable environmental nuisances such as traffic congestion or pollution issues,
- Strong retailer demand,
- Single management of the UDC with clear and realistic objectives.

Based on review articles of (Browne et al., 2005) and (Marcucci and Danielis, 2008), the main critical and important success factors have been identified as:

- Location which near or in the city
- A collection of Subsidies
- Freight carriers and shippers subsidies
- Viability of use of finance
- UDC cost of servicing
- Cost of access permit
- Delivery time delays
- Parking bay distance from the shop

(Paché, 2008), points out that UDC hinder competition between carriers due to the mutualisation of resources for delivering goods into the inner city. Freight logistics is no longer a competitive advantage for shippers.

It is worth noting that application of a single UDC is likely to be unattractive to the eyes of suppliers. This is because of the degree of diversions that is needed from the normal route. This might lead to a negation of savings associated with transport in order to achieve onward distribution(Taniguchi et al., 1999).

It has been established as an important element to have a UDC that is clear which has a centre that is old historic associated with less congestion in absence of UDC. In order to have a successful implementation of the UDC, it is important to have an addition of values depicting the total case which is associated with specific stakeholders. A clear UDC objective is needed so that more stakeholders can come into board and the whole system turn out to be successful (van Kolck, 2010).

4.1.2 Required conditions for a UDC implementation

According to (Interface Transport, 2004), the installation of a UDC involves three major conditions:

- Constraining regulation and policies and associated control means,
- An adapted localisation of the UDC enabling to easily and efficiently manage the inflows and outflows of goods
- A strong involvement of all stakeholders

(Stewart and Halliday, 2010), add that several major problems must be resolved to guaranty a successful development of a UDC:

- Who funds the UDC facility and the last mile if cost reduction obtained by the mutualisation of resources is not enough to finance the project?
- Who is responsible for delivery performance and issues related to loss of inventory?
- How can we rapidly and reliably inform carriers using the UDC that deliveries have been executed? It is a critical issue due to the multiple IT infrastructures used by logistics transporters.
- Which type of contract logistics operators have to define and implement within the UDC in order to minimise the risk due to mutualisation of resources?

Answering these questions as soon as the feasibility analysis of the UDC is conducted is crucial for its survival because all stakeholders must well understand the ins and outs of the project and the implications of their agreement to the solution suggested.

According to Hamilton (2006), observations from European experiences suggest that freight centres or UDC must “be market based and commercial entities in order to be successful”.

(Browne et al., 2005), state that interests and objectives of stakeholders are not the same, so, it is crucial to obtain from them early on a shared vision of benefits, cost and constraints of potential UDC before any implementation

4.2 Melbourne CBD: Regulations And Policies

Regarding the transferability of the International models of UDC, (Hamilton, 2006), point out that in Australia, congestion management measures are often ignored before their implementation, problems of acceptability dramatically increase when they start to bring about changes to community’s habits. To limit this type of behaviour from people, it is recommended to early and broadly debate these future changes and promote their benefits with all stakeholders.

By 2020, Australian’s land transport is expected to increase significantly. If we will not be able to manage the impact of freight, the safety of our environment and economic growth are predicted to be extremely affected and put in huge danger (NTC, 2006).

The approach which has been adopted in order to regulate use of vehicles in Australia mainly uses government intiated regulations which are achieved through the use of prescriptive tools which are associated with the road sector. Rules adopted are mainly employed to vehicles and their operations and they have a couple of aims which are targeted mainly towards asset and environmental protection. In order to ensure protection of roads, National Transport Commission (NTC), there are three regulation methods which have been applied. They include compliance and enforcement, road pricing and setting perspective standards which regulate masses and dimensions of vehicles (NTC, 2006) .

Each jurisdiction has separate policies and freight strategies in place for urban and regional freight. Table 4.1 provides an overall summary of policies and directions as set out in the various transport and freight related strategies in Victoria (Austroads, 2016).

Before supporting provision of financial subsidies in establishement of UDC, local authorities are required to carry out assessment of both environmental and social benefits. The facility which offers the most innovative, optimized and effective distribution activities which have lowest environmental and social impacts should be the one who is eligible for subsidies. Therefore, the facility operator should find a way of carrying out an integration which will enable the facility to fit perfectly to environment and still generate income meeting its commercial uses. City planners are tasked with coming up with performance-zoning codes which will help in supproting activities that lead to reduced negative impacts to the environment as well as the surroundings. Moreover, there is the need for the local authorities to come up with regulations which help in effective use of cargobikes which can be achieved by improving the existing bicyle infrastructure within the city (Aljohani, 2016).

Table 4.1: Freight practices and policies (Austroads, 2016)

Jurisdiction	Policy document name	Higher priority topics (many are freight generally rather than urban freight specifically)	Examples of projects or specific initiatives (Urban Freight)
VIC	The Freight State - The Victorian freight and logistics plan	•Freight gateway capacity	• Distinguish focuses in key rail cargo passageways that may compel future limit and build up a program to logically solve these challenges in future. • Conduct a review of current measures in order to ensure that rail freight and road links are operational and protected on 24/7 basis
		• Better use of the freight network	•Related to the Metropolitan Planning Strategy (MPS), distinguish key cargo regions and connections in Growth Corridors and create powerful procedures for their security. •Survey and update Planning Provisions to advance progressively successful mix of anticipating cargo with more extensive vehicle and land use arranging. • Work with nearby boards and the cargo business to improve the consistency of cargo conveyance get to courses of action over the metropolitan region.
		• Efficient freight network links	• Look for accomplices from neighbourhood government, industry and the scholarly world to preliminary and assess utilization of developments, for example, 'cargo accreditation plans'; 'conveyance administration plans'; 'conveyance combination focuses' and 'cargo administrators and beneficiaries gatherings'

		• Land use planning and protections	•Prepare a rail freight network development strategy • Work with Intelligent Transport Systems Australia to create and run cargo innovation exhibit ventures.
		• Planning for efficient and sustainable urban freight movements	• Work with industry to create systems to improve the appeal and business practicality of medium-term tasks.
	Draft Last Kilometre Freight Plan (Melbourne City Council)	•Local Area Planning	•Cargo Bikes
		•Public Transport	•Support for Pilot Projects •Out of Hours Deliveries
		•Freight Initiatives	•Use of new technologies for gathering and using freight delivery data.
		•Technology and Communication	•Use of real time communication to better inform delivery •Smarter regulation of loading zones.
		•Regulation	•Consider changes to regulation of freight access and delivery arrangements

4.3 Selection Process Of The Case Studies

This part contains a a comprehensive description of the process that has been used in selecting case stuudies and it gives a provision of the findings and how they apply to the Melbourne CBD context. The premise of this research consists of 113 schemes which a proof of thought as well as in-depth consideration has been given to the basis of a UDC.

This section gives a description of a case study and how it is selected as well as a summary of its findings while providing a discussion also towards their relevance to Melbourne CBD context (Allen et al. 2012). A good scenario depicting this list refers to the situation whereby the region looked to have an improvement of the plan of urban traffic through application of other measures other than using UDCs.

In order to determine the feasibily of a UDC, studies have been carried out based on three theoretical factors. These include political, commercial and technical feasibility (van Duin et al., 2010). Assessment of technical feasibility involves exploration of a few UDCs elements which includes type, characteristics and location. On the other hands, political and commercial feasibility of a UDC is established through application of important factors such as government subsidies. This is due to the fact that operation and keep-up of a UDC would be extremely difficult in the absence of subsidies.

On the basis of the observations made above, it can be established that majority of the discussions regarding UDC features provides important piece of information about the major characteristics that were considered for when developing criteria for case study selection.

When developing the criteria, a focus was laid on an important number of related factors and notes from studies that were conducted by (Panero et al., 2011, Browne et al., 2005), which included:

- Location: which is related to the area that is being served.
- UDC's objectives
- Having a successful UDC which has its current status being still in operation.
- The kind of products that is being handled.
- The number of forwarders who are participating is being determined in order to define schemes of a single of multi-company.
- The size of UDC's surface or land in (m^2) or (Km^2).
- UDC's work type, which can be either trial, full or study operation.
- Vehicle types that will be used
- Voluntary or compulsory
- The mode of Transport operation of the UDC which could either be temporary or permanent. This is in regard to existence of data about the effects of UDC on VMT.
- Finance issues- If the UDC is self-sustaining or it requires subsidies.
- Leadership initiative and whether it is bottom-up or top-down, private, public-private partnership and public
- Implications or effects towards the environment
- Advantages which are beneficial

On the basis of these criteria, out of 113 schemes, 33 UDC schemes were only conceptual and did not have any readily identifiable work and thus were excluded from the analysis (Allen et al. 2012). After considering the other 80 schemes which are remaining, three main classifications of UDC can be defined as (Allen et al., 2012):

- A UDC which serves an urban area partly or fully. These UDCs are usually meant to serve an urban area specific districts'. In most cases they are used to serve locations by use of features which are put across as historic layouts and narrow streets.

- UDCs serving large sites with a single landlord (such as an airport or shopping centre).
- Construction project UDCs: These UDCs are aimed providing some consolidation for construction materials which are used in major constrauction projects.

Three categories could be used in development of around 80 schemes as shown below (Allen et al., 2012):

- 'Study' refers to UDCs that did not progress beyond an initial research/feasibility project.
- 'Trials' refer to UDCs that did not proceed beyond a trial.
- 'Operational' refer to any schemes that extended beyond the trial stage.

Based on the above criteria, we selected the simulation and business model as an example of the case studies, and we have compared between them as shown in tables 4.2 and 4.3.

Table 4.2: The Comparison between the Simulation Models Case Studies

UCCs	Columbus, Ohio - USA	Marunouchi, Tokyo - JAPAN	Munich UCC - GERMANY	Marseilles- FRANCE	Bordeaux UCC - FRANCE	Dijon UCC - FRANCE	Gothenburg - SWEDEN	Copenhagen - DENMARK	Uppsala - SWEDEN
Year	1972-74	2002	1993 - 94	1990's	2003	1990's	Study: 1991. Experiment: 1996	2013	2001
Name of initiative	The UMTA/OSU Study	Co-operative Distribution System	NA	Data collection-Modelling	Local Delivery Point (ELP)	Local Delivery Point (ELP)	The coordinated distribution schemes.	Citylogistik-kbh	coordination of goods transports
Locations	District	District	Town-wide	Town-wide	Town-wide	Town-wide	District	Town-wide	District
Objectives	Urban freight traffic and measurement of its impacts on consolidation	To decrease distribution (especially delivery) costs.	To amplify the stacking limit of merchandise vehicles and to diminish the number of conveyances through union of shipments	To legitimize the development and movement of cargo in urban regions	1-Enable and support delivery of small packages within the urban areas. 2- Reducing the number of trucks which are within the city. 3- Reducing impacts to the environment. 4- Reduce amount level of noise in the urban areas.	Ensure movement of freight in urban areas has been rationalized	To reduce goods vehicle traffic and its related environmental impacts in an inner-city area.	1- Reducing traffic congestion, noise and air pollution. 2- To help reduce the use of large trucks in the city centre. 3- To provide better services and a coordinated transport for the consignees.	To reduce cost, congestion and environmental impact.
UCC Successful/ Failed	Successful	Successful	NA	NA	Successful	NA	NA	Successful	Successful
Type of product		Delivered all product types except chilled and frozen handled	Personal care products, stationery, food-stuffs, home appliances, clothing and building supplies / materials.	Retail goods	Retail goods	Retail goods	Food and grocery deliveries	(i) Fashion (ii) bicycle stores, (iii) convenience stores and kiosks, and (iv) specialized stores	Agricultural produces and food
Number of users	NA	5 Big carriers and 13 Small	NA	NA	15 Transport operators	NA	NA	1071 Retailers	4 Galleria
Trial, Study or Fully Operational	Study	Trial	Study	Study	Study	Study	Study and Trial	NA	Trial
Type of Vehicle used	Articulated vehicles	Natural gas trucks	Environmentally friendly vehicles	NA	Truck	NA	NA	Environmentally friendly vehicles	Trucks
Current Status	Not implemented		NA	NA	Active	NA	NA	Active	There is no evidence of the scheme proceeding
Voluntary/Compulsory	NA	Voluntary	NA	NA	NA	NA	Voluntary	Voluntary	Voluntary
Permanent/Temporary	NA	Temporary	NA	NA	NA	NA	NA	Permanent	NA
Transport Operations	NA	• 33% reduction in number of deliveries. • Improving traffic flows by 50% reduction in on-road parking and a 35% increase in the use of underground parking.	•29.2% reduction in number of deliveries. •18% reduction in drops per delivery run. • a 31-minute reduction in store delivery times. •increase in vehicle loading from 70 to 81%.	NA	Dispersion of observed results, gains by tour ranging from 0 to 5.3 km, number of shipments from the delivery space ranging from 1 to 6, reduction of energy consumption	NA	NA	Less traffic congestion and a better service for shops and shippers.	Reduced delivery times and fixed times of delivery. fewer stops per trip and reduction in total distance driven;
Financial Issues (Subsidies)	Required subsidies	NA	NA	NA	NA	NA	Required subsidies	Required subsidies	NA
Actors who started the initiatives	NA	Public-private partnership	NA	Public	Public	Public	NA	Public-private partnership	Public

Environmental Impacts	NA	Claimed 90% reduction in Nox – presumably only from the vehicles used.	29% reduction in city pollution.	NA	Average reduction in emissions of CO2 by stop: 845 g, about 40 kg per day	NA	NA	The minimisation of the environmental impacts of delivery vehicles,	Improved traffic and environmental conditions – lower emissions, congestion and noise
Beneficial Advantages	The investigation distinguished potential advantages of the accompanying decreases: 90% in number of vehicles; 91% in separation voyaged, 91% in travel time, 53% in emptying time, 37% in stacking time, 100% in lining time, 76% in yearly cost, vehicle emanations and traffic blockage..	Shown that an agreeable way to deal with an issue created far superior results that a non-helpful methodology which was the pre-preliminary methodology. 18 (7.8%) transporters out of 232 serving the zone partook and represented 7.2% of the trucks in the region and 22.2% of the "cargo"	Diminished traffic sway for members. Preferences of cargo focuses to encourage coordination exercises and to merge products streams by building up certain vehicle administrations.	Traffic reduction impacts to generally be less than 1%	Traffic reduction impacts to generally be less than 1%	Traffic reduction impacts to generally be less than 1%	NA	•Decrease in noise, congestion and pollution in the city centre • Fewer daily deliveries • Easier planning for shop staff • Fewer disruptions in store operations • Well-known driver helps achieve a smooth delivery process • Various additional third-party logistics (3PL) services are offered • A more attractive and productive city	•More effective deliveries for retailers & logistics companies through fewer deliveries, reduced delivery times •Improved vehicle utilisation – improved loading, fewer vehicles, fewer stops per trip and reduction in total distance driven; •Improved traffic and environmental conditions – lower emissions, congestion and noise plus improved security and accessibility.
References	(McKinnon, 1998a, McDermott and Robeson, 1974)	(OECD, 2003)	(Browne et al., 2005)	(Browne et al., 2005)	(Roche-Cerasi, 2012)	(Browne et al., 2005)	(Browne et al., 2005)	(Britta, 2015)	(Browne et al., 2005)

Table 4.3: The Comparison between the Business Models Case Studies

UCCs	*Oslo - NORWAY*	*Antwerp - BELGIUM*	*Vicenza - ITALY*	*Padua - ITALY*	*Paris (La Petite Reine) - FRANCE*	*Bremen - GERMANY*	*Utrecht - NETHERLANDS*	*Maastricht - NETHERLANDS*	*Arnhem- NETHERLANDS*	*Nijmegen - NETHERLANDS*	*Bristol (Broadmead) – UK*	*Gothenburg - SWEDEN*
Year	2014	NA	2005	2004	2003	1994	1994	1989 & 1991	1989	2008	2004	2012
Name of initiative	NA	CITYDEPOT	Veloce	Cityporto Padova	La Petite Reine	City Logistik project	Binnenstadservice.nl	Binnenstadservice.nl	Binnenstadservice.nl	Binnenstadservice.nl	START project	Stadsleveransen
Locations	Town-wide	Town-wide	Town-wide	Town-wide	District	Town-wide	Town-wide	District	District	District	District	District
Objectives	To optimize deliveries and minimize transport. To improve the situation for local freight stakeholders and for the city environment.	NA	To maximise the usage of the vehicles in circulation and reduce their number.	To reduce freight traffic inside the historical centre of the city, to reduce vehicle emissions,	To test an alternative to motorised vehicle for final delivery of goods and reduce the impacts of urban freight transport.	More efficient use of delivery vehicles / fewer journeys within inner city / less environmental damage.	To improve amenity and accessibility of city centre and to protect the city's arched basements from heavy vehicle damage. Reduce number of vehicle movements and kilometres, increase efficiency of distribution.	To overhaul urban freight delivery resulted in a main proposal to develop "urban distribution centres".	To overhaul urban freight delivery resulted in a main proposal to develop "urban distribution centres".	To reduce congestion, emission of local air pollutants, and noise.	To reduce goods vehicle activity in the central area. Helping to relieve traffic congestion, improve air quality and minimise conflict between vehicles at loading areas/delivery bays. increasing delivery reliability and offering a range of value-added services	To improve the efficiency of freight distribution in the city.
Successful/ Failed	Failed	NA	NA	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful
Type of product	Goods delivery	Parcels	Clothing, shops, bars and food services	Businesses	All product type	All product type	NA	Fresh produce and waste	Retail, fresh produce, waste	Non- perishable goods	Non- perishable goods	Goods delivery
Number of users	NA	NA	14 logistics operators	33 couriers and 2 operators	4 central arrondissements	135 competitive companies	Two companies	NA	NA	98 retailers	188 retailers	8-10 shops
Trial, Study or Fully Operational	Trial	NA	Trial	Trial	Trial	Operational	Operational	Study and Trial	Study	Trial then fully operational	Trial	Trial
Type of Vehicle used	Truck	Trucks	Electric vehicles	Natural gas powered and electric vehicle	Tricycle and Electrical vehicle	Clean vehicles	Clean vehicles	Clean vehicles	Clean vehicles	clean vehicles	Diesel-powered vehicle, Electric vehicle	Electric vehicles
Current Status	Stopped	NA	Active	Active	Active	Active	Active	There is no evidence that the scheme is continuing	There is no evidence that the project proceeded	Active	Active	NA
Voluntary/Compulsory	NA	NA	Voluntary	Voluntary	Voluntary	Voluntary	Voluntary	Voluntary	Voluntary	NA	Voluntary	NA
Permanent/Temporary	NA	NA	NA	Expected to become permanent	Permanent	Permanent	Permanent	NA	NA	NA	Permanent	NA

Transport Operations	NA	NA	40-50% reduction in fuel consumption.	•UDC vehicles are granted 24-hour access to limited traffic zones in the city centre, use of bus lanes and use of reserved loading areas. •VMT (-127,000 vehicle kilometres in 15 months, trip mileage reduced by 26%),	Use of the delivery services has been increasing during the trial. The number of trips in the 24th month (14 631) is 18 times higher than in the 1st month (796).	•1997 data: number of trips (-12.7%), load factor (+28%). •2005 data: VMT (-9,000 km per month), fuel (-1,100 litres of diesel per month).	NA	Estimated that a UCC would handle 10% of all freight tonnage delivered in the town centre after allowing for exempted items (fresh produce, waste etc)	NA	Reduce 32% vehicle kilometres	Reduce 68% of vehicle movements	NA
Financial Issues (Subsidies)	NA	Self-sustaining	NA	Required subsidies	Required subsidies	Required subsidies	Self-sustaining	Required subsidies	Required subsidies	Required subsidies	Required subsidies	Required subsidies
Actors who started the initiatives	NA	Private	Public-private partnership	Private	Public	Private	Public-private partnership	Public	Public	Public	Public	Public
Environmental Impacts	NA	NA	20-30% reduction in vehicle emissions	Pollutant emissions (38.4 tones CO_2 saved in 15 months).	Savings included 43 tons oil equivalent, 112 tons CO_2. Generating energy savings equivalent to 90 tons of oil equivalent. Avoiding contamination emissions, such as 84 kg PM and more than 200 T of CO_2. Reducing noise pollution and congestion.	NA	NA	NA	NA	Limited impacts on air quality by testing the NO_2 and PM10 as the indicators	Decrease gas emission, improve the local air quality (based on the data of CO_2, NO_2 and PM10	NA
Beneficial Advantages	NA	NA	Encourage the use of UCCs including permission to use bus lanes, lifting vehicle access time restrictions, priority parking space, and exemption from road pricing. Help to reduce the noise, congestion and vehicle emissions. Improve the load factors and reduce goods vehicle trips and total distance travelled in the urban area.	Public grants on total inflows have decreased from 85% in 2004 to 22% in 2007. The goal is to achieve economic self-sustainability. For a 5-year period, the estimated economic value of environmental benefits has been estimated to double the number of subsidies for the project.	•Reducing the number of trips to achieve more beneficial outcomes and reduce the cost partly. •Parcel freight has become the most important type of freight during the course of the trial. It has increased from 51% of all items handled at the beginning of the experiment to 97% after 2 years	The UDC benefited from EU CIVITAS-VIVALDI (demonstration project) funding. CIVITAS was aimed to introduce gas-powered trucks for city logistics. It is not clear if it keeps operating nowadays without external funding.	It was originally estimated that 80% of conforming shipments would be handled through the UCCs. In practice, far less produce than this passes through the UCCs. The two companies have estimated that the UCC operation only accounts for approximately 2% of the total goods throughput in the depot.	Traffic reduction impact to be less than 1%. Large reduction in freight vehicle km.	Estimated that a UCC would handle 10% of all freight tonnage delivered in the town centre after allowing for exempted items (fresh produce, waste etc). In cost terms it was estimated that the annual costs for a UCC (in million Dfl/annum) would be 20.4 without a UCC (transport only) and 15.5 with a UCC (transport 5.0, transhipment 10.5)	Decreasing the vehicle trips to achieve more beneficial outcomes and reduce the cost partly. Cooperation with shopkeepers, focus on receivers, provide extra paid services for retailers and decrease the congestion of traffic and gas emission in the cities, make the cities become more habitable.	Reducing 68% of vehicle movements to gain beneficial outcomes and reduce the cost partly.	In one year, the network of retailers using the solution expanded to some 200, and an additional haulier using electric cargo bikes has been added. An additional revenue stream of significance was found in the sale of advertising space on the vehicle.

References	(Nordtømme et al., 2015)	(Kin et al., 2016)	(Browne et al., 2005)	(Panero et al., 2011, Browne et al., 2005, Galli, 2015)	(Panero et al., 2011, Allen et al., 2007)	(Panero et al., 2011, Browne et al., 2005)	(Browne et al., 2005)	(Browne et al., 2005)	(Browne et al., 2005)	(van Duin et al., 2010, Thompson, 2014, van Rooijen and Quak, 2010)	(Panero et al., 2011, Browne et al., 2005, Julian et al., 2014)	(Carlo Vaghi, 2014)

One of the main drawbacks associated with this study was inadequacy of documentation records related to the number of schemes that was considered. This made it difficult to establish in keeping track of the start process, progress made as well as results and the schemes' current status. Specifically, it was difficult to find start dates, and information on whether the trial has been finished or on-going. Accordingly, the start date or end date can be considered as an indicative only for several UDCs.

Additionally, it was established that a good number of schemes stopped working and generating reports after the trial period was over. This was well noted in schemes that has been launched in Netherlands, France and Germany vanished. However, it was good to have an assumption that those UDCs trials garnered a lot of success which represented the practicality of those mentioned in the literature. After conducting a review of the trials that had been set up in Germany (Kohler, 2004), it is stated that almost about 200 schemes have been either implemented or planned, and (Klaus, 2005) have recently reported that in Germany, all schemes have been ended prematurely. In contrast (Nobel, 2005) it was reported that 5 schemes were still in operation as per the year 2005: Aachen, Bremen, Essen, Frankfurt am Main, and Regensburg. In addition, Nuremburg is still operating.

Based on the case studies analysis and the comparative analysis, a guideline on how to choose the case study that is appropriate for a particular city is proposed based on a decision tree analysis as shown in Figure 4.1.

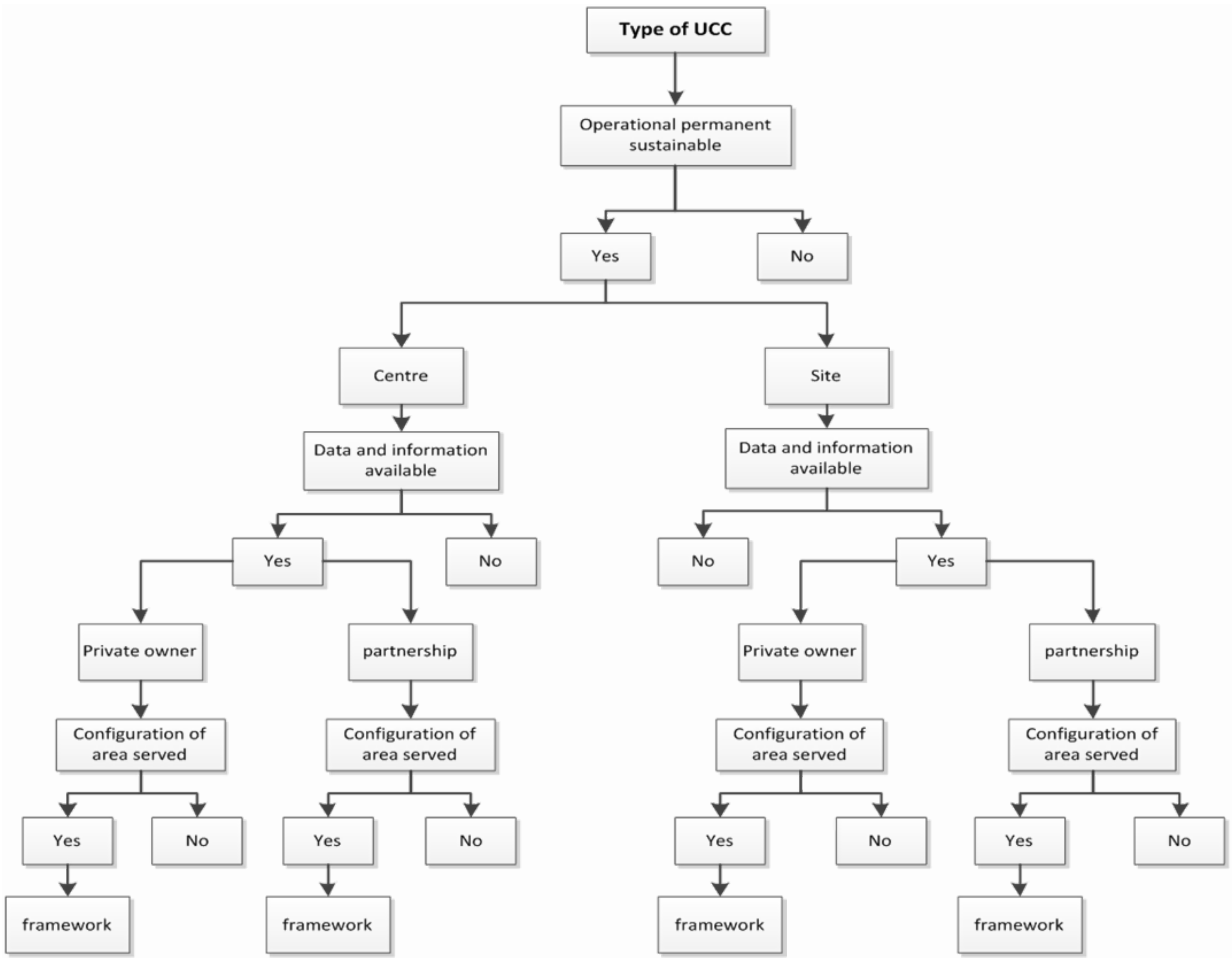


Figure 4.1: Decision Tree Analysis for Selecting A Case Study Appropriate to A City

CHAPTER 5

Transferability of the selected UDC

In the EU funded countries, it has been a major issue to perform a transfer of urban freight measures successfully from one point to another. This has allowed development of efforts and knowledge leveraging mechanisms. However, in order to replicate experiences in a successful manner, a proper analysis of the transferability process is required. This helps in identifying which are they success factors of initiatives of an original environment and developing an assurance of similar conditions in the new environment (Janjevic et al., 2013).

This chapter studies the UDC's transferability and presents a common transferability framework that was developed for these initiatives. The main objective is to establish a framework to assess the potential for transferability of urban logistics concepts, practices and models.

5.1 transferability Framework Of The Two Selected UDC

According to the key findings of each selected UDC, the potential transferability of each UDC is discussed for each key finding of a selected UDC and we examine if the transferability is possible.

Figure 5.1 shows the following steps of the transferability process for the selected case studies:

1. Description of the target city (Melbourne CBD)
2. Search and collect urban logistics case studies they already implemented the scheme Based on that two case studies were selected:
    - City of London UCC - UK
    - Paris (La Petite Reine) UCC – France
3. Place the location of the two case studies and the target city on the world map
4. Diagnostic of the main freight problems for the selected case studies and the target city
5. Find the transferability attributes
6. Propose the typology to be implemented
7. Build the business model for the city of Melbourne
8. The principle of the distribution centres (proposed typology)
9. Identify the distribution centres location on the map

These steps will be described in detail in the next subsections.

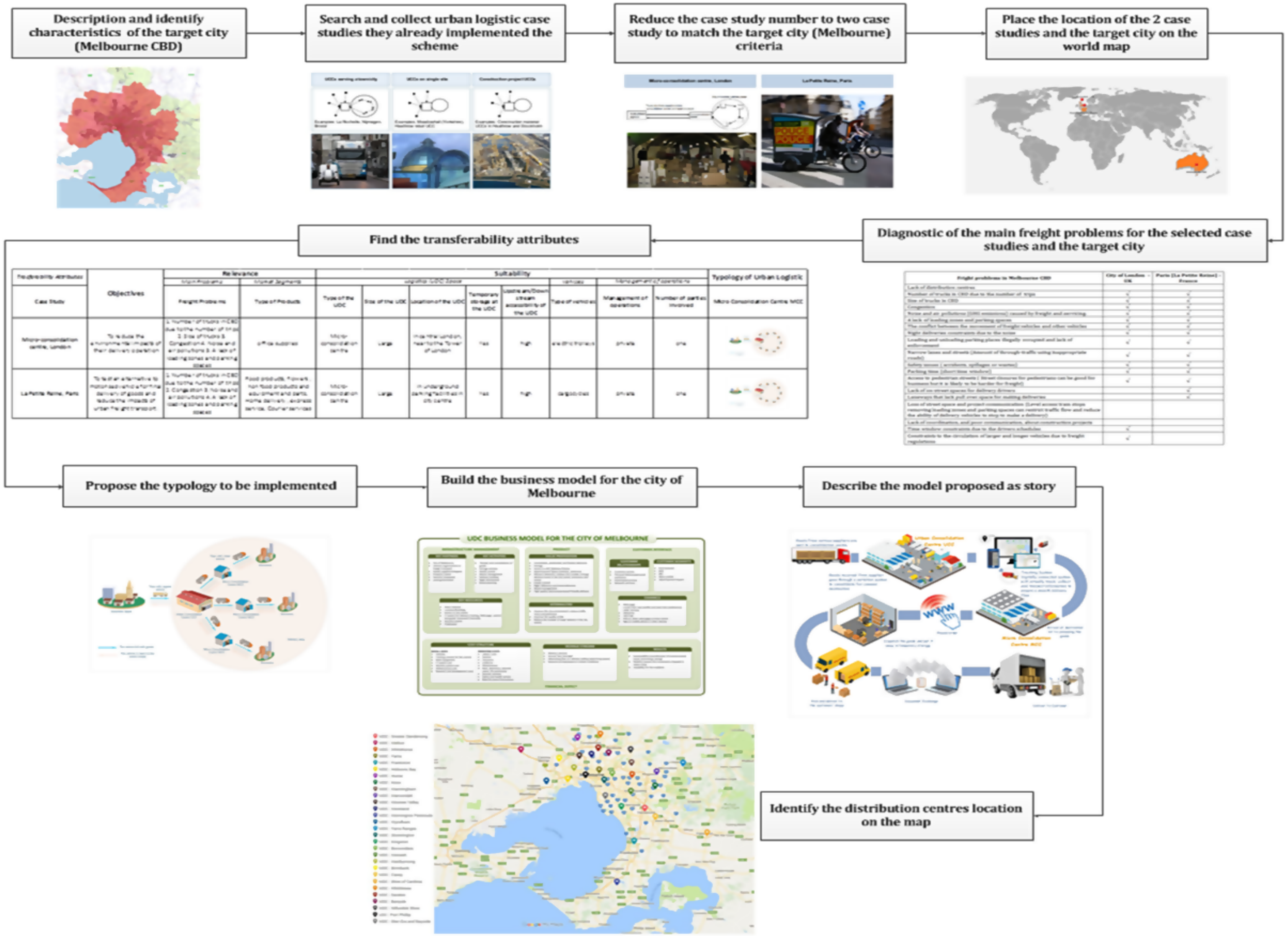


Figure 5.1: The transferability framework

5.1.1 Description of the target city (Melbourne CBD)

Melbourne

Melbourne is Victoria's capital city and the business, administrative, cultural and recreational hub of the state. As shown in Figure 5.2, it is located at the head of Port Phillip Bay, on the southeastern coast. The entire Greater Melbourne area covers 9992.5 km^2 and has a population of around 4.5 million (Melbourne, 2017).

The City of Melbourne municipality covers 37.7 km^2 and has a residential population of over 148,000 (as of 2016). It is made up of the city centre and a number of inner suburbs, each with its own distinctive character and with different businesses, dwellings and communities living and working there (Melbourne, 2017).

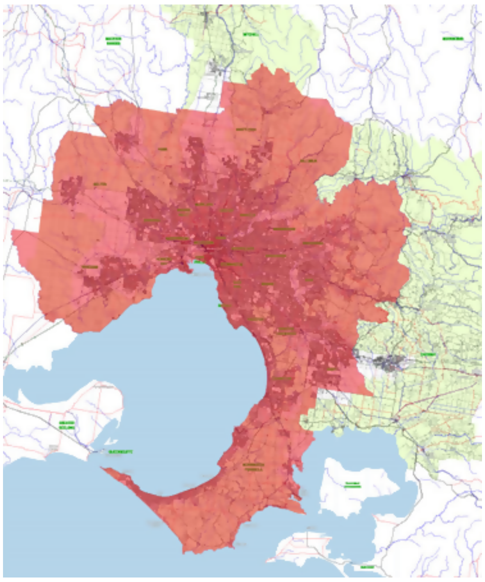


Figure 5.2: Australia maps, showing location of Melbourne (SRO, 2019).

The land-use

Metropolitan Melbourne is situated at the northern end of Port Phillip Bay, 30 nautical miles (55 km) from the bay's narrow entrance. Most of the flat terrain is less than 390 feet (120 metres) above sea level. The expansion of Melbourne from its origins at the mouth of the Yarra River to its present shape displays a strong correlation with the geology and drainage of the land (Prescott, 2016).

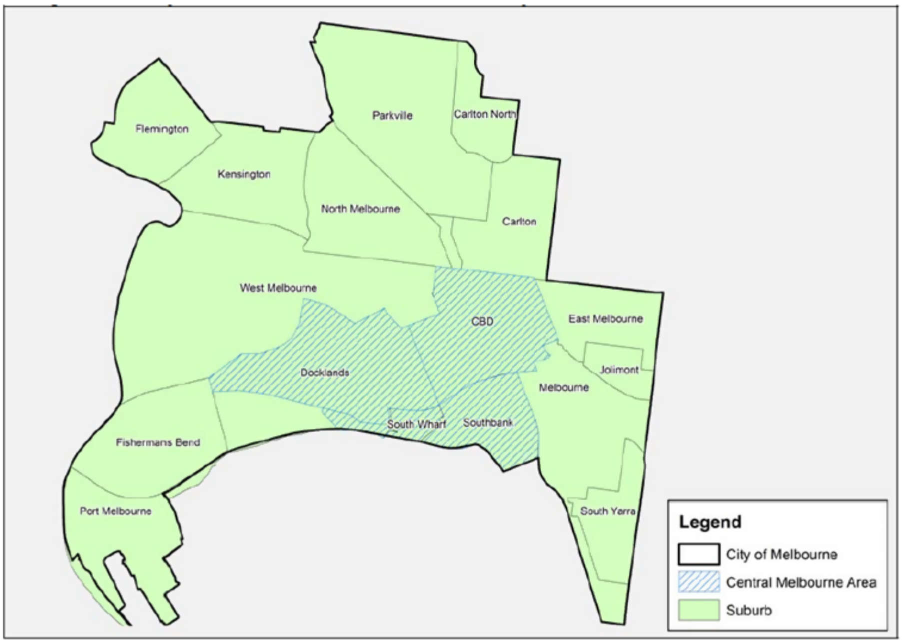


Figure 5.3: City of Melbourne Suburb and Central City Area Boundaries (Melbourne, 2015a).

The economy profiles

The economy of Melbourne City is a huge contributor to the economies of Victoria and Australia (Melbourne, 2017).

One of the core offerings by the city are employment, however the suburbs have been experiencing a faster rate of employment growth. The central business district of the city serves as a home of several services which include railway transportation, public accommodation, insurance, retailing, entertainment and banking. At the suburbs of this city are industries which depicts the place where metal and clothing factories were established in the nineteenth century. Additionally, in the suburbs more specifically in the east forms an area that consists of small manufacturing factories that had started after the world war II ended. These areas offered extensive land that was inexpensive and was free from high population and traffic congestion density (Prescott, 2016).

Based on the numbers of employees, some of the most successful and vital industries in Melbourne City are metal processing, engineering industries and manufacture of equipment involved in transport. In addition, there are industries which include manufacture of chemical, building materials, furniture, printing, food processing and textile factories. In Australia, Melbourne is established as one of the leading manufacturer of computer. Furthermore, it is developing and rapidly becoming as a centre for biotechnology and biomedicine. In Australia, Melbourne serves as the second-largest industrial hub after Sydney (Prescott, 2016, Wade, 2014).

Transportation and Travel demand

The City of Melbourne is well served with a good transportation infrastructure. This supports various means of transport that include use of cars, tram, buses and electric trains. A s a result of the available freeway network, Melbourne has road transport accounting for majority of the trips across the whole city. This has made the city to become a hub for intracity and intercity as well regional travel (Statistics., 2018). This City boast of upgraded freeways especially during the 1990s creating a linkage to other states through a network of national highways. A good example is the Western ring road which serves as a bypass route. Furthermore the project referred to as City Link created a linkage of three major freeways through tunnels, bridge and highway extensions that facilitated free and smooth movement of traffic. There is also an underground rail loop which serves the CBD section of the City (Prescott, 2016).

Another key part of the transport system includes use of buses, trains and one of the largest tram network in the world. There are also other modes of transport which include walking and cycling as well as use of taxis. Freight transport has also been used in supporting trips from industrial areas around the city and movement from Melbourne Airport towards the Port of Melbourne (Victoria, 2018).

Figure 5.4 is used to the various modes of transport which have been widely used in traversing around the city. It is clearly established that walking is the most preferred means of transport. This is further supported by a survey that was done in 2014, where it was established that around 65.4 % of people working in this city got around the city by foot. Moreover, other modes of transport which were popular in the city are as shown below (Melbourne, 2015a):

- Tram (19.6%)
- Train (4.7 %)
- Car (as driver – 3.7% and as passenger – 1.4%)

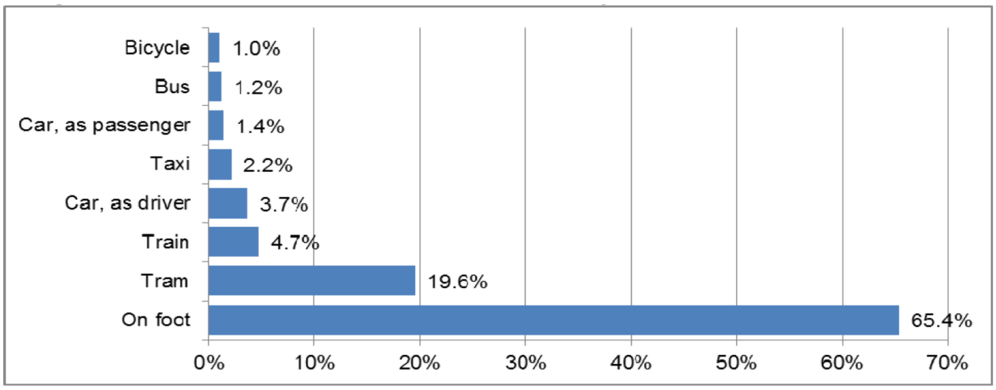


Figure 5.4: Modes of Travel Used to Get Around the City (Melbourne, 2015a).

5.1.2 Collect urban logistics case studies where they already implemented the scheme

Selecting the active UDCs case studies and discuss the potential transferability of these international models of UDC onto Melbourne CBD. The selection of the case studies was conducted in two phases:

- First, a prime selection of UDCs was realised from previous researches (Browne et al., 2005, Panero et al., 2011, Stewart and Halliday, 2010) - on the basis of three fundamental criteria:
  - UDC is currently operational and run permanently
  - UDC has worked since 2000 (post-2000 initiatives). By choosing this criteria, we expect that implemented UDC have integrated the best practices advised by many studies.
  - UDC serves a town centre or a site in the city.

On the basis of the three first criteria, results obtained are as follows

Table 5.1: First selection of operational UDC post-2000 initiatives

UCC	Post-2000 initiatives	Still operational and permanently running	Area serviced
Bluewater, Kent - UK	2002	Yes	Site
Bristol (Broadmead) UCC – UK	2004	Yes	Centre
City of London Micro-Consolidation Centre - UK	2009	Yes	Centre

Emporium Melbourne UCC - Australia	2014	Yes	Site
Evora UCC – Portugal	2000	Yes	Centre
Ferrara - Italy	2002	Yes	Centre
La Rochelle UCC - France	2001	Yes	Centre
London Heathrow Airport (retail) UCC – UK	2000	Yes	Site
London Heathrow Airport (Construction) UCC – UK	2001	Yes	Site
Malaga - Spain	2002	Yes	Centre
Meadowhall Shopping Centre UCC - UK	2003	Yes	Site
Nijmegen UCC - Netherlands	2008	Yes	Centre
Padua UCC – Italy	2004	Yes	Centre
Paris (La Petite Reine) UCC - France	2003	Yes	Centre
Stockholm (centre) UCC – Sweden	2000	Yes	Centre
Vicenza - Italy	2002	Yes	More than city centre

❖ Second, using the selection criteria defined in the methodology:

- The UDCs are not in experimentation phase and are totally operational.
- They operate permanently and are sustainable.
- Data and information are available in English and enable to understand and compare the results obtained (economic, environmental and social aspects).
- The UDCs are managed by private companies or private/public partnership.
- Contextual features of these UDC are compatible with the configuration of Melbourne.
- The type of model/method are available.

Over the 80 UDC studied in the research cited above there are just 29 scheme are still operatinoal, 13 are no longer operational, 14 scheme have no evidence if the scheme proceeded and 24 have no data available. From the operational scheme only 16 fit with the chosen criteria.

By using the selection criteria defined in the methodology, the selected UDC are as follows:

Table 5.2: The selection of the UDC case studies

UCC	Post-2000 initiatives	Operational permanent sustainable	Area serviced	Data and information: available	Operational management	Configuration of area served	Type of Model/Method: available
Bluewater, Kent - UK	2002	Yes	Site	No	Private Owner	Not Available	No
Bristol (Broadmead) UCC – UK	2004	Yes	Centre	Yes	Partnership	Yes	Yes
City of London Micro-Consolidation Centre - UK	**2009**	**Yes**	**Centre**	**Yes**	**Private Owner**	**Yes**	**Yes**
Emporium Melbourne UCC - Australia	2014	Yes	Site	No	??	No	No
Evora UCC – Portugal	2000	Yes	Centre	Yes	Private Owner	Yes	Yes
Ferrara - Italy	2002	Yes	Centre	No	Private Owner	Yes	No
La Rochelle UCC - France	2001	Yes	Centre	Yes	Partnership	Yes	Yes
London Heathrow Airport (retail) UCC – UK	2000	Yes	Site	Yes	Partnership	No	Yes
London Heathrow Airport (Construction) UCC – UK	2001	Yes	Site	Yes	Private Owner	No	No
Malaga - Spain	2002	Yes	Centre	No	Partnership	Yes	No
Meadowhall Shopping Centre UCC - UK	2003	Yes	Site	Yes	Private Owner	Not Available	No
Nijmegen UCC - Netherlands	2008	Yes	Centre	Yes	Partnership	Yes	Yes
Padua UCC – Italy	2004	Yes	Centre	Yes	Partnership	Yes	Yes
Paris (La Petite Reine) UCC - France	**2003**	**Yes**	**Centre**	**Yes**	**Private Owner**	**Yes**	**Yes**
Stockholm (centre) UCC – Sweden	2000	Yes	Centre	Yes, but limited	Partnership	Yes	No
Vicenza - Italy	2002	Yes	More than city centre	No	Partnership	Yes	No

1- Data and information are available in English or in French and are related to economics, environmental and social issues. A UDC which fails to these criteria is eliminated.

2- Operational management: private or public/private partnership

3- Configuration of area served presents some similitude with Melbourne CBD

4- The type of model/method is available.

Over the 16 pre-selected UDC, only eight completely satisfy the the criteria “Availability of data”

- Bristol (Broadmed) UCC – UK
- City of London Micro-Consolidation Centre – UK
- Evora UCC – Portugal
- La Rochelle UCC – France
- London Heathrow Airport (retail) UCC – UK
- Nijemgen UCC – Netherlands
- Padua UCC – Italy
- Paris (La Petite Reine) UCC – France

Even though London Heathrow- Retail (UK) seems an interesting element for a case study, it has not been selected because the area served by the UDC is a single and specific site whereas the other selected UDCs serve a city centre.

In order to narrow the scope and to select two cases that could render lessons for the institutional and policy context of the Melbourne CBD, additional elements were added to our criteria, such as:

- The contextual characteristics of the UDCs exhibited certain similarities to certain locations in Melbourne CBD.
- Policies and regulations required to support the implementation of the UDC are technically transferable.
- The logistic typologies scheme.

Based on the additional criteria, specially the logistic typologies scheme , two UDCs cases that have already been implemented in other countries were examined in further detail in order to discuss their potential applicability to Melbourne CBD, the following cases were selected:

- City of London Micro-Consolidation Centre – UK
- Paris (La Petite Reine) UCC – France

Table 5.3: The final selection of the UDC case studies

UCC	Post-2000 initiatives	Operational permanent sustainable	Area serviced	Data and information: available	Operational management	Configuration of area served	Type of Model/Method: available
City of London UCC - UK	2009	Yes	Centre	Yes	Private Owner	Yes	Yes (Network of transports and environment NTM-method)
Paris (La Petite Reine) UCC - France	2003	Yes	Centre	Yes	Private Owner	Yes	Yes (Business Model)

5.1.3 Place the location of the 2 case studies and the target city on the world map

- **City of London**

Based on the size of population, the City of London is the largest city and serves as the capital city of England as well the United Kingdom. It is located in the south eastern side of Great Britain. This city has extensive are which is approximated to be around 1,579 Km^2 as shown on Figure 5.5. In the entire European Union, London is one of the largest urban centres (Briney, 2017).

In a period of 20 years, the population of London has grown from an estimated figure of 6.7 million to around 7.5 million occupants. By 2015, this figure was projected to rise to over 8 million residents. This city has population which is thinly spread with the population density estimated to be 4,598 people per Km^2 (SEOS, 2017).

Figure 5.5: Britain maps, showing location of London (TUBS, 2011).

The economy profiles

London is characterized by a wide range of economic activities which include financial services and provision of international professional services that have contributed greatly to the UK Kingdom success. (THECITYUK, 2016). In accordance with Brookings Institution, London is ranked in the fifth position as a City that has the largest economy in the whole world (Florida, 2015).

22% of the UK's GDP is said to be generated by London. At the beginning of 2013, the number of private sector businesses in London was approximated to around 841,000 which is a figure that is greater than in any other country or region in the world. In all these private businesses, 15% were from the construction sector while 18% comprised of scientific, technical and professional activities. Moreover, majority of these businesses were medium-sized and small enterprises (Economics, 2011).

Transportation

London is characterized by an extensive transportation network that consists of both public and private services. Twenty five per cent of journeys that take place in London are made via public transport systems while 41% of these journeys come from the private services. The public transport network infrastructure of London makes it to serve as a central hub for the UK in air, road and rail transport (London, 2009).

The transport system in London uses a single electronic ticketing system through the Oyster card which is operated by Transport for London. In 2012 when the City hosted world Olympics competitions, the London's city network was crucial in promoting transport. This included uses of London River Services, London Buses, Docklands Light Railway, London Overground and London Underground. London is connected to other cities such as Brussels and Paris through the use of high-speed Eurostar and a ring of eighteen railway stations. There are ongoing initiatives which are aimed at expanding and upgrading networks lines around London under a programme referred to as Thameslink (London, 2013).

Travel demand

Based on measurement of journey stages, demand of London's total travel was observed to grow by 0.8% by the year 2014 while maintaining an impressive and consistent progressive pattern dating back to 1990s. In 2015, it was established that public transport contributed to about 45% of journey stages that were made in London as compared to 32% that resulted from the private transport. This has led to consistent and persistent upward trend which has made London to move away from private transport towards more of public transport modes. Since 2000, there has been 11.1% increase in the total shares of the public mode. In accordance with recent statistics, there was a further increase of about 0.2% in the public transport mode, while a 0.4% decrease was detected in the private. Walking and cycling mode shares remained at 21% and 2% respectively (London, 2016).

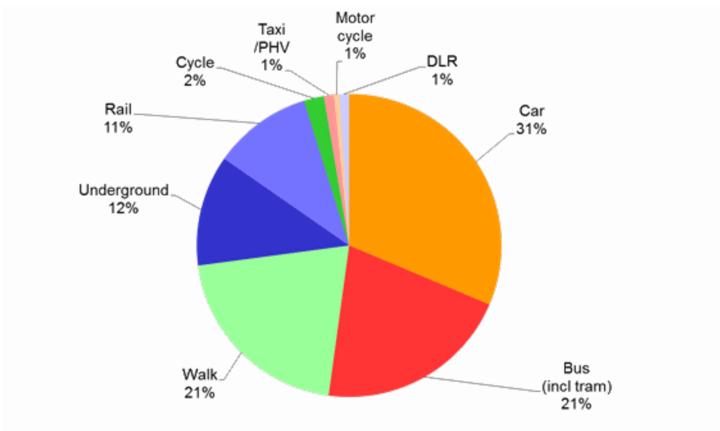


Figure 5.6: Modal shares of daily journey stages in London, 2015 (London, 2016).

- **Paris (La Petite Reine)**

Paris is France's capital city and has the highest population as compared to other cities in France. It is approximated to have an administrative area that has a total of about 105Km2 and based on 2015 census statistics, the size of population is expected to be 2,229,621. Paris is a department and commune as well as the capital-heart of the Île-de-France region which is in a colloquial language known as "Paris Region" with an estimated size 12,012 Km2 and a population of about 12,142,802 based on 2016 census statistics. The City of Paris contributes to about 18% of the country's total population. During the seventeenth century, Paris was one of Europe's greatest hub for fashion, commerce, science, arts and finance activities. Since then, Paris has been able to retain this position up to date. In 2014, the GDP of Paris region was estimated to be around €649.6 billion (US $763.4 billion) which accounted for 30.4% of France total GDP. In accordance with estimates between 2013 and 2014, the Paris Region ranked third in GDP size ranking globally while it was in position one in EU (INSEE, 2016).

Figure 5.7: France maps, showing location of Paris (Commons, 2011).

Economy of Paris

In France, the city of Paris is considered as the most important centre of economic activity which accounts for about 30% of the France's total GDP. Commerce and services are the main contributor of the economy of City of Paris. It is estimated to host more than 390,500 enterprise where 80.6% of them engages in commercial activities, diverse services and transportation as well as 3.8% in industry and 6.5% in construction (MMF, 2015).

Transportation in Paris

On the basis of geographical speed, tariffs, upkeep and spread, public transport system in an round Paris in one of the best in any of Europe's city. Paris is characterized by a criss-crossed public transportation infrastructure which consists of subways, buses , trams and rail which are all grouped under one authority referred as RATP. In order to ease traffic congestions, use of automobiles has been discouraged greatly and this has contributed hugely to improvements of the public transport. Despite all these efforts, congestion is widespread and traffic still remains high (Blake Ehrlich, 2017).

Figure 5.8, depicts the location of the case studies with the target city (Melbourne) for transferability.

Figure 5.8: The case studies location on the world map

5.1.4 Diagnostic the main freight problems for the case studies and Melbourne city

- **Melbourne**

Melbourne's strong population growth is predicted to continue, bringing with it increased congestion on the arterial road network. Increased traffic congestion has the potential to cause delays and frustration for commuters and limit accessibility for all road users. Works are underway to tackle the issue of traffic congestion (VicRoads, 2015).

Melbourne typifies some of the most common characteristics of urban freight in Australian cities with more than four million inhabitants, freight has a very important traffic impact and the first motivation to create solutions is to decrease this impact. Furthermore, Melbourne CBD serves as a major hub for shipping and retail activities which has more than 10,000 freight vehicles carrying out delivery services within the city. There is an additional of 20,000 more freight vehicles which pass through the CBD and an extra figure of more than 5000 businesses and retailers tasked with making frequent small deliveries (Melbourne, 2015b).

In order to reduce the negative impacts associated with freight movement within this region, Melbourne CBD has opted for some operational measures. However, it is worth noting that problems caused by the freight vehicles are not only restricted to the huge number of vehicles which are collecting and delivering goods on a daily basis. The main problems that have been identified related to the freight movement in Melbourne CBD and other factors create challenges for deliveries can be summarized as follows: (a) the increase of number of trucks in CBD due to the number of rips; (b) movement of freight vehicles and other vehicles conflict; (c) an inadequacy of loading/unloading zones and parking spaces; (d) Loss of street space and project communication (Melbourne's, 2015b).

Various problems will increase in the future, particularly those concerned with rising vehicular and people congestion, and the problems associated with the limited number of spaces for loading, unloading and parking.

- **City of London**

The main problems concerning freight transport are as follows (London, 2007):

(a) Number of delivery trips (particularly during peak periods).

(b) Number of freight vehicle which increase the congestion and air pollutions (CO_2 emissions).

(c) Conflict and collisions between the movement of freight vehicles and cyclists.

(d) Freight fly-tipping incidents.

(e) Vibration and Noise which are as a result of servicing and freight transport.

(f) Capping the driving hours of delivery vehicles carrying more than 3.5 tonnes, and unavailability of places where the drivers can legally stop to take some rest.

The major freight problems and barriers are the time window constraints due to the schedules, and size and width vehicle circulation constraints due to freight restrictions.

- **Paris (La Petite Reine)**

The major urban problems and obstacles that have impacts on the freight system are (Dablanc and Beziat, 2015, Panero et al., 2011):

(a) Parking during operations of deliveries and pick-ups of goods is highly problematic.

(b) Illegal parking.

(c) Problems of road safety (for the delivery driver as well as for the other users).

(d) High levels of congestion and air pollutions.

In general, all these problems affect urban freight distribution and loading/unloading operations, thus increasing transport costs.

The major urban freight problems and obstacles that city of Melbourne has faced and is currently facing, which have impacts on the freight system have been diagnostic, then a comparison between Melbourne, London and Paris has been conducted to find which city has the same freight problems with Melbourne. Table 5.4 shows the main freight problems for the selected case studies and the target cit.

Table 5.4: The main freight problems for the selected case studies and the target city

Fright problems in Melbourne CBD	London	Paris
Lack of distribution centres		
Number of trucks in CBD due to the number of trips	√	√
Size of trucks in CBD	√	√
Congestion	√	√
Noise and air pollutions (GHG emissions) caused by freight and servicing.	√	√
Unavailability of areas for parking and loading	√	√
freight vehicles-other vehicles movement conflict	√	√

Night deliveries constraints due to the noise	√	√
Loading and unloading parking places illegally occupied and lack of enforcement	√	√
Narrow lanes and streets (Amount of through-traffic using inappropriate roads)	√	√
Safety issues (accidents, spillages or wastes)	√	√
Parking time (short time window)	√	√
Access to pedestrian streets	√	√
Unavailability of spaces in the street where drivers can park their vehicles as they make deliveries		√
Unavailbility of pull over spaces which can be used when making deliveries		√
Loss of street space and project communication		
Poor communication and lack of coordination when carrying out constrcution projects		
Time window constraints due to the drivers schedules	√	
Constraints to the circulation of larger and longer vehicles due to freight regulations	√	

From table 5.4, the freight problems for Melbourne, London and Paris are nearly similar. So, its very hard to choose which city is more applicable with Melbourne.

5.1.5 Find the transferability attributes

After making a consideration on wanting to implement a UDC in a specific area of a city, it is highly recommended that you choose the most relevant and suitable solutions. Based on this paper, it has been suggested that a transferability of attributes can be considered by finding the best fit between specificities of the given area and the proposed solution (London and Paris) and (Melbourne). Table 5.5 presents these attributes by drawing a comparison between target area market segments and new targets after carrying out the initiative. There is a further comparison of the original environment's characteristics and target environment's characteristics after implementation of the initiative.

Table 5.5 shows the relevant market segments for each case studies that have been analysed. The majority of goods flows in London micro-consolidation initiatives are office supplies and the micro-consolidation initiatives in Paris target the following segments: non-food products, flowers, food products, parts and equipment. Home delivery, express service and courier services.

In regard to the micro-consolidation initiative and its sustainability in London and Paris, its structure to analyse the case studies characteristics based on the characteristics of the UDC space, the type of vehicle used and the operation management of the case study.

Based on the transferability attributes analysis, the suitability attributes for London and Paris initiatives are the same and the relevant market segments for Paris initiative are conformable with the market segment of Melbourne regarding the study objective. By analysing two UDC experiences for their potential transferability to the Melbourne context, we found that certain business model (which applied in the city of Paris) would likely work best in the city of Melbourne than another model.

Table 5.5: The transferability attributes

Transferability Attributes	**Relevance**	**Suitability**											
	Market Segments	UDC Space						Vehicles	Management of operations				
Case Study	**Type of Products**	**Type of the UDC**	**Size of the UDC**	**Location of the UDC**	**Attended/ unattended**	**Number of UDC**	**Upstream/Downstream accessibility of the UDC**	**Type of vehicles**	**Attended/ unattended delivery**	**Management of operations**	**Possibility of off-hours delivery to the ULS**	**Possibility of off-hours delivery from the UDC**	**Number of parties involved**
London	Office supplies	Micro-consolidation centre	Large	In central London, near to the Tower of London	Attended	One	High	Electric vehicles	Attended	Private	Yes	No	One
Paris	Food products, flowers, non-food products and equipment and parts, Home delivery, express service, Courier services	Micro-consolidation centre	Large	Underground parking facilities in city centre	Attended	Two	High	Electric vehicles	Attended	Private	Yes	No	One

5.1.6 Propose the typology to be implemented

Regarding to the transferability attributes analysis, we found that certain consolidation centre which applied in city of Paris (La Petite Reine) would likely work best in city of Melbourne.

Micro-consolidation centre is the urban topology that was applied in Paris (La Petite Reine). This topology seems to exhibit similarity with the scheme that was used by classical urban consolidation centre. Rationalized rounds were made through a combination of a fleet that consisted of non-polluting vehicles and bundling of goods. However, there exist a close set up between the delivery area and micro-consolidation centres which seems to have more of limited spatial range. This has a direct conditioning with a wide range of vehicles that are used at the last part of delivery process. Some of these vehicles include cargo-cycles and assisted trolleys which ran on electricity. A suburban depot is the usual place where bundling of goods is done and this is followed by a consolidated transport where which is headed towards the micro-consolidation centre. Chronopost and La Petite Reine in Paris are good examples (Janjevic et al., 2013). Figure 5.9 depicts a scenario which shows how this type of a device is used.

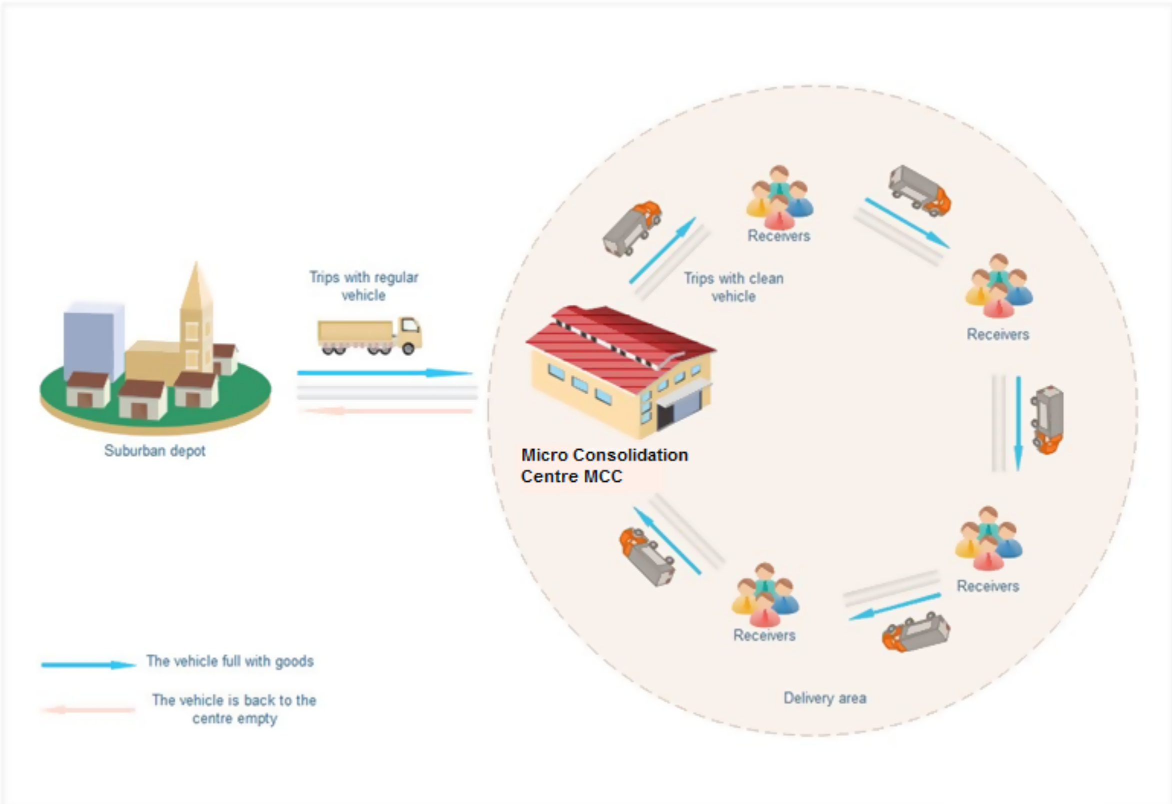


Figure 5.9: Logistic typology of micro-consolidation scheme

Due to the distance between areas in Melbourne being far away, the proposed typology is combining UCC and MCC; which will use a suburban depot to be able to bundle the goods and consolidate the deliveries towards several micro consolidation centres into a single urban consolidation centre and then the deliveries are consolidated and moved from the micro consolidation centre to the receivers. The aims of this typology are to decrease the total number of trips that are made by vehicles in the area of delivery, save the time and effort by consolidating the deliveries into several micro consolidations centre, and decreasing the number of necessary trips which are required delivery process by ensuring there is an increase of bundled goods. Figure 5.10 depicts how this kind of proposed device functions.

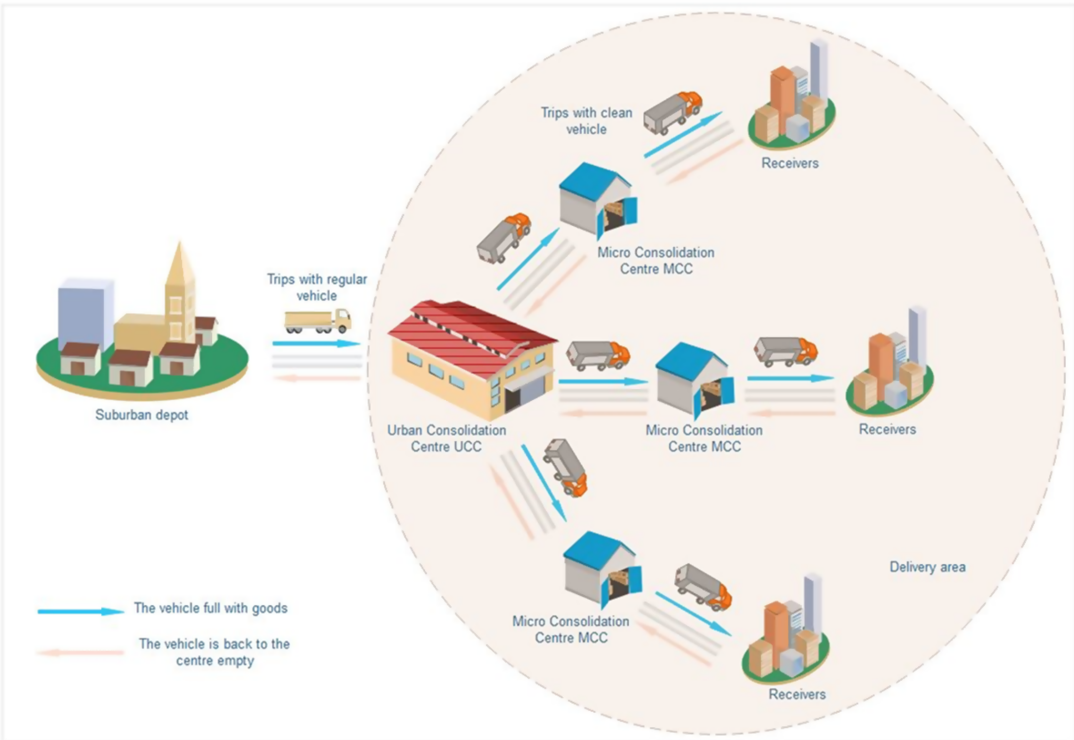


Figure 5.10: City logistic typology proposed to be implemented

5.1.7 Build the business model for the city of Melbourne

Initiatives which are aimed at improving city logistics applies business models which happen to one of the key role players. Absence of these business models would translate to into many barriers towards implementation of those initiatives successfully (Björklund et al., 2017). Regardless of these initiatives possessing a huge potential in fitting with needs of the stakeholders as well as forming long-term economic feasibility, most of them are greatly focused on technical solutions (Quak et al., 2014, De Marco et al., 2017).

City of Melbourne logistics initiatives which represented UCC were target in order to a our sample in this study. These logistics help in decoupling long-distance transport by use of last-mile transport and large trucks within the urban areas which has vehicles that are already designed to perform public transport.

Chapter six will describe in detail how to develop a business case model framework for urban consolidation centre that considers the sustainability aspect, particularly its applicability to Melbourne context.

5.1.8 The principle of the proposed distribution centres for the city of Melbourne

Figure 5.11 describes the principle of the proposed distribution centres of the city of Melbourne. The functioning of this device is:

- Bundling the goods from various suppliers, using a fleet of non-polluting vehicles, and s the goods are transported to the UCC.
- After receiving the goods from suppliers to the UCC, the goods go through a sortation system to consolidate the deliveries towards several MCC.
- The UCC has a tracking system, it's digitally connected system with the MCC which virtually track, collect and transmit information to ensure a smooth delivery flow.
- When the delivery arrives at destination lot (MCC), its ready to unload the goods.
- The customers can place their orders using the distribution centre website, and the order will transfer directly to the closest MCC.
- When the MCC receives the order, the goods will be dispatched, packed and put away in the temporary storage until delivered.
- When it is time to deliver, the goods will be picked, uploaded to the delivery vehicle and then delivered to the customer/shop.
- Finishing the delivery documents and send it to the customer online.
- The customer will receive their order on time, and then signed that they received the order.

The implementation of the proposed distribution centres has a number of advantages which are:

- Reduction of traffic congestion, noise and pollution in the urban areas by reducing the area covered when transporting parcel from one area to another. This is also achieved by carbon free energy sources such as electric vehicles which contain rechargeable batteries.
- Reduced negative impacts which result from freight and servicing on communities leading to improved liveability of the urban areas.
- Deliveries of a large are collected from a unique point of the UCC to the MCC which leads to times saving and a substantial decrease of distance covered during the delivery process.
- The number of journeys that need to be made when performing deliveries has decreased hugely as a result of increased number of load factors.
- Increase in the offered services (storage and solid recyclable wastes), the UDC helps the company to achieve its goals regarding circular economy, by managing the goods returning from the delivery operation (unused goods or waste). , .

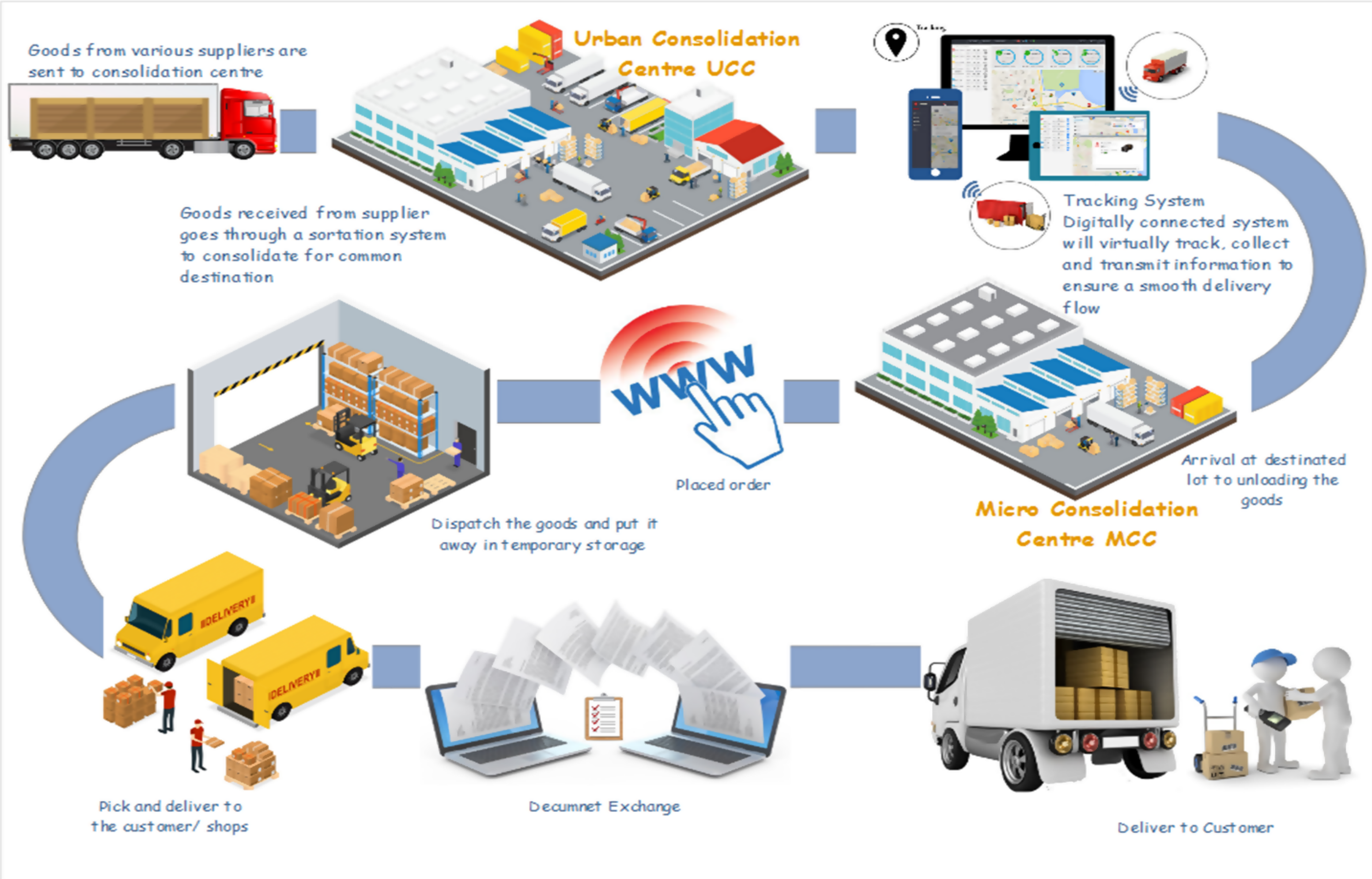


Figure 5.11: The proposed distribution centers principle

5.1.9 Identify the distribution centres location on the map

In order to achieve a supply chain which is efficient, location decisions are established to be very crucial. There exist a lot of methods which can be used when locating a facility. One of this method is Centre of Gravity (COG) which can be used to locate a single facility (Onnela, 2015). This method was applied in finding out UDC location coordinates which could be used by the local government area within the Greater Melbourne on the basis of export and import volumes. COG utilized the formula which is below:

$$y^* = \frac{\sum_i v_i y_i}{\sum_i v_i} \qquad (A)$$

$$x^* = \frac{\sum_i v_i x_i}{\sum_i v_i} \qquad (B)$$

Where:

y^*= optimal location's longitude coordinate

x^*= optimal location's longitude coordinate

v_i= export and import volumes of each location

y_i= load point's y coordinate

x_i= load point's x coordinate

In order to make the use of that method possible, a conversion of destination addresses into longitude and latitude was necessary. Longitude and latitude minutes were converted from radians to degrees. This was achieved by use of a special converter that required cities together with postal code to fed into it. Coordinates were generated by the converter which were then transferred to an excel table alongside their corresponding volume. After determination of all coordinate degrees for all destination locations, with the coordinates, calculation of two-way dimension of COG was made possible. This is achieved as shown below:

Every volume was multiplied with Y. The results obtained from this multiplications were added together and the sum was divided by the total volume. This was also made for X value. Table 5.6 shows City of Moreland as an example of how to calculate the COG (Y, X coordinates) based on the import volume.

For example (City of Moreland) : $\boldsymbol{COG\ (Y\ coordinate)} = \frac{\sum \boldsymbol{Y \times Import}}{\sum \boldsymbol{Import}} = \frac{\mathbf{86{,}430.81}}{\mathbf{2291.130}}$ = ***37.74264046***

Table 5.6: Centre of Gravity (COG) Import (Y, X Coordinate)

Local Government Area	Coordinates		2015/2016		Y × Import	X × Import	Centre of Gravity (COG) Import (Y Coordinate)	Centre of Gravity (COG) Import (X Coordinate)
	Y (° S)	X (° E)	Import ($M)	Export ($M)				
City of Moreland	**37.7241**	**144.9502**	**2291.130**	**1855.809**	**86,430.81**	**332,099.70**		
Brunswick	37.7667	144.9628	716.249	510.752	27,050.36	103,829.44	**37.74264046**	**144.95975**
Brunswick East	37.776	144.974	167.902	152.794	6,342.66	24,341.39		
Brunswick West	37.761	144.943	45.338	45.296	1,712.02	6,571.48		
Coburg	37.7438	144.9645	331.106	248.882	12,497.21	47,998.65		
Coburg North	37.726	144.96	507.869	374.442	19,159.88	73,620.73		
Fawkner	37.707	144.968	237.407	267.049	8,951.90	34,416.40		
Fitzroy North	37.784	144.986			0.00	0.00		
Glenroy	37.706	144.924	128.051	115.111	4,828.30	18,557.70		
Gowanbrae	37.702	144.899	3.679	4.180	138.70	533.05		
Hadfield	37.71	144.95	22.645	18.108	853.93	3,282.34		
Oak Park	37.718	144.919			0.00	0.00		
Pascoe Vale	37.727	144.942	100.451	92.957	3,789.71	14,559.55		
Pascoe Vale South	37.7431	144.9377	30.433	26.239	1,148.63	4,410.86		
Tullamarine	37.701	144.876			0.00	0.00		
			2291.130	**1855.809**	**86473.284**	**332121.585**		

Due to the unavailability of the data of import and export for some of the local government area we used the Major Industrial and Commercial Precincts/Infrastructure map from https://economy.id.com.au to pick the optimal location for the distribution centres. Figure 5.12 shows an example City of Whittlesea.

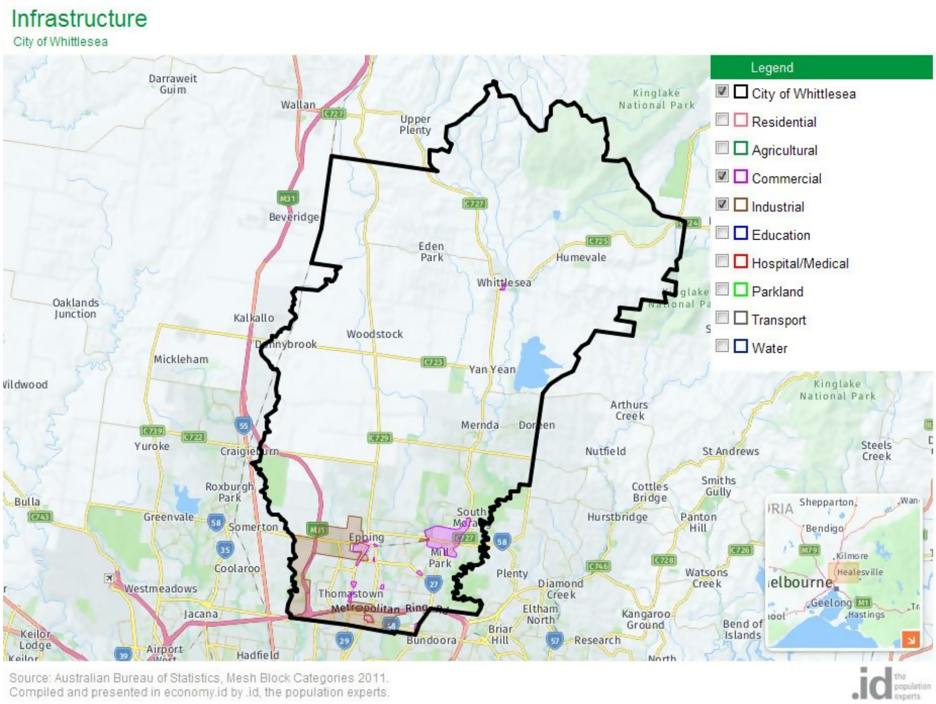


Figure 5.12: Major industrial and commercial precincts in City of Whittlesea

The result, the centre of gravity, then was a point somewhere in the map. Figure 5.13 represents these points on the map.

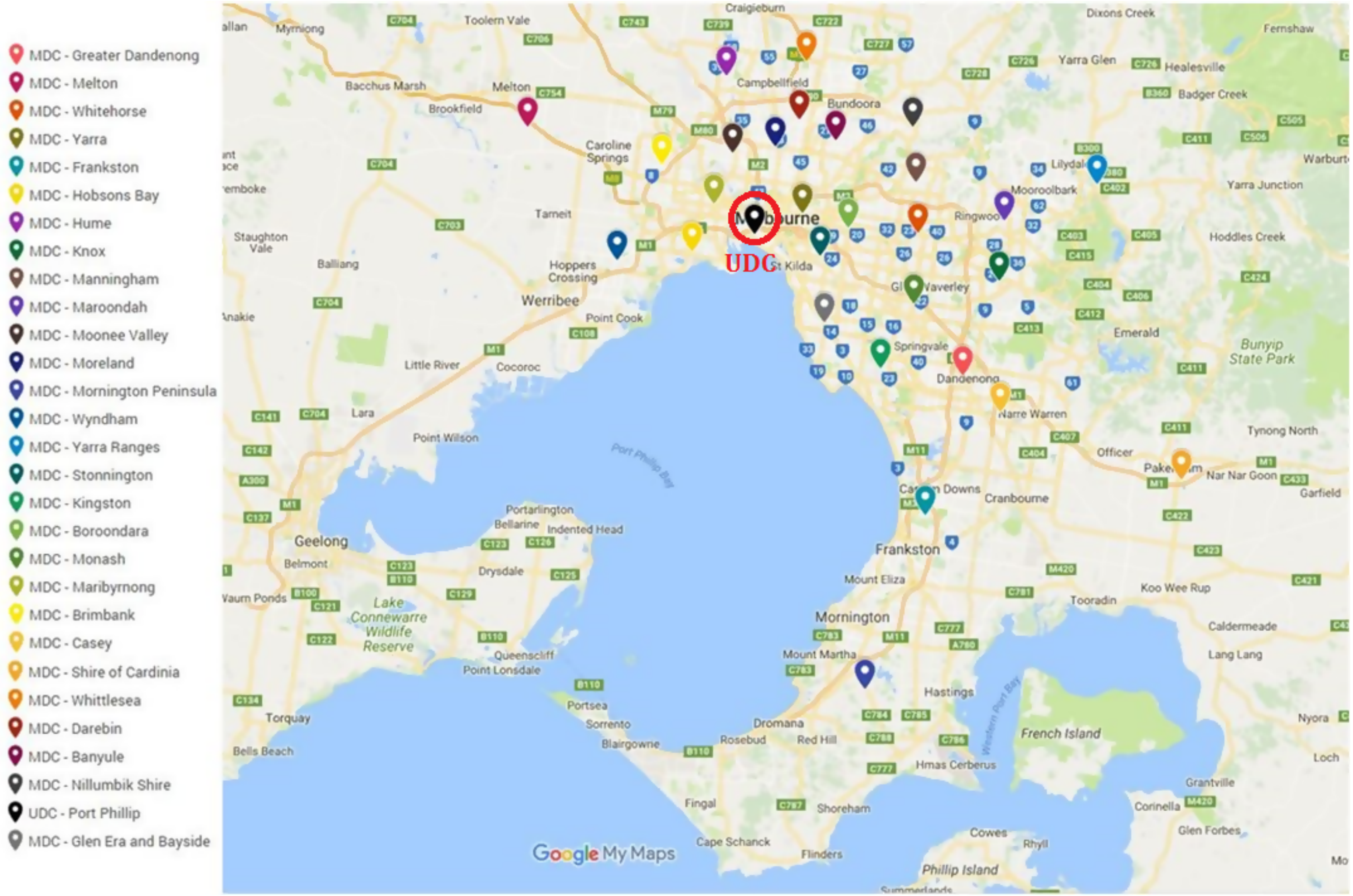


Figure 5.13: The optimal locations of the distribution centers

CHAPTER 6

Business Model

This chapter brings forward a business model framework for urban distribution centre, that considers the sustainability aspects, particularly it's applicability to Melbourne context, Which aims to:

a. Decrease the negative impacts which are associated with freight transport within the city centre.

b. A business model which is based on sustainability.

c. Boost commitment of all actors involved by offering incentives

6.1 Business Model Concept and Definition

A business model is referred as a conceptual toll which helps us understand how a firm is able to do its business. It is used in conducting comparison, communication, innovation, management, analysis and assessment of performance (Osterwalder et al., 2005). The concept applied in a business model has been characterized by a variety of fields of application which are promising and can be used in modern business practice. There has been increased attention towards research of on business models from both the scientific and academic world (Zott et al., 2010). This move can be attributed to the increased shift from traditional towards internet-based business activities. The terminology of the business model does not have a generally accepted consensus (Zott et al., 2010, Burkhart et al., 2011). As a result of the different definitions, there has been complications which delimits the components and nature of a model (Morris et al., 2005). Furthermore, the business model can be referred to as method, pattern, assumption, architecture, design, statement and plan (Morris et al., 2005, Zott et al., 2010).

Besides the fact that there has been a growing interest from researchers about recent business models, lack of agreement on widely and commonly accepted terms becomes a major hinderance in the progress of this research concept wise (Zott et al., 2010). The literature which is available has been fragmented largely in accordance with different researchers areas of interest (Zott et al., 2010). In accordance with Zott, there has been identification of three main areas of interest which include: Application of IT in e-commerce and organizations., strategic issues (company performance, value creation and competitive advantage), and innovation and technology management.

According to Zott et al. (2010), this theory is being surrounded by some emerging themes. Some of these are; in addition to products, network levels or companies, a business model is considered as a new unit of analysis. Secondly, there is a system-wide approach which is comprehensive and it is used in offering an explanation of how a business is running. Thirdly, organizational activities have been established to play an important role in the definition of many business models. Business models have their main objective being to both value capture and value creation.

There is a variety of perspectives which have been presented by business models. In accordance with Beattie and Smith (2013) and Zott et al. (2010) business models have been defined using a holistic description of how an organization does its business Teece (2010) . It has also been noted that the concept of a business model lacks theoretical foundation in business academics and economics. According to Teece (2010), a business model was described to be define how an enterprise is able to create value which is then delivered to its customers and also how the payment received are converted into profits. It is considered to be nothing less than the financial and organizational architecture of a business and it comprises of many assumptions about customers together with their needs, behavior of costs, reveenue and competitors (Teece, 2010). Osterwalder et al. (2010) and Osterwalder et al. (2005) shares a similar opinion and ideas in defining a business model. They denoted that a business model offers a description of the rational of how an organization is able to create, deliver as well as capture value. According to them, business model is described to consist of a series of elements. Some of these include:

- Customer interface- Comprises of customer relationships, segments and channels
- Value proposition- Consists of service offering and product.
- Infrastructure management- Consists of Key partners, activities and resources.
- Financial aspect- Comprise of revenue model and cost structure

Moreover, Coes (2014) states that there are a gap and inconsistency between business model literature and practice. In order to fil this gap, practitioners and academics have been engaging in discussion of the necessary business model components and how related tools can be created (Coes, 2014).

Osterwalder et al. (2010) created a Business Model Canvas (BMC) that aimed at filling out the gap that surrounding business model practice and theory as well as offer improvement of analysing it concept which facilitates a discussion of how to construct a standardized framework. BMC is described as an ontology of a business model which is characterized by quintessential business parts that form a business model into components, vocabulary, meanings and relationships as noted by Zott et al. (2010). In addition to offering a description of a business model, BMC aims at providing practitioners with a tool of which could them in business model design process. (Osterwalder et al., 2010). In accordance with Osterwalder et al. (2010), four areas are covered by the framework which are; offers, financial aspects, customers and infrastructure. Nine building blocks are used in representation of these four areas and they together contribute to the creation of a BMC (Osterwalder et al., 2010). BMC being one of the standardized framework that has been widely used in creating a business model, this study aims at utilizing a framework which is suitable for a service which can be used in urban distribution centre. The subsequent section will provide details of the nine building blocks which when combined together form a BMC.

6.2 The Business Model Canvas BMC

Based on the Osterwalder et al. (2010) business model definition, the value proposition becomes the focal point of the nine blocks, as support is provided by other blocks and deliver this value (Osterwalder et al., 2010). Customer relationships, segments, key partnerships and channels customer work together to form a network of business partners for the company (Osterwalder et al., 2010). Key activities and resources are the company's infrastructure which is essential in capturing and delivering value while on the other hand revenue streams and cost structure are being used in representation of financial aspects (Osterwalder et al., 2010). It is worth noting that building blocks are not intended to be focused on separately but the relationship as well as mechanics between them play an essential role in bringing the actual model to life and fruition (Osterwalder et al., 2010). Figure 6.1 shows the nine core infrastructure contributions and BMC.

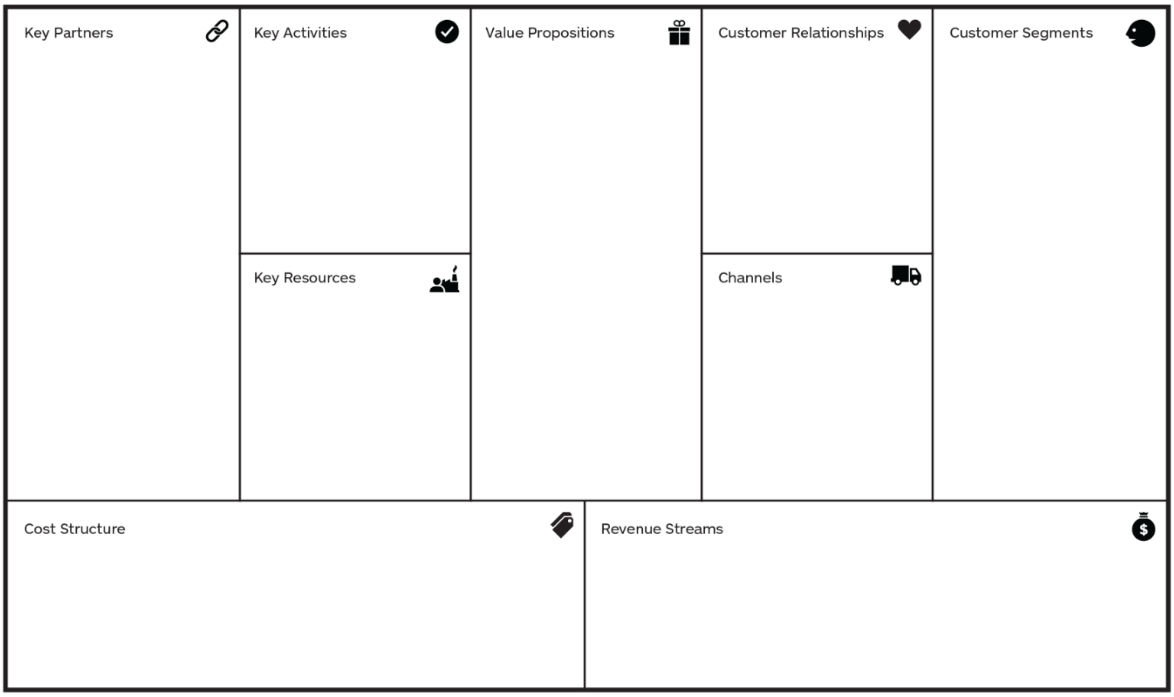


Figure 6.1: Business Model Canvas (Osterwalder et al., 2010)

Customer segments: This is a representation of the different organizations or groups of people which are the target market for the company's services or products. In order to improve the customer satisfaction, these groups should be divided according to their common needs, behaviours, and identify the target segment. The business model is fully designed accordingly to understand what the customer needs (Osterwalder et al., 2010).

Value proposition: the value proposition is the centre of the canvas. It is designed to serve customers by offering products or service that creates value for a specific customer segment. If the value proposition fails to meet the customer needs and to solve their problems, then the company's business model cannot survive for long (Osterwalder et al., 2010).

Channels: it's describing how a company reaches and communicates with the customer segment to deliver their value proposition. Therefore, channels are connecting the value proposition with the customer segments through serving several functions such as; adjust the way of communications, sales and distribution strategy to create good customer awareness about the company services and products (Osterwalder et al., 2010).

Customer Relationships: this block also links the value proposition and customer segments together, by clarifying the type of relationships between the company and their customers. The aims of this relationship are to sell more products or services and to increase the number of customers by improving the customer loyalty and their satisfaction (Osterwalder et al., 2010).

Revenue Streams: This is a representation of the profit that the company earned from the customer segments by delivering the value propositions to customers. In this block the pricing method must be chosen, however in order to increase the revenue to the maximum the company must know how much the customer is willing to pay to deliver the provided value (Osterwalder et al., 2010).

Key Resources: The key resources are required and important to make any business model work. And it is important and necessary to create and offer a value proposition, communicate market segments, improve the relationships with Customers, and earn revenues. Resources are different based on businesses and it could be financial, physical, human, or intellectual and they are owned either by provided key partners or leased by the company (Osterwalder et al., 2010).

Key Activities: Like Key Resources, it is one of the most important things a company must do to make any business model work. It can be categorised as production, platform/network or problem solving (Osterwalder et al., 2010).

Key Partnerships: This block describes the network and relationships between the suppliers and partners which make the business model operable. This network may reduce the risk and cost or resources which are hard to obtain (Osterwalder et al., 2010).

Cost Structure: It offers a description of all costs which are needed in order to operate a business model. These costs structure are mostly characterized depending on the business model as cost-driven (focuses on minimizing costs), value-driven (concentrates on maximizing value creation), fixed costs and variable costs (Osterwalder et al., 2010).

It is worth noting that each framework or tool has got its own shortcomings and limitations and we should always look for ways of improving them. This is also applicable to the BMC. It is subject to criticism from both researchers and academicians. In order to establish the suitability of using BMC in research works, the subsequent sections will provide a more description about the suitability aspect.

6.3 Criticism on the Business Model Canvas

Business model canvas, BMC, has been used more rapidly by companies which has been possible by the praise it has received for its simplicity of application. However, this feature of simplicity also comes with its disadvantages (Vliet, 2017). During application and experience with BMC, Kraaijenbrink (2012) pointed out in the business model innovation hub, that the BMC is similar to other tools and hence it got its own shortcomings and limitations and we should always devise mechanisms which lead to improvements of the tool. Also, Kraaijenbrink (2012) mentions three shortcomings which are not only limited to the canvas but also in the whole notion of a business model. These shortcomings are:

1. The business model canvas involves an exclusion of a strategic purpose of an organisation.
2. It involves an exclusion of competition notions.
3. And it mixes level of abstraction (Kraaijenbrink, 2012).

Based on (Coes, 2014) theoretical investigation, the BMC internally is focusing on what the firm's offer is, and what is necessary to do to deliver what they offer to their customers. In that stage, some external factors are missing in a business tool such as, competition and market forces, which stand up to face the harmful from outside of the company (Coes, 2014). Secondly, the BMC is designed to be suitable for the profit organization to earn revenues, and it has excluded the environmental, social values and the non-profit one. This is one of the vital, crucial and major limitation in business model (Coes, 2014). Finally, there exist confusions which affects understanding and explanation of the role played by some of the key resources, activities, customer relationships and channels. So all these confusions account for the differences which are experienced between building blocks (Coes, 2014).

Joyce and Paquin (2016) note that the BMC is developed to help users gain profit and the main purpose is to support the profit organizations to be included in its framework, however, environmental and social values implicitly de-emphasized behind the canvas's more explicit by its economic value and profit-making capture objectives. Hence, developing a business model which is sustainable requires a framework which is different and experts to work together to support this orientation which integrate the environmental, economic, and social value into its structure (Joyce and Paquin, 2016).

6.4 The Business Model for Urban Distribution Centre to The City of Melbourne

Osterwalder et al. (2010) came up with a model that could be applied and be used successfully in large firms. In accordance with TURBLOG (2011), the logic behind this methodology is to apply the nine building blocks in order to describe and develop a business model that will help to account and address the organizational settings differences.

As mentioned before, most of business models the business model uses frameworks which are profit-oriented. On the other hand in urban logistics, policies are designed by cities with an aim of reducing negative environmental impacts. This is achieved through reduction of trips made by freight vehicles hence reducing pollution and noise. Other impacts which are part of the aim are improvement of social impacts which include enhancement of the quality of life, working conditions as well as reducing congestion and accidents (TURBLOG, 2011).

There are several negative impacts which are associated with Urban freight transport and affects the society and environment in an adverse way. Hence, there have been more solutions which have recommended in regard to urban freight transport. As mentioned earlier, the city of Melbourne is also seeking to improve this area. The main advantage of the urban distribution centre is to reduce the negative impacts and not just focus on profit. Consequently, the BMC standard was adapted to urban logistics and presented by TURBLOG (2011),

The potential business model for the urban distribution centre in Melbourne city is created by use of information which is collected about the model's blocks. The proposed model was adapted to include a 11th building block to cover the results, which summarizes the main objectives that must be achieved from creating the business model, which aims to solve the freight transport problems. Figure 6.3 gives a summary of all basic blocks which contributed to the framework of the model.

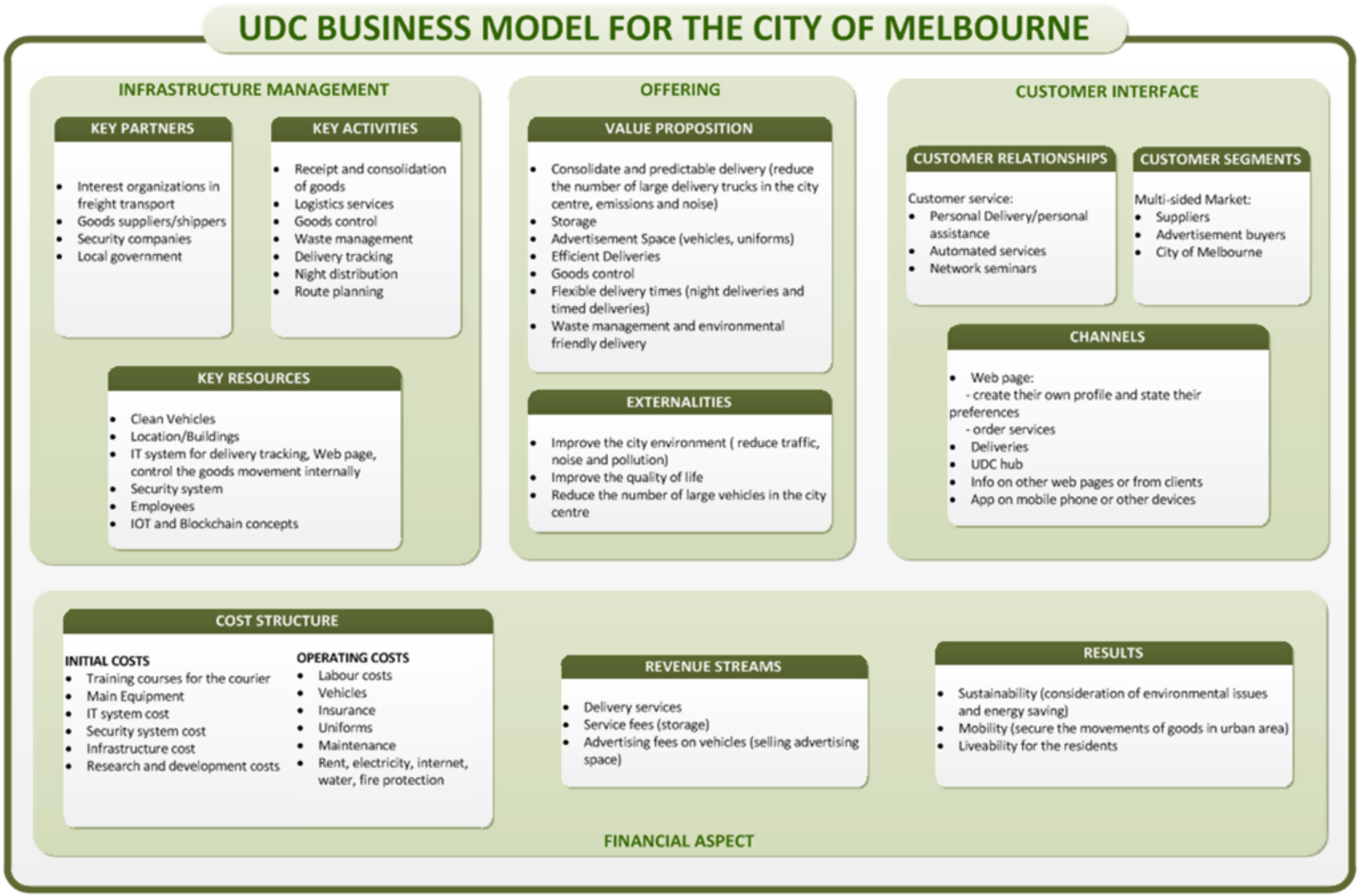


Figure 6.2: Urban distribution center business mode

The following paragraphs describe in detail the basic blocks of the modified business model as presented in figure 6.3:

Customer segments: This represents the first building block of a BMC which is usually related to the identification of the different kinds of demographics or businesses which will be the target market for the company. Since the urban distribution centre offers transportation and consolidation of goods, its value proposition targets various segments of the customers. A customer includes any retailer or freight forwarder who is in need of transport services. Furthermore, another unique relationship which characterizes a business model is that depending on how investment of a service is arranged, key partners of the urban freight transport also forms part of the potential customers (Horvath and Wu, 2017). Additionally, if this service is supported by Melbourne in various ways, it can also become a direct customer of the service. The customer segment types that is considered in the model are:

- ❖ Multi-sided market such as:
  - Suppliers
    Suppliers can be either the shipper or the carrier who prefer not entering the city during the peak hours and dropping off goods at the UDC at their convenience.
  - Advertisement buyers
    Any company which needs to advertise its product and it has a limited budget it can use the UDC vehicles and print the advertisement on it for a services fee.
  - Melbourne City
    The Melbourne City is interested in getting a liveable city where the urban freight transport impacts as less as possible for the attractiveness of the city centre.

Value proposition and Externalities: This helps a firm to be able to know problems which are being experienced by customers and how also check whether the needs of the customers have been met. This is a representation of a bundle of services and products which are tasked with creation of value for a segment of customers (De Marco et al., 2017). Value propositions are important in helping in the whole process which is undertaken to solve problems face by customers as well as ensuring that their needs have been fulfilled. The purpose of creating this model is to solve problems which are associated with freight distribution. The main benefits associated with this business model within the city has been established as creation of freight transportation mode which is cleaner and has less negative impacts to the environment of the city. Moreover, this service also brings marketing and commercial benefits to customers residing in the city (Horvath and Wu, 2017). Based on that, the element that considered that can contribute to the value creation are:

- Consolidate and predictable deliveries
  Reduction of large delivery trucks in the city centre, reduced traffic congestion, limited emissions and noise.
- Storage
  By providing storage services in UDC and consequently, suppliers who don't have a warehouse to store temporary goods can use the UDC as storage.
- Advertisement Space
  Any company which needs to advirtise their product and they have a limited budget they can use the UDC vehicles and uniforms to print the advertisement on it.
- Efficient Deliveries
  Through processes like quality checks, traceability of the delivery notes by automation.
- Goods control
  It is necessary to manage the goods inventory of the UDC with the suppliers in order to meet with the demand from from the customers.
- Flexible delivery times (night deliveries and timed deliveries)
  The suppliers not located closely to the city centre might not want to enter the city in the peak hour in the morning and prefer delivering another time at their convenience. If necessary, the UDC will be able to offer its services also during night and holidays.
- Waste management and environmentally friendly delivery
  The use of the UDC helps to decrease CO_2 emissions and contributes to the more efficient circular economy, by using clean vehicles and through a better management of the waste or unused goods returning from the city.

Application of BM canvas has its first finding being profit-orientation of the business model. On the other hand, urban logistics in the cities have their major concerns being translated into policies which imposes that business models take into cosnideration of social and environmental impacts (TURBLOG, 2011). In order to cover these issues the externailities which are considered as the impacts were also included in this business model (TURBLOG, 2011). In modified model these externalities are considered:

- Improve the city environment (reduce traffic, noise and pollution)

- Improve the quality of life
- Large vehicles should be reduced in the city centre (reduce congestion)

Channels: This is an interface which connects the customer and company. In particular, through the channels a value proposition can be delivered. Based on that, the channels in the business model are very important to keep in touch with the customers. So, for a smooth operation of the business model, it is necessary to have direct communication with the customer to raise awareness about the service. Furthermore, an online system which could be a website is needed in order to deliver a value proposition which can help in handling customer orders and shipment activities (Horvath and Wu, 2017, TURBLOG, 2011). Based on what we have mentioned above, there are two types of the channels that are considered in the model:

- <u>Direct Channels (deliveries, UDC hub).</u>
  Face-to-face discussions, the team at the UDC will get in contact directly with customers to propose to them additional services.
- <u>Indirect Channels (web page, mobile application).</u>
  Communication via web page, mobile application and e-mail will include a detailed study on potential gains and improvements for the entire construction supply chain due to the UDC, in order to convince companies of the benefits of the use of a UDC.

Customer Relationships: This depicts relationships which are estbalished between identified customer segment and the company. Besides the channels, the kind of relationships with the customer segments must be selected to create financial success and sustainability. Current models have considered the following kinds of relationships:

- ❖ Customer service:
  - <u>Personal Delivery/personal assistance</u>
    The UDC operator will present paid services to the customers/suppliers after asking contact at the reception of goods. And The UDC operator gave regular feedback on the experience to validate the added-value of a UDC.
  - <u>Automated services</u>
    The UDC will adopt an IT system through which it will share with clients all management activities of the logistics process.
  - <u>Network seminars</u>

With a dedicated service which is developed on the basis of human interaction, before, during and after the UDC operation.

Revenue Streams: The revenue stream presenting the cash a company generates from each customer segment. In this model, the revenue streams can be generated in many different ways, such as:

- Delivery services
  Commission for delivering outside opening hours.
- Storage fees
  Surface occupied on the floor after a storage time period in the warehouse.
- Advertising fees on vehicles
  Selling advertising space on UDC vehicles.

Particularly, based on the services which are required by the customer, there is a consideration of a pay per use fee which is introduced in this busineel model.

Key Resources: These are the resources which are required in implementation and delivery of value propositions. In proposed model, it is very vital to carry out identification of resources which are needed to create value for customers and ensure that the business model is working. These resources can be:

- Clean vehicles
  The vehicles' fleet is essential for the transport operations. The fleet has to be optimized according to the transport needs and characteristics. However, the fleet can be composed by a mix of owned vehicles, rented vehicles and subcontracted vehicles that help to meet with the peaks of transport demand.
- UDC Location/buildings
  Logistics facility relatively close to the city, suburbs and to road access. The City of Melbourne could be offered to provide a facility with a low rental price.
- IT system for delivery tracking, web page, control the goods movement internally
  To manage and optimize all the UDC inputs and outputs (supply, transport, reverse logistics, etc.). The optimization software for the route calculation and the goods consolidations is a key element for the operations of the UDC. This software allows the UDC to optimize the transport operations and achieve the required potential savings.
- Security system
  To help monitor potential hazardous behavior by staff to prevent unnecessary workplace accident and also to monitor incoming and outgoing delivery activities outside the UDC.

- <u>Employees</u>
  The authorised management appoints some employees to manage the UDC. The staff should receive a basic training to get the main rules to run a warehouse. With a background in consolidation and planning, it will be easier for the staff to identify materials and trade's needs.
- <u>Internet of things IOT and Blockchain concepts</u>
  It helps to increase speed and shipping accuracy; also, it offers retailers an opportunity to obtain unparalleled visibility into inventory and supply chain.

Key Activities: This a respresentation of activities which should be performed by an organization in order to support a realization of its value proposition. It is important to identify the activities that the consolidation centre performs as part of the service offer. In order for a business model to be effective, these activities form the most important processes which need to be done regularly. Revenue strerams and key activities will coincide with each other. In the present model the following activities have been considered:

- <u>Receipt and consolidation of goods</u>
  Optimizing the trucks load factors helps to decrease the total flow of trucks circulating in town and entering the UDC.
- <u>Logistics services</u>
  Material handling, goods control, warehousing, merchandise quality check, crossdocking, work pack creation.
- <u>Waste management</u>
  the UDC helps the company to achieve its goals regarding circular economy, by managing the goods returning from the delivery operation (unused goods or waste).
- <u>Delivery tracking</u>
  It helps to track the progress of the shipment from start to finish, including any stops it made along the way with addresses included. The package also might have been misplaced in a depot along the delivery route. Either way, a delivery tracking will make it easier to find the package and have it delivered to the proper destination.
- <u>Night distribution</u>
  The UDC will be able to offer its services also during night
- <u>Route planning</u>
  Optimizing the route permits to reduce the number of kilometres made by the delivery vehicle.

Key Partners: They offer help to this service by supporting provision of activities and resources which help in the consolidation center in order to deliver the value proposition (Horvath and Wu, 2017). Melbourne City is one of these key partners, which serves mainly in offering provision of all necessary infrastructure, so the support of the city is necessary to create the service. The city also helps in the business model through other measures that can provide facilitation of implementation and improvement of the proposed value of this business model (Horvath and Wu, 2017). The proposed model considered the key partner as follows:

- Interest organizations in freight transport

  To provide the delivery vehicles, which are preferentially low carbon vehicles to reduce the overall carbon footprint.
- Goods suppliers/shippers

  which must have a constant and efficient relationships with the UDC staff, in order to reach high level of performance regarding the whole logistics system. The suppliers can also retrieve the unused goodsat the UDC.
- Security companies

  In order to manage the security on UDC, storing such goods of different nature involve security measures to separate them regarding fire safety, environmental regulations, etc. The advice of a qualified professional is helpful in this case.
- Local government

  Even when the UDC emerges from a private initiative, the city / the region where the UDC is installed can bring its support by land rental at preferential rate, traffic regulations, extended access to the UDC vehicles.

Cost Structure: This represents costs related to a business model of a company. Costs are structured under two types in proposed model as initial costs and operating costs incurred by the consolidation centre to run the business model. So in calculating the model costs, one had to take into account the following:

INITIAL COSTS

- Training courses for the courier

  The staff should receive a basic training to get the main rules to run a warehouse.
- Main Equipment rental or purchase
- IT system development or purchase
- Security system cost
- Infrastructure cost
- Research and development costs

OPERATING COSTS

- Vehicles (purchase, fuel, maintenance, rental, insurance) variable cost that has to be minimized due to the reduction of the total kilometres covered.
- Labour costs
  Fixed cost for the permanent staff plus a variable cost for temporary workers during working peaks.
- Insurance
- Uniforms
- Maintenance
- Rent, electricity, internet, water
  The public authority can be helpful on this point, by granting a preferential rate.

Results: The proposed model was adapted in order to support inclusion of a 11th building block to cover the results, which summarize the main objectives that must achieve from creating and proposed the business model, to solve the freight transport problems. These results are:

- Sustainability (consideration of environmental issues and energy saving)
- Mobility (secure the movements of goods in urban area)
- Liveability for the residents

6.5 Conclusions

This chapter presented a proposed business model on the feasibility and sustainability of starting a UDC initiative in Melbourne CBD. A business model has been designed, which represents the UDC, carriers, receivers and the local government as stakeholders. The model is divided into four series of elements: the customer interface (customer segments, customer relationships and channels), the value proposition (product/service offering), the infrastructure management (key activities, key resources and key partners) and the financial aspect (cost structure, revenue streams and results). The main goal of this study was to identify a scheme which after performing an initial subsidy it allows all agents to operate in a way which can be financially sustained. This is achieved while the system offers substantial improvements to the environmental problems.

The proposed model brings some results regarding the qualitative assessment of the business probability and sustainability of a UDC initiative. Through the participation and the commitment of a range of stakeholders at the same table, the method of underlining the most aspects and criticalities of the business model has become easy and effective. For example, connecting the UDC to different logistics service providers could be an important issue throughout the development phase and one of the most important activities for running the UDC. This aspect also entails the connection of freight logistics service providers as partners or suppliers of the UDC. Therefore, it will be explicit that the implications of such aspects of the business model design of the UCC might be more clearly throughout the cooperative sessions of the BMC. In addition, these sessions support the design of the UDC business model, so enhancing the involvement and commitment of assorted stakeholders. This is often noticeable because of the UDC ought to build valuable proposals to both the private sector and the local administration. In fact, the exchange of necessities among stakeholders supports sympathy of the potential of the UDC initiative. Thus, the BMC has proved to be applicable to assess the UDC initiatives wherever actors with totally different objectives are concerned and should be coordinated.

CHAPTER 7

Conclusions

This chapter presents the main findings and contributions of this research in relation to key aim and research objectives in the research field of UDC and performance. The subsequent sections highlight the limitations and provide suggestions for future research.

7.1 Conclusions

All the objectives and questions stated in chapter one has been achieved and answered. In order to fulfil the purpose of the thesis, the contribution of this research can be summarized and concluded as follows:

__Research objective 1__(*To explore the interconnection between the framework factors (stakeholders, objective, descriptor and solution approach).*

__Research question 1__ *(Which option has the most potential to decrease emissions of GHG resulting from urban transport modes?)*

- Through the use of MINITAB, identification of multivariate linear regression has been made possible. Factors that contribute to the emission of GHG emanating from the road sector have been determined through application of this model. 20 years' span data was used in this model and VKT to NTV ratios were identified for all the six different modes of transportation. These form the most significant elements that influence emissions of GHG. Based on the outcome, there is an indication that regression model can be used in modelling emissions of GHG in an adequate manner. This is achieved by establishing adjusted R^2 coefficient of determination R^2 together with their values which are 89.46% and 91.8% respectively. This gives 1.48% error which is associated with the difference between actual value and the value which had been predicted. These results have also shown that the most crucial regression model variable is use of a personal vehicle.

- This study made use of DES model in order to carry out predictions of variables which affects emission of GHG. This gave a 1.94% error between the real and the predicted value. From these results, it is predicted that by 2060, the emission of CO_2 will rise up to a figure around 2,957,400K metric tons. This will happen if we will continue using gasoline vehicle types only. A switch to battery electric would lead to a potential 62.2% decrease in emission of CO_2. If we shift from 50% use gasoline vehicles and 25% use of plug-in vehicles as well as 25% of battery vehicles, this will yield a decrease of CO_2 emission to 27.16%. Use of both battery electric and plug-in vehicles on a 50% basis will result in 54.3% reduction of CO_2 emissions.

<u>Research objective 2</u> *(To understand the intrinsic and contextual factors for success of operational UDC internationally).*

<u>Research objective 3</u> *(To examine the potential transposition of international models of UDC to Melbourne CBD through the analysis of selected case studies).*

<u>Research question 2</u> *(What are the intrinsic and contextual factors and the common features and activities of success of operational UDC internationally)*

- After carrying an extensive analysis of some case studies, schemes as well as their organizational models, we have been able to determine the key factors that can contribute to success of suitable UDC initiatives. These factors are as illustrated below:
  - ***Level of demand-*** There need to be a good and sufficient number of products and users of UDC in order to lower cost that is associated with UDC initiatives. This ensures that initiatives related to UDC become more competitive within the urban distribution space.
  - ***Developing a private/public partnership***- by attributing the management of the UDC to a private company one is able to spread benefits and cost sharing of UDC among a large pool of associated stakeholders. This contributes in making the UDC initiative successful.
  - ***Location-*** it would be better to be located in an industrial area with an easy and reliable access to the road network (highway and motorway) in order to collect goods to deliver. This process aims at creating important community centres which should be around town and city centres. Other places include corridors of major public transport terminals as well as areas that have high population density such as city centres.
  - ***using clean vehicles-*** using clean vehicles enabling to extend delivery hours in city centre and circulate in pedestrian areas.
  - ***Financing-*** financing the start of the project through local or national subsidies to enable evaluation of how the UDC is performing before one could think of outsourcing. This allows room for financial stability.
  - ***Evidence-*** This involves showing evidence that the UDC minimises the costs of transportation and environmental nuisances (traffic congestion or pollution issues).

By reviewing a wide range of case studies, we have been able to present the various types of UDC that can be developed and shown their related characteristics. As presented earlier, gathering of enough products and determination of the mechanisms that will be used in sharing the cost of production between various stakeholders remains to be the two main factors that determine the success of UDC. A partnership between the private and public sector could a huge win for UDC and this could further bolster their success. This kind of collaboration between these two sectors can happen when the UDCs are meant to provide service to all people and this success can be fostered further through provision of incentives and support by the government. The last success factor touches on assessing the suitability of UDCs and how they focus on their additional positive impacts. This study has shown and established that installation of UDCs leads to creation of safer towns which is achieved through reduction of congestion and accidents. However, it is important to develop an assessment tool that can measure the value added by these infrastructures. This is mainly achieved through carrying out an assessment of the sustainability associated with the development. Therefore, it becomes important to have a link to methodologies of evaluation which pays consideration to the pertinent issues. These include GHG emissions, noise pollution, congestion and environmental impacts.

Research objective 4 *(Developing a proposition of a guideline that can be used in creating an urban freight domain model that can be offered through a combination of activities and common feature (e.g. stocking, ordering etc). This is presented as a data model that has a provision of carrying out modification of data and object properties.)*

Research question 4 *(What are the impacts of making a guideline in the applicability of urban logistics at the Inner City of Melbourne?)*

- The impacts of making a guideline in the applicability of urban logistics at the Inner City of Melbourne are:
  - Helping the city planner and decision makers to identify the suitable model to be implemented in Melbourne CBD.
  - Helping in delivery of sustainable policy goals about transport at an urban level such as:

    a. Facilitate freight delivery and servicing.

    b. Reduce congestion.

    c. Reduce traffic emissions (GHG emissions).

d. Ensure city centres have improved quality of life.

e. Ensure public and private fleets have an increased share of clean of vehicles.

- Guideline will be a first step to decide which model suits any urban distribution centre project.

- Implementation of the proposed distribution centres for the city of Melbourne has the following main benefits:
  - Reduction of traffice congestion, vibration, noise and pollution in the urban area.
  - Improvement of the urban area life.
  - Saving the time and effort by collection of items that need to delivered from an extensive area from a unique point (UCC) to the (MCC) with a significant decrease in the travelled distance.
  - Increase in the load factors and therefore decrease in the number of necessary journey needed to perform the deliveries.
  - Services offered to lead to an increased demand (solid recyclable wastes and storage).

- A business model has been designed, which represents receivers, carriers, the UDC, and the local government as stakeholders. The model is divided into four series of elements namely:

  - Customer interface- This includes customer relationships, channels and segments
  - Value proposition- This comprises of service and product offering
  - Infrastructure- This consists of key resources, activities and partners
  - Financial aspect- This section covers revenue streams, cost structure and results

  The proposed model was adapted to include a 11th building block to cover the results, which summarizes the main objectives that must be achieved from creating and proposing the business model, to solve the freight transport problems. These results are:
  - Sustainability (consideration of environmental issues and energy saving).
  - Mobility (secure the movements of goods in urban area).
  - Liveability for the residents.

7.2 Research limitations

The limitation in this study:

- Data availability- As noted in chapter three, there was a lot of discontinuity associated with some variables within data of the time-series. This is capable of introducing errors when carrying out estimation using the regression model. Neverthless, the results obtained as well as the proposed method in this study can be revisted in future in order to carry out tests with a data set which is good and more detailed.
- When performing analysis of the impact assessments associated with the UCC, our study was limited to only 113 impact assessments as denoted in chapter 4. This was caused by lack of majority of these assessments in English language while others had not been published hence missing out from the public domain.
- This study is based on a context of City of Melbourne in Australia. As a result of its unique and specific environment, the development of city logistics and their suitability are only based on this one area. Therefore, there is a need to conduct similar studies in other cities in order to improve validity and reliability of the results.

- Limitation is linked to the time constraint. The time limitations affected the intensity of the empirical study. As the thesis is conducted over a course of a limited period of time, the research subjects were limited to one city. Consequently, the distribution in other cities are not discussed.

- There is no funding or financial support for the research project to be implemented.

7.3 Future Research Directions

- Analysis which is more detailed occurring at a disaggregate level and involving different and various transportation modes will be done in future. While carrying out this study, a number of suggestions arose for further work on the topic of modelling GHG emissions from road and travel transportation: First, an analysis which is more detailed occurring at a disaggregate level and involving different and various transportation modes including freights in fuel efficiencies will be conducted. Second, a more thorough analysis of the emissions factors for different kinds of travel and of weekday-to-annual expansion factors may be insightful in evaluating neighbourhood sustainability in terms of GHG emissions more precisely. Furthermore, it is recommended to evaluate the five different scenarios in predicting the GHG emissions from cost and economic point view.

- Various case studies should be cross-examined in order to identify similarity that will bolster in development of a systematic guideline which can be used on developing and planning an UCC. This will have positive implications on how to manage urban logistics in a better way.
- Transferring the transferability process for the selected case studies from qualitative measure to quantitative measure.
- The developed business model will be further examined on its suitability. Results obtained in this study will be validated by performing some comparison with future techniques or alternatives models that might arise.
- In future, we can create a smart UDC through application of latest technologies such as blockchain concepts and Internet of Things (IoT). Application of blockchain technology will lead into creation of a valuable tool that is allowing creation of immutable records. They are presented in a distributed ledger that allows people in understanding about the movement of goods in a certain supply chain. On the other hand, IoT provides an opportunity which helps in collecting large amounts of data. This data is important because it helps in improving security as well as enhancing management of the supply chain and related processes. In overall, a combination of these technologies leads to a better visibility on the state of goods and how they can be delivered in a faster way while minimizing damage.

- In transportation and logistics, IoT can help in creation a machine-to-machine connection which enables various components of the supply chain to communicate with each other in an easier way. These components include containers, packages, loading equipment as well as other assets and advices involved in the supply chain process. Blockchain will help in in empowering IoT devices to become autonomous, perform data exchange, improve self- processes, execute actions without having to rely on a centralized authority.

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APPENDIX

Urban Consolidation Centre Case Studies.

The following table contains summary details by country for each of 80 UCC schemes identified in chapter 4 as having work carried out on them. Each UCC scheme has been identified in terms of i) the type of work carried out on the UCC (either Study, Trial, or Operational), and ii) the area served by the UCC scheme (either site specific, district, or town-wide). The start date of each UCC project, trial or operation is also included.

	Type of work carried out on the UCC			**Area served by the UCC scheme**			
Country/Location	Study	Trial	Operational	Site Specific	District	Town-wide	Starting Date
AUSTRIA							
Graz	X					X	2000
Australia							
Emporium Melbourne			X		X		2014 Still operating
BELGIUM							
Antwerp			X			X	NA
Brussels	X				X		1998
BRAZIL							
Belo Horizonte	NA				X		1992 to 2001
CANADA							
Vancouver	X					X	Mid 1970s

DENMARK							
Copenhagen			X			X	2013 still operating
FRANCE							
Arras	X					X	1990s
Bordeaux	X					X	2003
Dijon	X					X	1990s
La Rochelle			X		X		2001 Still operating
Lille	X					X	1990s
Marseilles	X					X	1990s
Paris I		X			X		1971
Paris II (LA PETITE REINE)		X			X		2003 Still operating
GERMANY							
Aachen			X		X		1997 Still operating
Potsdamer, Berlin			X	X			1992
Bremen			X			X	1994 Still operating
Cologne			X			X	1994
Dusseldorf		X			X		1997
Essen			X			X	1997 Still operating
Frankfurt			X			X	1995 Still operating
Freiburg			X		X		1993-97
Kassel			X			X	1994 Still operating

Munich	X					X	1993-94
Nuremburg			X		X		1996 Still operating
Regensburg			X			X	1998 Still operating
Stuttgart			X			X	1993-94
Ulm			X			X	1995
ITALY							
Ferrara			X			X	2002 Still operating
Genoa		X			X		2003
Lucca	NA					X	2003
Padua		X				X	2004 Still operating
Siena			X		X		1999 Still operating
Vicenza		X				X	2005 Still operating
JAPAN							
Marunouchi, Tokyo		X			X		2002
Motomachi	NA				X		2004
Osaka		X		X			NA
Tenjin			X		X		1978 Still operating
LUXEMBOURG							
Luxembourg	X					X	2012
MONACO							
Monaco			X			X	1989 Still operating

NETHERLANDS							
Amsterdam			X		X		1996 Still operating
Arnhem	X				X		1989
Groningen			X		X		1995 Still operating
Hague	X				X		2002
Leiden			X			X	1994 or1997
Maastricht	X				X		1989-91
Nijmegen		X			X		2008 Still operating
Utrecht			X			X	1994 Still operating
NORWAY							
Oslo		X				X	2014
POLAND							
West Pomeranian	NA					X	NA
PORTUGAL							
Evora		X			X		2000 Still operating
SPAIN							
Malaga			X		X		2002
SWEDEN							
Gothenburg I		X			X		1996
Gothenburg II		X			X		2012
Hammarby - Const			X	X			2001

Stockholm Old Town			X		X		2000 Still operating
Uppsala	X			X			2001
SWITZERLAND							
Basel		X				X	1993
Zurich		X				X	1994
U.K.							
Aberdeen	X				X		1997
Barnsley	X					X	1976
Bluewater, Kent			X	X			2002 Still operating
Bradford	X					X	1975
Bristol		X			X		2004 Still operating
Camberley	X					X	1975
Chester	X				X		1997
Chichester	X				X		1975
City of London	X				X		1997
City of London MCC		X				X	2009
Hammersmith	X				X		1974
Hull	X					X	1976
Heathrow - Const			X	X			2001 Still operating
Heathrow - Retail			X	X			2000 Still operating
London Construction		X		X			2005 to 2007

Meadowhall, Yorks			X	X			2001 Still operating
Swindon	X				X		1976
Winchester	X						1994
Worcester	X						1980s
U.S.A.							
Columbus, Ohio	X				X		1972

All the 80 UCC schemes have a datasheet which are contained in the subsequent pages. Every page has one UCC datasheet. The following data is contained on every page as depicted below:

- Type of UCC.
- Starting date.
- Model Type.
- The project name / Scheme.
- Location of centre(s).
- UCC's objectives.
- The UCC is "successful" and
- The current statues, i.e., it is still in operation and financially sounds.
- Products types which are handled.
- The number of participating forwarders
- Surface or Land used of the UCC (m^2) or (Km^2).
- Type of work carried out on the UCC (Study, Trial or Fully Operational).
- Vehicle types which are used.
- Voluntary or compulsory.
- The permanent or temporary scope of the system.
- Existence of data which deals with effects of UCCs on VMT as well as the transport operation.
- Economic profile and finance issues.
- The initiative leadership nature in regard to whether it is bottom-up, top-down, private, public or public-private.
- Impact on the environmental.
- Advantages which are beneficial.

Below is a list of these datasheets which are listed in an alphabetical order and by country (the same order as used in Table 1.

UCC	***Graz UCC - AUSTRIA***
Type of UCC	Type one (All or part of urban area)
Year	Planning started in 2000
Model Type	
The project name / Scheme	Demo Project
Locations	An existing freight village which hosts a UCC (called Cargo Centre Graz - CGZ) (Town-wide)
Objectives	Reducing the number of unloading stops and trips when transporting goods. Decrease traffic congestion related with freight. Reduce negative environmental effects which are associated with the freight transport. Low-emission and low-noise vehicles.
UCC Successful/ Failed	Failed
Type of product	Transport operators
Number of users	
Surface of the UCC (m^2) or (Km^2)	2000 m^2
Trial, Study or Fully Operational	Study
Type of Vehicle used	Green vehicles
Current Status	The scheme is still at the study and planning stage with less progress which results from lack and delayed securing of agreements from companies which they intend to use.
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	The following estimations were expected from the UCC: • Number of vehicles required to decrease by 80% • Vehicle trips to reduce by 70% • Total delivery time to be reduced by 70% • Unloading time of vehicles inside the city to reduce by 50%

Financial Issues (Subsidies)	
Actors who started the initiatives	Municipality
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Traffic and environmental benefits are expected.
References	(Browne et al., 2005)

UCC	***Emporium Melbourne UCC - AUSTRALIA***
Type of UCC	Type two (Large site with single landlord)
Year	2014
Model Type	
The project name / Scheme	
Locations	Located in the city centre (Melbourne CBD). (District)
Objectives	To manage freight in the central city.
UCC Successful/ Failed	Successful
Type of product	Retail and food
Number of users	225 stores
Surface of the UCC (m^2) or (Km^2)	7000 m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Truck lifts
Current Status	Active
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	Permanent
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Emporium freight has many benefits. It has a store whereby more than 7000m^2 have been saved in terms of the floor space. This has enabled drivers to have knowledge on when to make arrivals with a guaranteed access upon arrival. This eliminates the need foe entering the city leading to reduction of traffic congestion. This helps in saving money for many individuals and companies.
References	(Melbourne's, 2015a)

UCC	***Antwerp UCC - BELGIUM***
Type of UCC	Type one (All or part of urban area)
Year	
Model Type	Business model
The project name / Scheme	CITYDEPOT
Locations	The UCC which is located near a waterway in Antwerp. (Town-wide)
Objectives	
UCC Successful/ Failed	Successful
Type of product	Parcels
Number of users	
Surface of the UCC(Km^2) or (m^2)	
Trial, Study or Fully Operational	Fully operational
Vehicle type used	Electric vehicles
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Start-up has no subsidies which are involved
Actors who started the initiatives	UCC is a privately operated company which belongs to the postal company.
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	UCC has led to many improvements which include decrease of emissions, fuel consumptions as well as less delivery time.
References	(Kin et al., 2016)

UCC	***Brussels UCC - BELGIUM***
Type of UCC	Type one (All or part of urban area)
Year	1998
Model Type	Compatibility of a passenger model and the freight model
The project name / Scheme	REFORM project
Locations	In the "Pentagon" area of Brussels, the city's historic centre (Town-wide).
Objectives	The main objectives were: • Analysis of the situation of existing freight transport • Assessment of potential environmental impacts and road traffic • Devise mechanisms which will lead into implementation of a consolidated urban center.
UCC Successful/ Failed	Failed
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	1 km^2
Trial, Study or Fully Operational	Study
Type of Vehicle used	Heavy vehicle
Current Status	
Terms of Use Voluntary/Compulsory	Compulsory
Permanent/Temporary	
Transport Operations	An increment of the traffic flow which is associated with the UCC would lead to increased time of travel. This in tur results in high fuel consumption which leads to increased vehicle emissions.
Financial Issues (Subsidies)	
Actors who started the initiatives	Brussels regional authorities
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	High environmental, traffic and economic costs would outweigh the benefits which are associated with the UCC.
References	(Browne et al., 2005)

UCC	***Belo Horizonte UCC - BRAZIL***
Type of UCC	Type one (All or part of urban area)
Year	1992 to 2001
Model Type	Adoption model
The project name / Scheme	
Locations	On the main accessing roads to the Belo Horizonte Metropolitan Region (RMBH). (District)
Objectives	Benefit of the city's own economy, welfare and quality of life of its population. It aims optimise the activities of collection and distribution of loads in urban areas, trying to simultaneously minimise the costs to society
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	500 m^2
Trial, Study or Fully Operational	Study
Type of Vehicle used	Trucks, vans and motorcycles
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	Núcleo de Transportes of the Engineering School of the Federal University of Minas Gerais – UFMG
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(De Magalhães, 2010)

UCC	***Vancouver UCC - CANADA***
Type of UCC	Type one (All or part of urban area)
Year	Mid 1970's
Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	To carry out investigation of impacts which are associated with establishment of an urban freight consolidation center.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Decrease of traffic by a percentage which is less than one per cent
References	(Browne et al., 2005)

UCC	***Copenhagen - DENMARK***
Type of UCC	Type one (All or part of urban area)
Year	2013
Model Type	Simulation model
The project name / Scheme	Citylogistik-kbh
Locations	Close to the E20, a highway located south of Copenhagen. (Town-wide)
Objectives	Main objectives were: • Improve attractiveness of the city • Reduce traffic congestion, air and noise pollution • Minimize the number of large trucks used in the city. • Provide a transport system which is more coordinated.
UCC Successful/ Failed	Successful
Type of product	(i) fashion (clothes and shoes), (ii) bicycle stores, (iii) convenience stores and kiosks, and (iv) specialized stores (e.g., consumer electronics, sports stores).
Number of users	1071 retailers
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	An environmentally friendly electric vehicle
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Reduced congestion of traffic and shippers and shops to have better services.
Financial Issues (Subsidies)	The Danish Transport Authority to support long-term economic sustainability.
Actors who started the initiatives	Citylogistik-kbh ApS • Copenhagen Business School (CBS) • Danish Technical University • Transport Innovation Network

	• Danish Transport Authority
Environmental Impacts	Reduced adverse effects to the environment which results from the delivery vehicles.
Inconvenience for Residents	
Beneficial Advantages	• Reduction in noise, congestion and pollution in the city centre • Fewer daily deliveries • Staff time savings in shops • Easier planning for shop staff • Fewer disruptions in store operations • Well-known driver helps achieve a smooth delivery process •Various additional third-party logistics (3PL) services are offered • A more attractive and productive city
References	(Britta, 2015)

UCC	***Arras - FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	1990's
Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	No evidence of the project proceeding
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	

Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Reduced traffic impacts to generally be lesser than one per cent.
References	(Browne et al., 2005)

UCC	***Bordeaux UCC - FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	2003
Model Type	The simulation model
The project name / Scheme	Nearby distribution area (ELP)
Locations	Town-wide
Objectives	1-Facilitating the delivery of small packages inner city. 2- Decreasing the number of trucks inner city centre. 3- Decreasing environmental impacts. 4- Decreasing noise levels.
UCC Successful/ Failed	Successful
Type of product	Retail goods
Number of users	15 Transport operators
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	Truck
Current Status	Active
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	Dispersion of observed results, gains by tour ranging from 0 to 5.3 km, number of shipments from the delivery space ranging from 1 to 6, reduction of energy consumption
Financial Issues (Subsidies)	

Actors who started the initiatives	Government
Environmental Impacts	Average reduction in emissions of CO2 by stop: 845 g, about 40 kg per day
Inconvenience for Residents	
Beneficial Advantages	Traffic reduction impacts to generally be less than 1%
References	(Roche-Cerasi, 2012)

UCC	***Dijon UCC - FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	1990's
Model Type	The simulation model
The project name / Scheme	Local Delivery Point (ELP)
Locations	Town-wide
Objectives	To have freight movement which has been rationalized.
UCC Successful/ Failed	
Type of product	Retail goods
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	Government
Environmental Impacts	
Inconvenience for Residents	

Beneficial Advantages	Reduce traffic congestion by less than one per cent
References	(Browne et al., 2005)

UCC	***La Rochelle UCC - FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	2001
Model Type	The management model
The project name / Scheme	ELCIDIS project (ELectric City DIstribution System)
Locations	The UDC is located inside the city 1.5km from the serving area. (District)
Objectives	• Delivery spaces to be used better • Traffic regulation to be improved • Pollution and congestion to be reduced • Show how electric vehicles are effective • Distribution of goods to be rationalized.
UCC Successful/ Failed	Successful
Type of product	Delivery
Number of users	1300 businesses
Surface of the UCC (m^2) or (Km^2)	800
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Electrical
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Reduce 61% vehicle kilometres; Use seven electric vehicles
Financial Issues (Subsidies)	Subsidies from government.
Actors who started the initiatives	Private transport companies

Environmental Impacts	• Use of electric vehicles in situ led to reduction of air pollutant. • Energy/fuel consumption reduced by 48% • VMT and congestion balance is unclear • Reduced of noise and accidents which made an increase in cost saving
Inconvenience for Residents	Less Inconvenience
Beneficial Advantages	• The local government gives subsidies which have led to increased public funding towards the project.
References	(Panero et al., 2011, van Duin et al., 2010, Browne et al., 2005)

UCC	***Lille - FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	1990's
Model Type	
The project name / Scheme	
Locations	The Metropolitan Area of Lille (Town-wide)
Objectives	
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	

Inconvenience for Residents	
Beneficial Advantages	Traffic impacts reduction to generally be less than one per cent
References	(Browne et al., 2005)

UCC	***Marseilles- FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	1990's
Model Type	The simulation model
The project name / Scheme	Data collection-Modelling
Locations	Town-wide
Objectives	Freight in urban areas to be rationalised
UCC Successful/ Failed	
Type of product	Retail goods
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	Government

Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Traffic impacts reduction to generally be less than one per cent
References	(Browne et al., 2005)

UCC	***Paris I - FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	1971
Model Type	
The project name / Scheme	Chronopost
Locations	Garanor (north-east). (District) and Sogaris (south of Paris)
Objectives	
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Trial
Type of Vehicle used	
Current Status	After few year of operation of Garanor closed in its designated role while Sogaris continued despite recording low levels of activity
Terms of Use Compulsory/ Voluntary	Compulsory based the load restriction.

Temporary / Permanent	Temporary
Transport Operations	
Financial Issues (Subsidies)	Private sector
Actors who started the initiatives	Government
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Traffic reduction impacts to generally be less than 1% Traffic impacts reduction to generally be less than one per cent
References	(Browne et al., 2005)

UCC	***Paris II (La Petite Reine) UCC - FRANCE***
Type of UCC	Type one (All or part of urban area)
Year	2003
Model Type	Business model
The project name / Scheme	La Petite Reine
Locations	UDC situated in the city centre (by the Louvre museum), Four of the central neighbourhoods. (District) are serviced by this UDC
Objectives	• Reduce urban freight transport impacts by use of motorized vehicle in order to serve in the final part of delivery.
UCC Successful/ Failed	Successful
Type of product	Non-food products, flowers, Food products, and equipment. Home delivery, express service, Courier services

Number of users	Four central arrondissements
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Trial initially
Type of Vehicle used	Tricycle and Electrical vehicle
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	During the trial period the use of delivery services have increased by a figure which is 18 times bigger being recorded in the 24th month as compared to the first month.
Financial Issues (Subsidies)	ADEME (Agence De l'Environnement et de la Maîtrise de l'Énergie / French Agency of Environment Management)
Actors who started the initiatives	The City of Paris
Environmental Impacts	For the first 24 months: savings included 156,000 km (of diesel vans), 43 tons oil equivalent, 112 tons CO2. Generating energy savings equivalent to roughly 90 toes (tons of oil equivalent). Avoiding contamination emissions, such as 84 kg PM and more than 200 T of CO_2. Reducing noise pollution and congestion.
Inconvenience for Residents	less Inconvenience
Beneficial Advantages	• Reducing the number of trips to achieve more beneficial outcomes and reduce the cost partly. • Freight of cargo has turned into the most significant kind of freight during the preliminary trial period. It has expanded from 51% to 97% following 2 years.
References	(Panero et al., 2011, Allen et al., 2007)

UCC	***Aachen UCC - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	In 1995, the planning process started. The subsequent and trial period commenced in 1997
Model Type	" bottom up " analysis method
The project name / Scheme	Claix Citylogistik Aachen e.V
Locations	District
Objectives	Generate advantages to retailers and transport companies by increasing the load factor of delivery vehicles. This would decrease air and noise pollution as well as traffic congestion.
UCC Successful/ Failed	Successful
Type of product	Premises and Forwarders located in the area of delivery.

Number of users	
Surface of the UCC (m^2) or (Km^2)	650 m^2
Trial, Study or Fully Operational	Trial and then Operational
Type of Vehicle used	CC vehicle ,4x7.5 t goods vehicles with Euro III engines,
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Improved transport efficiency; drawbacks – added time of unloading and loading at distribution centre.
Financial Issues (Subsidies)	(Vent Transporte) which is a transport company
Actors who started the initiatives	"Claix Citylogistik Aachen e.V." (City-Logistik-Aix-La-Chapelle).
Environmental Impacts	
Inconvenience for Residents	Less Inconvenience
Beneficial Advantages	• Transport system which has enhanced efficiency • drawbacks – added time of unloading and loading at distribution centre
References	(Browne et al., 2005)

UCC	***Potsdamer Platz, Berlin - GERMANY***
Type of UCC	Type three (Construction)
Year	1992-2002
Model Type	
The project name / Scheme	Baustellenlogistik Potsdamer Platz GmbH (baulog)
Locations	The Potsdammer Platz area in Berlin. (Site Specific)
Objectives	Decrease traffic associated with lorries.
UCC Successful/ Failed	Successful
Type of product	Construction
Number of users	
Surface of the UCC (m^2) or (Km^2)	On-site
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Lorry

Current Status	Closed
Terms of Use Voluntary/Compulsory	Compulsory
Permanent/Temporary	Temporary
Transport Operations	Avoidance of 50,000 lorry kilometres per day (using other modes) and the completion of the building work six months ahead of schedule.
Financial Issues (Subsidies)	A variety of public and private organizations which include Deutsche Bahn AG and the federal state of Berlin, Sony Berlin GmbH, Asea Brown Boveri and Daimler-Benz InterServices GmbH.
Actors who started the initiatives	The private and public sectors
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	• Using rail or water mode of transport in order to remove excavated materials • Delivery of mixed concrete to area of works. • Organize and transport cargo by use of rail and road transport • Transportation of refuse which is involved in building
References	(Browne et al., 2005)
UCC	***Bremen UCC - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1994
Model Type	Business model
The project name / Scheme	City Logistik project
Locations	UDC located in multi-modal freight village (GVZ) outside the city. (Town-wide)
Objectives	• Having delivery vehicles which are more efficient • Reducing number of journeys in the city • Less adverse effect to the environment
UCC Successful/ Failed	Successful

Type of product	Chemical industry, break bulk logistics, energy industry, aerospace, trade, automotive and commerce industry.
Number of users	135 competitive companies
Surface of the UCC (m^2) or (Km^2)	1.0 million m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Clean vehicles
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	1997 data: number of trips (-12.7%), load factor (+28%). 2005 data: VMT (-9,000 km per month), fuel (-1,100 litres of diesel per month).
Financial Issues (Subsidies)	Supported by the national transportation ministry
Actors who started the initiatives	EU CIVITAS-VIVALDI
Environmental Impacts	
Inconvenience for Residents	less Inconvenience
Beneficial Advantages	The UDC profited by EU CIVITAS-VIVALDI (exhibition venture) subsidizing. CIVITAS was intended to present gas-fueled trucks for city coordinations. It isn't clear whether it continues working these days without outside financing.
References	(Browne et al., 2005, Panero et al., 2011)
UCC	***Cologne - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1994
Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	Have retail supplies which are all consolidated and delivered using a “neutral” carrier.
UCC Successful/ Failed	
Type of product	Parcel, Retail

Number of users	12 spedition companies
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Rigid vehicles
Current Status	No evidence of the project continuing
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	Consolidation yields saving from the transport cost which are way less than introduction of extra costs. Hence it can be concluded that the benefits of its operations are offset and outweighed by increased operational costs.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	• Recycling of waste products • Low emissions • Faster home deliveries • Reduced traffic
References	(Browne et al., 2005)

UCC	***Dusseldorf - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1997
Model Type	"bottom up" analysis
The project name / Scheme	
Locations	District
Objectives	An investigation into the job of clients and future dreams for the take-up of City Logistics and Combined energy and power generation.

UCC Successful/ Failed	Failed
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	5 weeks trial
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	• transport becomes more effective efficiency • drawbacks – additional time for unloading and loading within the distribution centre.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Essen - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1997
Model Type	
The project name / Scheme	Stadtlogistik
Locations	In the state of North Rhine-Westphalia in Germany (Town-wide)

Objectives	• Goods' delivery vehicles to be improved • Minimize negative impacts to the environment
UCC Successful/ Failed	
Type of product	
Number of users	Six transport companies
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	18 t lorry, a 7.5 t vehicle and a 3.5t vehicle.
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Approximately 10 tonnes of goods are handled, on average, per day.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Frankfurt am Main - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1995
Model Type	
The project name / Scheme	City Logistik project

Locations	In the state of North Rhine-Westphalia in Germany (Town-wide)
Objectives	• Reduction of congestion • Consolidation of goods to enhance delivery of goods
UCC Successful/ Failed	
Type of product	
Number of users	11 forwarding companies
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	
Financial Issues (Subsidies)	Research and studies were funded but not the running of the scheme.
Actors who started the initiatives	Private initiative
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	• Environmental improvements • Reduced cost of delivery
References	(Browne et al., 2005)

UCC	***Freiburg - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1993-97
Model Type	

The project name / Scheme	
Locations	District
Objectives	To consider potential for UCCs and other freight transport policies.
UCC Successful/ Failed	Successful
Type of product	Chilled fresh product, Delivery
Number of users	12 partners
Surface of the UCC (m^2) or (Km^2)	No single consolidation points.
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Lorry and trucks
Current Status	Stopped
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Journey times reduced from 566 to 168 hours per month. 33% reduction in delivery runs. 50 % reduction in number of vehicles travelling into the city centre / day. Time spent in the city by lorries reduced from 612 to 317 hours. 70% reduction in distance travelled by the trucks and an 11% reduction in the number of trucks.
Financial Issues (Subsidies)	No subsidies were provided, nor regulatory assistance given.
Actors who started the initiatives	A private initiative of logistics companies encouraged to consider centralized management of deliveries by the Chamber of Commerce and Industry.
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Kassel UCC – GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1994
Model Type	German Model
The project name / Scheme	City logistik scheme

Locations	Located in the centre of Germany near city of Kassel. (Town-wide)
Objectives	Development identified as home deliveries, vehicle tracking and route planning, waste recycling, use of low emission vehicles and increasing range of products handled.to reduce the constantly rising traffic volume in Kassel, especially industrial and individual traffic.
UCC Successful/ Failed	Successful
Type of product	The automotive and transport industries, telematics and software development, environmental and energy technologies, as well as culture and tourism.
Number of users	It was conducted by 10 transport companies. After operating for eight and half year, there are three of ten partners left.
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Rigid vehicles
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Reduce 60% vehicle kilometres; 13% of the number of trucks per retailer and increase the volume of vehicle capacity by 80%; Use conventional vehicles.
Financial Issues (Subsidies)	Got subsidies from the municipality during the first year.
Actors who started the initiatives	Private transport company
Environmental Impacts	Load factor (increased from 40% to 80% by volume, from 25% to 60% by weight), VMT (-40% miles to the city, -60% miles within the CBD).
Inconvenience for Residents	Less Inconvenience
Beneficial Advantages	A doubling of the capacity use of the vehicles going in to the city centre reduced the vehicle kilometres in the city centre by 60%
References	(van Duin et al., 2010, Browne et al., 2005)

UCC	***Munich UCC - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1993 - 94
Model Type	The simulation model
The project name / Scheme	City-Logistik
Locations	Town-wide

Objectives	To maximise the loading capacity of goods vehicles and to reduce the number of deliveries through consolidation of shipments of "some specific lines of industry"
UCC Successful/ Failed	
Type of product	Personal care products, stationery, food-stuffs, home appliances, clothing and building supplies / materials.
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	Environmentally friendly vehicles
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	•29.2% reduction in number of deliveries. •18% reduction in drops per delivery run. • a 31-minute reduction in store delivery times. •increase in vehicle loading from 70 to 81%.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	29% reduction in city pollution.
Inconvenience for Residents	
Beneficial Advantages	Reduced traffic impact for participants. Advantages of freight centres- to facilitate logistics activities and to consolidate goods flows by developing certain transport services.
References	(Browne et al., 2005)

UCC	***Nuremburg UCC - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1996
Model Type	
The project name / Scheme	City logistik scheme (ISOLDE)

Locations	Located in the city centre. (District)
Objectives	To reduce congestion and the costs of distribution
UCC Successful/ Failed	Successful
Type of product	Parcels and delivery service
Number of users	
Surface of the UCC (m^2) or (Km^2)	1.6 km
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Electric powered and conventional vehicles
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	
Financial Issues (Subsidies)	DPD (Deutscher Paket Dienst GmbH & Co.)
Actors who started the initiatives	The shopkeepers of the city centre
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Environmental benefits, reduced vehicle movement and operating, reduced traffic impacts for participants
References	(Browne et al., 2005)

UCC	***Regensburg UCC – GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1998
Model Type	

The project name / Scheme	Reglog
Locations	Outside the city, integrated in a Freight Village. (Town-wide)
Objectives	To help assist the accessibility problems and negative impacts associated with goods vehicle deliveries (safety, noise, air quality etc.).
UCC Successful/ Failed	Successful
Type of product	Businesses participate
Number of users	Six involved companies
Surface of the UCC (m^2) or (Km^2)	1 km
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Trucks
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	VMT (20,000 vehicle kilometres saved between 1998 and 2005).
Financial Issues (Subsidies)	Subsidies from Regensburg GVZ
Actors who started the initiatives	BMW
Environmental Impacts	VMT (20,000 vehicle kilometres saved between 1998 and 2005).
Inconvenience for Residents	less Inconvenience
Beneficial Advantages	The scheme helps to reduce the work of 7-8 delivery vehicles onto one or sometimes two Reglog vehicles. Approximately 20,000 goods vehicle kilometres has been saved between 1998 and 2005 as a result of Reglog.
References	(Browne et al., 2005, Panero et al., 2011)

UCC	***Stuttgart - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	1993/4

Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	
UCC Successful/ Failed	
Type of product	Retail, Parcels
Number of users	The spedition companies involved (2 or 3)
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Rigids vehicle
Current Status	No evidence of the project continuing
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	Transport cost savings resulting from consolidation are less than the additional handling costs making the economics of the operation marginal and the environmental benefits were partly offset by an increase in total operating costs. But operators claimed improved operating efficiency and an improvement in their image.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Opportunities for further development identified as home deliveries, vehicle tracking and route planning, waste recycling, use of low emission vehicles
References	(Browne et al., 2005)

UCC	***Ulm - GERMANY***
Type of UCC	Type one (All or part of urban area)
Year	Mid 1995

Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	
UCC Successful/ Failed	
Type of product	Retail, Parcels
Number of users	The spedition companies involved (2 – 4)
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Rigids vehicle
Current Status	No evidence of the project continuing
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	Transport cost savings resulting from consolidation are less than the additional handling costs making the economics of the operation marginal and the environmental benefits were partly offset by an increase in total operating costs. But operators claimed improved operating efficiency and an improvement in their image.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Opportunities for further development identified as home deliveries, vehicle tracking and route planning, waste recycling, use of low emission vehicles
References	(Browne et al., 2005)

UCC	***Ferrara - ITALY***
Type of UCC	Type one (All or part of urban area)
Year	2002

Model Type	
The project name / Scheme	EcoPorto
Locations	Approx. 2 km outside the city. (Town-wide)
Objectives	To start up a logistics platform that aims to achieve economic profit together with efficiency and reduced environmental impact in the distribution of goods in the urban area and across a region.
UCC Successful/ Failed	Successful
Type of product	
Number of users	Fifteen transport operators
Surface of the UCC (m^2) or (Km^2)	It comprises a 20,000 m^2 of which 7,500 m^2 is currently built on, 2,500-3,000 m^2 of which is refrigerated depots.
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Environmentally-friendly vehicles
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Ferrara has Limited Traffic Zones and Pedestrian Zones of Ferrara. Goods vehicles entering these areas are subject to vehicle access time restrictions and must pay a tariff. Environmentally-friendly vehicles (including those operated from EcoPorto) can enter these areas for the entire working day (06:00-17:30) while other third-party operators can only enter between 06:00-11:00 and 15:30-17:30). Also, its receive an 80% discount on the entry tariff.
Financial Issues (Subsidies)	There has been no public financial contribution
Actors who started the initiatives	CoopSer (a private company)
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)
UCC	***Genoa - ITALY***
Type of UCC	Type one (All or part of urban area)
Year	2003-2004

Model Type	
The project name / Scheme	
Locations	District
Objectives	To help resolve the problems faced by trades people with regards to access to and mobility within the historical city centre.
UCC Successful/ Failed	
Type of product	
Number of users	Twenty-five transport operators used the UCC with 68 consignments being handled per day during 2004.
Surface of the UCC (m^2) or (Km^2)	1,400 m^2
Trial, Study or Fully Operational	Trial
Type of Vehicle used	10 delivery vehicles (8 x electric 2 x methane).
Current Status	The UCC trial finished in December 2004 due to national funding coming to an end.
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	It was co-funded by the European project MEROPE
Actors who started the initiatives	Genoa-Eco Distribuzione Merci Srl – a joint venture of the Chamber of Commerce, Trades Unions and Municipality of Genoa
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Lucca - ITALY***
Type of UCC	Type one (All or part of urban area)

Year	2003
Model Type	
The project name / Scheme	Eco-Friendly City Freight Distribution
Locations	Near the city centre and the major highways. (Town - wide)
Objectives	
UCC Successful/ Failed	Successful
Type of product	Pallets and parcels delivery
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	
Type of Vehicle used	Electric vehicle
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	Operational results: o Reduction of congestion by reducing the total number of vehicles in the historical city centre. o Optimisation of loading capacity and delivery routes.
Financial Issues (Subsidies)	Municipality of Lucca, Tuscany region, European Commission
Actors who started the initiatives	Municipality of Lucca
Environmental Impacts	Environmental benefits, in terms of reduction of pollutant emissions (period analysed 2007 – 2012) CO_2: 270 tonnes, CO: 1.2 tonnes, NO_x: 160 kg, PM10: 100 kg
Inconvenience for Residents	
Beneficial Advantages	Reduction of noise pollution and risk for historical buildings. Qualitative results: improvement of the quality of life in the city centre for residents, visitors and tourists.
References	(VPF, 2017)

UCC	**Padua UCC – ITALY**
Type of UCC	Type one (All or part of urban area)
Year	2004
Model Type	Business model
The project name / Scheme	Cityporto Padova
Locations	The UDC is in the Interporto (freight village) out of the city. Venice is 26 miles away. (Town-wide)
Objectives	To consolidate the distribution of goods to reduce freight traffic inside the historical centre of the city, use environmentally-friendly delivery vehicles to reduce vehicle emissions, maintain the city's dynamism and vitality by offering reliable delivery services.
UCC Successful/ Failed	Successful
Type of product	Businesses
Number of users	33 couriers and 2 operators
Surface of the UCC (m^2) or (Km^2)	1000 m^2
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Natural gas powered and electric vehicle
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Expected to become permanent
Transport Operations	•UDC vehicles are granted 24-hour access to limited traffic zones in the city centre, use of bus lanes and use of reserved loading areas. •VMT (-127,000 vehicle kilometres in 15 months, trip mileage reduced by 26%).
Financial Issues (Subsidies)	The City and the Province of Padua, and the local Chamber of Commerce
Actors who started the initiatives	Interporto di Padova SpA
Environmental Impacts	Pollutant emissions (38.4 tones CO2 saved in 15 months).
Inconvenience for Residents	less Inconvenience

Beneficial Advantages	Public grants on total inflows have decreased from 85% in 2004 to 22% in 2007. The goal is to achieve economic self-sustainability. For a 5-year period, the estimated economic value of environmental benefits has been estimated to double the number of subsidies for the project.
References	(Browne et al., 2005, Panero et al., 2011, Galli, 2015)

UCC	***Siena UCC – ITALY***
Type of UCC	Type one (All or part of urban area)
Year	1999
Model Type	
The project name / Scheme	Piattaforma logistica COTAS
Locations	Two consolidation depots located just outside the city walls, one for food and one for other goods. (District)
Objectives	To improve the efficiency and reduce the number of trips and environmental impacts of urban goods transport in the historic city centre.
UCC Successful/ Failed	Successful
Type of product	Transport operators
Number of users	18 associated partners
Surface of the UCC (m^2) or (Km^2)	2000 m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Gas powered vehicles, Electrical
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	The UDC company operates twelve 3.5-ton gas powered vehicles and six 3.5-ton electric vehicles. Delivery trips to the city centre (-37%).
Financial Issues (Subsidies)	Subsidies from eDRUL
Actors who started the initiatives	ALIFE
Environmental Impacts	Delivery trips to the city centre (-37%).
Inconvenience for Residents	less Inconvenience

Beneficial Advantages	The UDC was established with financial aid of a demonstration project (ALIFE) – nearly 2 million Euro. Annual operating costs since the third year onwards are stabilized at 145,000 Euro approx. The UDC has also received funding from eDRUL project from 2002 to 2005, specifically aiming to enhancing IT services.
References	(Browne et al., 2005, Panero et al., 2011)

UCC	***Vicenza - ITALY***
Type of UCC	Type one (All or part of urban area)
Year	2005
Model Type	Business model
The project name / Scheme	Veloce
Locations	Outside the city (Town-wide)
Objectives	Part of a project to rationalise urban goods distribution through innovation to maximise the usage of the vehicles in circulation and reduce their number. Consolidation is the goal.
UCC Successful/ Failed	Successful
Type of product	Clothing, shops, bars and food services
Number of users	14 logistics operators
Surface of the UCC (m^2) or (Km^2)	The hub is c6-7000 m^2 of which 2,000 m^2
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Electric vehicles
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	40-50% reduction in fuel consumption.
Financial Issues (Subsidies)	
Actors who started the initiatives	public-private company
Environmental Impacts	20-30% reduction in vehicle emissions
Inconvenience for Residents	
Beneficial Advantages	Encourage the use of UCCs including permission to use bus lanes, lifting vehicle access time restrictions, priority parking space, exemption from road pricing. Help to reduce the noise, congestion and vehicle emissions. Improve the load factors and reduce goods vehicle trips and total distance travelled in the urban area.
References	(Browne et al., 2005)

UCC	***Marunouchi, Tokyo - JAPAN***
Type of UCC	Type one (All or part of urban area)
Year	2002
Model Type	Simulation model
The project name / Scheme	Co-operative Distribution System
Locations	District
Objectives	To investigate CDS (Co-operative Distribution System) in order to decrease distribution (especially delivery) costs.
UCC Successful/ Failed	Successful
Type of product	Delivered all product types except chilled and frozen handled
Number of users	5 big carriers and 13 smalls
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Natural gas trucks
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Temporary
Transport Operations	186 trucks delivered into the SP and 125 trucks made deliveries from the SP – a reduction of 33%. Only 30% of the freight carried by the participants went via the SP, the remainder was delivered direct to each building. The traffic control measures that were tested resulted in a50% reduction in on-road parking and a 35% increase in the use of underground parking thus improving traffic flows.
Financial Issues (Subsidies)	
Actors who started the initiatives	Public-private partnership
Environmental Impacts	Claimed 90% reduction in Nox – presumably only from the vehicles used.
Inconvenience for Residents	
Beneficial Advantages	Demonstrated that a cooperative approach to a problem produced far better outcomes that a non-cooperative approach which was the pre-trial approach. 18 (7.8%) carriers out of 232 serving the area participated and accounted for 7.2% of the trucks in the area and 22.2% of the "freights"
References	(OECD, 2003)

UCC	***Motomachi Joint Delivery Centre UCC - Yokohama - JAPAN***
Type of UCC	Type two (Large site with single landlord)
Year	2004
Model Type	Multi-Agent Systems (MAS) model
The project name / Scheme	Motomachi Shopping Street (MSS) project
Locations	1km away from Motomachi shopping street. (District)
Objectives	Developed to address concerns: roadside environment (air quality & noise) & traffic safety. To reduce number of trucks going through & parking on shopping street.
UCC Successful/ Failed	Successful
Type of product	Retail (Fresh products, Furniture)
Number of users	300 shops
Surface of the UCC (m^2) or (Km^2)	330 m^2
Trial, Study or Fully Operational	
Type of Vehicle used	Eco-truck
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	CO_2 emissions was reduced and improved the roadside environment especially the air quality and noise.
Inconvenience for Residents	
Beneficial Advantages	Reduce the transportation cost as well as the operation cost by reducing the number of trucks in the Motomatchi street.
References	(Thompson, 2014)

UCC	***Osaka - JAPAN***
Type of UCC	Type one (All or part of urban area)
Year	Not specified
Model Type	
The project name / Scheme	Urban distribution centre
Locations	Site Specific
Objectives	Improvements in delivery efficiency and cost reduction
UCC Successful/ Failed	
Type of product	
Number of users	Only 2 organisations involved
Surface of the UCC (m^2) or (Km^2)	
Trial , Study or Fully Operational	Trial
Type of Vehicle used	
Current Status	Not known if the project proceeded
Terms of Use Voluntary/Compulsory	Compulsory
Permanent/Temporary	Permanent
Transport Operations	Reduction in travel time for trucks, work hours and total costs.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Fukuoka (Tenjin) UCC – JAPAN***
Type of UCC	Type two (Large site with single landlord)
Year	1978
Model Type	Nemoto (1997) developed a mathematical evaluation model
The project name / Scheme	AIC
Locations	The depot is located in the city outskirts, close to the roads connecting to mainland Japan (route to Osaka, Tokyo). (Town-wide)
Objectives	Elimination of traffic congestion through the integration of services through establishing a consolidation centre (AIC).
UCC Successful/ Failed	Successful
Type of product	Business
Number of users	29 existing carriers
Surface of the UCC (m^2) or (Km^2)	15 Km^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Trucks
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	A 28% decrease in the total distance travelled (compared with not using a UCC). decrease in number of trucks compared with those previously doing the same work of 61%.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	Operating trucks (-61%), VMT (-28%), parking operations (-72%), parking time (-17%), energy, pollutant emissions.
Inconvenience for Residents	less Inconvenience

Beneficial Advantages	Decrease in number of trucks compared with those previously doing the same work of 61% , decrease in total traffic along the trunk road to city centre after introduction of the UCC of 0.8% , decrease in total delivery vehicle parking time in service roads in city centre after introduction of the UCC of 6.8%, decrease in total NOx emissions in Tenjin after the introduction of the UCC of 0.4% (measured at the intersection of two trunk roads), decrease in total fuel consumption in Tenjin after the introduction of the UCC of 0.3%
References	(Browne et al., 2005, Panero et al., 2011)

UCC	***LUXEMBOURG UCC***
Type of UCC	Type one (All or part of urban area)
Year	2012
Model Type	Governance model
The project name / Scheme	
Locations	Town-wide
Objectives	To coordinate the management of a city logistics policy focusing on a new Urban Consolidation Centre
UCC Successful/ Failed	Successful
Type of product	Parcels
Number of users	
Surface of the UCC (m^2) or (Km^2)	300-400 m^2
Trial, Study or Fully Operational	Study
Type of Vehicle used	Electric vans and CNG trucks
Current Status	Completed at the end of January 2015
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Funded by the Ministry of Sustainable Development and Infrastructure (MDDI) of Luxembourg and CFL Multimodal
Actors who started the initiatives	The Ministry of Sustainable Development and Infrastructure (MDDI) and the large logistics operator CFL Multimodal
Environmental Impacts	A strong reduction in emissions and a much smaller reduction in costs due to the low price of electricity.
Inconvenience for Residents	
Beneficial Advantages	The expected overall impacts are lower costs for businesses and reduced negative externalities for local communities.
References	(Leonardi et al., 2015)

UCC	***MONACO UCC***
Type of UCC	Type one (All or part of urban area)
Year	1989
Model Type	Monaco model
The project name / Scheme	MoCC
Locations	At the beginning, the UDC consisted of one 1,300 m^2 depot in the Fontvieille quarter; but later another depot needed to be added in a logistics area in Nice (France), a 20 minutes' drive to Monaco. (Town-wide)
Objectives	Reduce traffic congestion in the city and improving the distribution of goods
UCC Successful/ Failed	Successful
Type of product	Delivery
Number of users	
Surface of the UCC (m^2) or (Km^2)	1300 m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Electrical
Current Status	Active
Terms of Use Voluntary/Compulsory	Compulsory for vehicles >8.5t
Permanent/Temporary	Permanent
Transport Operations	Deliveries are made using 6.5-ton vehicles. Vehicles over 8.5 tons are banned from delivering in the city and must transfer their loads to the UDCs. There are time windows for deliveries using vehicles under 8.5 ton. -21% VMT, -36% energy consumption
Financial Issues (Subsidies)	Shared between the Principality of Monaco, the MoCC operator and the receivers and deliverers of goods
Actors who started the initiatives	Monaco Logistique, The Chamber of Commerce and Industry and ADEME (the French Energy Agency)
Environmental Impacts	Inside Monaco, -21% VMT, -36% energy consumption. Pollutant emissions have been reduced by the same proportion as energy.
Inconvenience for Residents	Less Inconvenience
Beneficial Advantages	A major share of the benefits is achieved in the consolidated trips between the depots in Nice and Fontvieille. For this trip, -53% VMT, -25% energy consumption.
References	(Panero et al., 2011)

UCC	***Amsterdam - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	1996
Model Type	Hybrid model
The project name / Scheme	Floating water distribution
Locations	District
Objectives	To reduce commercial vehicle movements in city centre
UCC Successful/ Failed	Successful
Type of product	Parcels
Number of users	5 largest operators
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Clean vehicles
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	Private initiative of logistics companies in partnership with the Chamber of Commerce and municipality
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Arnhem - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	1989
Model Type	Business model
The project name / Scheme	Binnenstadservice.nl
Locations	District
Objectives	To overhaul urban freight delivery resulted in a main proposal to develop “urban distribution centres”.
UCC Successful/ Failed	Successful
Type of product	Retail, fresh produce, waste
Number of users	
Surface of the UCC (m^2) or (Km^2)	8,000 m^2
Trial, Study or Fully Operational	Study
Type of Vehicle used	Environmentally friendly vehicles
Current Status	There is no evidence that the project proceeded
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Coopers & Lybrand
Actors who started the initiatives	Government
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Estimated that a UCC would handle 10% of all freight tonnage delivered in the town centre after allowing for exempted items (fresh produce, waste), consignments >1 cu. m. In cost terms it was estimated that the annual costs for a UCC (in million Dfl/annum) would be 20.4 without a UCC (transport only) and 15.5 with a UCC (transport 5.0, transhipment 10.5)
References	(Browne et al., 2005)

UCC	***Groningen - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	1995
Model Type	
The project name / Scheme	City Centre Better
Locations	North of the Netherlands. (District)
Objectives	To find a solution for the heavy traffic and environmental problems the City of Groningen decided to control the freight deliveries into the city centre with the help of several measures, e.g. special time-windows for distribution.
UCC Successful/ Failed	Successful
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Small environmentally friendly vehicles.
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	No problems with flow public transport, less transport time in the inner-city area. The deliveries became more efficient and more economical for the transport operators.
Financial Issues (Subsidies)	Coopers & Lybrand
Actors who started the initiatives	Government
Environmental Impacts	The environmental situation and the quality of life have become better
Inconvenience for Residents	
Beneficial Advantages	The research activity in Groningen has shown the positive reaction from all parties and positive results. In 1999 Groningen has won the first price of a city distribution contest, offered by the National Platform City Distribution.
References	(Browne et al., 2005, Kramer, 2003)

UCC	***Hague - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	2002
Model Type	Bottom-up approach
The project name / Scheme	
Locations	District
Objectives	The aim is to reduce the number of deliveries per week to an outlet by recognising that the average lead-time is 4-5 days
UCC Successful/ Failed	
Type of product	Fashion, Bars, jewellery
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	Small electric trucks
Current Status	There is no evidence that the scheme proceeded
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	Predicted reduction in no. of trips of 5%.
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	Heavy focus on environmental advantages of reducing lorry movements
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005, van Duin et al., 2010)

UCC	***Leiden UCC - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	1989 Trial, 1994 operational-2000.
Model Type	Dutch model
The project name / Scheme	Coordinated distribution in Leiden
Locations	In Leiderdorp next to Leiden located far from the highway. (Town-wide)
Objectives	To deliver 500 shipments per week to the city centre. a daily reduction of the number of commercial vehicles from 24,000 to 5,000 (-80%). To decrease congestion and decrease distribution costs.
UCC Successful/ Failed	Failed
Type of product	Parcels
Number of users	
Surface of the UCC (m^2) or (Km^2)	8,000 m^2
Trial, Study or Fully Operational	Study and Operational
Type of Vehicle used	Electrical
Current Status	Closed
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Estimated that a UCC would handle 10% of all freight tonnage delivered in the town centre after allowing for exempted items (fresh produce, waste etc), consignments >1 cu. m. Breakeven considered to be 600 shipments per day, while at best only achieved 394 a week.
Financial Issues (Subsidies)	Coopers & Lybrand
Actors who started the initiatives	Municipality
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(van Duin et al., 2010, Browne et al., 2005, Jarl Schoemaker, 2003, Janjevic et al., 2016)

UCC	***Maastricht - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	1989 & 1991
Model Type	Business model
The project name / Scheme	Binnenstadservice.nl
Locations	District
Objectives	To overhaul urban freight delivery resulted in a main proposal to develop “urban distribution centres”.
UCC Successful/ Failed	Successful
Type of product	Fresh produce, waste
Number of users	
Surface of the UCC (m^2) or (Km^2)	8,000 m^2
Trial, Study or Fully Operational	Study and Trial
Type of Vehicle used	Environmentally friendly vehicles
Current Status	There is no evidence that the scheme is continuing
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	Estimated that a UCC would handle 10% of all freight tonnage delivered in the town centre after allowing for exempted items (fresh produce, waste etc), consignments >1 cu. m. In cost terms it was estimated that the annual costs for a UCC (in million Dfl/annum) would be 20.4 without a UCC (transport only) and 15.5 with a UCC (transport 5.0, transhipment 10.5)
Financial Issues (Subsidies)	Coopers & Lybrand
Actors who started the initiatives	Government
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Traffic reduction impact to be less than 1%. Large reduction in freight vehicle km.
References	(Browne et al., 2005)

UCC	***Nijmegen UCC - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	2008
Model Type	Business model
The project name / Scheme	Binnenstadservice.nl
Locations	1.5 km^2 away from the serving area. (District)
Objectives	- To provide logistical services to local inner-city stores, regional consumers, carriers and local government. - To minimise the number of trips through the city centre. - To reduce congestion, emission of local air pollutants, and noise.
UCC Successful/ Failed	Successful
Type of product	Non- perishable goods
Number of users	98 retailers
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Trial then fully operational
Type of Vehicle used	Clean vehicles: electronic bicycles & natural gas trucks, electric vehicles
Current Status	Active
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	Reduce 32% vehicle kilometres.
Financial Issues (Subsidies)	Subsidies from government.
Actors who started the initiatives	Municipality
Environmental Impacts	Limited impacts on air quality by testing the NO2 and PM10 as the indicators, the noise nuisance is ignorable for residents.
Inconvenience for Residents	less Inconvenience
Beneficial Advantages	Decreasing the vehicle trips to achieve more beneficial outcomes and reduce the cost partly. Cooperation with shopkeepers, focus on receivers, obtain subsides from government, provide extra paid services from retailers and decrease the congestion of traffic and gas emission in the cities, make the cities become more habitable.
References	(van Duin et al., 2010, van Rooijen and Quak, 2010, Thompson, 2014)

UCC	***Utrecht - NETHERLANDS***
Type of UCC	Type one (All or part of urban area)
Year	First investigated in 1991. Operational since 1994.
Model Type	Business model
The project name / Scheme	Bevoorradingsplan Binnenstad Utrecht
Locations	Town-wide
Objectives	To improve amenity and accessibility of city centre and to protect the city's arched basements from heavy vehicle damage. reduce number of vehicle movements and kilometres, enforce weight and dimension restrictions in city centre, increase efficiency of distribution. The target was to reduce the number of trucks entering the city centre from 1500 to 400 a day.
UCC Successful/ Failed	Successful
Type of product	
Number of users	Two companies
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	
Financial Issues (Subsidies)	Does not receive any public subsidy
Actors who started the initiatives	Private sector with some support from municipal authority
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	It was originally estimated that 80% of conforming shipments would be handled through the UCCs. In practice, far less produce than this passes through the UCCs. The two companies have estimated that the UCC operation only accounts for approximately 2% of the total goods throughput in the depot.
References	(Ruesch et al., 2015)

UCC	***Oslo UCC - NORWAY***
Type of UCC	Type one (All or part of urban area)
Year	Spring 2014
Model Type	Business model
The project name / Scheme	
Locations	City centre of Oslo. (Town-wide)
Objectives	To optimize deliveries and minimize transport. To improve the situation for local freight stakeholders and for the city environment.
UCC Successful/ Failed	Failed
Type of product	Goods Delivery
Number of users	
Surface of the UCC (m^2) or (Km^2)	16 km^2
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Large Truck
Current Status	Stopped
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Nordtømme et al., 2015)

UCC	***West Pomeranian UCC - POLAND***
Type of UCC	Type one (All or part of urban area)
Year	
Model Type	SWOT analysis
The project name / Scheme	
Locations	Located on the Baltic Sea coast in west-north part of Poland. (Town-wide)
Objectives	• Reducing costs of transport-manufacturers supply of goods for recipients located in the city to the centre from which deliveries to the final customers are realized after all supplies had been accumulated from a specified territory. • Better use of the transport fleet. • Reducing noise and pollution due to the use of environmentally friendly means of transport at the time and in the area where the traffic of traditional means of transport would be impossible (e.g. in the city centres at night).
UCC Successful/ Failed	
Type of product	Tourism
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	
Type of Vehicle used	Environmentally friendly vehicle (electric and hybrid propulsion)
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Chwesiuk et al., 2010)

UCC	***Evora UCC – PORTUGAL***
Type of UCC	Type one (All or part of urban area)
Year	2000
Model Type	The management model
The project name / Scheme	The project is called ECOLOGUS
Locations	City outskirts. Well-preserved old town centre enclosed by medieval walls. (District)
Objectives	Guarantee economic distribution of goods / reduce environmental impact (especially on buildings) / improve flow of traffic / improve image of transport sector.
UCC Successful/ Failed	Successful
Type of product	Delivery
Number of users	9 shipping companies supported by a national association of freight carriers
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Biodiesel vehicles
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	The UDC has been developed in response to a new regulation banning vehicles over 3.5 ton from the city centre. For the 9 involved companies, this regulation would have implied to increase from 14 to 25 vehicles to keep delivering to the city. 35% reduction in trips.
Financial Issues (Subsidies)	Subsidies from legal autonomous entity
Actors who started the initiatives	An association of private companies (ECOGUS)
Environmental Impacts	35% reduction in trips and CO_2 emissions.
Inconvenience for Residents	less Inconvenience
Beneficial Advantages	Delivery cost is expected to be kept around 30 Euro per ton of goods delivered. Expected benefits: 35% reduction in trips and CO_2 emissions. These benefits are estimated and not confirmed yet by real operational data.
References	(Panero et al., 2011, Browne et al., 2005)

UCC	***Malaga - SPAIN***
Type of UCC	Type one (All or part of urban area)
Year	2002, with an operational start date of February 2004
Model Type	
The project name / Scheme	CUDE
Locations	The historic centre of Malaga (District)
Objectives	To consolidate loads bound for the city arriving on vehicles >16t onto the 16t vehicles for transfer to the UCC.
UCC Successful/ Failed	No longer operational
Type of product	Parcels, food, clothing, restaurant, financial service, public service
Number of users	
Surface of the UCC (m^2) or (Km^2)	3,000 m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Electric vehicles
Current Status	Stopped in 2009
Terms of Use Voluntary/Compulsory	Compulsory
Permanent/Temporary	Permanent
Transport Operations	Reduction in vehicle movement and operating
Financial Issues (Subsidies)	An independent company
Actors who started the initiatives	Local municipality
Environmental Impacts	Fewer emissions.
Inconvenience for Residents	
Beneficial Advantages	In August 2004, after four months of operation, the Malaga UCC was achieving throughput of approximately one-third of its capacity. Fetrama (the Malaga Transport Federation) believes that this relatively low degree of use is possibly due to the goods vehicles continuing to make deliveries in the historic centre of Malaga by double-parking and parking illegally.
References	(Browne et al., 2005)

UCC	***Gothenburg I - SWEDEN***
Type of UCC	Type one (All or part of urban area)
Year	Study: 1991. Experiment: 1996
Model Type	A simulation Model
The project name / Scheme	The coordinated distribution schemes.
Locations	Located at the inner-city area of Gothenburg. (District)
Objectives	To reduce goods vehicle traffic and its related environmental impacts in an inner-city area.
UCC Successful/ Failed	
Type of product	Food and grocery deliveries
Number of users	5 suppliers
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study and Trial
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Supported by the local government, the Communication Research Board and Volvo.
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Huijsmans and Wildeboer, 1997)

UCC	***Gothenburg II - SWEDEN***
Type of UCC	Type one (All or part of urban area)
Year	2012
Model Type	Business model
The project name / Scheme	Stadsleveransen
Locations	In the central business district of the city
Objectives	To improve the efficiency of freight distribution in the city.
UCC Successful/ Failed	Successful
Type of product	Goods delivery
Number of users	A small group of 8-10 shops
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Small electric vehicles
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	EC-projects, the PA, the trade association, six property owners, a municipal energy company and the regional municipal administration
Actors who started the initiatives	Municipality
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	In one year, the network of retailers using the solution expanded to some 200, and an additional haulier using electric cargo bikes has been added. An additional revenue stream of significance was found in the sale of advertising space on the vehicle.
References	(Carlo Vaghi, 2014)

UCC	***Hammarby UCC - SWEDEN***
Type of UCC	Type three (Construction)
Year	Spring 2001 and to remain until the building project is complete (2010).
Model Type	Simulation model
The project name / Scheme	SHCC
Locations	Near the building construction site. (Site Specific)
Objectives	The objectives of the project were to: decrease # of small deliveries, reduce congestion, reduce energy use and emissions of CO2, NOx, and particles, and improved living and working conditions. Minimising the impact of the largest ongoing urban development in Sweden on the early residents (8,000 apartments being built in total). Eliminating unco-ordinated delivery vehicles "touring" the site in search of their delivery point.
UCC Successful/ Failed	Successful
Type of product	Construction materials
Number of users	Large construction site with 8000 apartments
Surface of the UCC (m^2) or (Km^2)	3,500 m^2 inside and 4,000 m^2 outside
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Truck
Current Status	Closed
Terms of Use Voluntary/Compulsory	Compulsory except for exempted materials.
Permanent/Temporary	Permanent
Transport Operations	Estimated that for every truck delivering under this system there would have been 4-5 without the use of the centre. 700t delivered per day / average of 1.5t per final delivery / one delivery every 30 seconds
Financial Issues (Subsidies)	The Local Investment Programme – LIP, Part funded by the EU through the CIVITAS Trendsetter programme.
Actors who started the initiatives	City of Stockholm
Environmental Impacts	Might cause environment issues for nearby residents, because of the construction of building and delivery activities from UCC to building sites.
Inconvenience for Residents	Might feel Inconvenience
Beneficial Advantages	Reduce operation cost for construction project totally.
References	(Browne et al., 2005)

UCC	***Stockholm (centre) UCC – SWEDEN***
Type of UCC	Type one (All or part of urban area)
Year	2000
Model Type	
The project name / Scheme	Stockholm Royal Seaport Project (SRSP).
Locations	The logistic centre is located at the point called O-centralen near the Old Town (District)
Objectives	Reduce the number of small direct deliveries, to reduce congestion levels, to improve environment and living conditions as well as to reduce energy consumption and emissions.
UCC Successful/ Failed	Successful
Type of product	Food deliveries
Number of users	35 restaurants
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Hybrid trucks, electric vans
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Goods are delivered to restaurants (80%) and stores (20%). The UDC has cold storage facilities. By 2005 the UDC was delivering to 35 out of 100 restaurants in the old town. Deliveries are made with a biogas powered truck. Deliveries in the old town are only allowed from 6am to 11am. A one-year extension until 4pm was granted for the vehicles operating from the UDC. VMT is expected to decrease by 65%.
Financial Issues (Subsidies)	CIVITAS-TRENDSETTING
Actors who started the initiatives	Home2you
Environmental Impacts	Estimated 17% reduction in energy consumption and pollutant emissions.
Inconvenience for Residents	less Inconvenience
Beneficial Advantages	Reduce vehicle movement and congestion in narrow streets.
References	(Browne et al., 2005, Panero et al., 2011)

UCC	***Uppsala - SWEDEN***
Type of UCC	Type one (All or part of urban area)
Year	2001
Model Type	A simulation Model
The project name / Scheme	USTRA, The Universities coordination of goods transports
Locations	District
Objectives	To map city centre goods distribution in order to investigate the potential for coordinated goods distribution to reduce cost, congestion and environmental impact.
UCC Successful/ Failed	Successful
Type of product	Agricultural produces and food
Number of users	4 Galleria
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study and then trial
Type of Vehicle used	Trucks
Current Status	There is no evidence of the scheme proceeding
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	Reduced delivery times and fixed times of delivery. Fewer stops per trip and reduction in total distance driven.
Financial Issues (Subsidies)	
Actors who started the initiatives	Swedish University of Agricultural Sciences
Environmental Impacts	Improved traffic and environmental conditions – lower emissions, congestion and noise
Inconvenience for Residents	
Beneficial Advantages	Improvements of a coordinated approach seen as: More effective deliveries for retailers & logistics companies through fewer deliveries, reduced delivery times and fixed times of delivery; Improved vehicle utilisation – improved loading, fewer vehicles, fewer stops per trip and reduction in total distance driven; Improved traffic and environmental conditions – lower emissions, congestion and noise plus improved security and accessibility.
References	(Browne et al., 2005, Gebresenbet, 1999, Gebresenbet and Ljungberg, 2002)

UCC	***Basel - SWITZERLAND***
Type of UCC	Type one (All or part of urban area)
Year	1993
Model Type	
The project name / Scheme	Basel City Logistik
Locations	Town-wide
Objectives	To solve the freight distribution problems in the city by reducing the number of commercial vehicle movements and the levels of pollutants, noise and energy consumption, but without reducing delivery services
UCC Successful/ Failed	Failed
Type of product	
Number of users	12 transport companies + postal services
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Eco-diesel; gas; electric.
Current Status	Stopped
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	Load factor: raised from 28% to 47%, Number of consignments / day / vehicle: from 8 to 15, Average tonnage / load: from 0.28 to 0.52 Fuel consumption: diesel from 17 litres / 100 km to 15, Petrol from 18.8 l / 100 km to 18.6.
Financial Issues (Subsidies)	The cost of the study project, management and coordination + the gas & electric vehicles were funded by DIANE 6 at outset, but the intention is that the operation will be self-funding.
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Zurich - SWITZERLAND***
Type of UCC	Type one (All or part of urban area)
Year	1994
Model Type	
The project name / Scheme	The Oerlikon Cargo project
Locations	Located close to the national freeway and the Zurich western bypass. (Town - wide)
Objectives	To reduce the number of deliveries and consequently to improve the accessibility and quality of life in the city centre.
UCC Successful/ Failed	Not very successful
Type of product	
Number of users	7 retailers
Surface of the UCC (m^2) or (Km^2)	100 m^2
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Electric vans
Current Status	Stopped
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	
Financial Issues (Subsidies)	Project part-funded by 2 major retailers (Migros & Co-op)
Actors who started the initiatives	Government
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	The trial ran for 8 months. The investment in setting up the trial was approximately 190,000 Swiss Francs (including advertising costs of 30,000 Francs). The operating costs of the trial were 40,000 Francs (this including rent paid for the UCC, and the handling and delivery costs).
References	(Browne et al., 2005)

UCC	***Aberdeen - UK***
Type of UCC	Type two (Large site with single landlord)
Year	1997
Model Type	
The project name / Scheme	
Locations	City’s prime shopping area. (District)
Objectives	To reduce / eliminate large vehicles making small deliveries to create environmental benefits in city’s prime shopping area.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	The scheme did not proceed
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Barnsley - UK***
Type of UCC	Type one (All or part of urban area)
Year	1976
Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	To examine the feasibility of peripheral transhipment in an urban area with a view to enhancing the urban environment Seeking to understand the impact of transhipment, and by implication, consolidation on traffic levels and the cost of urban delivery.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	Managed by the local authority or a private contractor
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Bluewater, Kent - UK***
Type of UCC	Type one (All or part of urban area)
Year	2002
Model Type	
The project name / Scheme	
Locations	Site Specific
Objectives	A commercial venture principally aimed at enabling retailers to minimise their in-store stock holding and stock handling operations thereby enabling them to maximise sales space and minimise non-retailing activities by their staff.
UCC Successful/ Failed	The success or otherwise of the operation is not known
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	6,500 m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	
Financial Issues (Subsidies)	Tibbett & Britten plc (now part of Exel plc).
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	Deliveries are consolidated and made to times agreed with the retailer. Minimum response time is 3 hours.
References	(Browne et al., 2005)

UCC	***Bradford -UK***
Type of UCC	Type one (All or part of urban area)
Year	1975
Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	To examine the feasibility of peripheral transhipment in an urban area with a view to enhancing the urban environment. Seeking to understand the impact of transhipment, and by implication, consolidation on traffic levels and the cost of urban delivery.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	WYTCONSULT
Actors who started the initiatives	Managed by the local authority or a private contractor
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Bristol (Broadmead) UCC – UK***
Type of UCC	Type one (All or part of urban area)
Year	2004
Model Type	Business model
The project name / Scheme	START project (Short Term Action to Reorganize Transport of Goods)
Locations	The UDC is located in the city outskirts, close to strategic road network 16km from Broadmead shopping area. (District)
Objectives	To reduce goods vehicle activity in the central retailing area (Broadmead), thereby helping to relieve traffic congestion, improve air quality and minimise conflict between vehicles at loading areas/delivery bays. Intended to provide suppliers and retailers with improved logistics services, removing the need for suppliers to send their vehicles into central Bristol, increasing delivery reliability and offering a range of value-added services for such as pre-retailing, remote storage, and packaging and waste collection.
UCC Successful/ Failed	Successful
Type of product	Non- perishable goods
Number of users	188 retailers
Surface of the UCC (m^2) or (Km^2)	5000 m^2
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Diesel-powered vehicle, Electric vehicle
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Reduce 68% of vehicle movements; Use standard engine vehicles.
Financial Issues (Subsidies)	Subsidies from government.
Actors who started the initiatives	Municipality
Environmental Impacts	Decrease gas emission, improve the local air quality (based on the data of CO_2, NO_2 and PM_{10}
Inconvenience for Residents	Less Inconvenience
Beneficial Advantages	By reducing 68% of vehicle movements to gain beneficial outcomes and reduce the cost partly.
References	(Browne et al., 2005, Panero et al., 2011, Julian et al., 2014)

UCC	***Camberley - UK***
Type of UCC	Type one (All or part of urban area)
Year	1975
Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	To examine the feasibility of peripheral transhipment in an urban area with a view to enhancing the urban environment. Seeking to understand the impact of transhipment, and by implication, consolidation on traffic levels and the cost of urban delivery.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	CIDP Ltd
Actors who started the initiatives	Managed by the local authority or a private contractor
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Chester - UK***
Type of UCC	Type one (All or part of urban area)
Year	1997
Model Type	
The project name / Scheme	
Locations	District
Objectives	To measure the traffic levels and a postal survey to gain the views of possible users.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Chichester - UK***
Type of UCC	Type one (All or part of urban area)
Year	1975
Model Type	
The project name / Scheme	
Locations	District
Objectives	Seeking to understand the impact of transhipment, and by implication, consolidation on traffic levels and the cost of urban delivery. To examine the feasibility of peripheral transhipment in an urban area with a view to enhancing the urban environment.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Lichfield and associates / County Planning Officer
Actors who started the initiatives	Managed by the local authority or a private contractor
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	The County Planner recommended the "all traffic" option to avoid any hgv's entering the city centre. This was the more expensive option but also offered the greatest environmental benefit. 3 options were cost modelled: 1. All throughput, low delivery frequency, 3t vehicles indexed cost 259.9 2. Ltd throughput, high delivery frequency, 3t vehicles indexed cost 103.8 3. Ltd throughput, low delivery frequency, 3t vehicles indexed cost 100.0
References	(Browne et al., 2005)

UCC	***City of London - UK***
Type of UCC	Type one (All or part of urban area)
Year	1997
Model Type	
The project name / Scheme	
Locations	District
Objectives	A study to consider freight and its impact on the challenge "to create a working and leisure environment which will secure the City's future . . . "
UCC Successful/ Failed	
Type of product	Food hygiene
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	Electric
Current Status	No scheme has been proceeded with to date.
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	DETR (now DfT)
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***City of London Micro-Consolidation Centre - UK***
Type of UCC	Type one (All or part of urban area)
Year	2009
Model Type	Network of transports and environment NTM-method
The project name / Scheme	Micro-consolidation centre
Locations	City of London. (Town-wide)
Objectives	To reduce the environmental impacts of their delivery operation
UCC Successful/ Failed	Successful
Type of product	Office products
Number of users	
Surface of the UCC (m^2) or (Km^2)	2.9 km^2
Trial, Study or Fully Operational	Trial then fully operational
Type of Vehicle used	Electrical
Current Status	Active
Terms of Use Voluntary/Compulsory	Compulsory
Permanent/Temporary	Permanent
Transport Operations	The total distance travelled as a result of this delivery system fell by 20%
Financial Issues (Subsidies)	The London Borough of Camden, Office Depot
Actors who started the initiatives	Office Depot
Environmental Impacts	Reduction of 20 per cent in the total distance driven per parcel delivered between the suburban depot and the customer delivery locations. Total CO_2 equivalent emissions per parcel delivered was 54 per cent lower in May 2010 than in October 2009
Inconvenience for Residents	Less Inconvenience
Beneficial Advantages	Reduce the CO_2 emissions due to the reduction in the total distance travelled per parcel and the use of electric vehicles
References	(Julian et al., 2014)

UCC	***Hammersmith (London) - UK***
Type of UCC	Type one (All or part of urban area)
Year	1974
Model Type	
The project name / Scheme	
Locations	District
Objectives	To examine the feasibility of peripheral transhipment in an urban area with a view to enhancing the urban environment. Seeking to understand the impact of transhipment, and by implication, consolidation on traffic levels and the cost of urban delivery.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Metra Ltd
Actors who started the initiatives	Managed by the local authority or a private contractor.
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Hull - UK***
Type of UCC	Type one (All or part of urban area)
Year	1976
Model Type	
The project name / Scheme	
Locations	Town-wide
Objectives	Seeking to understand the impact of transhipment, and by implication, consolidation on traffic levels and the cost of urban delivery. To examine the feasibility of peripheral transhipment in an urban area with a view to enhancing the urban environment.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Lorries and the Environment Committee / TRRL
Actors who started the initiatives	Managed by the local authority or a private contractor.
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Heathrow Airport (Construction) UCC – UK***
Type of UCC	Type three (Construction)
Year	2001
Model Type	
The project name / Scheme	Construction consolidation centre
Locations	At Hatton Cross (Site Specific)
Objectives	To deliver our extensive capital programme on-time, on-budget, with minimum impact on our customers
UCC Successful/ Failed	Successful
Type of product	Construction materials
Number of users	All building and specialist contractors working in the terminal (85 in total)
Surface of the UCC (m^2) or (Km^2)	1858 m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Truck
Current Status	Still operating
Terms of Use Voluntary/Compulsory	Compulsory except for exempted items.
Permanent/Temporary	Permanent
Transport Operations	Reduction in number of deliveries "airside" – not quantified
Financial Issues (Subsidies)	
Actors who started the initiatives	Wilson James Ltd., Mace Ltd., British Airports Authority (BAA)
Environmental Impacts	Reductions in congestion, pollution and carbon dioxide emissions.
Inconvenience for Residents	
Beneficial Advantages	Improvements in productivity (+5% claimed through having materials on time), safety and environmental matters. Reduction in waste. The centre provides a "buffer stock" for materials with long or complex supply chains.
References	(Browne et al., 2005)

UCC	***Heathrow Airport (retail) UCC – UK***
Type of UCC	Type two (Large site with single landlord)
Year	2000
Model Type	German Model
The project name / Scheme	Retail consolidation centre
Locations	The consolidation depot is located 2.5 km^2 from Terminal 4. (Site Specific)
Objectives	To reduce goods vehicle movements, and to improve goods handling systems and waste packaging management in the terminals. All deliveries should pass except for newspaper deliveries, cash and valuable items which should continue to be delivered directly to retail outlets
UCC Successful/ Failed	Successful
Type of product	Chilled & frozen
Number of users	40 retailers
Surface of the UCC (m^2) or (Km^2)	2323 m^2
Trial, Study or Fully Operational	Fully operational
Type of Vehicle used	Tractor, Van trailers with tail-lifts, trailers had dual compartments and Electric vehicle.
Current Status	Active
Terms of Use Voluntary/Compulsory	Initially voluntary. Compulsory for all retailers in the terminals since 2004.
Permanent/Temporary	Permanent
Transport Operations	Reduces vehicle deliveries to outlets in the airport by approximately 80 per cent. It has been estimated that in 2008 these consolidated deliveries resulted in a saving of 218,000 km^2. This reduction in total distance travelled together with the use of an electric vehicle has been estimated to result in a 158,000 kg reduction in CO_2 emissions.
Financial Issues (Subsidies)	The operator DHL, The airport operator HAL
Actors who started the initiatives	A partnership between British Airports Authority (BAA) and a logistics provider (Exel)

Environmental Impacts	Decreasing several air pollutants including more than 22 tons of CO_2 and 70 kg of carbon monoxide, roughly 200 kg of NOx and 15 kg of PM per year. Emission reductions, including CO_2 savings of over 62 and 160 metric tons per year in 2003 and in 2004, respectively. Reductions in congestion
Inconvenience for Residents	Less Inconvenience
Beneficial Advantages	Large reduction in the number of vehicles traveling within the airport, faster and more reliable deliveries, improved overall security, and customers' increased satisfaction (e.g., door-to-door service; more flexibility to schedule deliveries), as well as reductions in congestion, VMT and pollution.
References	(Browne et al., 2005, Panero et al., 2011, Julian et al., 2014)

UCC	***London Construction Consolidation Centre (LCCC) - UK***
Type of UCC	Type three (Construction)
Year	2005 to 2007
Model Type	An operational model
The project name / Scheme	LCCC project
Locations	South Bermondsey, approximately five kilometres south of the City of London. Not far away from the four major construction sites. (Site Specific)
Objectives	The LCCC was intended to reduce the number of deliveries going directly to the construction sites and thereby reducing traffic congestion and vehicle emissions.
UCC Successful/ Failed	Successful
Type of product	Construction
Number of users	4 construction sites
Surface of the UCC (m^2) or (Km^2)	5000 m^2
Trial, Study or Fully Operational	Trial
Type of Vehicle used	Flatbed rigid vehicles, Van, curtain-sider rigid vehicle
Current Status	Closed
Terms of Use Voluntary/Compulsory	Compulsory
Permanent/Temporary	
Transport Operations	The reduction in the number of vehicles delivering materials to four construction sites was estimated from 60 to 70 per cent. The total amount of deliveries was reduced by approximately 40 per cent.
Financial Issues (Subsidies)	Funded by Transport for London, partnership of private developers/construction companies
Actors who started the initiatives	
Environmental Impacts	CO_2 emissions reduced by 70-80% because of the 60-70% reduction in vehicle movement, thus the local air quality was improved
Inconvenience for Residents	Less Inconvenience, this is because of some materials such as aggregates, structural steel and concrete were sent to the construction site directly.
Beneficial Advantages	Reduce operation cost for construction project totally. Increased the productivity of the labour force on the construction sites by up to 25 minutes per person per day.
References	(Julian et al., 2014, Panero et al., 2011)

UCC	***Meadowhall Shopping Centre UCC - UK***
Type of UCC	Type two (Large site with single landlord)
Year	2001
Model Type	
The project name / Scheme	
Locations	Located adjacent to the M1 on the edge of the city of Sheffield. The UCC is located on the perimeter of the shopping centre site. (Site Specific)
Objectives	To provide the retailers with value-added services such as storage
UCC Successful/ Failed	Successful
Type of product	Retail
Number of users	180 retailers
Surface of the UCC (m^2) or (Km^2)	3,000 m^2
Trial, Study or Fully Operational	Trial and then fully operation
Type of Vehicle used	
Current Status	Active
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	Permanent
Transport Operations	Reduced the number of vehicles delivering to Meadowhall shopping centre. The number of vehicle deliveries to stores using the UCC has been reduced by approximately 65 per cent
Financial Issues (Subsidies)	Initially operated by Exel Logistics until 2006 but is now run by Clipper Secure Logistics
Actors who started the initiatives	British Land (the owners of the Meadowhall shopping centre)
Environmental Impacts	Vehicle trip reduction will contribute to traffic and environmental advantages
Inconvenience for Residents	
Beneficial Advantages	Reduction in total goods vehicle journeys and an increase in delivery time flexibility minimising total mileage and allowing goods vehicle deliveries at off-peak times.
References	(Browne et al., 2005)

UCC	***Swindon - UK***
Type of UCC	Type one (All or part of urban area)
Year	1976 based on 1973 data
Model Type	
The project name / Scheme	
Locations	District
Objectives	To examine the feasibility of peripheral transhipment in an urban area with a view to enhancing the urban environment. Seeking to understand the impact of transhipment, and by implication, consolidation on traffic levels and the cost of urban delivery
UCC Successful/ Failed	
Type of product	Bulk materials, hazardous materials, furniture
Number of users	
Surface of the UCC (m^2) or (Km^2)	<5 km^2
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	Compulsory
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	Transport and Road Research Laboratory (TRRL)
Actors who started the initiatives	Managed by the local authority or a private contractor.
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	A cost penalty of £9.10 per tonne handled was estimated of which more than 50% was labour plus an additional £2.00 per tonne for loss and damage. There appears to have been a 20% profit margin in the figures.
References	(Browne et al., 2005)

UCC	***Winchester - UK***
Type of UCC	Type one (All or part of urban area)
Year	1994
Model Type	The classic 1970's model
The project name / Scheme	PICK-UP Centre/delivery point
Locations	Town-wide
Objectives	To restrict the weight and size of lorries allowed into the town.
UCC Successful/ Failed	
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	
Current Status	
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	The large vehicles into small approach is now largely discounted as a means of reducing the effect of freight vehicles in town centres except where the large vehicles only have a small load or is making a large number of deliveries.
Financial Issues (Subsidies)	
Actors who started the initiatives	Oscar Faber TPA Consultancy for Hampshire County Council
Environmental Impacts	The environmental benefits were agreed, but it was considered that "the magnitude of these benefits is relatively small compared with the cost of setting up and operation of a transhipment centre".
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Worcester - UK***
Type of UCC	Type one (All or part of urban area)
Year	1980's Finally abandoned in 1990
Model Type	
The project name / Scheme	
Locations	Outside the city centre (next to the ring road). (Town-wide)
Objectives	To permit retailers to receive deliveries in pedestrianised zones in the city centre during the periods when vehicles were banned and seen as an alternative to out-of-hours servicing.
UCC Successful/ Failed	The Council rejected the scheme
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	<2 km^2
Trial, Study or Fully Operational	Study
Type of Vehicle used	Electric vehicles
Current Status	The Council rejected the scheme on basis of operating and capital costs.
Terms of Use Voluntary/Compulsory	Voluntary
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	
References	(Browne et al., 2005)

UCC	***Columbus, Ohio - USA***
Type of UCC	Type one (All or part of urban area)
Year	1972-74
Model Type	Simulation model
The project name / Scheme	The UMTA/OSU Study
Locations	District
Objectives	To measure the impact of a consolidation centre on urban freight traffic
UCC Successful/ Failed	Successful
Type of product	
Number of users	
Surface of the UCC (m^2) or (Km^2)	
Trial, Study or Fully Operational	Study
Type of Vehicle used	Articulated vehicles
Current Status	Not implemented
Terms of Use Voluntary/Compulsory	
Permanent/Temporary	
Transport Operations	
Financial Issues (Subsidies)	US Department of Transport
Actors who started the initiatives	
Environmental Impacts	
Inconvenience for Residents	
Beneficial Advantages	The study identified potential benefits of the following reductions: 90% in number of vehicles; 91% in distance travelled, 91% in transit time, 53% in unloading time, 37% in loading time, 100% in queuing time, 76% in annual cost, vehicle emissions and traffic congestion.
References	(McKinnon, 1998b, McDermott and Robeson, 1974)