City Logistics in China – An Empirical Study from An Emerging-Market-Economy Country

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Abstract

City logistics is a young research area. It has undergone over three decades of development since its conception in the last century. It is believed to have the potential to support the realisation of building up sustainable cities. After successful development during the last three decades, China has been seeking a more healthy economic growth model relying on urbanisation and domestic consumption. This is because one billion citizens are expected to be living in Chinese cities by 2030. Logistics has hereby been given the mission to assist this transition of the economic growth model by establishing a reliable goods supply on one hand, and improving citizens' quality of life on the other – all in a way that develops sustainable urbanisation. This thesis thus addresses this issue, aiming to examine *whether the concept of city logistics is suitable and applicable for China's cities to build a sustainable urbanisation*.

In order to provide a reliable answer to the above-raised question, the thesis is designed in a structural way and consists of several interrelated parts in sequence. After the introduction of the research background and questions, the thesis begins with an exploration of city logistics, both in theory and in practice. The findings of this part include the conceptual framework of city logistics, an extensive list of city logistics solutions and an elaboration of the urban consolidation centre solution. Together these findings present a comprehensive discussion and lay the foundation for the empirical study of city logistics in China.

The thesis then shifts focus from city logistics in general to China. The results of a macro-environment analysis indicate that city logistics must operate within complex surroundings abundant in challenges and opportunities, which require joint effort both from the private and public sector in a shared work process.

An empirical study is conducted in the selected city of Chengdu. Following a situational analysis, a visionary master plan is recommended for developing a city logistics system consisting of four building blocks that are functionally inter-related. In respect to implementing the city logistics system and any related solutions, it is of utmost importance to study the attitudes of users of city logistics services. Therefore, an empirical study using the technique of partial least squares path modelling is carried out in order to determine the influential factors and their impacts. The results confirm the proposed path model and indicate valuable implications for cities and managers implementing the solution of an urban consolidation centre.

The rest of the thesis focuses on the investigation of the solution of an urban consolidation centre from a corporate perspective. It employs the approach of business case analysis and investigates its commercial feasibility. Although the results, namely the net profit figure (0.9%), yielded during the study, is lower than the predicted outcome, the study can help cities and managers acknowledge the reality of implementing an urban consolidation centre from a commercial viewpoint. A series of measures is also recommended to help find ways to increase the profitability of the centre to facilitate a successful implementation.

To sum up, the findings from the individual parts work together to provide a consolidated answer to the overriding research question.

Zusamenfassung

City-Logistik ist ein junges Forschungsgebiet. Es wird angenommen, dass es das Potential hat, um die Realisierung des Aufbaus nachhaltiger Städte zu unterstützen. Nach einer erfolgreichen Entwicklung in den vergangenen 30 Jahren hat China den Bedarf nach einem nachhaltigen Wirtschaftswachstumsmodell, das vor allem auf die Urbanisierung und den Binnenmarktkonsum gestützt wird. Der Hauptgrund dafür ist, dass nach einer Prognose 1 Milliarde Bürger in den chinesischen Städten bis zum Jahr 2030 leben werden. Logistik ist hiermit der Auftrag gegeben, um das Wirtschaftswachstum zu unterstützen. Es soll auf einer Seite eine zuverlässige Güterversorgung aufbauen und auf anderer Seite die Lebensqualität durch Minimierung der negative Effekte der Logistikaktivität (insbesonderes der Güterverkehr innerhalb einer Stadt) verbessern. Diese Arbeit fokussiert die City-Logistik in China und untersucht „*Ob das Konzept der City-Logistik für die chinesischen Städte geeignet und anwendbar ist, um eine nachhaltige Urbanisation aufzubauen*.“

Um eine verlässliche Antwort auf die oben-gestellte Frage zu anstreben, ist diese Arbeit in einer strukturellen Weise entworfen und besteht aus vier miteinander-verbundenen Kapitel.

Nach der Einführung von Hintergrund und den Forschungsfragen beginnt die Arbeit mit der Untersuchung von City-Logistik auf Theorie und Praxis in dem ersten Kapitel. Zu den Ergebnissen von dem Grundlagenkapitel gehören ein Konzeptrahmen von City-Logistik, eine umfangreiche Liste von City-Logistik-Lösungen und eine Ausarbeitung der Lösung von Urban-Consolidation-Centre. Alle Ergebnisse basieren auf einer umfassenden Diskussion dar und bilden die Basis für die empirische Untersuchung zur City-Logistik in China.

Das zweite Kapitel fokussiert auf die Entwicklung der City-Logistik in China. Die Ergebnisse der Analyse von Makro-Umgebung zeigen die City-Logistik in China in einem komplexen Umfeld. Sowohl der private Sektor als auch der öffentliche Sektor sollen gemeinsam anstrengen, um die Herausforderungen zu überwindeln und die Gelegenheit zu ergreifen.

Das dritte Kapitel führt eine empirische Untersuchung als Beispiel der Stadt Chengdu ein. Folgend den Ergebnisse einer Situationsanalyse wird ein visionärer Masterplan für die Entwicklung eines City-Logistik-Systems mit vier Subsystemen, die funktional miteinander verbunden sind, empfohlen. In Bezug auf die Umsetzung des City-Logistik-Systems und alle damit verbundenen Lösungen ist es außerordentlich wichtig, die Einstellungen von den potentialen Nutzern auf die City-Logistik-Dienstleitungen zu studieren. Daher wird eine Kausalanalyse mit der Methode des Partial-Least-Squares-Ansatzes auf der Suche nach den Einflussfaktoren und deren Auswirkungen realisiert. Die Ergebnisse bestätigen das angenomme Pfad-Model und geben wertvolle Hinweise und Implikationen für Städte und Managers, die sich mit der Umsetzung der Lösung von Urban-Consolidation-Centre beschäftigen.

Das letzte Kapitel der Arbeit untersucht die wirtschaftliche Realisierbarkeit der Lösung von Urban-Consolidation-Centre aus Unternehmensperspektive. Der Ansatz von Business-Case-Analysis wird als Forschungsmethode angwandt. Die durschnittliche Nettoumsatzrendite der Business-Case-Analysis in den kommenden fünf Jahre ist unten 1% (0.9%). Weiterhin werden eine Reihe von Maßnahmen empfohlen, um die Rentabilität des Centres zu erhöhen und eine erfolgreiche Umsetzung zu erreichen.

Zusammenfassend lassen sich die Forschungsergebnisse aus den vier Fortschungsteilen der Studie eine konsolidierte Antwort auf die Forschungsfrage liefern können.

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List of Abbreviations

3PL	3rd-Party Logistics
BCA	Business Case Analysis
BESTUFS	Best Urban Freight Solutions
CIVITAS	Cleaner and Better Transport in Cities
C-LIEGE	Clean Last Mile Transport and Logistics Management
DSP	Delivery and Servicing Plan
EFV	Environmental-Friendly Vehicle
EC	European Commission
EU	European Union
EME	Emerging Market Economy
EZ	Environment Zone
FQP	Freight Quality Partnerships
ITS	Intelligent Transport Systems
GDP	Gross Domestic Product
LSP	Logistics Service Provider
PLS	Partial Least Square
PLS PM	Partial Least Square Path Modelling
POS	Points of Sales
PPP	Public-Private Partnership
RGPUFT	Review of Good Practices in Urban Freight Transportation
SA	Sensitivity Analysis
SEM	Structural Equation Modelling
START	Short Term Actions to Reorganize Transport of Goods
SUGAR	Sustainable Urban Goods Logistics Achieved by Regional and Local Policies
SWOT	Strengths, Weaknesses, Opportunities and Threats
TRAIBLAZER	Transport And Innovation Logistics by Local Authorities with a Zest for Efficiency and Realization
TURBLOG	Transferability of Urban Logistics Concepts and Practices from a Worldwide Perspective
UCC	Urban Consolidation Centre

1. Introduction

A city is a relatively highly organised population settlement.[1] It is the result of the history of human immigration. Goods production and consumption are two dominant functions of a city. However, along with the industrial revolution, globalisation and urbanisation, cities are growing more and more into pure consumption centres of goods. The production function is gradually being taken out of the city centre. Consequently logistics emerged to fulfil a city's demand for goods consumption from outside the city.

1.1. Research background

1.1.1. Urbanisation process and city development

Principally, cities can offer more favourable settings to meet people's demands for education, health care, movement, living and other services due to their public resources such as most higher-education, medical and cultural institutions, and transport infrastructure. Increasingly the populous is flowing into cities seeking jobs and a better life.

Moreover, cities with a dense population featuring advantages of scale and proximity can deliver services more efficiently than less densely settled rural areas by consuming less energy and utilising less land resources per unit. Accordingly, the pressure on natural habitat and areas of biodiversity can be relieved, and more social wealth can be produced.

Urbanisation refers to a process of human transition from a rural to a more urban society. It reflects the growing proportion of urban population and area. The term urbanisation rate – calculated as the percentage of the total population living in towns and cities – is used to reflect the urbanisation level of a country or region.[2] Closely linked to modernisation and industrialisation, urbanisation is an ongoing global trend that is reshaping our living areas. After the first urbanisation wave, which took place from 1750 to 1950 when the urbanisation rate and urban population in more-developed regions (including North America and Europe) grew from 10% to 52% and 15 to 423 million, respectively, our world has been experiencing its second urbanisation wave, which has mainly occurred in less developed regions such as East and South-East Asia and Latin America.[3] In 2010, approximately 3.6 billion people, over half the world's population, lived in urban areas. By forecast, the urban population will swell to 6.3 billion by 2050, accounting for approximately 67.2% of the total population (see Figure 1).[4] Above all, most of the new growth has and will be concentrated in less developed regions, especially Asia and Africa. Along with the rapid urbanisation growth, megacities[5] have captured a great deal of public attention because they contribute higher productivity to a country's economy. For instance, 17 megacities

[1] See Britannica (2013).

[2] See UN (2007), p.6.

[3] See UN (2007), p.7.

[4] See UN (2012), p.1.

[5] See UN (2012), p.6: "megacity" refers to cities with populations over ten million people (defined by the United Nations).

contributed 14% of global GDP. [6] The number of megacities rose from 2 (Tokyo and New York) in 1970 to 23 in 2011, and is expected to reach 37 in 2025, of which 29 will have emerged from less developed countries.[7]

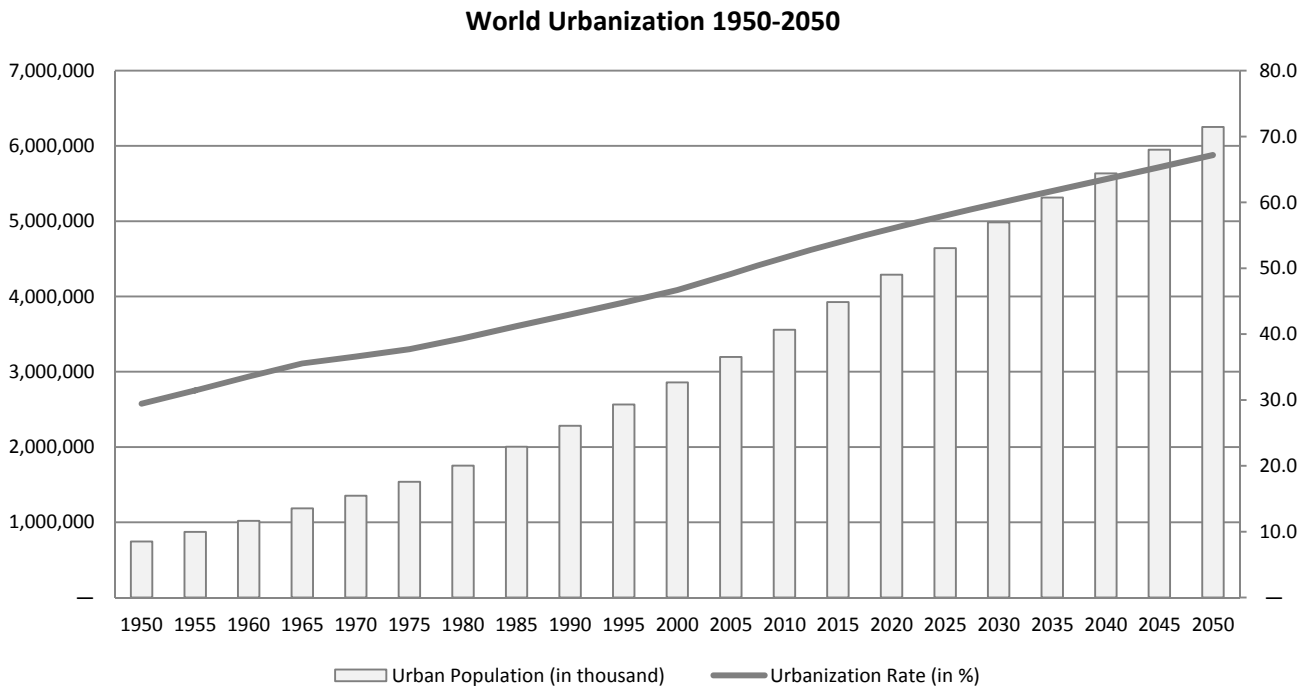

Figure 1: World urbanisation process (1950-2050)[8]

Source: UN (2012).

Following the trend of growing urban populations and expanding urban areas, increasing numbers of companies and industries are moving into urban surroundings and locating in metropolitan regions. The advantages provided by metropolitan regions such as local networks with suppliers and education/research institutions, and connections to end customers in urban areas, often lead to companies' distribution and sales facilities being located in cities.[9] Also, the growing population in cities will demand and consume increasing volumes of goods. This will result in rising commodity and goods flow from the surroundings to supply urban areas. Bringing the goods in and out of the cities in a sustainable and efficient way, particularly in regard to megacities will become one of the main challenges.

1.1.2. Logistics and city logistics

The social division of the labour market leads to goods exchange and trade. The separation of goods production and consumption resulted in the birth of logistics, which was required to bridge the two functions temporally, geographically and organisationally (see Figure 2).[10] Logistics has played a fundamental role in economic and social development throughout much of human history. The birth of the logistics concept can be traced to the

[6] See MGI (2011), p.12.

[7] See UN (2012), p.5-7.

[8] The urbanisation rate and urban population from 2015-2050 were forecasted by the United Nations.

[9] See Felix et al. (2013) and Elbert et al. (2013b).

[10] See Ihde (2001), p.1-25.

military arena.[11] Nowadays, logistics has evolved into both an art and science and is an omnipresent global phenomenon, especially in economic areas. While new companies evolve to deliver products to their customers with quick and reliable courier, express and parcel services, traditional industries can outsource the transport of bull goods and concentrate on their core business.[12] Consequently, logistics has grown into an indispensable part and a foundation of the industrial sector as well as personal everyday life. The definition of logistics differs from author to author, who define logistics from various perspectives. Three approaches, including process-oriented, life-cycle-oriented and services-oriented definitions, have been summarised to present a comprehensive understanding.[13] In spite of the differences, it is commonly understood that logistics involves all activities during the goods movement from the original point to the destination point of final consumption. In view of the principle of supply chain management, all of these activities including purchasing, planning, coordination, transportation, warehousing, distribution and customer services should work as a logistics system to attain the goal of a business being run in an efficient manner.[14]

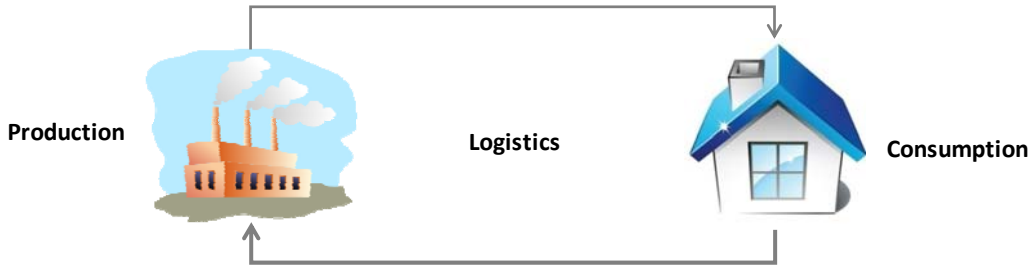

Figure 2: Relationships among production, consumption and logistics

Source: Pfohl (2004), p.59. Translated and modified by the author.

Cities, due to their dense population within urban areas, concentrate on increasing their logistical activities in order to fulfil urban citizens' demands for goods supply and related services. A range of terms can be found in the literature describing the related activities and defining their scope, among which urban goods movement[15], urban freight transport[16], urban goods transport[17], urban freight traffic[18], urban goods distribution[19], urban logistics[20] and city logistics[21] are the most common. Although the terms differ literally and in the scope of handled goods and related activities, all are cited as a result of the importance of the evolving personal and industrial demands within urban areas. In order to achieve unification and avoid unnecessary literal confusions, the term 'city logistics' is used by this thesis and throughout the research to describe all logistical activities

[11] See Ihde (2001), p.22.

[12] See Pfohl (2004), p.3.

[13] See Pfohl (2010), p.12-14.

[14] See Arnold et al. (2002), A1-4 – A1-5.

[15] See Ogden (1992), Dablanc (2007) and Munuzuri et al. (2005).

[16] See Ambrosini/Routhier (2004) and Quak (2008).

[17] See OECD (2003).

[18] See Allen et al. (2000).

[19] See Van Binsbergen/Visser (1999).

[20] See Anderson/Allen/Browne (2005).

[21] See Wagner.(2002), p.1: it is described as City-Logistik or Stadt-Logistik in German.

taking place within a city, including the goods movement to, from, within and through urban areas. Hereby it is not just limited to personal consumer goods – industrial goods and postal products required by urban business are also indispensable objects within the scope of city logistics. All related logistical activities and operations of collecting and delivering goods, such as warehousing, transportation, home delivery, reverse logistics (e.g., waste collection, goods return and repair) as well as any value-added-service activities (e.g., inventory management) are defined as the major content of city logistics. Also, other activities regarding traffic infrastructure such as urban road maintenance and building and telecommunication infrastructure have a close relationship with city logistics; they build up the basis and provide production factors.[22]

Due to the growing urban population and sustained economic growth, city logistics has become a significant component of an urban economy through sustaining the existing lifestyle of the urban population. It is fundamental in serving personal as well as industrial and commercial activities within urban areas.[23] Cities are now facing global and regional competition for investment and trade, and qualified personnel for sustained economic prosperity. Efficient city logistics can benefit a city through improving the competitiveness of the urban economy and increasing the attractiveness of living environments.[24]

1.1.3. Urban sustainability and city logistics

The idea of sustainability is neither new nor fixed – it can be traced to our ecological systems from the earliest civilisations to the present. Defined by the Brundtland Commission[25], sustainable development is the development that meets the needs of the current generation without compromising the ability of future generations. A sustainable city should "*improve the quality of life in a city, including ecological, cultural, political, institutional, social and economic components without leaving a burden on the future generations*".[26] It requires a comprehensive development in respect to economic, environmental and social perspectives. Making cities sustainable is one of the most important missions of current generations, and has been placed on the global agenda.[27]

Despite the positive significance, city logistics is also criticised for its negative (economic, environmental and social) impacts in urban areas.[28] The delivery of goods in medium and large cities represents a significant contribution to urban problems of congestion, lack of parking, pollution and energy consumption.[29]

Numerous flows of goods shipments to, from and within urban areas intensify the congestion level of city centres already choked with passenger traffic, which generates a huge social cost for the whole city. Pollutant emissions including the primary greenhouse gas carbon dioxide, nitrogen oxides and particulate matter are the main air pollutants resulting from growing goods traffic, particularly when using conventional trucks equipped

[22] See Ihde (2001), p.111-112.

[23] See Anderson/Allen/Browne (2005).

[24] See Taniguchi et al. (2001), p.2.

[25] See UN (1987), p.34.

[26] In reference to Anastasiadis/Metaxas (2010): defined by the preparatory meetings for the URBAN21 Conference (Berlin, July 2000).

[27] See UN (2012).

[28] See Ramokgopa (2004).

[29] See Munuzuri/van Duin/Escudero (2010).

with old technology. As a result, citizens have to suffer the physical consequences of pollutant emissions and the noise caused by continuous goods traffic flows. Injuries and death are other social impacts that may be caused by the competition of goods traffic with passenger traffic for the scare urban transport infrastructure.

Furthermore, city logistics is still facing other weighty issues. Energy conservation is an important issue, not only due to there being a limited supply but also because of emissions.[30] Many cities are following the trend of becoming large consumers of goods and services, while draining reliant resources from the city centre. The growing urban population and economy, and their consumption of resources, require increasing goods movements into urban areas. The emergence of e-commerce has resulted in the growth of home deliveries. The changes in the nature of goods distribution such as consignments being in smaller volumes, but time-sensitive deliveries create more frequent goods flows.[31] Logistics companies are expected to provide a high level of services with lower costs.

All of the above-mentioned issues aggravate the negative impacts of city logistics and set challenges for urban areas, which house half of the world's population. They require innovative approaches, in particular in terms of urban planning, transport policy and land use to make the best use of the scarce land resources and infrastructure in urban areas. Herby, city logistics plays a key role in affecting the sustainable development of a city. How to satisfy a city's demands for logistics services without harming its sustainability has been highlighted as a major issue and attracted attention from both researchers and policymakers.

1.1.4. China and its city logistics

During the last three decades, China has captured the world's attention with its unprecedented growth and tremendous structural changes to its economic system. Since 2009 China has held the position of the world's second largest economy. However, due to its huge population, China is still ranked as an upper-middle-income country[32] and considered the largest emerging market economy (EME) country[33] attributed to its rapid economic growth, emerging groups of middle class, economic reforms, as well as significant and continuing industrialisation, urbanisation, and integration into the world economy.

However, the current growth model also caused what can be cited as a good example of negative externalities. It has led to deep regional imbalances, income inequality, as well as environmental degradation. China's high city populous pays the price for being able to enjoy the advantages of urban residency in the form of traffic congestion, shortages of clean water and air pollution.

In order to improve its citizens' living standards and upgrade China to a well-developed high-income country, there remains a noticeable gap to be closed. In a major step towards fulfilling this goal, China is taking measures and effecting a transition of economic growth model so as to switch from being highly export dependent to more domestically reliant, thus stimulating domestic consumption. Urbanisation is seen as a potential driver of domestic consumption expansion and of shifting the growth model both today and in the coming years.[34] In this

[30] See Taniguchi/van der Heijden (2000).

[31] See Rodrigue (2006).

[32] See World Bank (2012).

[33] See detailed discussions in section 3.1.

[34] See Li (2012).

respect, 2011 was a significant milestone for China, with its urban population surpassing its rural population for the first time in its history; 51.3% of China's total population now lives in cities. Furthermore, this rapid urbanisation process is expected to continue and contribute to the evolving domestic consumption market in China.[35]

Nevertheless, a series of challenges needs to be addressed in order to guarantee a reliable goods supply for the growing population and contribute to building up urban sustainability. China is still suffering from inefficient logistical operations and a poorly developed logistics infrastructure in urban areas. Thus, improving the efficiency of city logistics should be highly prioritised by Chinese cities and its related stakeholders.

1.2. Research questions and outline

1.2.1. Research questions

The essential objective of a city is to create a favourable environment to meet human requirements for living and development. The birth of modern cities and their development are the result of the evolution process of human society. A city, equipped with a good logistical infrastructure, information technology and transport systems is a centre for commodity distribution, processing and consumption. In line with rapid economic growth in urban areas, the demands on city logistics increase tremendously, which leads to increasing delivery frequencies combined with the dense population and its diverse requirements regarding goods consumption. At the same time, the development of city logistics still causes a great deal of negative external effects, for instance traffic congestion, traffic noise, traffic accidents, and air pollution due to traffic emissions. How to reduce traffic distance, shorten delivery times, and lower logistics costs has become a critical issue of urban economic development waiting to be resolved. An efficient city logistics system can integrate the logistical activities, such as transportation, warehousing, loading and unloading, packaging, distribution processing, and information handling, into the whole social goods production, distribution and consumption. It can, therefore, through re-allocating and integrating logistical resources and employing innovations of logistical technology, effectively reduce the total social costs, alleviate traffic pressure, improve the urban living environment, and realise the suitability of urban economic development.

City logistics is a young research area. It has experienced a period of over three decades of development since its conception in the last century. It is believed to have the potential to support the realisation of building up sustainable cities.[36] Due to the extreme pressure placed on a vastly inadequate urban infrastructure in large expanding cities caused by urban goods movements, city logistics has attracted a high level of interest in China in researching and implementing solutions to logistical challenges (e.g., low level of efficiency and productivity, high energy consumption, environmental pollutions and traffic pressures) within its megacities in order to realise the strategies of achieving sustainable, long-term improvements in quality of life for its citizens and to meet the needs of the next generations. This thesis specifically addresses the Chinese issues and aims to explore the following:

- Is the concept of city logistics suitable and applicable for China's cities to build up a sustainable urbanisation?

[35] See NBSC (2012).

[36] See Taniguchi et al. (2001), p.2-3.

To this extent, it shifts the focus of research from city logistics in general to a specific country characterised by high economic growth, urban population expansion and an ambition to achieve urban sustainability. To answer the research question above, a great amount of effort needs to be invested into finding a solution that also takes into consideration China and its cities' particular environment and requirements. Above all, the attitudes and engagement of individual stakeholders, the users of city logistics services in particular, should be emphasised. Derived from this framework of analysis, further related questions are posed sequentially throughout this research, which together provide a structural way to answer the major research question raised above. Accordingly, the main objectives of this research are to answer the following questions:

1) Exploration of theory: What is the conceptual framework of city logistics?
2) Exploration of practice: What lessons were learned in the past decades from trials or implementations of city logistics solutions?
3) Country-level empirical study: What is the macro-environment of city logistics in China?
4) City-level empirical study: What is the visionary master plan of the city logistics system in Chengdu? Which factors influence users' participation and how do they impact their decisions?
5) Corporate-level empirical study: Is the solution of urban consolidation centre commercially durable?

1.2.2. Research outline

Based on the structure of the underlying research questions, Figure 3 illustrates a broad outline of this research.

After the introduction of the research background and questions, Chapter 2 reviews the current literature about city logistics in general and any city logistics practices adopted in past decades. It presents a comprehensive discussion and builds a baseline for the comprehensive research of city logistics in China. The concept of city logistics is discussed in the first section. The definition of city logistics in this thesis together with theoretical foundations is presented accordingly. The second section takes a step forward and analyses the constitution of a city logistics system, which provides the basis for establishing the visionary master plan of the city logistics system in Chengdu in Chapter 4. In addition, all the related stakeholders and their responsibilities as well as interests are discussed. After setting up the framework for city logistics solutions, the third section reviews all of the selected reference cases from the available data sources, which are either trials or active in operation. The fourth section focuses in the solution of urban consolidation centre. It discusses its characteristics, reviews all the related practice and summarises the barriers and critical successful factors.

After the exploration of city logistics in theory and practice, Chapter 3 shifts the focus of the research onto China and attempts to tackle the third research question from a country perspective. It begins with the introduction of China as a typical EME country in the first section. It then goes through all the important external environments of city logistics in China including economic growth, urbanisation, urban industries, environmental restrictions, political environment and logistics development in the following sections. This chapter concludes with a summary of these external environments' impacts on China's city logistics development.

Based on the results of the analysis of China's macro-environment for developing city logistics, a more comprehensive study of city logistics in Chengdu is initiated in Chapter 4 aiming at answering the fourth research question. Using the approach of SWOT analysis, the first section investigates the current situation of city logistics in Chengdu. A visionary master plan for a city logistics system is then recommended based on the

results of the situational analysis in the second section. In respect to implementing the city logistics system and any related solutions, it is of utmost importance to study the attitudes of users of city logistics services, retailers in particular, as they usually hold the decisive influence on implementing any new city logistics solutions or changing the current logistics models. Therefore, an empirical study is conducted in the third section in search of the influential factors and their impacts. A measurement model with a related set of hypotheses is then set up after reviewing relative literature. The required empirical data are collected using the survey approach covering over 100 retail companies. Using the approach of partial least squares path modelling, the survey results are then analysed and the underlying path model evaluated.

Regarding the fifth research question, Chapter 5 contains a new empirical study from the corporate perspective. Section 1 first introduces the approach of business case analysis, the target user and operator, as well as the objectives. Section 2 dissects the solution of urban consolidation centre into integral elements and develops the basis for the next section. The business case analysis model is then constructed in section 3. It contains an estimation of logistics volume, resource requirement, operating costs, generation of revenue, business tax as well as the governmental subsidy. The results of the BCA model are presented in section 4. Furthermore, the approach of sensitivity analysis is used to test the sensitivity or robustness of the given model to the variations in its input factors. In doing so, it offers a detailed examination of the commercial feasibility of the UCC solution and provides an answer to the fifth research question.

Finally, Chapter 6 reviews the research undertaken in this thesis. It summarises the key findings and indicates all the implications for research and practice. The thesis is then closed with a discussion about the limitations in this research and offers a recommendation for further research in the future.

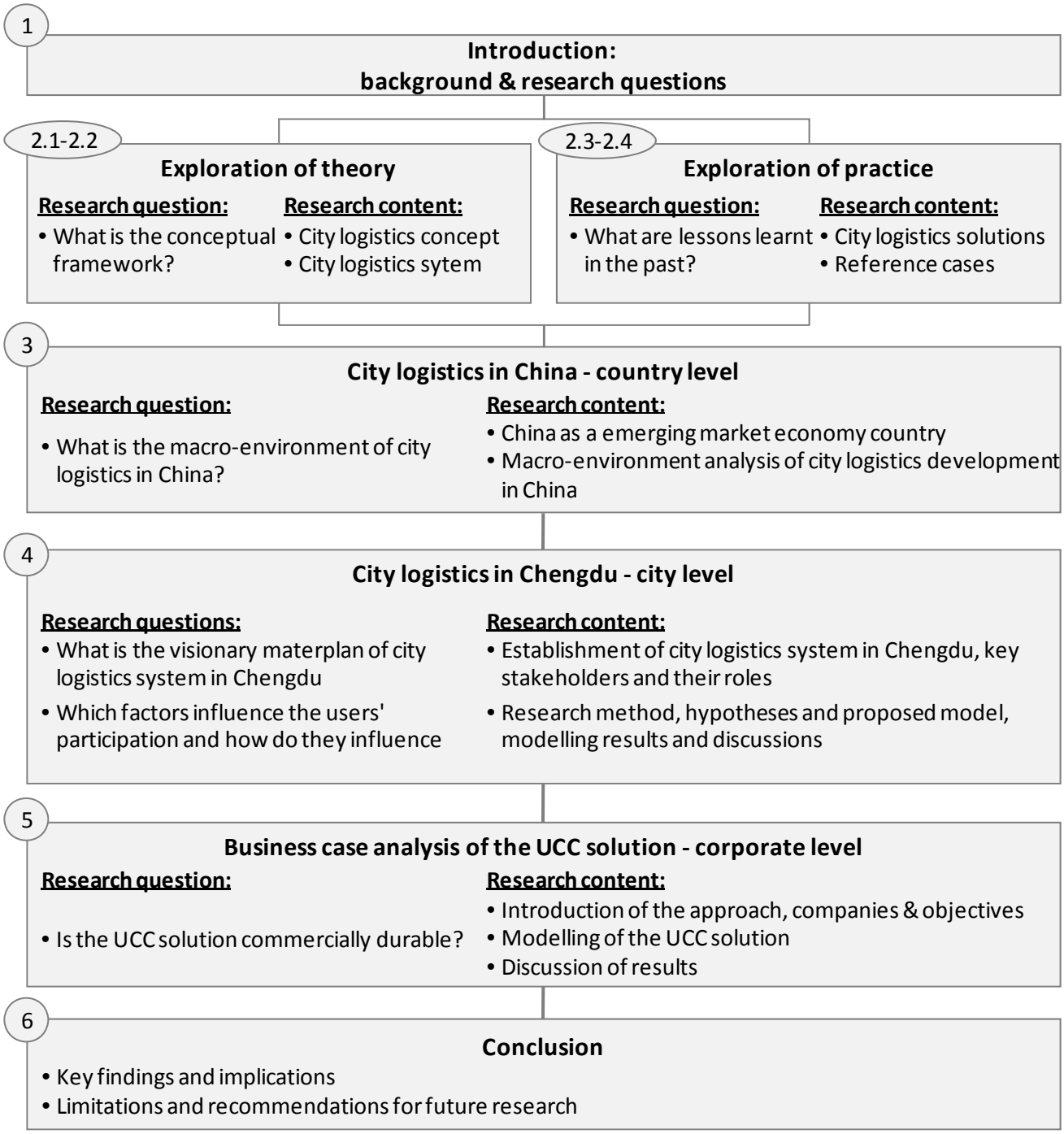

Figure 3: Research outline of the thesis

2. City logistics research review

Goods traffic and logistics activities maintain a set of core relations within urban areas since a city is concomitantly an entity consisting of production, distribution and consumption. City logistics, which aims at creating more efficient urban freight movements, is a relatively young research field that has evolved rapidly over the last few decades. Due to its potential to develop sustainable urban environments, remarkable effort has been invested by the academic world.

Through focusing on the topic of city logistics, this chapter attempts to answer the research question from both a theoretical and practical perspective. It reviews the current literature about city logistics in general. Section 1 discusses the concept of city logistics including its definition and theoretical foundations. Section 2 analyses what constitutes a city logistics system, and discusses all related stakeholders and their responsibilities as well as interests. The third section shifts the research focus from theory to practice and reviews all the city logistics solutions and relevant reference cases. Chapter 2 closes with an analysis of the solution of the urban consolidation centre and lessons learned in section 4. The research structure of this chapter is presented in Figure 4.

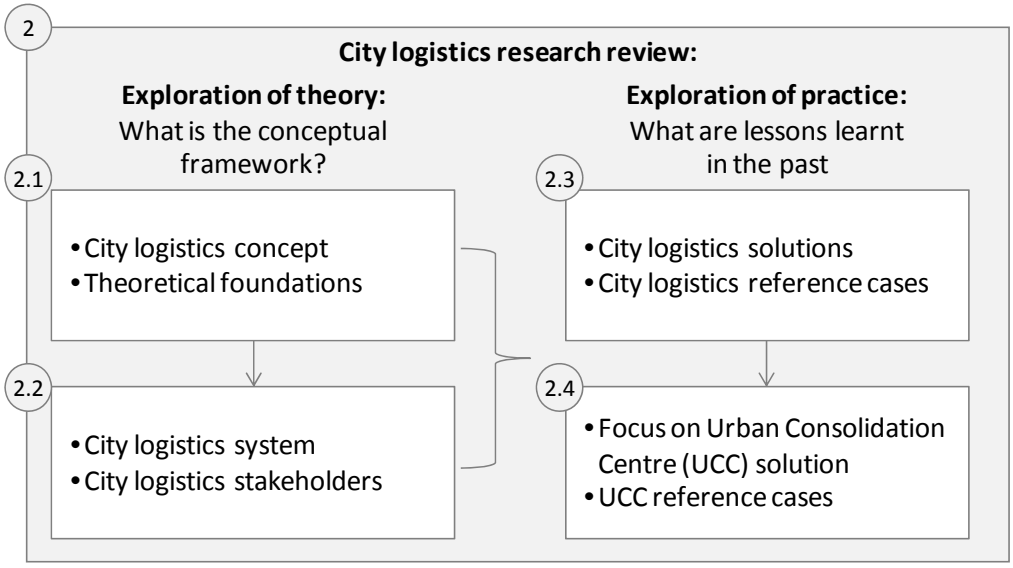

Figure 4: Research structure of Chapter 2

2.1. City logistics concept and theoretical foundations

2.1.1. City logistics concept

2.1.1.1. The concept and objectives of city logistics

In spite of its young history, city logistics has attracted a tremendous amount of attention. Various definitions can be found in the literature formulated from different perspectives, which are summarised in Table 1. This thesis defines city logistics as:

- All logistical activities of strafing, delivering and collecting goods happening within a city, including the goods movement to, from, within, and through urban areas.

The concept of city logistics is based on a holistic view of goods traffic within a city. It includes considerations of goods distribution and waste disposal as well as negative effects such as air pollution, noise and traffic accidents.[37] The concept of consolidation plays a vital role that is largely facilitated by an urban consolidation and distribution centre.[38] It incorporates a number of activities and specific goals of different stakeholders.[39] Instead of considering and operating each shipment or vehicle individually, it now becomes an integrated component of a logistics system. Through optimising logistics systems within an urban area, city logistics can benefit both the private and public sectors by reducing their logistics costs and alleviating traffic congestion and environmental problems.[40] City logistics works only when all of the influencing factors can be determined.[41]

Author	Description
Zentes (1994)	A cross-company model of distribution and reverse logistics, aiming at maximising economic benefits as well as optimising the ecological impacts.[42]
Wittenbrink (1995)	All the operative and dispositive activities in a city, which are customer-oriented in accordance with the goods' type, quantity and volume together with environmental factors (in a wider sense), and intend to provide an efficient supply of real goods (as well as reverse logistics services such as waste disposal). [43]
OECD (1996)	Measures for maximising the loading factor of vehicles and minimising the number of vehicles per km, aiming at making goods distribution in the cities more environmentally sustainable.
Kaupp (1997a)	The planning, monitoring and controlling of logistical processes in a cross-company logistics system aligned with economic and environmental objectives. The major function of city logistics is the cooperative production of logistics services in order to ensure the requirement of a city or metropolitan area in relation to goods supply and disposal.[44]
Visser (1999)	A service based on co-operation between companies that pool their distribution trips on a voluntary basis. City logistics is a combination of terminal consolidation and route consolidation.
Taniguchi/ Thompson/ Yamada (1999)	The process of totally optimising the logistics and transport activities by private companies in urban areas while considering the traffic environment, traffic congestion and energy consumption within the framework of a market economy.
Benjelloun (2009)	City logistics aims to reduce the nuisances associated with freight transportation while supporting the sustainable development of urban areas. It proceeds generally through the coordination of shippers, carriers and movements, and the consolidation of loads of different customers and carriers in the same environment-friendly vehicles.

Table 1: List of city logistics definitions

[37] See Pfohl (2010), p.275-276.

[38] See Browne et all (2005) and Benjelloun/Crainic (2009).

[39] See Vaghi (2010).

[40] See Taniguchi et al. (2001), p.2-3.

[41] See Wagner (2001), p.30.

[42] Original expression in German: Ein Modell einer unternehmensübergreifenden Distributions- und Retrodistributionslogistik, das auf ökologieorientierte Ziele als auch auf eine Ökonomisierung ausgerichtet ist.

[43] Original expression in German: Alle – operativen und dispositiven – Tätigkeiten, die sich auf die bedarfsgerechte, nach Art, Menge, Zeit, Raum und Umweltfaktoren (i.w.S.) abgestimmet, effiziente Bereitstellung (bzw. Entsorgung) von Realgütern in einer Stadt beziehen.

[44] Original expression in German: Die an ökonomischen und ökologischen Zielen ausgerichtete Planung, Steuerung und Kontrolle logistischer Leistungsprozesse in einem unternehmensübergreifenden Logistiksystem. Aufgabe der City-Logistik ist die kooperative Produktion von Logistikleistungen, die eine Ver- und Entsorgung einer Stadt oder eines Ballungsraums sicherstellen.

The objectives of the city logistics concept are therefore summarised below: [45]

- Private sector: maximise the utilisation of all logistical resources to satisfy a city's demand for high-qualified logistics services; reduce the total logistics cost; shorten delivery times; and ensure a sustainable goods supply for citizens.
- Public sector: minimise the negative effects caused by the logistical activities within urban areas, such as by alleviating traffic congestion and pressure, lowering traffic noise, preventing traffic accident, and improve the city living environment.
- City as a whole: help achieve the sustainability of urban economic growth through avoiding unnecessary goods traffic, introducing innovative logistical technology, and optimising the logistics process within a city.

City logistics grew in importance and eventually became the central topic of public discussions in the 1990s. Then the development of freight and passenger traffic, in metropolitan regions in particular, was causing an ever-increasing burden and even an overload of the road infrastructure. Because of the impacts on residents and the environment, also with regard to the reliability and productivity of freight traffic in cities, city logistics became an influential issue in the trade and transport industries. As a result of the unproportional development between traffic volume and road infrastructure, the most important advantages of road traffic such as flexibility and free route choice were less possible to realise. Decreasing reliability and productivity are aspects concerning the road transport industry. City logistics provides hereby a concept that applies logistical thinking focusing on the total demand of the industry rather than individual companies, so as it can maximise the scare infrastructure and resources in a city.[46]

2.1.1.2. The objects served by city logistics

City logistics concerns both goods pick-up and delivery in retail, parcel and courier services, waste transport, transport of equipment for the construction industry, and a broad range of other types of transport. Despite the common objectives of reducing the negative impacts caused by the interactions between goods vehicles and other infrastructure users, the content varies depending on the service requirements of different customers. According to the target groups, city logistics can be divided into two types: business customer oriented and consumer customer (or end customer) oriented.[47] This thesis takes the objects served by city logistics as the major criterion and classifies city logistics into five groups (see Table 2):

- Group 1 – consumer goods: consumer goods are the most important objects serviced by city logistics due to their presence in a city and linkage to people's daily life. Retail, wholesale markets and e-commerce are three major sales channels enabling consumer goods to reach their end customers.
- Group 2 – building materials: in order to provide more efficient infrastructure and traffic systems, and satisfy urban residents' requirements for work and living, large amounts of building materials have to be transported from outside a city for construction projects of roads, houses, etc., which as a result causes a large volume of freight traffic.

[45] See Cranic et al. (2009).

[46] See Buchholz/Clausen/Vastag (1998), p.311-316.

[47] See Oexler (2002), p.61-63.

- Group 3 – industrial goods: raw materials, components and parts, and installations such as generators are important inputs for manufacturing. They are delivered from various suppliers all over the world. The last-mile delivery within urban areas places demands on city logistics. Fortunately, as more and more manufacturers are moving outside of urban areas, their demand on city logistics is declining.[48]
- Group 4 – public products: public products are defined here as products provided directly by public sectors, or private sectors authorised by public sectors. Mail services and waste collection are two representative sectors here. In the EU, it is estimated that postal services handle 135 billion items per year, two thirds of which are generated by mail services.[49]
- Group 5 – others: although big occasions such as major sporting events and exhibitions do not take place that frequently, their external impacts caused by related logistical activities in a certain period and district are considered quite large depending on the scale of the event and number of participants.

Among the five groups of goods, group 1 – consumer goods should play a central role in city logistics as it has a much larger demand size and higher demand frequency than the other groups. Furthermore, the market is usually highly fragmented and has large external impacts on the surrounding communities as well as the cities.

Group	Objects	Representatives	City logistics related features			
			Demand size	**Demand frequency**	**Market fragmentation**	**External impacts**
Group 1	Consumer goods	- Retailers - Wholesale markets - E-commerce users	Large	High	Large	Large
Group 2	Building material	- Infrastructural projects - Residential construction	Medium	Medium	Medium	Large
Group 3	Industrial goods	- Raw material - Components and parts - Installations	Medium	Low	Medium	Small
Group 4	Public products	- Mail services - Waste collection	Medium	High	Small	Small
Group 5	Other goods: big events	- Sport games - Exhibitions	Small	Low	Small	Large

Table 2: Objects served by city logistics

2.1.1.3. The characteristics of city logistics

On the basis of the aggregation level of economics, logistics can be divided into macro-, micro and meso-logistics. Systems of macro-logistics contain all kinds of macroeconomic factors. The freight traffic system is one representative macro-logistics system in the national economy. Systems of micro-logistics focus more on

[48] See Byron/Mistry (2011), Novotny (2012) and Fraunhofer IAO (2014): however, one potential trend may come into reality in some developed countries, namely that small manufacturers tend to stay in urban areas due to the various advantages including information spillovers and knowledge-sharing, unparalleled access to employees, excellent proximity to a dense infrastructure and logistics network as well as a dynamic customer base.

[49] See EC (2003).

the microeconomic level or individual industries.[50] They can be divided further into hospital logistics, military logistics, corporate logistics, and logistics of other organisations. Also, meso-logistics should be viewed as somewhere between the former two systems. A meso-logistics system does not include all macroeconomic elements, but it does contain more than the freight traffic of one individual organisation or industry. City logistics is one example of a meso-logistics system. It consists of different types of organisations such as retailers, wholesalers, distributors, transportation companies, express companies or third-party suppliers. Therefore, city logistics is featured more than general logistics:

- City logistics is not a closed system, but is rather inseparably connected with other types of logistics such as regional and corporate logistics. A city logistics network is usually tightly combined with other regional logistics networks through important intersections such as logistics centres or railway cargo terminals or airports. Also, the distribution networks of many retailers or manufacturers within a city are often incorporated into the whole city logistics system.
- As a type of meso-logistics, city logistics places greater importance on goods movement to, from and within a city. The origination points are distribution centres or warehouses located outside a city (in suburbs or neighbouring areas), whereas the destination points (or points of sales) including shopping malls, convenience stores, supermarket outlets, department stores, household appliance markets and resident communities are always scattered across every street within a city. Therefore, the radius of the distribution network is relatively short.[51]
- In addition, city logistics is characterised by a higher frequency and smaller volume of multi-items.[52] Besides serving urban industries with raw materials, spare parts and finished goods, city logistics focuses mainly on urban residents' daily life in relation to consumer goods. In particular along with the booming e-commerce industry, goods shipments are becoming more frequent while each shipment becomes smaller. Also, business customers as well as consumer ones increasingly require door-to-door services.
- As a result of the shorter delivery distance, higher frequency and smaller volume, road transport[53] becomes the most important and appropriate traffic means to fulfil the functions of city logistics. The urban road network is then utilised to construct the delivery channels. Other transportation types such as air, railway or ocean are used more for inter-city or international logistics. However, the existing goods traffic in urban areas and its occupancy of the already insufficient urban infrastructure cause substantial negative effects such as air pollution and traffic congestion. Hence freight vehicles are being required to become lighter, smaller and especially more environmental-friendly. Beyond freight vehicles, e-tricycles and e-bicycles are also commonly found to fulfil the last-mile delivery and reach end

[50] See Pfohl (2010), p.14-16.

[51] See Awasthi/Proth (2006).

[52] See Clausen (1990).

[53] Besides road transport, other traffic means also play a a role in a city's logistics network for specific types of goods in specific cases, e.g., pipelines for natural gas or petroleum in many cities; trams for automobile components in Dresden, Germany; inland waterways for waste collection in the Liege region of Belgium; inland waterways for beer transport in Utrecht, Netherlands; and cargotrams for waste transportation in Zurich, Switzerland.

customers in those congested areas.[54] Furthermore, some cities have begun to utilise the existing urban rail infrastructure to realise goods delivery within a city in a sustainable way.[55]

- Above all, the development of city logistics relies on the local economy, society and technology. The target customers are also located within a city. City logistics' strategic objectives of maximising the performance and efficiency are mainly confined to a city. Due to the significance of city logistics, city authorities incorporate its development into city planning to serve the urban economy and improve the living standards of inhabitants.

2.1.2. Theoretical foundations

2.1.2.1. Cooperation theory

Cooperation can be understood as a (voluntary) cooperative relationship between individuals, departments or organisations.[56] The theory of cooperation was initially developed by Morton Deutsch in early 1949[57] and later elaborated by David W. Johnson[58], whose publications present the most extensive summary of the theory and the research bearing on it. It discusses two basic ideas. One concerns the type of interdependence among goals of people in a given situation; while the other relates to the type of action taken by the people involved. The theory advocates a cooperative-constructive process to resolve conflict, as it can lead to positive outcomes such as mutual benefits and satisfaction, strengthening relationships, positive psychological effects, and so on. Also, it indicates useful implications regarding understanding and managing conflict[59]:

- First, it advocates using attitudes of a cooperative or win-win orientation to resolve a conflict rather than a competitive or win-lose orientation.
- Second, the theory highlights the importance of reframing the conflict as a mutual problem to be solved during the cooperative process since reframing aids in developing a cooperative orientation to resolve the conflict.
- Third, the theory proposes a set of norms that are similar to those for respectful, responsible, honest, empowering, and caring behaviour towards friends or colleagues like "be responsive to the other's legitimate needs" so it can normalise the behaviour of all the involving parties and assist the generation of a constructive resolution.
- Fourth, a reasonable doctrine should include conceptions of both norms and values. Interrelated values such as reciprocity, human equality, shared community, fallibility, and non-violence that are followed have the potential to abort conflict.
- Further, only attitudes, norms and values of understanding conflict are not sufficient. Competitive knowledge and skills (e.g., breaking the ice; reducing fears; active listening and responsive communication; etc.) are required to develop a cooperative process in various social and cultural contexts in order to manage conflict.

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[54] E-bicycles are the most common traffic means of domestic express companies for last-mile delivery in China.

[55] Amesterdam, Zurich and Dreseden are the three pilot cities trying on innovative transport means for their city logistics.

[56] See Pfohl (2004).

[57] See Deutsch (1949a) and Deutsch (1949b).

[58] See Johnson (2003). Another important publication from Johnson is Cooperation and Competition: Theory and Research. (1989, book).

[59] See Deutsch (2006).

In today's dynamic and complex world, it is common to hear the importance of cooperation for success in both private and public areas. Also, cooperation is believed to be crucial to management success and is of growing importance in the business world. Indeed, cooperation has become a topic of interest in many social scientific disciplines such as economics, sociology, anthropology, psychology, and political science as well as in organisation theory and strategic management.[60] The context of cooperation theory has also been further developed.

Cooperation theory has been extended by organisational researchers. The theory helps organisation researchers understand the dynamics between superiors and subordinates and the relationships among departments. A series of consistent research studies supported that cooperation can strengthen work relationships, morale, and complex tasks in particular, and improve productivity. The needs of both individuals and organisations can be realised by cooperation as the individuals can be integrated into the organisation by cooperative groups to help it be productive.[61]

Cooperation between different organisations can have many benefits, most of which are defined in non-economic terms. One of the most significant and sought-after components of inter-organisational cooperation is effective coordination, which results in higher performance (e.g., fast cycle time of product to market, improved quality, high-quality decision making, and improved competitiveness). In addition, it is argued that cooperation tends to have a very positive tone, particularly for work from the social and behavioural science disciplines.[62]

Further, it is of critical significance to understand how effective cooperation can be set up. Indeed, scholars have attempted to tackle this issue using various theories (including Transaction Cost Economics Theory, Institutional Economics Theory, Institutions and Institutional Change, Total Costs of Production Equation, Organisational Level Institutional Economics Framework, etc.)[63] Also, identified were a number factors (e.g., trust, the number of partners in a relationship, similarity in partners' values, the perceived status and legitimacy of partners, and the perception that interactive procedures) affecting the generation of the cooperative relationship.[64]

Actually there exists a set of important factors that may individually motivate organisations to participate in inter-organisational cooperation:[65]

- Organisations will be seek out or be receptive to inter-organisational cooperation as a result of resource scarcity or performance distress, which may be caused by increasing costs, scarce labour supplies or higher manpower training requirements.
- Organisations will be induced to seek out or be receptive to inter-organisational cooperation by a positive value created by cooperative activities such as costs saving, better service, or higher satisfactory level of customers.

[60] See Smith/Carroll/Ashford (1995).

[61] See Tjosvold (1984).

[62] See Smith/Carroll/Ashford (1995).

[63] See Glaser-Segura/Anghel (2002).

[64] See Smith/Carroll/Ashford (1995).

[65] See Schermerhorn, Jr. (1975).

- Organisations will be seek out or be receptive to inter-organisational cooperation when powerful external sources including governments and third-party organisations demand this activity.

In addition, inter-organisational cooperation is still associated with a set of potential costs that may be incurred by participating organisations. That includes loss of decision-making autonomy, unfavourable ramifications for organisational image or identity, and the direct expenditure of scarce organisational resources as well. These potential costs are considered as the negative results of cooperative activities. An inter-organisational cooperation can be implemented when organisations find measures to tackle the risk and gain support from them.[66] Overall, the three motivating factors and measures tackling potential costs are key factors impacting inter-organisational cooperation, which is depicted in Figure 5.

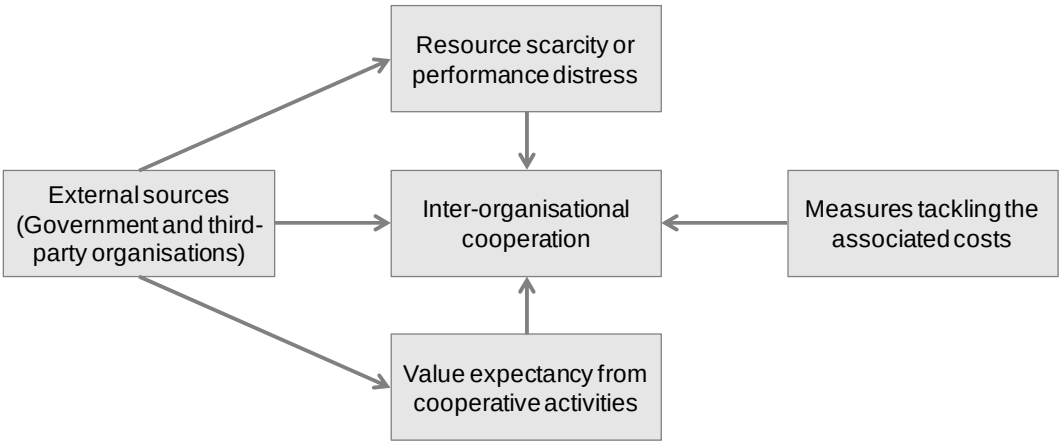

Figure 5: Key factors of inter-organisational cooperation

Source: in reference to Schermerhorn, Jr. (1975).

2.1.2.2. Cooperation in logistics

Cooperation in logistics is not new. The competitive environment nowadays is forcing management to focus on a firm's core competences (e.g., value generating) and gradually outsource the performance of other activities to external service providers or suppliers. This results in a growing awareness of the importance of inter-organisational relationship in the logistics channel as the number of company interfaces increases.[67] Hereby, business networking strategies, cooperation in logistics in particular, are recognised as a strategic approach to increase efficiency. Consequently, individual companies make growing investments to improve coordination with different partners or stages of the logistics channel and strengthen their cooperative relationship, aiming to react quickly and cost effectively to fast-changing market demands.[68]

Cooperation in logistics is defined as joint work limited to certain functions or divisions of individual companies that are legally independent and economically interdependent, and share common interests and objectives over a long period.[69] It is an extension of an arm's length relationship. Companies involved in the

[66] See Schermerhorn, Jr. (1975).

[67] See Pfohl (2010), p.286.

[68] See Leitner et al. (2011).

[69] See Kleer (1991), p.61.

cooperation are tied together more tightly and share more information.[70] In the case of cooperation, there are fewer suppliers and longer-term supplier-customer relationships. It is therefore considered a high-level relationship, determined by the degree of information sharing.[71]

Although there are critics of cooperation in logistics due to its disadvantages such as the loss of flexibility and higher investment for coordination between partners, there is sufficient evidence to support companies establishing effective cooperation with their partners in the logistics channel. This is because cooperation in logistics provides a set of advantages including:[72]

- Avoiding unnecessary duplication of logistical activities such as large-scale storage of a product at each level in the logistics channel
- Assisting the coordination of logistical decisions of companies involved in the logistics channel
- Setting up a counterbalance to the trend of integration and working against the accretion of economic power of some individual companies
- Rationalisation of the goods flow and improving coordination efficiency with the involvement of advanced information technology.[73]

One essential perception of cooperation in logistics is that one should take account of the total value chain of logistics from producers of raw materials to end customers as a whole rather than individual organisations. Companies building up cooperative relationships in the logistics channel aim to either reduce the cost or improve service / product quality of the logistics channel through the above-mentioned advantages. This has the effect of enhancing the competitive advantages of the whole supply chain and creating a win-win situation.

In today's fiercely competitive market, lower costs are crucial for winning business. Hereby logistic costs make a significant part of individual companies' total costs. Logistics has therefore gained a great deal of attention by substantially increasing the efficiency and flexibility of the whole supply chain. Cooperation has the potential to realise the ambitious goals of reducing transaction cost of inter-organisational logistics systems/networks resulting from (indicated by the Transaction Cost Theory):[74]

- Minimising the risk caused by transaction-related investment through the establishment of long-term agreements with suppliers and customers
- Enabling and/or accelerating an inter-organisational learning process
- Reducing quality risk and relevant controlling costs through intensively interactive information exchange
- Facilitating communication through cross-company information systems
- Creating an adequate inter-organisational culture through confidence-building measures

[70] See Ming/Grabot/Houé (2014).

[71] See Sepulveda Rojas/Frein (2008).

[72] See Pfohl (2010), p.299.

[73] See Sepulveda Rojas/Frein (2008): utilisation of information technology, such as Logistics Information System (LIS), Electronic Data Interchange (EDI) and Bar Coding, can help cooperative partners to perform joint initiatives, such as Collaborative Planning, Forecasting and Replenishment (CPRF) and Vendor Managed Inventories (VMI).

[74] See Pfohl (2004), p.372 and Kogut (1988).

Effective cooperation requires inter-organisational coordination. Actually, it is argued that inter-organisational networks (cooperation) denote complex arrangements of reciprocal, cooperative, rather than competitive relationships between companies that are legally independent but economically interdependent.[75]

In terms of city logistics, cooperation hereby provides an organisational approach to realise its objectives. In order to enable the consolidation of numerous small shipments, it requires a consistent cooperation among goods suppliers (e.g., logistics companies) as well as goods receivers (e.g., retailers). Also, the involvement of the public sector can allow for the utilisation of necessary infrastructure and provide inducement to promote the participation of the private sector.

2.1.2.3. Cooperation types in logistics

Cooperation along the logistics channel can be divided into many types according to different classification criteria such as cooperation direction, integration level, and scope and intensity degree.

First, in terms of cooperation direction, cooperation can be differentiated into vertical, horizontal and lateral cooperation in logistics (see Figure 6):[76]

- Vertical cooperation occurs when two or more organisations from a vertical level such as manufacturers, distributors, carriers, and retailers along the logistics channel share their responsibilities, resources and performance information to serve relatively similar end customers.[77] The key drivers of this cooperation include cost savings such as inventory and transportation reductions, logistics facilities or equipment rationalization and better information usage. Vendor-Managed Inventory (VMI), Efficient Customer Response (ECR), and Collaborative, Planning, Forecasting, and Replenishment (CPFR), Supply Chain Management (SCM) are examples of the implementation of vertical cooperation in practice.[78]
- Horizontal cooperation is defined as concerted practices between companies operating at the same level(s) in the logistics channel.[79] It occurs when two or more unrelated or competing organisations (e.g., manufacturers, retailers or logistics companies) cooperate to share their private information, facilities or resources such as joint distribution centres between two retailers. Horizontal cooperation help companies, which individually do not have access to highly productive transport networks, to activate cost-cutting potential and/or improve performance in logistics.[80] One representative example of horizontal cooperation is ocean shipping alliances, which aim to acquire economics of scale to increase product offerings and reduce their costs.[81]
- Lateral cooperation, also quoted as complementary cooperation in some cases, involves the joint work of various traffic technologies (e.g., the realisation of intermodal transportation) and cooperation between different traffic areas (e.g., cooperation between port industries and road freight traffic or

[75] See Pfohl/Buse (2000).

[76] See Pfohl (2010), p.288-290 and Simatupang/Sridharan (2002).

[77] See Kleer (1991), p.62-63.

[78] See Cruijssen/Dullaert/Fleuren (2006).

[79] See EU (2001).

[80] See Leitner et al. (2011).

[81] See Clarke (1997) and Sheppard/Seidman (2001).

railway freight traffic).[82] One of the main objectives of lateral cooperation in logistics is to gain more flexibility by combining and sharing capabilities in both vertical and horizontal manners. Examples include Lean Logistics and Transport Dynamics attempting to synchronise shippers and carriers of multi-enterprises in an effective transportation network.[83]

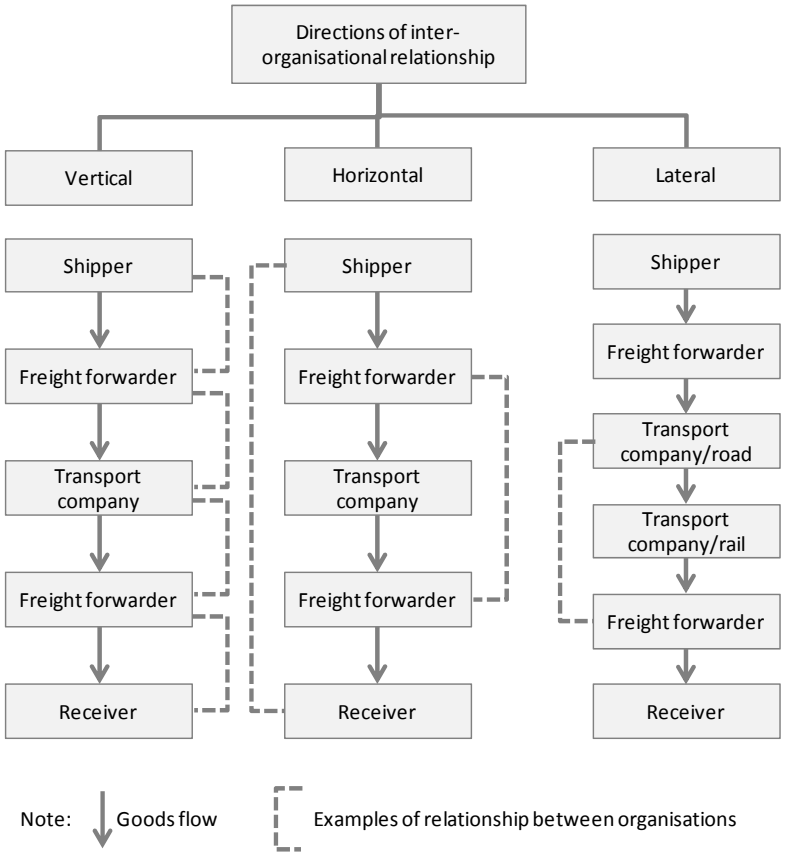

Figure 6: Cooperation types – cooperation directions

Source: Freichel (1992), p.61. Translated from German into English and modified by the author.

Second, cooperation can be also classified based on the integration level of the cooperative relationship between organisations. Indeed, three types of cooperation (see Figure 7) have been identified using this criterion between an arm's length relationship (a form of pre-cooperation) and a joint venture (a form of post-cooperation):[84]

- Type I is a cooperation format consisting of mutually recognised organisations that coordinate activities and planning on a limited basis. It usually occurs at project level featuring a short-term focus and the involvement of one division or functional area of each organisation.
- Type II is a cooperation format with relatively higher level of integration between organisations. Greater extent of joint activities will be accomplished under the cooperation beyond coordination and planning. Also, the cooperation is established with the expectation that it will be long term and of finite length. More divisions and functions will later become involved from each organisation.

[82] See Pfohl (2010), p.290.

[83] See Simatupang/Sridharan (2002).

[84] See Lambert/Emmelhainz/Gardner (1999).

- Type III integrates the cooperation of involved organisations at a significant level. Each organisation regards the others as an extension of their own unit rather than a pure partner. "Strategic alliance" is often found in the literature as a reference to this 3rd type of cooperation in logistics.[85]

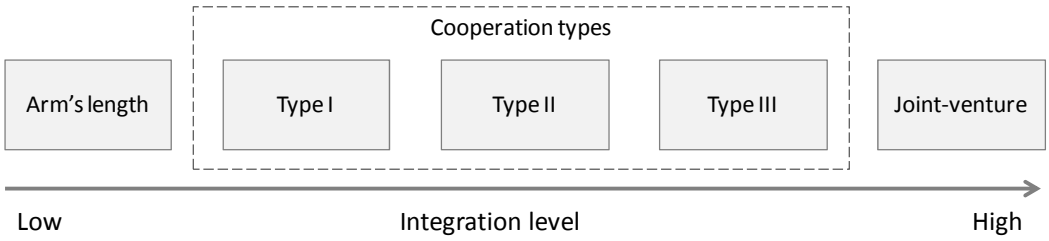

Figure 7: Cooperation types – integration level

Source: Lambert/Emmelhainz/Gardner (1999). Modified by the author.

Third, cooperation can be further differentiated using a two-dimensional criterion – scope and intensity. Hereby, scope is concerned with the range of services included in the cooperation.[86] Intensity is concerned with the extent of direct involvement exiting between the partners.[87] Cooperation along the logistics channel can then be divided into four types (see Figure 8):[88]

- Limited cooperation has both narrow scope and low intensity. For instance, one limited cooperative relationship (between the manufacturer and the transport company) is started when one transport company is subcontracted by a manufacturer to deliver raw materials and components from its suppliers to the plant.
- Focused cooperation is high in intensity but narrow in scope. It features with a strong commitment of resources from involved partners to invest, and perform on a consistent basis, a limited number of services.
- Extensive cooperation incorporates a broad range of services, but lacks the intensity of integrated cooperation. It usually occurs between a customer company and a third-party logistics provider who uses its existing infrastructure and expertise to provide a wide scope of services. The customer does not invest a large amount of resources or time to sustain an intensive cooperation.
- Integrated cooperation is both broad in scope and high in intensity. It is a result of an evolutionary process, with all partners continuously making efforts to strengthen their cooperative relationship and expand the scope of logistics-related services. Meanwhile interactions become more intense as each partner gains knowledge and awareness about the others, and learn to resolve crises and conflict in a joint manner.

[85] See Cruijssen/Dullaert/Fleuren (2006).

[86] See Krass (1983), p.112-115: in the case of cooperation between shippers and logistics companies, the scope can be further differentiated according to geographic areas, goods types, transport means, shipment size or delivery time.

[87] See Krass (1983), p.107-112: the dimensions of width and depth can be used to define the cooperation intensity between shippers and logistics companies.

[88] See Zinn/Parasuraman (1997).

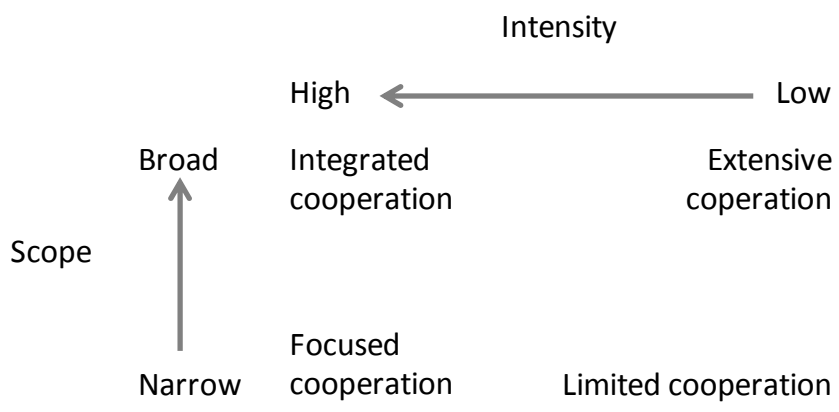

Figure 8: Cooperation types – scope and intensity

Source: Zinn/Parasuraman (1997).

In terms of cooperation types in city logistics, practice varies from one country to another. For instance, horizontal cooperation between logistics/transport companies is observed more often in Germany where cities strive to reduce total freight traffic through joint, alternative disposition and tour planning.[89] Whereas city logistics projects in the UK focus on a vertical level. A set of individual retailers are often served by a logistics company through a cooperative platform established under the support of landlords of retailer sites. Also, the cooperation is a dynamic process. It begins as a limited cooperation involving a limited number of participants, featuring a narrow scope of services and low intensity. The cooperation evolves into a higher level along with partners to strengthen their cooperation and expand the scope of services.

2.1.2.4. Cooperation in logistics and inducement-contribution theory

Inducement-contribution theory[90] is an important theory in the fields of organisation and motivation. It considers organisation as a system consisting of interrelated (through management and market) social behaviour of a number of individuals (participants).[91] The individuals including managers, employees, customers, suppliers, investors, the communities and lenders are always the basic strategic factors and constitute the general scope of an organisation.[92]

The theory argues that each individual makes some sort of contribution to the organisation and receives certain inducements in response. Individuals will maintain their participation so long as the inducements received are greater than their contribution made to the organisation. This evaluation is measured by individuals in terms of their own values, which may reflect or include both, economic and non-economic ones. Contributions of various individuals are sources for the organisation to generate inducements to pay back to participants. Organisation

[89] See Pfohl (2010), p.288 and Leitner et al. (2011).

[90] Inducement-contribution theory is referred as Anreiz-Beitrags-Theorie in German literature.

[91] See Seidel (2007), p.55: defined by Chester I. Barnard (1886-1961), president of AT&T's subsidiary - New Jersey Bell Telephone (1927-1948), author of The Funktion of the Executive (1938) and Organisation and Management (1948).

[92] See Staehle (1994), p.406: Abb. 2.86 illustrates examples for inducements and contribution of various individuals.

equilibrium (or balance) occurs when it can continue to provide inducements to individuals to compensate them for their contributions.[93]

It is the individuals and subgroups that make contributions to the existence of the organisation. In other words, any units providing inputs required by the organisation should be regarded as integral parts of the system. Regardless of history or obligations individuals must be induced to cooperate or there can be no cooperation to sustain the continued existence and survival of the organisation. Individuals leaving or changing will disturb the organisation's equilibrium. A redistribution of inducements to others may be required to obtain their participation in order to seek and achieve a new level of equilibrium.[94]

The theory's basic arguments reveal that the inducement utilities provided by the organisation to its participants must correspond with contribution utilities made by individuals, at least at a level of equilibrium, in order to become a viable business. Also, the duration of an organisation depends mainly on two factors. One relates to effectiveness: to what extent the organisation's objectives are achieved by the participants. While the other relates to efficiency: to what extent individuals' requirements are satisfied.[95]

Successful cooperation is like a marriage. It happens only in the case of constant hard work from the parties involved. Both parties must understand each other's needs, and be compatible with shared values. A successful cooperation in logistics requires open communication, mutual commitment to the cooperation, fairness and flexibility.[96]

According to the inducement-contribution theory, each organisation in the logistics channel makes its contribution and receives relevant inducements. Logistics cooperation achieves equilibrium between inducements and contribution, only in the case that the two following conditions are fulfilled:[97]

- The participants in the cooperation appreciate that the inducements received are higher than their contribution based on their own value understanding.
- The contribution made by individual participants secures that the cooperative system can grant all the necessary inducements for participants.

The equilibrium capability is also influenced by the efficiency of the logistics system and the distribution of achievements. In addition, the success of the cooperation mainly depends on whether it is able to find the right cooperation partners in the logistics channel featuring with strengths and weaknesses that complement each other. The basic notion of cooperation is to utilise the existing strengths of all involved partners to balance the weaknesses. Further, ingredients such as compatibility, understanding of partners' business needs, open communications, mutual commitment, fairness, flexibility and trust as well are considered critical elements

[93] See Seidel (2007), p.56-57 and Tosi (2010).

[94] See Tosi (2010).

[95] See Seidel (2007), p.57.

[96] See Tate (1996).

[97] See Pfohl (2010), p.290-291.

affecting a successful logistics partnership.[98] Third, the factor of environmental uncertainty also has an influence on cooperation performance, in particular between logistics companies at the horizontal level.[99]

Indicated by the inducement-contribution theory, it is of significance to examine the different stakeholders involved in the city logistics system and identify their interests and roles in order to induce a sufficient number of individuals to cooperate in the system.[100]

2.2. City logistics system and stakeholders

A system is an integrated whole consisting of a set of elements that are either interacting or interdependent. It is usually facilitated by functions of input, transfer and output. City logistics can be broken down into many different elements such as storage, transportation and handling. This section focuses on the structure of a city logistics system and its building blocks, and an attempt is made to investigate all the involved stakeholders and their interests.

2.2.1. City logistics system

From a system's approach, a city logistics system consists of many building blocks involving the city logistics operational model, infrastructure network, information platform and support measures. A city logistics system is a fundament of urban economy. Using the production factors as inputs (e.g., human resource, finance resource, material resource and information resource), the system shall generate logistics services, economic benefits and external effects as the outputs to serve the industrial and trade activities in urban areas (see Figure 9).

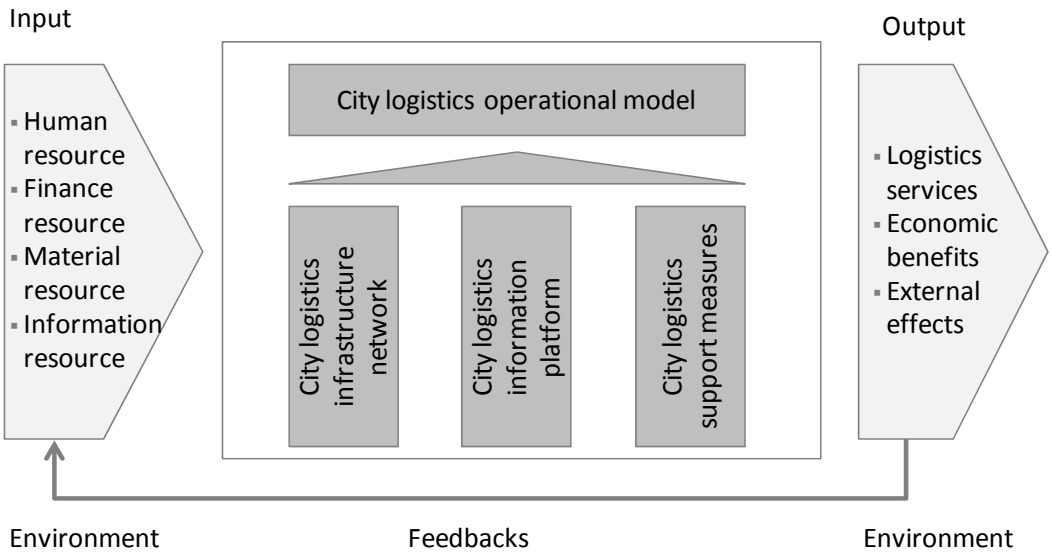

Figure 9: City logistics system

Source: in reference to Pfohl (2010), p.20. Translated and modified by the author.

[98] See Tate (1996).

[99] See Elbert et al. (2013a).

[100] See detailed discussion in section 2.2.2.

2.2.1.1. City logistics operational model

The operational model is the core of city logistics. Goods transported by each transportation means with larger loading capacities (such as large trucks, ships, trains or aeroplanes) from manufacturers or traders outside a city should be unloaded at logistics centres and transferred onto city logistics vehicles with smaller loading capacities (in most cases) in the suburbs, and then sent to the personal or business customers in urban areas after the last-mile delivery. The empty capacity of the city logistics vehicles shall be used to fulfil the task of reverse logistics (e.g., collecting package cartons or sending back return goods). Logistical activities, such as goods receiving, loading and unloading, identification, consolidation, pick and pack, storage, labelling, transportation, distribution are realised within the operational model (see Figure 10).

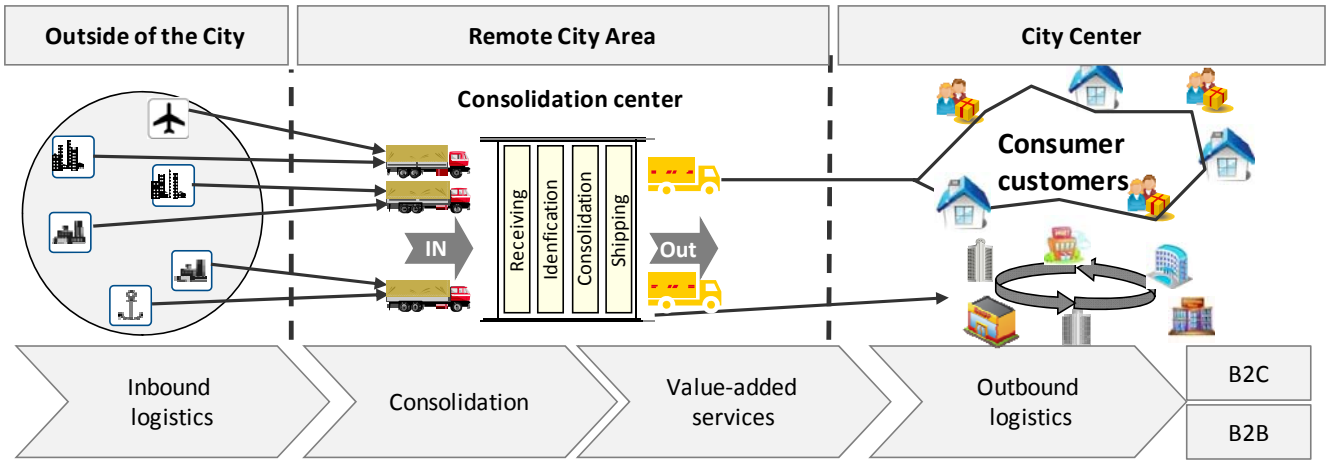

Figure 10: City logistics operational model

Note: "B2C" stands for business to consumer customers; "B2B" stands for business to business customers.

Among all the logistical activities, consolidation is a significant aspect that makes the operation of a city logistics system different to any other logistics system. Also here cooperation is the enabler of realising the consolidation. The scope of logistics services is closely linked to the integration level of partners in the logistics channel. Based on cooperation directions[101] in the logistics channel, two major operational models of city logistics can be accordingly classified:[102]

1) Operational model based on horizontal cooperation between freight carriers

   Freight carriers are physically responsible for arranging facilities and equipment to transport the goods from shippers to goods receivers. They decide what transport means should be used in which way to reach their customers at the right time. The current operational model of each carrier is usually under

[101] See discussions in section 2.1.2.3.

[102] Operational models can also be classified into other types using different criteria. See Wittenbrink (1995), p.182-202: the author identified five types of operational model according to the application fields, including joint delivery to the same goods recipients, joint delivery to goods recipients located in traffic-free zones, joint delivery to certain city districts or an entire city, cooperation in the field of local traffic and cooperation in the field of goods/packages collection. See Kaupp (1997), p.26-35: the author differentiated operational models from centralised operation (consolidation via logistics centres or via cross-dock centres) to decentralised operation (consolidation via scattered logistics centres or via cooperation between logistics companies).

pressure of rising costs (e.g., due to limited business scope) and delivery delay (e.g., due to traffic congestion). Cooperation between individual freight carriers has an advantage in terms of economy of scale and has the potential to reduce logistics costs through increasing the utilisation degree of freight vehicles. In addition, it can also improve service quality through releasing the last-mile delivery into urban areas from the whole logistics channel.

Within a cooperative framework, freight carriers need to transport their goods to a designated third-party operators outside urban areas using cost-effective transport means. The last-mile delivery will then be carried out by this third party in a freight vehicle suitable for city logistics. This third-party operator can be:

- a joint venture between all the involved freight carriers,
- or a logistics company dedicated for last-mile delivery that has no competition with the partners,
- or one of the freight carriers that has remarkable competitive advantages such as logistics facilities.

Actually, the first option tends to be preferred due to the advantage of avoiding any potential business competition.

2) Operational model based on vertical cooperation among goods receivers and freight carriers

Cooperation between goods receivers and freight carriers is the basis for outsourcing city logistics services to professional logistics companies. It provides the possibility to consolidate numerous goods shipments from individual shippers/suppliers before they flow into urban areas. In terms of city logistics, several operational models can be identified:

- Consolidated delivery to all stores of the same business customers, which have a large number of suppliers such as supermarket companies
- Consolidated delivery to many individual businesses that are geographically congregated in specific locations such as traffic-free zones and shopping centres

Within the operational model, delivery points for shippers/suppliers will be shifted outside urban areas to the consolidation centre of the subcontracted logistics company. Goods shipments will be arranged in full truckloads rather than being delivered to customers individually in smaller truckloads. In that way, the total freight traffic flow can be substantially reduced and goods receivers are able to focus on their core business. However, there are also exiting difficulties (see Figure 11). In the first case, the logistics company needs to have effective communication with numerous shippers/suppliers to minimise the loss in delivery time. Besides shippers/suppliers, the logistics company needs to coordinate with individual goods receivers in the second case and takes account of their different requirements in terms of delivery time, packaging and temperature controlling.

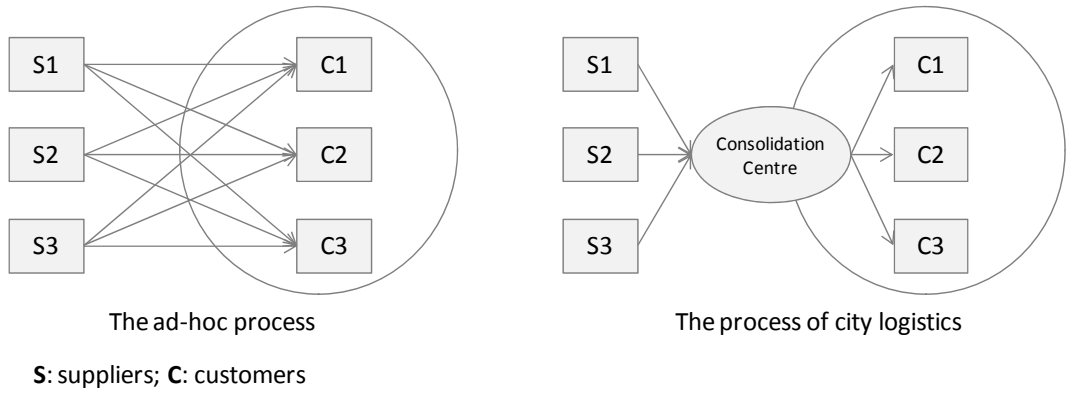

Figure 11: Positive effects of the city logistics concept

Source: Pfohl (2010), p.276. Translated from German into English by the author.

2.2.1.2. City logistics infrastructure network

Infrastructure is extremely important for economic development and urbanisation. It is a pivotal enabler of attracting investment for a city and deciding where to locate a business or a company. The city logistics infrastructure network is the fundamental basis of the entire city logistics system, consisting of three segments:

1) City logistics nodes

   City logistics nodes are interfaces connecting city logistics with inter-city logistics or international logistics. It is the location where all the logistical activities are organised and realised. City logistics nodes differ in terms of function, service scope and geographic coverage. Logistics centre, an interface between many (at least two) freight carriers, is the main physical type of city logistics node. It has the aim of concentrating as many logistics companies in the same location as possible in order to enable the cooperation and division of labour of freight carriers and operators. A logistics centre helps put different kinds of goods together in a location and plays a role of helping reduce the inner-city freight traffic through a combined route scheduling and city-friendly distribution system.[103]

2) City logistics distribution channel

   The distribution channel is part of the city logistics infrastructure network. It is a city's physical path through which goods and services are delivered to end customers. Intermodal transport modes such as urban rail transit and inland waterways are the favourite traffic means for city logistics because of their advantages of environment protection and energy consumption.[104] However, as a result of lack of sufficient infrastructure for intermodal transport modes, the urban road network is nowadays the major distribution channel for most cities.

3) City logistics delivery/loading bays

[103] See Bundesminister für Verkehr (1992), p.57.

[104] See Alessandrini et al. (2012) and Nemoto et al. (2006).

Due to the high density of business and traffic within urban areas, especially around shopping centres and traffic-free zones, city logistics vehicles are usually not able to reach end customers. The setup of delivery/loading bays can therefore ease the last leg of goods delivery, improve the efficiency of the total operation process and minimise the negative effects for ordinary urban traffic. Otherwise city logistics vehicles have to park on streets, which may cause traffic congestion. On-street and off-street delivery/loading bays are the two major types (see Table 3). Moreover, it is desirable to introduce technical solutions to plan the location, size and number of delivery/loading bays, and manage the access and stop of urban freight vehicles, so as to optimise the use of scare areas of delivery/loading bays.[105]

Type			Description
On-street delivery/loading bay			Set up for all commercial facilities nearby when it is impossible to set up any off-street ones. In order to minimise its negative effects for ordinary urban traffic, it is usually set up on streets with lower traffic volume, and is sometimes only allowed to be used during off-peak hours
Off-street delivery/ loading bay	City logistics dedicated delivery/loading bay	City logistics dedicated	Large commercial establishments such as hypermarkets, shopping malls and office buildings are required to provide dedicated delivery/loading bays for city logistics
	Shared delivery/ loading bay with passenger traffic	Shared delivery/loading bay with passenger Traffic	Freight traffic shares the delivery/loading bay with passenger traffic at the same time
		Time-shared delivery/loading bay with passenger traffic	Freight traffic can be allowed to use the delivery/loading bay when it is not occupied by passenger traffic (usually at night)

Table 3: Types of delivery/loading bays

2.2.1.3. City logistics information platform

Being in the midst of an era of the proliferation of information technology (IT) means logistics companies have an increasing demand to optimise their logistical activities with their suppliers and customers in supply chains. New IT technology presents new tools to manage information flows. It has been demonstrated that greater use of information technology can massively improve the efficiency of logistics operations through increasing capacity while reducing costs.[106]

The building block of a city logistics information platform provides the overall IT solutions, intelligent transport system (ITS) in particular[107] and technical equipment to combine and support all processes and involved logistical activities, and improve the operation efficiency of the city logistics system. It adopts a holistic approach to the integration of the various systems of shippers outside a city, city logistics operators in logistics centres, end customers within urban areas and city administrators. Through information collection, transmitting,

[105] See Dezi/Dondi/Sangiorgi (2010): one method was developed and studied in Bologna (Italy) to maximise the parking spaces (single commercial vehicle loading/unloading zone) and their use in an existing urban areas.

[106] See Closs et al. (1997).

[107] See further discussions and the application in section 2.3.2.5.

storage, handling and output, the platform presents an innovative means to support information sharing, storing customer requirements, arranging vehicle scheduling and routing, and generating statistical reports. Furthermore, the platform provides functions such as monitoring the environmental impacts of city logistics operation in terms of noise, CO_2 and NO_x, and issuing governmental regulations.[108]

Beyond the information technology, more automated equipment and technology, including unloading equipment, singulator stations, pallets, roll cages, ULDs, identification technology, storage technology, cross-docking technology and picking technology are required as enablers of a city logistics concept to shorten the operational process from receiving products from various suppliers to deliver the consolidated shipments to final recipients in urban areas.[109]

2.2.1.4. City logistics support measures

The building block of city logistics support measures is the soft environment of the city logistics system. Setting up certain regulations and policies is a crucial aspect of developing an efficient city logistics system and plays a significant role in the successful implementation of city logistics solutions. Any support measures are designed with three major targets:[110]

- To maximise the operation efficiency so that the activities of city logistics can be performed without exacerbating the negative impacts (environmental and social impacts) on urban areas
- To minimise the negative impacts (environmental and social impacts) caused by the activities of city logistics in urban areas without retarding the operation efficiency
- To improve the operation efficiency so that the activities of city logistics can be performed well and their negative impacts on the urban area can be reduced

Through issuing and executing certain support measures, city authorities can have a considerable impact on the city logistics infrastructure (e.g., land use, road construction), city logistics operators (e.g., subsidise good performances) and city logistics vehicles (e.g., set up time or weight/size restriction). It can either assist goods vehicle operation or restrict inefficient ones.

2.2.2. City logistics stakeholders

2.2.2.1. City logistics stakeholders and their interests

As explicated in section 2.2.1, a city logistics system consists of building blocks involving numerous stakeholders, who have different roles, specific objectives and sometimes even conflicting interests.[111] The efficiency and effectiveness of the system is heavily influenced by the interrelationship between stakeholders and the available resources. It is hence essential to understand all of the involved stakeholders and align their interests within the city logistics system to smoothen the operation process.

[108] See DHL/Siemens/CDI (2011), p.59-63 and Kaupp (1997), p.33-36.

[109] See DHL/Siemens/CDI (2011), p.64-70.

[110] See Browne et al. (2007), p.29-30.

[111] See Taniguchi et al. (2001), p.3.

Based on decision power, all of the involved stakeholders can be grouped into three major types of public authorities, professionals and impactees (an overview is depicted in Table 4), whose decision making directly or indirectly impacts the city logistics operation (see their interrelationship in Figure 12).[112]

Stakeholder	Items	Interest
Public authorities	National/regional governments	Maximise net economic benefits Minimise the external impacts of city logistics
	Local governments (e.g., city authorities)	Improvement of the efficiency and effectiveness of city logistics Urban economic growth Urban sustainable development Investment and business
Professionals	Goods receivers/consignees (business and private ones)	Logistics services improvement Costs reduction Market growth
	Shippers/suppliers (e.g., manufacturers, retailers, wholesalers or their logistics companies)	Costs reduction Accessibility to the customers Market growth
	Carriers (e.g., logistics companies)	Freedom of provision of efficient and effective distribution services with minimum restrictions Accessibility to the customers Cost effectiveness Market growth
	Operators of logistics facilities (e.g., logistics property developers, terminal operators)	Involvement in city logistics programming Supply of facility services
Impactees	Inhabitants	Negative external impacts e.g., noise, congestion, air pollution, etc.
	Visitors/shoppers	Products and services Negative external impacts e.g., noise, congestion, air pollution, etc.

Table 4: City logistics stakeholders

Source: in reference to Vaghi (2010), Ramokgopa (2004), and BESTUFS 2_D2.1 (2005).

Public authorities attempt to enhance a city's attractiveness for both business and individuals. Therefore, they aim to maximise the economic benefits of city logistics as well as minimise its negative environmental and social externalities through governance and legislation. National/regional and local governments, as the major representatives of public authorities, can influence city logistics by different means. National/regional governments issue more nation-/region-wide regulations or policies, while local governments can design more specific ones.

The professionals, ranging from suppliers, goods receivers, carriers and logistics facility operators, are active stakeholders within a city logistics system. Suppliers and goods receiverss are located separately at the origin and destination of the supply chain and are considered the most crucial stakeholders since they are the

[112] See Quak (2008), p.31-32.

customers of city logistics services and decide the city logistics operator and operational models. Freight carriers are the core operators of city logistics and providers of services. Their expertise and practice directly determine the level of efficiency and effectiveness of the city logistics system. Logistics facility operators play a subsidiary role in helping to implement all city logistics solutions through providing necessary logistics facilities. Usually, all four groups of professionals belong to the private sector, which focuses on maximising net economic benefits, but sometimes overlooks the negative impacts of their logistical activities.

Impactees are the inhabitants or visitors who work, live or shop in or visit a city.[113] Being affected by the negative impacts of goods movement, they care more about the liveability of the city and sustainability of the urban development, which conflicts with the interests of private professionals.

Hereby, public authorities, especially the local municipalities, as the representatives of cities and their inhabitants, play a major role in resolving these conflicts. Active local municipalities can play three types of role as developer (of technology), provider (of financial means) and operator (e.g., traffic management) to coordinate, facilitate and promote the implementation of advanced city logistics solutions.[114] They are seen here as one crucial driving force in the innovation of city logistics.

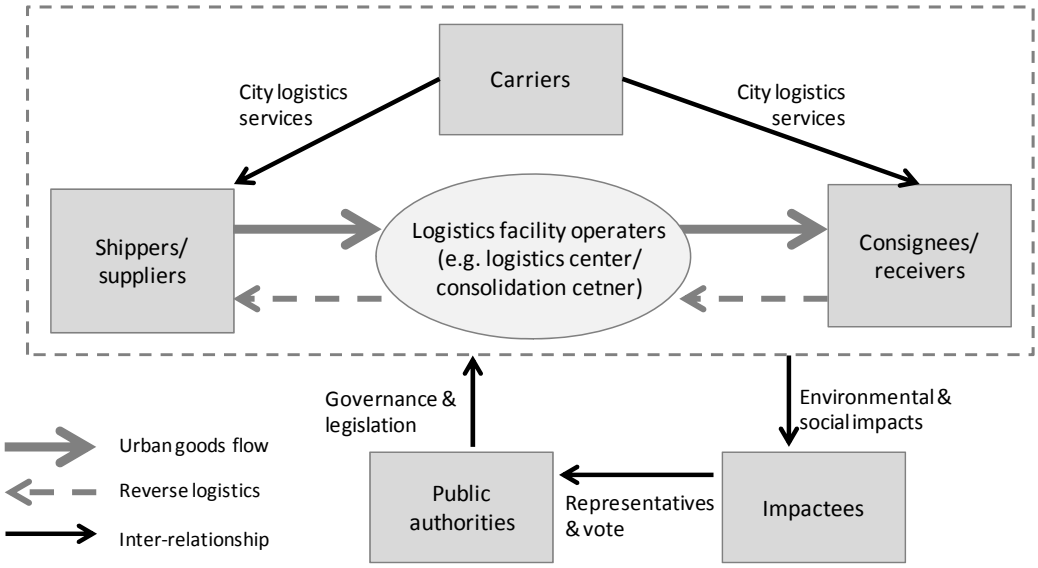

Figure 12: Inter-relationship among city logistics stakeholders

2.2.2.2. City logistics stakeholders and their inducement and contribution

Indicated by the inducement-contribution theory any cooperative initiatives in the field of city logistics can be realised only when the two conditions below are fulfilled:[115]

- The participants in the cooperation appreciate the inducements received are higher than their contribution on their own value understanding.

[113] See Taniguchi et al. (2001), p.4.

[114] See Van Binsbergen/Visser (2001), p.514.

[115] See section 2.1.2.4.

- The contribution made by individual participants secures that the cooperative system can grant all the necessary inducements for participants.

Based on this theory, it is of significance to examine the inducements and contribution of stakeholders relating to any city logistics cooperation. Actually, different stakeholders in a city logistics system seek their own interests based on their value understanding, which were identified in section 2.2.2.1 (see Table 4). General expectations of active stakeholders can be understood as the inducements for the realisation of city logistics cooperation:[116]

- Reduction of negative external impacts and noise nuisance
- Improvement of the goods supply situation
- Improvement of images
- Improvement of the reverse logistics
- Improvement of customer services
- Improvement of parking facilities
- Improvement of traffic situation
- Simplification of the concurrence with inhabitants and urban communities

Besides the inducements, it is also crucial to identify the contribution of key stakeholders of any city logistics cooperation projects. Besides the public authorities, two professional stakeholders from the private area, carriers (or shippers/carriers)[117] and goods receivers, should attract definite attentions as the former is the executor of any innovative concepts and the latter has a decisive impact on the behaviour of the former stakeholder. Their participation has impressive effects in the implementation of the city logistics concept. The decisive contribution for freight carriers and retailers according to the literature is summarised below:

For freight carriers:[118]

- To achieve correspondence with current systems
- To invest additional effort for negotiation and administration
- To attract sufficient participants as customers/users
- To find the right partners

For retailers:[119]

- To achieve correspondence with current systems
- To invest additional effort for negotiation and administration
- To solve possible problems caused by consolidating goods shipments from various suppliers (e.g., longer delivery times)
- To improve the acceptance of end customers
- To find the right partners

[116] See Oexler (2002), p.14.

[117] Shippers/suppliers will play the role of carriers, when they are responsible to organise the logistics services by their logistics teams.

[118] See Oexler (2002), p.15.

[119] See Oexler (2002), p.16.

Cooperation equilibrium of city logistics involving freight carriers and/or retailers can be achieved only when the participants can be provided with sufficient inducements to reward their investment and effort.

2.3. City logistics solutions and reference cases

A solution is an action or a process of solving a problem. A city logistics solution is one that aims to solve the problems facing city logistics and to realise its objectives. The term city logistics solution[120] is used here to identify all possible implementations of the concept of city logistics in practice, aiming at improving the efficiency and building up a sustainable city. A reference case is a kind of implementation of a city logistics solution. This section attempts to identify and investigate the available city logistics solutions and their reference cases, focusing on those that have been either tested or are still in operation. By doing that, it is possible to extract and summarise all of the meaningful lessons regarding, both critical successful factors and major barriers for the failed trials. However, due to the limitations of this work it is not possible to include every kind of solution, but most of them.

2.3.1. Data sources and selection criteria

2.3.1.1. Data sources

Two sources are used in this thesis to look for any city logistics solutions and related reference cases:

1) Major source: project reports / white papers funded by public sectors
2) Supplementary source: proceedings of scientific conferences focusing on city logistics; academic articles/papers/thesis in electronic databases; and websites of related projects and publications

The first is the major data source for all reviewed solutions and reference cases. The European Commission (EC) is the primary sponsor for most city logistics projects. Various projects and reports funded/co-funded by the EC can be found in the literature.[121] Some focus purely on realising objectives of city logistics,[122] while some cover both, goods and passenger traffic in urban areas.[123] This section chooses some of those EC-funded projects as they provide a good overview of the most recent results of city logistics practice. Furthermore, other project reports funded by national or regional authorities are chosen here in order to provide an additional overview of city logistics practice with a wider geographic perspective than Europe. The main projects are summarised in Table 5. All these projects together provide the fundamental basis for various city logistics solutions and references.

However, one report or article may not be able to demonstrate a city logistics solution or a reference case in a complete way. Further literature needs to be cited to supplement necessary information and arguments that are lacking in the major source. Hence, three other types of data sources are chosen to form the supplementary source. The proceedings of scientific conferences focusing on city logistics are taken as the 1st type. A large

[120] Other terms such as city logistics scheme, city logistics project, city logistics program, city logistics measurement, city logistics initiatives can also be found.

[121] A list of EC-funded (or co-funded) city logistics projects is attached in the Appendix 1.

[122] For instance BESTUFS (2013).

[123] For instance CIVITAS (2013).

number of conferences during the past decades have been organised to discuss, share and promote knowledge in the field of city logistics, including one group on urban goods movement at the World Conference on Transport Research, the National Urban Freight Conference (NUFC) from the Metrans Transportation Centre and City Logistics Conferences. Among them, the City Logistics Conference, organised by the Institute of City Logistics (ICL) in Kyoto, Japan, attracted the most attention as it acts as a platform for exchanging knowledge, experience and information regarding city logistics and urban freight transport.[124] The 2nd type comprises academic articles, papers and theses in electronic databases (such as ScienceDirect, Emerald, EBSCO, Springer, etc.). Websites of related projects and publications are used here as the 3rd type of the supplementary source to widen and deepen understanding of the topic.

[124] See ICL (2013).

Project/report	Brief introduction	Period	Sponsor
BESTUFS[125]	BESTUFS aims to maintain and expand an open European network in order to identify, describe and disseminate best practices, success criteria and bottlenecks of city logistics solutions.	BESTUFS I (1998-2002) BESTUFS II (2002-2008)	EC
CIVITAS[126]	CIVITAS supports European cities to introduce ambitious transport measures and policies towards sustainable urban mobility.	CIVITAS I (02-06) CIVITAS II (05-09) CIVITAS PLUS (08-12) CIVITAS PLUS II (12-16)	EC
C-LIEGE[127]	C-LIEGE aims to define shared policies and measures for an energy-efficient urban freight transport demand management and planning through a cooperative approach between public and private stakeholders in EU cities and regions.	2011-2013	EC
START[128]	START deals with making goods distribution more energy efficient by combining access restrictions, incentives and the development of consolidation centres.	2006-2009	EC
SUGAR[129]	SUGAR focuses on addressing the problem of inefficient and ineffective management of urban freight distribution, a critical component of the overall urban transport system and a primary source of vehicle pollutant emissions.	2008-2011	EC
TRAILBLAZER[130]	TRAILBLAZER aims to showcase existing good practices and promote public sector policy interventions, which can bring about a reduction in energy used in urban freight transport.	2011-2013	EC
TURBLOG[131]	TURBLOG acts as a coordination platform, gathering the experience to extend, expand and transfer the existent knowledge of urban logistics to other countries from a worldwide perspective.	2009-2011	EC
RGPUFT[132]	This report provides information on freight transport policies implemented in several regions including Asia, Europe, and United States.	2010	UN

Table 5: Major data source – a list of city-logistics-related projects/reports

2.3.1.2. Selection criteria

A set of criteria is proposed in this section for identifying all available city logistics solutions and their reference cases:

- Criterion A: the city logistics solution is designed with the aim of improving efficiency and building up a sustainable city.

[125] See BESTUFS (2013): Best Urban Freight Solutions.

[126] See CIVITAS (2013): Cleaner and Better Transport in Cities.

[127] See C-LIEGE (2013a): Clean Last mile transport and logistics management.

[128] See START (2013): Short-Term Actions to Reorganise Transport of Goods.

[129] See SUGAR (2013): Sustainable Urban Goods Logistics Achieved by Regional and Local Policies.

[130] See TRAILBLAZER (2013): Transport And Innovation Logistics by Local Authorities with a Zest for Efficiency and Realisation.

[131] See TURBLOG (2013): Transferability of urban logistics concepts and practices from a worldwide perspective.

[132] See Wisetjindawat/Showaku (2010): Review of good practices in urban freight transportation.

- Criterion B: the solution has been implemented or at least tested for a sufficient length of time. In other words, at least one reference case is available to review the content and conclusions of practice.
- Criterion C: the solutions and related reference cases have been reported in public. Also, there is sufficient material (including articles, reports, or papers) accessible.

Following the selection criteria, the next sections will investigate the major solutions and relevant reference cases of all the listed projects (see Table 5) in sequence.

2.3.2. BESTUFS project

2.3.2.1. Project introduction

BESTUFS (Best Urban Freight Solutions) is a coordination action sponsored by the European Commission (DG Transport and Energy) aiming to maintain and expand an open European network involving urban freight experts, users group, public representatives from European, national, regional and local administrations in order to identify, describe and disseminate best practices, success criteria and bottlenecks of city logistics solutions. The project consists of both, practitioners such as Deutsche Post and experts and researchers such as PTV AG and the University of Westminster. The project was conducted in two phases:

- BESTUFS I: 1998-2002
- BESTUFS II: 2002-2008

During the 10-year project phase workshops, conferences and roundtables were regularly organised to discuss and evaluate intermediary results. After the completion of this project in 2008, the project team published a set of project reports / good-practice handbooks, which provide a detailed overview of comprehensive city logistics solutions and reference cases from all European countries.

In total there are eight types of solution recommended by the BESTUFS project team. Each is supported and demonstrated by more than one practical reference case (project-level case studies). Table 6 reveals the classification of all the city logistics solutions and the number of relevant reference cases.

City logistics solution	# of reference cases[133]			
	research	trial	operation	in total
City access regulation		1	16	17
Last-mile solutions (e-commerce and home shopping)	1	4	5	10
Environmental-friendly vehicles (EFVs)		4	1	5
Intelligent transport systems (ITS)	6	2		8
Public-private partnership (PPP) in urban freight transport			6	6
Road pricing in urban freight transport			7	7
Urban consolidation centre (UCC)	1		7	8
Waste transport and logistics	2	2	2	6
# of RC in total	10	13	44	67

Table 6: Overview of city logistics solutions and reference cases of BESTUFS

Source: summarised from BESTUFS 1_D2.4 (2004), BESTUFS 2_D2.1 (2005), BESTUFS 2_D2.2 (2006), BESTUFS 2_D2.3 p1 (2007), BESTUFS 2_D2.3 p2 (2007), BESTUFS 2_D2.4 p1 (2008), BESTUFS 2_D2.4 p2 (2008), BESTUFS 2_D2.4 p3 (2008).

2.3.2.2. City access regulation

The concept of city access regulation came as a means to tackle the issues of air and noise pollution, and traffic congestion confronting most European cities. It provides city authorities with a powerful instrument to influence urban goods traffic, which is criticised as a major cause of environmental and social problems. The purpose of the access regulations is to reduce and minimise the negative effects caused by goods and service vehicles in urban areas without reducing the ease and efficiency with which the city logistics activities are performed.[134] City authorities can regulate the access of urban traffic through various objects:

- Delivery time window

  In order to reduce the nuisance caused by urban freight traffic and improve the attractiveness of urban areas, many cities set up scheduled time windows for goods deliveries. It has become common today that many European cities restrict the access of freight traffic during peak hours and often shift goods deliveries to off-peak hours.

- Vehicle restriction through emissions, size and weight

  Emission, size and weight are critical technical indicators in terms of potential nuisance caused by vehicle traffic. City authorities use this solution to improve traffic safety, alleviate traffic congestion and reduce air and noise pollution. Vehicles are always allocated specific time windows and urban zones to access their customers according to their weight.[135] While large heavy trucks are even excluded or banned from entering the city centre.[136]

- Environmental zone (EZ) / pedestrian zone / low-emission zone

[133] The phase of reference cases is recorded according to information in the project reports not the actual situation.

[134] See Browne (2007), p.29-30.

[135] The new regime for the city of Paris goods delivery regulations is one representative case.

[136] Liège's transit ban for HGVs is one good practice.

In spite of the differences in the context of literature, the three terms express the same concept, which was developed with the objective of creating a special convenient and attractive area for business, shopping and living through improving air quality and lowering traffic pollution. Historical city centres, business centres and congested centres are often designated environmental zones (EZ), where even stricter time windows are introduced for goods deliveries. Sometimes only environmental-friendly vehicles or bikes are permitted to access the zones and execute any delivery activities. The solution can be found in five of the recorded reference cases.

- Loading/unloading zones

  The loading/unloading zones focus on problems caused by a shortage of available (un)loading zones or accessibility of these zones due to vehicles' long occupancy. Therefore, it is necessary to plan and reserve sufficient public and private (un)loading zones within urban areas both off- and on-street. Further, regulating the use of these zones is another critical task. Budapest[137] and Reims[138] provide good examples of implementing the solution of loading/unloading zones.

- Licences

  The access restriction of certain time windows can create a relatively comfortable environment for businesses and residents in urban areas; however, it can still cause inconvenience for both the carriers as well as those located within the restricted areas, in particular when the business is located in an environmental zone under a very strict time restriction and requires special delivery services such as the catering industry. The concept of a license for delivery outside the time window is then developed as a solution to minimise the burden. Local businesses or related carriers are allowed to apply for such licenses with a certain time limitation.[139]

- Preferred truck routes

  The heavy trucks' occupancy of street network particularly within a metropolitan area can cause many inconvenient environmental and social effects. The idea of setting up preferred truck routes is to prevent the trucks from penetrating urban areas.[140] One good practice of an implementation of this solution is the city of Bremen, where a lorry-guiding network was introduced to assist heavy goods vehicles in finding the best routes.[141]

- Load factor

  Increasing the load factor of each good shipment is an effective means of reducing the total amount of urban freight traffic. Therefore, various measurements are introduced to assist or reward carriers' practice of increasing their load factor. In fact, the city of Copenhagen initiated this solution. Freight vehicles that utilise more than 60% of their loading capacities were granted a certificate to use especially reserved loading zones within urban areas.[142]

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[137] See BESTUFS 2_D2.2 (2006), p.83-86.

[138] See BESTUFS 2_D2.2 (2006), p.45-46.

[139] See BESTUFS 2_D2.2 (2006), p.76: the access restriction in Enschede is a reference case for this solution.

[140] See BESTUFS 1_D1.1 (2001), p.11.

[141] See BESTUFS 2_D2.2 (2006), p.81-83.

[142] See BESTUFS 1_D2.4 (2004), p.45-47.

In terms of supportive practices, there are in total 17 reference cases recorded in the BESTUFS reports, which provide a good idea of the implementation of city access regulations in Europe:

- In general, time windows, vehicle restriction and EZ are adopted by many European cities, while (un)loading zones and licenses are usually taken as supplementary solutions to improve the ease and efficiency of city logistics within urban areas. There is only one reported reference case for either preferred truck routes or load factor. It indicates that more effort or experiments may be required to promote the utilisation of these two solutions.
- Even though many access regulation solutions are introduced separately in most cases, they are not used in isolation but enforced together with others aiming to improve their effectiveness. Also, this argument has been backed well by the results of good practices in the cities of Barcelona, Cordoba and Seville in Spain; Montpellier and Paris in France; Namur in Belgium; Amsterdam, Haarlem, Tilburg, Groningen and Enscheda in the Netherlands; as well as London in the UK.

2.3.2.3. Last-mile solutions

Last-mile delivery is the last leg of a supply chain that connects the final destinations to the rest of the chain, and is the most visible part of city logistics in urban areas. The e-commerce industry has grown quickly in the last decade, but still only holds a small market share compared to the conventional retail industry. This growth trend is expected to continue for the foreseeable future. High growth results in more frequent shipments of small loads of goods to satisfy increasing consumer needs. Efficient and reliable logistics becomes then a decisive factor of e-retailers' economic success. The last-mile solutions are developed to meet this demand and to:[143]

- Shorten delivery times
- Increase the reliability and overall service quality
- Increase the flexibility of deliveries in terms of delivery addresses and time in order to create greater convenience of goods pick-up for customers
- Increase the transparency and accessibility of goods' status

Theoretically, there are certain options available for improving the operational efficiency of different aspects of the supply chain; each has advantages and disadvantages (see an overview of these three aspects in Table 7).

Aspect	Option 1	Option 2	Option 3
Distribution channel	Picking centre (warehouse / distribution centre)	Picking in retail outlet	
Transport operation	In-house: shipper operates own vehicles for deliveries	Outsourcing: shipper uses 3rd-party operator for deliveries	
Delivery point	Attended home delivery	Reception & delivery boxes/access control systems at the customer's home	Locker bank / convenience store
Information flow	Use of phone / text/ email to communicate with customer for attended home delivery	Use of text/email to communicate with customer for delivery to locker bank/ collection point	

Table 7: Overview of last-mile solutions

Source: summarised from BESTUFS 2_D1.1 (2005), p.18-19 and BESTUFS 2 (2007), p.52-54.

[143] See BESTUFS 2_D1.1 (2005), p.13.

With respect to practice, the reference cases in the BESTUFS project focus more in transport operation and delivery point:

1) Transport operation
   - In-house operation: this is indicated from the practice of Caddy home (online supermarket) in Brussels and surroundings that in-house operation has the advantages of offering flexible and reliable delivery services. Moreover, value-added services such as bottle return and payment are also included in the last-mile solution.[144]
   - Outsourcing: LeShop (online supermarket) from Switzerland is a good case for operating last-mile deliveries in cooperation with a professional logistics company. Its success proves that this option has the advantage of focusing on its own business without high investment in last mile infrastructure.[145] Beyond that, outsourcing the last-mile delivery of repair services is another feasible area.[146]
2) Delivery point
   - Attended home delivery: attended home delivery is a conventional way for goods handover of last-mile deliveries; however, it requires the presence of recipients during a scheduled time window. This can reduce the recipient's dissatisfaction if the goods shipment cannot be delivered on time because of traffic congestion, and inconvenience to the couriers if the recipients cannot attend the goods pick-up because of any unexpected issues.
   - Reception & delivery boxes/access control systems at the customer's home: in order to solve the issue discussed above, dedicated facilities such as reception & delivery boxes or access control systems needed to be installed in the customer's home or surrounding areas. The case of Internet House in Berlin attempted the installation of cupboard-like boxes in apartments to ease the home deliveries of ordered goods.[147] In addition, more innovative solutions have been tried and put into practice. DHL introduced its (fully automatic) Packstation establishing a wide network covering all of its customers in Germany and has proved to be a success. On one hand, it enables a consolidation of goods flow, which used to be generated through home deliveries to each individual household; on the other hand, it offers greater convenience and flexibility for goods pick-up for its customers. Moreover, customers are also able to use the Packstation to send parcels.[148]
   - Locker bank / convenience store: the main idea is to use existing infrastructures such as convenience stores, fuel stations, video libraries and kiosks to assist the final process of home deliveries. No large investment is required. In fact, RelayStar[149] in the Benelux countries and the UK, and PickPoint AG[150] in Germany, Austria and the UK, both realised this idea and helped improve their operational efficiency.

[144] See BESTUFS 2_D 2.4 p1 (2008), p.45-46.

[145] See BESTUFS 2_D 2.4 p1 (2008), p.47-51.

[146] See case study of ServiceLog in BESTUFS 1_D2.4 (2004), p.101-102.

[147] See BESTUFS 2_D2.4 p1 (2008), p.41.

[148] See BESTUFS 2_D2.4 p1 (2008), p.54-57.

[149] See BESTUFS 2_D2.4 p1 (2008), p.35-37.

[150] See BESTUFS 2_D2.4 p1 (2008), p.38-40.

2.3.2.4. Environmental-friendly vehicles

Freight vehicles are the most important transport means (the only ones in many cities which are not feasible for intermodal traffic) of goods movement within urban areas. Their technical performance is the determining factor of negative effects. Environmentally friendly vehicles (EFVs) are favourable products in the public sector as they produce much less harmful impacts (e.g., emissions, noise) to the environment than conventional ones running on gasoline or diesel. The introduction of EFVs into urban freight traffic has the potential to realise their advantage in the field of environmental protection, reduce local emission in a city and build up green logistics.[151]

In a narrow sense, the term EFVs is used to refer to vehicles equipped with propulsion systems running on alternative fuels, such as LPG (liquefied petroleum gas), CNG (compressed natural gas), bio-fuel, electricity, or a mixture of them. However, in a relatively broader sense, vehicles with a conventional propulsion system should also be incorporated into the scope of EFVs if they are able to perform more environmental-friendly through introducing innovative technology. Hence, two groups of EFVs are presented in Table 8.

Propulsion systems	Features
Alternative propulsion systems	• Alternative-fuel vehicles (AFVs) • LPG (liquefied petroleum gas) • CNG (compressed natural gas) • Bio-fuel technology • Electric vehicles • Hybrid-electric vehicles (HEV) • Hydrogen-based (fuel cell) technology
Classical/conventional propulsion systems equipped with innovative technology	• Can reduce fuel consumption and gas emission • Can reduce noise level • Can increase the load capacity or improve usage efficiency

Table 8: EFVs classification

Source: summarised from BESTUFS 2_D2.1 (2005), p.64-69.

A set of barriers still needs to be removed before EFVs can be observed as commonplace in every street in congested city centres:[152]

- High cost of procurement and maintenance, which is a major reason for their low acceptance among private sectors
- Lack of sufficient dedicated infrastructure (mainly filling stations), which hinders EFVs from being more popularly used
- Less reliable, such as lower travel speed and limited total travel distance due to lower energy density of vehicle batteries
- Less productive, less loading capacity due to hybrid propulsion

[151] See Clausen/Schaumann (2012).

[152] See BESTUFS 2_D2.1 (2005), p.63 and Clausen/Schaumann (2012).

Therefore, the support from public sectors is of great necessity to promote the usage of EFVs in urban freight traffic and increase their adoption in the private sector. City authorities have the power to:

- Reduce the procurement and maintenance costs of EFVs through measures such as tax reduction or provision of subsidies
- Create favourable access regulations such as access permissions outside the scheduled time window, use privilege of reserved (un)loading zones and bus lanes
- Fund the establishment of a dedicated infrastructure
- Reduce the competitive strength of conventional vehicles through introducing road pricing[153]

In practice, five reference cases are recorded in detail to demonstrate effort both from the public and private sector to support the implementation of the EFVs solutions. However, there is still gap to be closed before EFVs can be put fully into operation, as four of the five cases never got beyond the experimental phase.

2.3.2.5. Intelligent transport systems

In general, the term intelligent transport system (ITS) refers to the combined application of information and communication technology. It provides a wide range of technical tools/instruments to manage transport networks for city planners and novel services for carriers from the private sector. Involving the application of advanced technology in urban freight transport, ITS have the potential to:[154]

- Reduce the total negative effects of city logistics through
    - Increasing the productivity of freight vehicles (increase the use of vehicles' loading capacity)
    - Increasing the reliability of city logistics services (e.g., avoid any temporary traffic jams)
    - Reducing traffic accidents and increasing safety
- Increase the capacity of urban freight systems without building any additional infrastructure

Due to these advantages, applying telematics to urban freight transport can be seen to have a bright outlook. Using the dimension of usage group, the application of ITS can be classified into:

- Public users (often city authorities) to enforce any urban-freight-transport-related policies
- Private users (e.g., carriers) to improve the operational efficiency
- Or both groups

And the ITS application for each group is depicted in Table 9.

[153] Road pricing will be discussed in section 2.3.2.7.

[154] See Taniguchi et al. (2001), p.49-50.

Usage group	ITS application
Public users	Automatic fee control system in connection with road pricing
	Electronic access control
	Electronic management of zones for delivery
	Traffic monitoring and traffic control (enforcement)
	Trucking route signalisation
Private users	Electronic freight exchange systems for urban freight transport
	Electronic operational management of terminals
	Freight and fleet management systems
	Tour planning
	Tracking and tracing
	On-board computers for delivery vehicles
Both groups	ITS for the management of dangerous goods transports
	Traffic information

Table 9: ITS application in urban freight transport

Source: summarised from BESTUFS 2_D2.3 p2 (2007), p.23-31.

With respect to practice at country level, the application of ITS in the field of urban freight transport varies from one state to another. With the evidence presented in the BESTUFS report, it is possible to classify the 17 countries involved into three groups based on acceptance of the importance of ITS for urban freight transport and their application level:[155]

- Very important and widely used

  In countries like Germany, Japan, Switzerland and the UK, ITS have been recognised as a significant technical solution for tackling issues faced by city logistics. Thereby, a great deal of effort and resources are allocated to support research activities as well as the application of ITS to improve urban traffic flow.

- Important and applied in certain areas

  While in other countries including Australia, the Czech Republic, France, Greece, the Netherlands, Slovakia and Slovenia, ITS solutions have been progressively accepted. However, the usage of the combined information and communication technology is still limited in certain areas. For instance, the Netherlands focuses on better usage of existing infrastructures, and Australia mainly uses ITS to solve urban transport problems related to port freight transport.

- New concept and will be further developed

  But for some countries like Austria, Belgium, Hungary, Italy, Poland and Spain, the ITS concept is considered a new topic. Its usage is still in an early stage.

[155] See BESTUFS 2_D2.3 p2 (2007), p.40-45.

However, in the near future, ITS usage is expected to become more popular and gain increasing support from both, public and private groups. This trend is backed strongly by the results of a survey[156] conducted by the project team and the evidence demonstrated by all the related projects collected in the report[157].

2.3.2.6. Public-private partnership

Defined by the United Nations, public–private partnership (PPP) is *a means by which the public and private sectors can work together as they provide a contractual and formalized framework needed for easier cooperation between all parties*.[158] For the past three decades, it has been used as a useful instrument by many developed and developing countries for infrastructure development.[159]

In relevance to urban freight transport, the PPP concept refers to a form of partnership between public (e.g., national or local governments, administration, public institutions) and private (e.g., logistics companies, retailers, economic associations) sector entities in order to use their different comparative advantages of all kinds of aspects including information, managerial know-how and financial resources, etc. to realise the objectives of city logistics.[160] With respect to the formal degree of partnership, three categories can be identified:[161]

- Informal cooperation

  The informal cooperation is often realised in the form of informal discussions, workshops or conferences for a general exchange of information, expertise or opinions over specific topics /projects. Despite the loose form of cooperation, it is seen and undertaken usually as a necessary premise for authorities to design and enforce certain urban freight traffic policies or solutions.

- Contractual agreements

  Contractual agreements are regarded as a formal part of public-private partnerships. The partnerships are often strengthened through both parties signing an agreement. In the context of urban freight transport, the reference case of the Bristol Urban Freight Platform is undertaken under such a formal contractual agreement. DHL Exel, a professional logistics service provider, has been contracted to take responsibility for operations within the platform owned by the local authority to serve target customers.

- Joint ventures (JVs)

  JV is an even closer form of cooperation. A JV is often established with the idea of sharing the risks and rewards when the uncertainty of risks cannot be clearly identified. A practical example of this form of PPP can be found in Terni (Italy), where a JV was put in place between the public (50%) and local industry (50%) to operate a logistics platform.

[156] See BESTUFS 2_D2.3 p2 (2007), p.37-39.

[157] See BESTUFS 2_D2.3 p2 (2007), p.46-51.

[158] See UN (2004), p.4.

[159] See Urio (2010), p.6.

[160] See BESTUFS 2_D2.4 p2 (2008), p.20.

[161] In reference to BESTUFS 2_D2.4 p2 (2008), p.20-23.

In general, PPP has become a common and popular means for developing, financing and operating infrastructural projects. Yet, in relation to urban freight transport, there only a few reference cases were identified by BESTUFS.

At the country level Germany, the Netherlands and Denmark were found to have made active effort to put into practice the PPP concept in urban freight transport. For instance, almost 100 German cities set up city logistics cooperation with interest groups from urban goods delivery aiming to create a win-win situation for all involved actors.[162]

At the project level, there were six PPP projects presented in detail in the handbook. The public-private partnership between city authorities and private-interest groups are usually focusing on:[163]

- Establishment and operation of urban freight traffic infrastructure and related facilities
  Cargo Centre Graz in Austria aimed at establishing a new freight village; the Espaces de liaison de proximate (ELP) in Bordeaux (France) aimed at (un)loading zones in the city centre; Mabru, the morning market in Brussels aimed to provide an infrastructure used by wholesalers and retailers; while SpediThun aimed to operate an urban distribution centre.
- Design of city logistics solutions
  A contract form of PPP was undertaken both in Utrecht and Groningen (the Netherlands) to develop and formulate innovative solutions to tackle the issues facing their city logistics.

2.3.2.7. Road pricing

Road pricing is not new. It is generally used as an instrument of traffic management on existing roads rather than charging on new roads as a financing mechanism. Through setting up a pricing mechanism, city planners tend to induce drivers not to use certain roads at certain times of the day.[164] The idea of introducing road pricing into urban freight traffic is to tackle the issues of many city centres becoming increasingly congested and polluted. By imposing certain fees on the use of (urban) roads, city authorities are able to influence a city's freight traffic system.[165]

Policies of road pricing are featured with two main advantages: [166]

- Road pricing is an economic idea based on market mechanisms. Compared to city access regulations, it takes advantage of allowing road users to make decisions over road use based on individual preference. By encouraging individuals whose benefit is higher than the charged fees and discouraging others with less benefit, the overall benefit of the entire city can be increased.
- Rather than issuing legislations to directly prohibit urban freight traffic, road pricing provides the possibility to encourage the private sector (in particular carriers) to improve its operational efficiency,

[162] See BESTUFS 2_D2.4 p2 (2008), p.36-37.

[163] See BESTUFS 2_D2.4 p2 (2008), p.42-58.

[164] See Walker (2011), p.12-13.

[165] See BESTUFS 2_D2.3 p1 (2007), p.24.

[166] See BESTUFS 2_D2.3 p1 (2007), p.25.

either through increasing the load factor to reduce the requirement towards daily shipments in order to reduce road use or by adopting more innovative vehicle technology.

With respect to practice, the utilisation of road pricing in urban freight traffic was identified by the project team as still in its infancy.[167] Still, there are many quite successful and effective projects that practice policies of road pricing. Among them, seven were recorded in detail in BESTUFS project report, which can be grouped into:[168]

- Road pricing to all urban traffic

  The projects of the London City Congestion Charging and the Congestion Charge in Stockholm are two good reference cases that can showcase the process and related results. The policy of the congestion charge was developed with the objective to alleviate the traffic burden in congested city centres. Both passenger and freight traffic are included in the scope to be charged with the exemption of public busses, EFVs and special groups (such as emergency and military vehicles). The net revenues reintroduced from the charged fees exempting the costs of set-up and enforcement, are usually taken to fund/subsidise promotion of the public transport system, introduction of innovative urban freight solutions, and/or extension of the current urban infrastructure.

- Road pricing dedicated to freight traffic

  It is generally agreed that freight road transport is not popular among policymakers due to its poor performance in the field of environmental protection compared to other transport means such as rail. A main purpose of the introduction of the Heavy Vehicle Fee / LSVA[169] in Switzerland was to shift heavy vehicle traffic through the Gotthard road tunnel from road to rail by increasing the costs of road use. In addition, the collected fees can be used to finance public transport projects (e.g., the New Alpine Rail Transversal) to increase the competiveness of public transport means.

- Road pricing dedicated to finance specific infrastructure

  The construction of certain transport infrastructure such as city rings is recognised as an effective way to reduce the urban congestion burden. However, such large construction projects often require high investment. In order to finance the building of city rings, local authorities of Lyon in France as well as Oslo in Norway practiced a dedicated road pricing policy to charge ring users in order to gather the funding.

- Road pricing based on travel distance

  Triggered by the principle of “the user/polluter pays”, the government in the Netherlands initiated the scheme of Kilometerheffing pricing in major Dutch cities with the aim of creating a fair road pricing policy. All the road users are charged based on the travel distance on all Dutch roads.

- Combination of road pricing to other solutions

[167] Ses BESTUFS 2_D2.3 p1 (2007), p.33-35.

[168] See BESTUFS 2_D2.3 p1 (2007), p. 42-78.

[169] LSVA stands for Lkw-Abgabe beim Schweizer Alpen-Transitverkehr.

The electronic road pricing solution was introduced by the city of Rome because the access restriction of the Limited Traffic Zone covering the 5km^2 historical centre was difficult and inefficient to manually enforce. The policy of road pricing was incorporated into the whole scheme with the objectives of reducing traffic congestion and shifting traffic modals from private towards public.

At the time of the project, road pricing was considered to be of low importance by many European cities. However, later the policy was estimated to have substantially gained in importance. It was hence considered a progressive and future-oriented theme by the project team.[170]

2.3.2.8. Urban consolidation centre

Urban consolidation centre (UCC)[171] is a physical implementation of the concept of city logistics to reduce urban freight traffic and gain greater operational efficiency. It is understood as a logistics facility that shifts the goods shipment from long-distance transport means such as railway, large container trucks or ships to short-distance ones (mainly road traffic).[172] It is usually established outside the city centre in close proximity to its target customers to serve a city centre, an entire town or specific site. Goods shipments from different shippers/suppliers are sorted and consolidated at the UCC based on the destinations or travel routes and delivered to its customers within the geographic coverage area.[173]In many cases, EFVs are often utilised to fulfil the final delivery from UCCs to the target areas within city centres.

In a broad sense, a UCC is an integral part of the logistical infrastructure of a country/region. It is a logistics terminal or transhipment point that connects at least two transport modes (long distance and short distance) and offers the opportunity to long-distance transport companies to send goods destined for customers in urban areas to locations with easy accesses rather than congested city centres.

In general, a UCC is designed to provide consolidated goods deliveries. Moreover, it can facilitate the realisation of internal synergies by concentrating on economies of scale. A package of value-added services can be generated by a UCC. Subject to capacity and the storage conditions, a UCC can act as buffer stock for retailers to provide off-site storage and inventory management services. Second, product quality and quantity check is also incorporated into the service package. Further services including the removal of packaging, preparation of products for sales floor and pricing/labelling will ease the pre-retailing process. The provision of return and recycling of product, waste and packaging flows is another valuable part of the service package to improve customer satisfaction.[174]

The idea behind the development of an UCC solution is to change the operational model in order to:[175]

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[170] See BESTUFS 2_D2.3 p1 (2007), p.33-34.

[171] Besides "urban consolidation centre", a good number of synonymous terminlogies from the existing literature express the similar concept: "freight platform" (in reference Maroudas – Tsakyrellis, E. (2011), p. 28), "urban distribution centre" (see Panero, M., Shin, H.-S. & Lopez, D. P. (2011), p.3-4), "urban freight consolidation centre" (see Marcucci, E. / Danielis, E. (2008)), "urban freight platform" (see BESTUF 2_D2.3 Part 1, p. 97), "public distribution depot", "central goods sorting point", and "urban transhipment centre" etc. (See BESTUFS 2 (2007), p.61).

[172] See Russo/Comi (2010).

[173] See Browne et. al (2005), p.4.

[174] See BESTUFS 2 (2007), p.71.

[175] See Browne et. al (2005), p.4.

- Reduce the freight traffic in urban areas through consolidating goods shipments
- Reduce the total delivery trips and improve operational efficiency through increasing the load factors
- Reduce or eliminate the environmental impacts through replacing large and heavy trucks with smaller and lighter ones, in particular when in combination with EFVs
- Reduce the need for goods storage and related logistics activities in urban areas through increasing the delivery frequency
- Create more value and reduce the logistics costs through offering more value-added services such as off-site storage

With respect to practice, the UCC solution has attracted plenty of attention. A huge amount of effort and resources have been invested into researching and implementing this concept due to the potential economic, social and environmental benefits. A further discussion will be presented in section 2.4.

2.3.2.9. Waste logistics

To build up a sustainable urban freight transport is the objective of city logistics and plays a dominant role in the overall development process. Comprehensive city logistics solutions should not only ensure an environmental-friendly and efficient supply of goods to retailers and residents in a city, but as well as manage the removal of waste. The solutions of waste logistics provide the potential to remove the waste outside a city in an efficient and effective manner.

Waste management has become an important issue in European countries. Within the context of EU strategy, it focuses mainly on avoiding waste production, reducing the environmental impact from waste transport and exchanging best practices in relation to avoidance measures. However, there is lack of particular consideration of transport and logistics issues.[176] The idea of introducing waste logistics solutions into city logistics is to compensate this gap and tackle the issues caused by the ever-growing waste movement volumes within urban areas and their negative effects such as noise and exhaust emissions of waste collection vehicles.

As an important part of an overall waste management activity, waste logistics refers to the logistics management and disposal of hazardous or non-hazardous waste from packaging and products. The process of waste logistics consists of waste collection, transportation, transhipment and storage.[177] The waste movement usually flows in the counter direction of last-mile deliveries and is therefore incorporated into the functions of reverse logistics.

Within the context of urban freight transport, there are a great variety of different solutions that have been studied, tested and initiated to optimise the waste traffic flow and reduce the negative effects caused the overall process of waste logistics.

- Modal shift from road to inland barge, rail, transport/collection by tram, or pipelines

  Intermodal transport mode usually has better environmental benefits and can generate economies of scale. Examples from cities in Belgium, Switzerland and the UK prove that the implementation of

[176] See BESTUFS 2_D1.2 (2006), p.12.

[177] See BESTUFS 2_D1.2 (2006), p.12-13.

intermodal transport modes in the area of urban waste logistics can be environmentally and economically[178] viable. Representative cases include:

- Inland waterway urban transport of household waste transport in the Liege region of Belgium
- Cargotram for waste collection in Zurich
- Integrales Entsorgungssystem (IES) im Kanton Thurgau (Switzerland), which uses the railway to transport waste
- Pipeline for waste collection and transport in Helsinki

- The usage of EFVs for waste collection and transport

  As explicated in the preceding sections, EFVs exhibit a comparatively better performance in the field of environmental protection that meets the objective of waste logistics. With respect to practice, Madrid and Gothenburg bring some reference cases, where fleets of CNG-propelled vehicles and hybrid-propelled vehicles were respectively tested in the two cities.[179]

- Technical solutions for waste collection (e.g., compression and container technology)

  Examples from Greece show that the usage of standard litterbins and vehicles with compressors can reduce waste collection time and increase loading capacity.[180]

- The usage of ITS to support route planning and tour optimisation (e.g., route-guidance and route-planning software, GIS application for the positioning of containers etc.)

  Effort was found both from Germany and Austria, where two projects were initiated to test how best to use telematics technology to optimise the process of waste logistics and reduce vehicle kilometres as well as noise and exhaust emissions.[181]

- Management of time windows for waste logistics to reduce traffic congestion

  The idea behind this is to shift the traffic of waste movements to off-peak hours either early morning or at night to ease the congested urban traffic network. Practical cases can be found both in Spanish cities like Barcelona and Madrid[182] as well as many Greek cities.[183]

2.3.3. START project

The START (Short-Term Actions to Reorganise Transport of Goods) project, co-funded by STEER, a strand of the Intelligent Energy Europe programme of the European Commission, started off as a joint initiative between five European cities Bristol (UK), Goteborg (Sweden), Ljubljana (Slovenia), Ravenna (Italy) and Riga (Latvia).

[178] See BESTUFS 2_D1.2 (2006), p.15: inland barges can be cost effective compared to road at a distance of 10-12 km.

[179] See BETSUFS 2_D1.2 (2006), p.14.

[180] See BESTUFS 2_D2.4 p3 (2008), p.32-33.

[181] See case studies – OPTRANS and Potential of optimisation in waste disposal logistics in BESTUFS 2_D2.4 p3 (2008), p.54-55 and p.56-57.

[182] See BESTUFS 2_D1.2 p3 (2006), p.17.

[183] See BESTUFS 2_D2.4 p3 (2008), p.32.

Despite the diversity in terms of culture, history of urban planning and management, economic development, and freight distribution practices, the five cities share a common goal of seeking urban sustainability. The project was conducted during 2006-2009 on the basis of local freight network involving representative from most related stakeholders in order to:[184]

- Reduce energy consumption and emission of urban freight traffic
- Reduce urban freight traffic and congestion
- Increase awareness and acceptance from the local transport sectors about the possible ways to increase the energy and economic efficiency of freight transport
- Increase public-private cooperation
- Increase transnational exchange of experience among the stakeholders on freight transport in involved European cities

With respect to the practical aspect, START concentrated on three themes of city logistics solutions: access restriction, consolidation of deliveries and incentives. Since the concepts of the first two were discussed in the previous section, an explanation of incentives will be focussed on in the rest of this section. An overview of all the related reference cases is provided in Table 10.

Incentives are designed as regulatory solutions to improve and maximise the ease and efficiency of activities of city logistics and their performance so that their environmental and social impacts in urban areas can be reduced accordingly.[185] They provide a means to reduce high urban freight transport emissions and energy consumption by rewarding the use of environmental-friendly vehicles and ITS for communication and fleet management[186], high load factor and the adoption of consolidation solutions or off-peak deliveries.[187] Concrete measurements recorded by the reference cases in the project include providing favourable supports such as financial means, access permission, or privileged use of loading zones for UCC vehicles or EFVs, establishing a local freight network involving public sectors and interest groups from the private sector, and offering technical guidance and driver-training opportunities.

Although the three themes share a common concept and objectives, they were implemented with different content in the context of the five involved European cities (see Table 10). Considering the diversity of freight distribution development levels, the progress of putting the solutions into practice is not the same in the five cities. Bristol takes the leading position in terms of implementation, while other cities follow behind with trials or discussions of any innovative solutions. Above all, the actions of the START project highlight:

- A cooperative local freight network with the involvement of authorities from the public sector and various interest groups from the private sector is the basis and start for any successful practice of innovative city logistics solutions
- The solutions of access restriction or incentives should be developed as a package together with common objectives rather than separately

[184] See START_D6.3 (2009), p.3.

[185] See Browne (2007), p.29-30.

[186] See City Ports (2005), p.147-149.

[187] See Holguín-Veras (2007).

Pilot sites	Access restrictions	Consolidation	Incentives
Bristol	• Access restriction for Broadmead area	UCC in operation	• Freight Quality Partnership[188] • Technical guidance and driver training • Access to restricted the area for UCC vehicles • Prioritised lane for UCC vehicles
Goteborg	• EZ for load factor restriction • Time window in inner-city area	UCC in trial	• Privilege of using loading zones • Permission to enter restricted urban areas for EFVs
Ljubljana	• Proposal for new access restriction	UCC in research	• Incentives for EFVs included in the Traffic Act
Ravenna	• Restriction to city centre according to EURO emissions levels • Different ion of access time window	Virtual UCC in research[189]	• Financial support for EFVs • Access limitation favouring clean, light and EFVs
Riga	• Proposal for "drop-off" points at restricted Historical Centre	Consolidation of deliveries in operation	• Information campaigns on biofuel

Table 10: Overview of city logistics solutions and reference cases of START

Source: summarised from START (2009).

2.3.4. RGPUFT report

The report of RGPUFT (Review of Good Practices in Urban Freight Transportation) is one output of the project Eco-Efficient and Sustainable Urban Infrastructure Development in Asia and Latin America, which was funded by the Economic and Social Commission for Asia and the Pacific of United Nations with the objective of improving the capacity of policy-makers, planners and decision makers in selected cities in Asia and Latin America to increase the environmental sustainability of urban infrastructure development. Beyond that, other reports with good practices in the field of urban infrastructure like water infrastructure and waste management are available under the outputs of the project.[190]

Using its own structure, the report categorised all identified solutions into five groups, which are further detailed with concrete policies and measures (see Table 11). The first two groups focus on the government. Local authorities can practice the solutions either through issuing regulation/policy/legislation or sponsoring. Also, the other two groups usually require massive resources and support from the private sector. Above all, considerable experience and knowledge have been accumulated in the implementation of these policies and measures, either in successful projects or failures. The fifth category is recommended based on feasibility studies carried out in the Netherlands and Japan. Even though there is of yet no practical evidence, underground freight transport may become a revolutionary solution in the future if urban congestion continues to worsen and technological innovation makes it more competitive to transport goods underground than by road.

[188] The objective of the Freight Quality Partnership is to promote and facilitate the efficient, economic, safe and sustainable distribution of freight in Bristol and the surrounding area.

[189] The concept of a virtual UCC was introduced with the purpose to study the feasibility of such a UCC solution and the acceptance among transport companies.

[190] See UN (2011).

Regarding the detailed reference cases, GVZ in Bremen, Interporto in Bologna, City Logistik in Kassel and Public Wholesale Markets in Japan are elicited in the report, since it is considered by the project team that the best way to develop sustainable transport is through consolidating deliveries and increasing the usage of more environmental-friendly modes.[191]

Categories	Policies and Measures	Evidence from
Licensing and regulations	Low-emission zones	Sweden, Amsterdam, London
	Combined use lanes[192]	Barcelona
	Freight-exclusive lanes	Port of New Orleans
	Incentives for off-peak delivery[193]	Port of Los Angles
	Restricted delivery hours	Boston
	Truck bans	Manila, Bangkok, Tokyo
Freight centres and consolidated deliveries	Multi-modal freight centres	Germany
	Urban freight centres	Germany
	Business group developments[194]	Japan
Low-emission vehicles, environmental-friendly modes, and alternative fuels	Increasing use of low emission modes such as rail and water transports	Europe
	Encouraging the development of low-emission vehicles, multi-purpose vehicles, and alternative fuels	Europe, Japan
Technology-based service improvement and driver training	ITS, e.g., ETC[195], GPS[196], and Traffic information systems	Europe, Japan, US
	Service improvement through technology: web-based delivery routing systems, park & buy, unattended delivery systems	Europe, Japan
	Driver training	Europe, Japan
New freight transport systems	Underground freight transport	Netherlands, Japan

Table 11: Overview of city logistics solutions

Source: summarised from Wisetjindawat/Showa-ku (2010).

2.3.5. SUGAR project

SUGAR (Sustainable Urban Goods Logistics Achieved by Regional and Local Policies) is a regional initiative project funded by the EU's European Regional Development through the INTERREG IVE programme. The project was completed in 2011 after duration of 40 months with a focus on addressing the problem of inefficient and ineffective management of urban freight distribution.

Three main pillars constitute the activities of SUGAR:

[191] See Wisetjindawat/Showa-ku (2010), p.21 and p.52.

[192] The idea behind is to maximise the usage of lanes through introducing advanced technology such as variable message signs (VMS) in Barcelona to allow different interest groups to use the lanes at different times of a day.

[193] It can be understood as extension of the access restriction regulation through setting up a time window. It uses measures such as introducing a peak-hour fee to delivery companies to increase the attractiveness of off-peak delivery.

[194] The wholesale market in Japan is one example where numberous small and medium-size wholesalers are gathered. This geographic aggregation provides a necessary condition for transport operators to consolidate goods deliveries of different wholesales for customers in urban areas.

[195] ETC stands for Electronic Toll Collection.

[196] GPS stands for Global Positioning System.

- Identify and analyse good practices (a handbook of reference cases is published)
- Transfer experience over good practices in particular among public administrations on policy and planning levers in transport, environment, and spatial and territorial issues
- Develop action plans through SWOT analysis, definition of local visions and conduction of strategic development workshops

In total 44 reference cases were reviewed and explicated in the published handbook. Approximately 40% were selected from the Emilia Romagna region in Italy (6), London (5), Paris (3) and Barcelona (3).[197] The rest are from other well-developed European cities with two exceptions being from Japan. Overall, France, Italy, the UK, the Netherlands and Spain collectively provide the majority (77.3%) of cases. The distribution of all the reference cases among different countries is depicted in Figure 13.

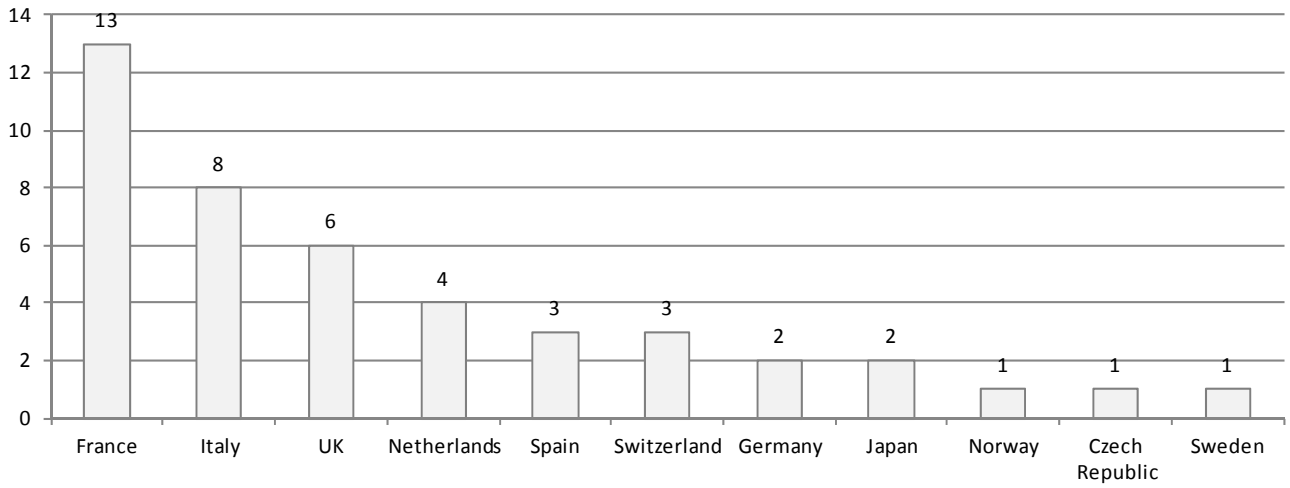

Figure 13: The source country of reference cases in SUGAR

Differentiating from previous projects like BESTUFS, CIVITAS, C-LIEGE and START, the SUGAR working group reviewed and evaluated city logistics solutions and their reference cases from the perspective of public authorities with a specific focus on local and regional public policies in urban freight transport. Each of the 44 cases is presented in a structured way including policy design details, implementation details, and support mechanism, results and key considerations. That can help readers, particularly readers from public authorities to easily understand the whole process and transfer the experience to their own context.

Overall, from reviewing all the reference cases presented in the handbook, public authorities' role in practicing city logistics solutions can be distinguished from full engagement as a major leader to partial engagement as a supporter or driver. Various measurements can be further identified based on their degree of involvement (see Table 12):

- Full involvement

[197] The four sites are considered by the working group of SUGAR project as good sites, where city logistics is well performed and their experience and practices are transferable to other cities.

First, public authorities can either incorporate freight transport into a city's overall planning or issue dedicated plans to promote the development of urban freight transport. Furthermore, related plans, such as data collection modelling can be taken to assess the status of urban freight transport to support the process of plan design. Also, the Freight Quality Partnership, as part of London's overall Freight Plan, is another related scheme undertaken by the local administration to encourage freight operators to improve their performance. Second, platforms / partnership with private sectors or other cities will help city authorities to acquire experience and knowledge on good practice. Third, access restriction regulations and road pricing are two major optional tools that public authorities can take to influence their freight traffic and its performance.

- Partially involvement

  In this case, public authorities often play a supplementary role and issue support measures to ease the implementation process of any innovative solutions. Information campaign is a common tool to increase the awareness among important interest groups. Financial incentives are usually used to reduce private companies' costs to increase the commercial feasibility. Infrastructure facilitation is a necessary premise to initiate any creative solution, such as the introduction of intermodal transport mode into urban freight transport. Further, specific regulatory incentives are often provided to improve the productivity and operational efficiency. Above all, these support measures have the common goal to increase the attractiveness of these solutions.

Involvement	Type	Sub-type	Reference case (e.g.)
Fully	Planning	Urban planning including freight transport	Mobility master plan including freight (Paris)
		Dedicated urban freight transport plan and related measures	Freight distribution plan (Bologna)
	Platform	Partnership with private sectors	Partnership on goods practices (Toulouse)
		Partnership with other cities	Intercity coordination (RER)
	Access restriction regulations	Delivery space / (un)loading zones	Dynamic delivery areas (Poitiers)
		Environmental zones / low-emission zones	Protected delivery zones (Prague)
		Routes	Multi-use lanes (Barcelona)
		Vehicles' weight, emission	Traffic limitation by Euro standards (PER)
	Road pricing	E.g., heavy vehicle fee, congestion charge	Congestion charging (Stockholm)
Partially	Information campaigns	Increase the awareness among interest group	All
	Financial incentive	Feasibility study and experimental phase	Consignity (Paris) and SMART FREIGHT (Trondheim)
		Procurement of EFVs, technology and/or equipment	Silent deliveries with PIEK labelling (Netherlands)
		UCC operation	Binnenstadservice (Netherlands)
	Facilitation of infrastructure	Installation/set-up of natural gas stations	Urban rail logistics: Monoprix (Paris)
		Pavement modification, ramps	Night deliveries experiment (Barcelona)
		UCC	Cityporto (Padua)
	Regulatory incentives	Access permission to restricted areas	Urban consolidation centre (Bristol)
		Authorisation of land space for specific use	Urban logistics terminals (Tokyo)
		Use permission of delivery zones	Petite Reine (Rouen)

Table 12: Overview of public authorities' role in city logistics solutions

Source: summarised from SUGAR (2011).

2.3.6. TURBLOG project

TURBLOG (Transferability of urban logistics concepts and practices from a worldwide perspective) is a project (10/2009 – 09/2011) under the 7th Framework Programme of the European Union and designed from a complementary perspective for the work of BESTUFS to address urban logistics from a worldwide level in particular in Brazil and Peru. It acts as a coordination platform, gathering the experience to extend, expand and transfer the existent knowledge of urban logistics to other countries.

After 24 months, the project team was able to meet its overall objectives and provide a series of fruitful deliverables:

- D1 – A worldwide overview of urban logistics interventions and data collection techniques, which provides a snapshot of solutions and measures in urban logistics with a particular emphasis of data collection techniques combined with related worldwide practices

- D2 – Business Concepts and Models for Urban Logistics, which aims at identifying the best business models for urban logistics and apply the models in the selected case studies
- D3 – Urban Logistics Practices, Synthesis of Selected Case Studies in nine selected cities including Paris (France), Utrecht (the Netherlands), Belo Horizonte (Brazil), Mexico City Metropolitan Area (Mexico), Santiago de Chile (Chile), Tokyo (Japan), Beijing (China), New York (United States of America) and Mumbai (India)
- D4 – Transferability Guidelines and Evaluation, which recommends a detailed methodology for transferring best practices in the field of urban logistics to other regions

Although all possible solutions for urban logistics presented in the first handbook of project deliverable are structured in a rather different way than in other handbooks and their implementations are demonstrated by an even wider perspective with many practices from non-EU regions, there are no major differences in content. Thereby, no 'new' findings will be presented again in this section.

With respect to the detailed case studies, TURBLOG extends the geographic scope and includes good practices from developing countries like Brazil, Mexico and Chile in Latin America, Beijing and Mumbai in Asia (see the overview of good practices in the selected nine cities in Table 13) compared to the results of projects elaborated in the preceding sections. Further, as the best practices for Paris, Utrecht and New York[198] have been either presented as city logistics solutions or used as reference cases in the previous projects, only the five new ones will be presented in this section.

[198] Besides, Shinjuku Matenro Staff in Tokyo is a practice of the consolidation concept. It will be taken a reference case of UCC in section 2.4.

Selected cities	Good practices	Short description
Paris	Chronopost Concorde / Urban Logistics Spaces	Using underground parking facilities to establish transhipment facilities and EFVs
	La Petite Reine	E-tricycles/cargo cycles used for last-mile deliveries
	Freight-oriented Master Plan	Dedicated master plan for freight transport
	Monoprix Rail Project	Alternative mode/modal shift for urban logistics
Utrecht	Environmental zone	Access restriction regulation
	City Distribution Centres	UCC concept
	The Beer Boat	Alternative mode/modal shift (barge) for deliveries of food and drinks
	The Cargohopper	EFVs with larger loading capacity suitable for narrow urban streets
Belo Horizonte	Requirement of loading and unloading parking spaces and loading docks inside companies with large traffic movements	Access restriction regulation for (un)loading zones
	Sale and Delivery Directly from the Producer of Organic Products to the Customer	Deliveries direct from suppliers for the perishable food industry
Mexico City	Zero Emissions Corridor in the Central Axis	Freight traffic ban in certain lanes
	Freight Transport Regulation Programme for Perimeter "A" of the Historic Centre of Mexico City	Access restrictions based on vehicles' weight
	Vehicle Verification Program for Pollutant and Greenhouse Gas Emissions	Access restriction based on emission standards
Santiago	Abertis Logistics Park	Logistics park with advantages through economies of scale by centralising goods storage in one area
Tokyo	Shinjuku Matenro Staff / Joint Delivery Systems	Consolidated deliveries by EFVs for users located in high-rise buildings
Beijing	Beijing Tobacco Logistics Centre	Centralised warehousing and integrated distribution for tobacco industry
New York City	Off-hour Delivery	Off-hour delivery with considerable governmental incentives
Mumbai	Mumbai Dabbawalas Food Delivery	Lunch-box delivery using public suburban railways with low technology but effective organisation

Table 13: Overview of good practices in nine selected cities of TURBLOG

Source: summarised from TURBLOG_D3.1 (2011) – TURBLOG_D3.9 (2011).

1) Good practices in Belo Horizonte (Brazil)
   - Requirement of loading and unloading parking spaces and loading docks inside companies with large traffic movements

     It can be understood as a type of access restriction regulation towards the (un)loading zones and is a similar concept to the regulation carried out in Barcelona.[199] The idea behind this concept is to require large companies with an area of over 6,000 m^2 like shopping centres (malls), super- and hypermarkets, industrial players, passenger transport companies, freight companies, commercial companies, public projects, etc. that are usually large traffic generators in a city, to establish

[199] See SUGAR (2011), p.79-82: Using building code regulations for off-street delivery areas, Barcelona (Spain).

dedicated facilities for goods (un)loading and vehicle parking.[200] This is so that it can ease the goods carriers' activities and improve their operational efficiency, and avoid using on-street spaces to finish the last process of goods delivery.

- Sale and Delivery Directly from the Producer of Organic Products to the Customer
  The concept of delivering the goods directly from producers to customers was created by private companies to reduce the number of intermediate agents in the market chain and create value both for the producers and their customers. Indeed two companies realise this concept: Fito (a producer as well as a retailer) and Dahorta (a local producer) using freight fleet and even motorcycles. In addition, it needs to mention that the success of the two companies is attributed to: [201]
    - Short distance between producers and their customers makes it possible to direct delivery at a reasonable costs
    - The features of organic goods including high fragility, extremely perishable increases the urgency of deliveries
    - Customers' (households) daily needs for organic goods requires a highly frequent delivery
    - The quantity to be delivered varies due to irregular production and high dependence on a certain climate and time of a year

2) Good practices in Mexico City (Mexico) including:
   - Zero Emissions Corridor in the Central Axis
   - Freight Transport Regulation Programme for Perimeter "A" of the Historic Centre of Mexico City
   - Vehicle Verification Program for Pollutant and Greenhouse Gas Emissions

   Similar to many other Latin American metropolises, the Mexico City metropolitan area features jammed roadways, insufficient and poor public transport, growing journey times, extension of peak hours and serious pollution.[202] The three above-mentioned regulations were carried out within this context to achieve the common goal of reducing the emissions and improving air quality in the city, despite all three being isolated measures and having no direct link.

   The first measure was introduced to tackle the issue of the central axis being overloaded with both passenger and freight traffic. The local authority attempted to turn it into a zero-emission area through the introduction of reliable electric trolleybuses and banning the entry of freight traffic.[203] The second measure was the implementation of a typical access restriction regulation based on vehicles' weight and size to protect the historic centre of Mexico City.[204] The third is another restriction regulation based on vehicle emission standards, which forces users to repair their vehicles if they fail to pass the verification tests.[205]

3) Good practice in Santiago (Chile): Abertis Logistics Park

[200] See TURBLOG_D3.3 (2011), p.48-61.

[201] See TURBLOG_D3.3 (2011), p.62-71.

[202] See TURBLOG_D3.4 (2011), p.32.

[203] See TURBLOG_D3.4 (2011), p.47-50.

[204] See TURBLOG_D3.4 (2011), p.51-52.

[205] See TURBLOG_D3.4 (2011), p.53-55.

Located in the north-western sector of the metropolitan region of Santiago inside the ENEA (a business and industry park), the Abertis Logistics Park encompasses a total area of 632,810 m^2, and planned to build a 327,800 m^2 warehouse for rent and 13,000 m^2 for support facilities such as restaurants, high-ceilinged offices, rest areas and restrooms for drivers of similar standards to those found in Europe.[206]

As a type of logistics zone, the Logistics Park involves two modes of transport: air freight and road transport. It is situated 2.3 km from Santiago International Airport and accessible by two of the city's main highways. In addition, it is well connected by major access routes to Chile's major ports. Given its location and size, the Logistics Park acts as an instrument of territorial arrangement and has the potential to:[207]

- Provide advantages through economies by centralising the goods storage in one area
- Improve occupancy rates through dispatching larger trucks
- Enable the transfer of goods shipments from larger trucks to smaller ones
- Reduce the negative impacts of freight mobility such as road safety, infrastructure deterioration or traffic congestion

4) Good practice in Beijing (China): Beijing Tobacco Logistics Centre

As a sector of China's logistics, tobacco logistics also features higher costs, lower efficiency and negative effects on traffic problems and the environment. The good practice from China was undertaken by the Beijing Municipal Tobacco Monopoly Bureau, which is responsible for distributing 12,000 multi-packs of tobacco products to around 7,000 retailers (15,000 in total) located in streets or business areas in the city's 18 metropolitan and outlying districts every day.[208]

The solution to the logistical problems was to establish a centralised distribution centre (DC, covering an area of 52,700 m^2) to replace the previous inefficient and costly decentralised distribution network (18 DCs scattered across 18 metropolitan and outlying districts) to provide citywide warehousing and integrated distribution with modern technology, advanced equipment and integral management processes.[209]

In effect, the new centralised concept has facilitated cigarette producers and improved efficiency as they do not have to plan vehicle routes to 18 DCs but only to a centralised one. Moreover, using modern technology for a rational planning of distribution routes, the Logistics Park is able to improve the quality of delivery services. As a result, the Beijing Tobacco Logistics Centre was designated as China's first "National Logistics Demonstration Base" due to its good performance. Other cities like Nantong and Chongqing have started to adopt the one-storehouse concept for their urban logistics.[210]

5) Good practice Mumbai (India): Dabbawalas Food Delivery

[206] See TURBLOG_D3.4 (2011), p.57.

[207] See TURBLOG_D3.5 (2011), p.58-59.

[208] See TURBLOG_D3.7 (2011), p.31.

[209] See TURBLOG_D3.7 (2011), p.32.

[210] See TURBLOG_D3.7 (2011), p.37.

Dabbawalas[211] Food Delivery is an indigenous model within the context of Mumbai about food logistics using public transport systems (suburban railways). The case study is selected as a good practice for its outstanding performance because of its precision (mistake rate: 1/16 million) and efficiency, although the logistical tasks are mainly conducted by local employees with rural roots and equipped with low technology.[212]

Mumbai is a very cosmopolitan city where people gather with diverse cultures, backgrounds and habits. Office employees (middle-class citizens of the city) in particular tend to have specific tastes and needs regarding food, and the freshly home-cooked meals provided by the dabbawalas fit these special requirements. Every working day, freshly cooked food in standard lunch boxes is collected by groups of dabbawallas from individual households dispersed over the suburban metropolitan region (usually between 7:00 a.m. and 9:00 a.m.). The lunch boxes are then carried either on foot or by bicycle for sorting at the nearest suburban railway station and transported onwards by train. After arriving at the destination railway stations (usually by 11:30 a.m.), the boxes are re-sorted based on their clients' address. The boxes are finally carried by local dabbawallas and handed over before 1:00 p.m. to their clients, who are spread over the smaller urban area. Moreover, the empty boxes are collected after lunch, loaded onto standard carts and transported by train to their origin stations. By 5:30 p.m. they have been sent back to the individual households.[213]

Despite the low use of advanced technology and equipment, the dabbawalas have displayed an excellent performance mainly as a result of their codification system[214], teamwork[215] and meticulous timing[216]. Today, the 5000 dabbawalas have a monopoly in Mumbai. They supply around 200,000 lunch boxes every working day throughout the year.[217] As a private logistics service in an informal sector, the dabbawallas require no support in relation to policy measures. They offer a good example of how to deliver food in a metropolis with a low use of technology, but still in an effective manner.

2.3.7. TRAILBLAZER project

TRAILBLAZER (Transport and Innovation Logistics by Local Authorities with a Zest for Efficiency and Realisation) is a project (07/2010 – 06/2013) co-funded by the Intelligent Energy Europe (IEE) programme within the Energy-Efficient Transport (STEER) stream. Local authorities, industry leaders and communication experts comprise the core members of the project consortium. By showcasing existing good practices and promoting the implementation of delivery and servicing plans across Europe, the project consortium aims to

[211] A dabbawal refers to a person in Mumbai employed to carry and deliver freshly made food packed in lunch boxes from the home to office workers.

[212] See TURBLOG_D3.9 (2011), p.47-48.

[213] See TURBLOG_D3.9 (2011), p.50-52.

[214] It uses signs, colors, numbers and a few letters to code each lunch box. Both the origin and destination railway stations, and the dabbawals handling each lunch box are coded in a unique way.

[215] The dabbawals are divided into 120 groups. Each group is made up of 8 teams. Each team comprises 8 dabbawals. Each dabbalwal is assigned up to 30 customers and 30 lunch boxes.

[216] The service is famous for its punctuality, except under certain special conditions like adverse weather and traffic accidents.

[217] See TURBLOG_D3.9 (2011), p.48.

achieve the main objective of reducing by 10% the energy used in urban freight transport and related emissions.[218]

A delivery and servicing plan (DSP), made up of a package of different city logistics solutions, includes strategic documents that outline how an organisation should perform freight transport efficiently, safely and in a sustainable way to meet the growing need. The concept of DSP was used by the TRAILBLAZER project consortium to build up a framework for local municipalities to better manage all types of freight vehicle movement. A successful implementation of a DSP usually comprises various sustainable freight measures simultaneously, which are interconnected under the partnership of public and private stakeholders with common goals of improving the efficiency of urban freight management. The development process of a DSP consists of data collection, a review of business practices and site visits. By doing so, the DSP document can be formulated so that it contains suitable action plans, a mix of freight measures and a customised solution to help a city/town or a site/district deal with its need for delivery services and mitigate the negative impacts caused by related activities.

Actually, there are various measures that have been either tested or put into operation. The group of experienced TRAILBLAZER organisations[219] identified and summarised ten of them (see the overview of reference cases in selected cities in Table 14):[220]

- Consolidation of deliveries
- Intermodal freight centres
- Freight quality partnerships (FQPs)
- Last-mile solutions
- Access restrictions
- Night-time deliveries
- Underground distribution[221]
- Fleet management and ITS
- Procurement practice[222]

With regard to the implementation of the DSPs, fourteen reference cases including four from PATHFINDERS[223] were selected and analysed. All of the implemented DSPs were carried out with a selection of several freight transport measures. For instance, in the case of Vercelli (Italy), a DSP, comprising regulating parking places using an automatic license-plate-recognition system, authorising EFVs with special permits and

[218] See TRAILBLAZER_D5.2 (2012), p.6.

[219] They include Borlänge Municipality, Deutsche Post AG, London Borough of Sutton and Transport & Travel Research Ltd..

[220] See TRAILBLAZER_D2.2 (2011), p.16.

[221] See TRAILBLAZER_D2.2 (2011), p.35-37: the concept of distribution underground aims to shift the goods movement from congested urban areas to underground either using tunnels or pipelines. However, the lack of a working infrastructure and suitable transport means there are large barriers hindering the concpet from being realised in practice.

[222] See TRAILBLAZER_D2.2 (2011), p.42-43: the idea behind is to get customers (like retailers, shop owners) involved in urban freight management and attempt to improve its efficiency through influencing the customers' choices towards procurement of delivery services.

[223] PATHFINDERs is used to describe a group of less experienced authorities including the Municipality of Eskilstuna (Sweden), the Municipality of Växjö (Sweden), the Municipality of Vercelli (Italy) and the City of Zagreb (Croatia).

granted access, and restricting polluting vehicles, is used to streamline goods distribution and make urban freight transport more efficient.[224] In the end, PATHFINDERS achieved impressive results through the sharing of useful knowledge and experiences amongst a group of experienced organisations and promoting the implementation of DSPs. The attained energy savings in the urban supply chains ranged from 6% to 53% in the four pilot cities.[225] The project findings indicate that the authorities' ownership and responsibility, incentive measures, as well as collaboration between interest groups and local authorities are critical factors influencing the success of any implementation of DSPs.

	Consolidation of deliveries	FQPs	Last-mile solutions	Access restrictions	Fleet management and ITS	Procurement practice
Sutton (UK)					X	X
Croydon (UK)		X		X		X
Borlänge (Sweden)	X					X
Heathrow airport (UK)	X			X		
Bristol (UK)	X		X		X	
Regensburg (Germany)	X		X			
Lucca (Italy)	X		X	X		
Bordeaux (France)			X	X	X	
Aalborg (Denmark)		X	X	X	X	
TfL[226] Palestra (UK)		X				X
Vercelli (Italy)		X		X	X	
Zagreb (Croatia)				X		
Växjö (Sweden)	X				X	X
Eskilstuna (Sweden)	X				X	X

Table 14: Overview of reference cases in TRAILBLAZER

Source: summarised from TRAILBLAZER _Output 6.2 (2013), p.11.

2.3.8. CIVITAS and C-LIEGE project

CIVITAS (Cleaner and Better Transport in Cities), co-financed by the European Union, is an initiative supporting European cities in the implementation of ambitious transport measures and policies towards sustainable, clean and energy-efficient urban mobility. Since being launched in 2002, CIVITAS has undergone three phases: CIVITAS I (2002 – 2006), CIVITAS II (2005-2009), and CIVITAS PLUS (2008-2012). The 4th phase (CIVITAS PLUS II) started in 2012 and will end in 2016. In the past decade, CIVITAS has helped introduce numerous innovations and measures in over 70 European cities.

C-LIEGE (Clean Last Mile Transport and Logistics Management) is an ongoing initiative (06/2011 – 11/2013) funded by the Intelligent Energy Europe of European Commission. It aims to define shared policies and measures for energy-efficient urban freight transport demand management and planning through a cooperative

[224] See TRAILBLAZER _Output 6.2 (2013), p.15-18.

[225] See TRAILBLAZER Newsletter (2013).

[226] TfL stands for Transport for London headquarters buidling.

approach between public and private stakeholders in EU cities and regions in order to benefit administrations and other relevant target groups in improving urban freight transport and enhancing energy saving in Europe.

Although both CIVITAS and C-LIEGE are two ongoing initiatives, a large number of solutions and related practical cases have been identified and collected in their published project reports. Within CIVITAS projects, city logistics solutions are always combined with other urban traffic measures in the reports, however, not all of these are available. While within the context of C-LIEGE, a detailed and systematic methodology has been developed to identify and select good practices not only from the pilot sites but also other relevant EU projects and studies including CIVITAS projects. In fact, over half of the 98 good practices were selected from CIVITAS. Thereby, the solutions are summarised based on the data from C-LIEGE (see an overview in Table 15).

Type of the solution	City logistics solution	# of reference cases
Soft Measures	Access restrictions (AR)	13
	Advance booking (AB)	1
	Alternative delivery systems (ADS)	2
	Distribution plan scheme (DP)	5
	Driver's behaviour (DB)	3
	Extending environmental Zones (EZ)	4
	Freight exchange (FE)	1
	Freight quality partnership (FQP)	11
	Incentives (INC)	2
	Innovative financing models (IFM)	1
	Mobility credits scheme and electronic passes (MCS)	1
	Optimisation of routes (OR)	7
	Promotional incentive campaigns (CAMP)	1
	Urban logistics plans (ULP)	1
	Van-sharing service (VSS)	2
Hard Measures	Distribution micro-platforms in the inner city (DMP)	11
	Intelligent transport systems (ITS)	1
	IT logistics tools (ITL)	7
	Measures to tackle noise (NOISE)	2
	Modal shift (MS)	7
	Urban freight hubs at the edge of the city (UFH)	10
	Use of environmental-friendly vehicles (EFV)	15
	Use of intelligent traffic management (ITM)	7

Table 15: Overview of city logistics solutions structured by C-LIEGE

Source: summarised from C-LIEGE (2013b).

2.3.9. Summary

In the past few decades, city logistics has garnered an increasing amount of interest from the political and research establishment due to the even worsening problems in the field of city logistics that lead to a

considerable diversity in many initiatives and research directions aiming at improving urban sustainability.[227] Numerous solutions from different perspectives are developed during the process, tested and put into operation. Reviewing these practices, key lessons can be summarised:

1) City logistics is a fundament of a city

   City logistics is not an isolated system, but has significant connections with other parts of a city, in particular the urban transport system.[228] Hence, it is necessary to incorporate urban logistics plans into the overall urban planning of a city. For instance in the case of urban infrastructure planning, it is beneficial to take into account the needs of urban goods traffic. Barcelona is a good example of where municipal ordnance has required actors in the economic sector such as offices and shopkeepers to establish certain delivery areas and save storage space in order to facilitate the activities of goods delivery and handover.[229]

2) City logistics causes negative impacts, but provides necessary services as well

   City logistics is often seen as a major cause of environmental and social problems in a city such as air and noise pollution, traffic congestion and accidents. However, in fact, logistics builds up a fundament of a city's economy. It provides delivery services to satisfy the needs of business, industry and residents. Only enforcing restriction regulations would not work from a long-term perspective, because all the (commercial and/or operational) impacts imposed on the carriers or logistics companies would be transferred further to the whole supply chain including the customers in the city. It can then harm a city's competence and attractiveness for investment. Therefore, any innovative solutions should not only be able to reduce the negative impacts but also refrain from hindering the operational activities, or even ease and improve efficiency.

3) City logistics is a complicated system that requires the implementation of a package of solutions

   The evidence indicates that no single solution can tackle all the issues facing city logistics. Rather than to be dealt with in isolation, solutions need to be developed in a combined way to maximise their effectiveness and serve the interests of the stakeholders in a city as much as possible.[230] The concept of DSP hereby provides a useful tool to help a city collect urban freight data, review business practices and visit operations at sites. The implementation of a DSP comprises the implementation of a selection of city logistics solutions, which are interconnected under public-private partnerships in order to gain benefits from improvements in urban goods movement.[231]

4) Good cooperation between the public and private sector is a good start to city logistics

[227] See Quak (2008), p.20.

[228] See C-LIEGE_D2.1 (2012), p.158.

[229] See SUGAR (2011), P.242-245.

[230] See TURBLOG_D3 (2011), p.84-85.

[231] See TRAILBLAZER_D2.2 (2011), p.16-17.

City logistics involves both the public and private sector. Both parties can contribute their own resources and expertise in the design of new solutions and ensure their implementation. A local freight network is one good way to gather public representatives such as local authorities, freight operators, business associations and retail organisations from the private sector to address freight transport problems. The public-private partnership under this network has the advantages of anchoring project ideas, getting both parties connected over various issues and easing the implementation process of any measure or regulation.[232] It is argued that cities involving private parties in policy design from the very beginning more easily acquire stakeholders' acceptance and support. They are accordingly more likely to succeed in the long term.[233]

5) Public authorities play a crucial role in the development of city logistics

Although many good city logistics solutions and successful practices are driven and designed by private companies, such as DHL's Packstation, it is generally understood that it is the authorities, which as the representative of a city, should be more engaged in putting forward the development of city logistics to realise a city's ambitious goal of building urban sustainability. In fact, there are various options available to them. Besides developing master plans or issuing regulations, public authorities can support the development of innovative solutions and/or the introduction of advanced technology using financial incentives or regulatory permissions. In particular during the initial phase, governmental support (subsidies and/or facilitation of basic infrastructure) remains a necessary prerequisite.

6) Cities are specific and the solutions adopted should be customised

Each successful case can be very specific. Cities are diverse in terms of culture, history of urban planning and management, economic development and freight distribution practices.[234] It is essential to take into account a city's own context, examine the basic elements and develop customised solutions, when it aims to transfer specific knowledge and experience from others.

2.4. Focus on the UCC solution and reference cases

UCC is among the most popular city logistics solutions, aimed at bundling and consolidating deliveries from different groups.[235] As elaborated in section 2.3.2.8, UCC is a physical implementation of the concept of city logistics to reduce urban freight traffic and gain greater operational efficiency. To some extent, it is sometimes even considered as a synonym for city logistics.[236] Due to the great potential to realise a city's ambitious goal of building urban sustainability, UCC attracts plenty of attention and resources from both the public and private sector. It is considered in principle as the best way to achieve sustainable urban goods transportation by reducing freight trips and energy consumed for deliveries.[237] In spite of the common challenges, UCC is seen as one of the solutions for dealing with the impacts of urban freight traffic such as accessibility, congestion,

[232] See START_D2.1 (2007), p.31-32.

[233] See TURBLOG_D3 (2011), p.85.

[234] See START_D6.3 (2009), p.7-8.

[235] See SUGAR (2011), p.249.

[236] See Quak (2008), p.66.

[237] See Wisetjindawat/Showa-ku (2010), p.21.

environment and safety.[238] There are major differences in the projects implemented in different countries[239] and even in different cities within the same country.[240] This section thereby focuses on the UCC solution and attempts to elaborate on its characteristics and summarises the lessons learned by reviewing and analysing all the related practices in the past decades for cities such as those in China which will have an interest in UCC practice.

2.4.1. UCC characteristics

2.4.1.1. Objects' scope, target customers and their participation

As elaborated in section 2.1.1.2, there are five groups of objects served by city logistics. Among them, consumer goods and building materials are usually within the objects' scope handled by UCCs. In addition, waste collection of packaging and recycling materials is also included in the service range of a UCC. With respect to the operational projects, UCCs are found to be better suited to handling types of non-perishable goods. Perishable and highly sensitive goods such as fresh food and newspapers are sometimes beyond the scope of a UCC because of their specific requirements regarding distribution and handlings.[241] Consolidation centres serving airports, which deal with a wide range of goods, are exceptions. Also, fresh food is common and frequently required by end customers at all airports. Due to the different handling requirements of building materials, specific UCCs are always designed and set up to connect suppliers from outside a city with recipients at construction sites.

In regard to the target customers, the two major stakeholders of city logistics from the private sector are usually targeted as the customers of UCCs, because they are two beneficiaries of the UCC:

- Goods suppliers/freight carriers from outside a city: consolidation based on the inbound side
- Goods recipients like retailers in urban areas: consolidation based on the outbound side

Both types have relevant reference cases operated in practice. Many UCC projects in German cities (e.g., city logistics schemes in Aachen, Kassel, Regensburg,), Italian cities (Padua, Siena), Japanese cities (e.g., Tenjin UCC, Motomachi UCC in Yokohama[242]) and Swiss cities (e.g., Basel UCC) take the freight carriers/forwarders/operators as direct customers and generate revenue through releasing them from last-mile deliveries. While examples from other countries like France (e.g., La Rochelle), the Netherlands (e.g., Hague, Leiden, Utrecht), Spain (e.g., Malaga) and the UK (e.g., Bristol, Sheffield, London Heathrow Airport) have another way. They focus more on the needs of the goods recipients in urban areas, who are considered as the decision makers in the supply chain. They hereby have the power to influence the operational process and ask their suppliers/freight carriers to transport the goods to the address of any possible UCC instead of congested outlets in urban areas. Both models have advantages and disadvantages, which was confirmed by successful and unsuccessful projects of each model in the past. Therefore, it is critical to examine the specific conditions including the operational model (the decision maker of the supply chain), the willingness to use the UCC

[238] OECD (2003).

[239] Ambrosini/Routhier (2004).

[240] Quak (2008).

[241] See BESTUFS 2 (2007), p.73.

[242] See SUGAR (2011), p.182-186.

services, and the existing potential to increase their operational efficiency (benefits), when a city wants to practice a UCC project. Besides the two models that focus on only one side of the supply chain, some UCC cases (like Gothenburg in Sweden and Paris in France[243]) choose both suppliers/carriers and goods recipients as customers.

In most cases, goods recipients and/or carriers are encouraged to use UCC services to gain economic benefits and a good image. Their participation is voluntary and based on their judgment on the UCC's potential to achieve the benefits. While in several specific cases, local authorities adopt legislative measures to force the involved parties to participate in UCC projects in order to reduce the growing traffic flows and minimise their negative impacts. For instance, in the case of Potsdamer Platz in Berlin, Hammarby in Stockholm and Heathrow Construction in London, all the construction materials (except for exempted materials) were/are required to be consolidated through the UCCs in order to alleviate the impacts of the large and heavy shipments on the areas neighbouring the construction sites. In addition, freight restriction regulations are also used to enforce the usage of UCC services to protect sites and locations that are sensitive to freight movements (like historical city centres or busy airport terminals) and increase the utilisation rate of the UCC capacity (e.g., Monaco, Malaga and London Heathrow – retail).

2.4.1.2. Spatial coverage and classification

Based on the size of spatial coverage, UCCs can be classified into four types:[244]

- Single site with one landlord (e.g., airport consolidation centres in Heathrow, East Midlands, Manchester)
- A town/city (e.g., Monaco, German cities)
- Several towns/cities together (e.g., Bristol Freight Consolidation Platform, Binnenstadservice in the Netherlands)
- Special projects (e.g., construction consolidation centres in London, Stockholm)

In the first case, the target market is always located at a single site, which is geographically isolated but faces challenges such as traffic congestion and air pollution. The UCC is then built in a dedicated way to tackle these challenges. The airport consolidation centre is a good example of this type of UCC. In most cases, an airport is owned by a single landlord, who has the potential to influence its tenants' choice regarding logistics services and plays a critical role during the implementation of a UCC. In the case of London Heathrow Airport Consolidation Centre, the UCC services are provided in the name of BAA, the airport owner, to retail shops, restaurants and coffee bars in the airport.[245]

With respect to the second type, the target market is located within the urban areas of a town/city. A UCC is initiated with the aim to minimise trips through urban areas, and the related environmental and social impacts in the whole town/city. The geographical area served varies from a specific retail area like a shopping centre or a historical city centre to an entire tow/city. During the start phase, retailers or other businesses in an environmental zone are brought in as initiators of the UCC. Further businesses from a wider area are expected to

[243] See Browne et al. (2005), p.123 & 156: both transport operaters and business in the target ares included in the UCC projects as customers.

[244] See Browne et al. (2005), p.17-18.

[245] See TRAILBLAZER_O2.1 (2010a).

take part in the UCC if so encouraged by the attained benefits. Examples include many German city logistics schemes and those in La Rochelle in France, Monaco and Geneva.[246]

With the growth of a UCC's capacity and productivity, not only can it serve customers from one town/city, but also retailers from neighbouring towns/cities, which are still under the geographic coverage of the UCC freight vehicles. The Bristol Freight Consolidation Platform is one representative project in this case. Encouraged by the performance and benefits, businesses from Bath are also engaged in the expansion of UCC in Bristol. Also, the Binnenstadservice in the Netherlands, started in 2008, is another example of a UCC serving nine Dutch cities (Den Bosch, Arnhem, Gouda, Nijmegen Amsterdam, Maastricht, Rotterdam, Tilburg and Utrecht).[247]

All three types discussed above deal with consumer goods. Yet, special UCCs are designed that target non-consumer goods (construction materials are served objects in many cases). Construction consolidation centres in London[248] and Stockholm (Hammarby)[249] are two typical examples set up to consolidate construction materials from different suppliers to construction sites in urban areas in order to reduce vehicle movements and associated emissions in a certain location at a certain time. Some UCCs were set up to serve a temporary construction project like Heathrow Terminal 5 and the Olympic Park and Crossrail in London.[250] Others are operated in a permanent manner.

2.4.1.3. Service range

Within the scope of UCC services, there are major types:

- Primary services including last-mile delivery and good storage
- Value-added services before and after goods sales

It is a UCC's major responsibility to deliver the consolidated goods shipments in the right condition and quantity to customers at the right time, place and cost. Compared to normal warehouses or distribution centres, UCCs are usually facilitated with much less capacity and space to hold stock. UCCs are used to store goods that are transported by long-distance transport means in large quantities but are not required to be instantly loaded onto the shelves of outlets in urban areas due to their limited space. UCCs are also designed to shift the goods storage from outlets to off-site locations to save costs and provide local buffer stocks for seasonal peaks of sales to improve product availability and customer satisfaction. Therefore, a certain amount of space is required to be saved for UCCs that is able to hold stocks for a short period.

Besides the primary services, a UCC can also provide a package of value-added services both before and after sales, mainly within the context of consumer goods:

1) Pre-sales:
    - Quality and quantity check

[246] See BESTUFS 2 (2007), p.64.

[247] See SUGAR (2011), p.111-115.

[248] See Lewis/Fell/Palmer (2010), p.9-10.

[249] See BESTUFS 2_D2.3 p1 (2007), p.134-136.

[250] See Lewis/Fell/Palmer (2010), p.9-10.

- Removal of packaging
- Preparation of products for sales floor
- Pricing/labelling

2) After-sales
    - Products return and recycling
    - Waste and packaging material collection

Furthermore, when equipped with advanced information technology, a UCC may also provide services such as inventory monitoring and information analysis linked to an in-store system, which can increase the visibility of the supply chain, increase the product availability and reduce stock loses.

Through providing the services listed above, a UCC can, on one hand, help retailers focus on their core business and improve their competitiveness and, on the other, generate more revenue and become even more attractive for further customers.

2.4.1.4. UCC location

The location of a UCC is a critical factor that can determine the success or failure of implementing any UCC projects. Choosing the best location is certainly one of the most important decisions and has substantial impacts on the initial cost base and performance of a UCC, affecting the possibility to achieve the potential benefits of the solution. Many aspects must be considered during the site selection process.

The connection to the target market is a primary aspect. UCCs are usually located in suburban areas in close proximity to their target market. Since a UCC generates a high volume of traffic flows both upstream and downstream, it is preferred to locate it some distance away from residential areas or areas that cannot handle increased further traffic volumes. In addition, the distance should be within the service coverage of the UCC freight vehicles, especially when EFVs are used to complete the last-mile delivery.[251] This makes it more difficult for a UCC to quickly respond to customers' emergent requirements and increases lead times and transport costs if the UCC is located too far from the target market. Roadways are the most common transport means for fulfilling the last-mile delivery. Therefore, a good connection to the urban road infrastructure is necessary to ease the transport activity.

Second, it is crucial to ensure that the UCC is easily accessible for shippers/suppliers so that long-distance transport means such as large container trucks or even trains are able to access the UCC without barriers. In fact, it is common to find that many UCCs are either located near to large logistics terminals like freight villages, ports and/or airports or are at least well connected to them in order to ease the process of inbound logistics and increase the UCC's attractiveness to shippers/suppliers.

Moreover, further aspects should be taken into account during the site selection process for a UCC. Although automation technology is being utilised more and more to replace manpower and increase operational efficiency, a UCC still requires a certain number of personnel to perform its primary and value-added services. Direct access to public transport will certainly facilitate employees' commute and accordingly reduce their demand to

[251] See BESTUFS_2 (2007), p.72.

travel with their own cars, which could otherwise cause traffic congestion at a UCC.[252] UCCs, particularly when equipped with cold chain facilities, are large energy consumers. Therefore, it is becoming increasingly important to consider the climatic aspect of geography with the rise of energy costs.[253]

Above all, UCCs are integral components of the supply chain and are becoming logistical nodes of a city's logistics network. Consequently, it would be beneficial and necessary to incorporate UCC locations into the overall urban planning of a city.

2.4.1.5. Operational model and last-mile delivery

To put the UCC concept into practice requires, on the one hand, setting up dedicated logistical faculties and purchasing advanced equipment and, on the other, choosing suitable operators to run all the logistical activities. PPP, which has been extensively used to develop infrastructure, hereby provides a useful tool to organise the implementation of UCC projects. Summarised by the existing UCC cases, their operational models can be classified into four types (see Table 16) based on the involvement of the public and private sector as well as the degree of their partnership.

Type	Content	Reference cases
Public setup + private operation	Private LSPs as tenderer/subcontractor	La Rochelle (France), Malaga (Spain), Monaco and Bristol (UK)
Public-private joint venture	UCCs' establishment and operation are initiated under public-private joint venture	Italian cities like Genoa, Padua, Siena and Vicenza
Private setup + private operation	UCCs are owned by landlords of the retailer sites and operated by appointed/subcontracted LSPs	Shopping malls in Kent and Sheffield (UK); London Heathrow Airport Retail & Construction, Stockholm Construction
	Dutch system of licenses: the depot of a licensed carrier is used as a UCC which is operated by the licensed carrier	Dutch cities like Amsterdam, Groningen, Leiden, Maastricht and Utrecht
Private joint venture	The cooperating carriers deliver goods to a depot (UCC) owned and operated by a "neutral" company	German cities like Cologne, Kassel, Stuttgart; Tenjin (Fukuoka in Japan)

Table 16: UCC operational models

Source: summarised from Panero/Shin/Lopez (2011), p.8-10.

Setting up UCCs requires a large amount of investment. It is usually the stakeholders with the potential to influence customers' participation[254] that often fund and establish the UCCs. In the case of "public setup + private operation " and "public-private joint venture", the public institutions actively get involved in the establishment process and at the same time issue regulations to force customers to participate in UCC projects or increase the attractiveness of the UCC services as well. The landlords of retail sites, who have the potential to influence the choice of their tenants/retailers regarding UCC services, in the case of "private setup + private operation" are another type. Within the context of the London Heathrow Airport Consolidation Centre, all retailers are demanded by BAA (the airport owner) to accept the UCC services, which are partially subsidised

[252] See SUGAR (2011), p.233: the case of urban logistics terminals, Tokyo (Japan). Shuttle buses can also be employed as an alternative solution, which is common in industrial zones or logistics parks in Chinese cities.

[253] See DHL/Siemens/CDI (2011), p.51.

[254] Such as BAA for London Heathrow Consolidation Centre (Retail) and Bristol Council for Bristol Freight Platform.

by the airport. In addition, the existing logistical facilities (like the depots of licensed carriers in the Dutch system of licenses and German private joint venture) can also be used to provide consolidated deliveries with a lower initial investment.

Overall, most UCC projects are based on a profitable business plan and aimed to be financially successful in their own right in the long term.[255] Logistical activities within UCC projects are often carried out by professional private logistics service providers (LSPs) with sufficient knowledge and experience to ensure the operational efficiency and productivity, so that public agencies can reduce their subsidies in proportion with the UCC's development. LSPs are chosen and contracted to run UCC operations for a certain period. Their performance and level of customer satisfaction during that period decide whether they will be able to continue. In most cases, only one LSP is appointed in order to increase the efficiency and minimise organisational complications. There are three distinct ways that an LSP can run a UCC's operation:[256]

- A fully tendered model: the UCC owner pays the operator a fixed fee when it meets the service targets. The owner holds the risk of low participation of target customers and charges them for the service level directly.
- A shared risk management: the UCC owner underwrites an agreed fixed cost for UCC operation. The revenue levied for items handled by a UCC shall benefit both the owner and operator. Meanwhile both parties share the risk of low participation.
- A purely commercial contract: the operator derives all revenue from the users of UCC services and has solely the risk of a low participation rate. UCC owners may usually either mandate target customers to use UCC services or create favourable regulations and policies.

With regard to last-mile delivery, freight vehicles are now the most important transport means used to ship goods from UCCs to recipients in the city. Those less polluting, smaller and lighter vehicles tend to be preferred by cities. EFVs are often adopted and utilised by many European cities to fulfil the last leg and connect UCCs and city centres in order to maximise the environmental benefits.[257] However, EFVs are having several disadvantages[258] such as high costs of procurement and maintenance, and being less productive, which make it difficult to achieve sustainability from an economic perspective.[259] Although smaller and lighter vehicles create less traffic congestion and lower emissions per trip, they generate more traffic flows compared to large ones under the same given shipment volume. In fact, there are both environmental and economic penalties for excluding large goods vehicles (LGVs) from the scope of UCCs.[260] Consequently, it is crucial to select the right freight vehicles based on the volume requirement of goods shipment, traffic access to the final destinations, as well as the local vehicle regulations to make the operation sustainable.

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[255] See SUGAR (2011), p.250-251.

[256] See Lewis/Fell/Palmer (2010), p.37.

[257] See Browne/Allen/Leonardi (2011): the trial of a micro-consolidation centre together with electrically-assisted cargo tricycles and electric vans is one example in this case. The evaluation results proved successful from the office supplies company's (the goods shiper) perspective of transport, environmental and financial terms.

[258] See discussion in section 2.3.2.4 - Environmental-friendly vehicles.

[259] See Lewis/Fell/Palmer (2010), p.35: it is also argued that EFVs, e-vehicles in particular, may become competitive along with the reduction of the procurement cost and rise of gasoline and diesel.

[260] See Browne et. al .(2005), p.38.

Additionally, in some special cases, cargo cycles[261] can also be adopted as a practical transport means to help freight carriers to hand over goods to the final recipients whose locations are somehow difficult to access for common freight vehicles.

2.4.1.6. Support measures

UCC is an innovative solution and has the potential to help realise city logistics' goal of building up urban sustainability. However, successfully implementing the UCC solution in a city is always tied together with high risk due to uncertainty in terms of productivity and customer participation. Support from the public sector (mainly local authorities) is hereby of critical importance to lessen uncertainty and improve the possibility of implementing UCCs in a successful way. There are a series of potential measures to support the UCCs (see Table 17):

1) Pre-implementation

   Since the birth of the UCC concept, massive amounts of resources and effort have been invested in researching and practicing UCCs in different cities. However, each city has its own context in terms of historical background, urbanisation level and city urban freight development. It is necessary to tailor the UCC solution based on a city's specific condition and conduct a feasibility study. Local authorities can lead and fund such a study to identify the uncertainty and generate measures to mitigate potential risks.

2) Facilities setup

   To establish a UCC and related equipment requires a large investment. The public sector can either get directly involved as the owner of a UCC, or co-fund the setup as a joint venture with a private company. In addition, local authorities can also grant subsidies to cover the substantial capital expenditure. It is common to find that public institutions in Europe subsidise almost all the EFVs included in UCC schemes.

3) During operation

   The operational productivity and efficiency of a UCC as well as the quantity of customers adopting the UCC services are two crucial factors deciding whether the implementation of UCC can become a successful model or a failure. This is because the former determinant impacts the operational costs and the latter is the major parameter of the revenue generated by a UCC. Support measures from public institutions thus often focus on these two factors. Furthermore, evidence (both from theoretical study and existing UCC practice) shows that it takes a period of time before a UCC has a substantial throughput to lower the average cost per unit of goods and reach its eventual level.[262] It is important to consider how to cover the operational costs during the initial start-up phase when the operational cost per unit of goods is still above its eventual level. Local authorities are often found as the providers of funding for this initial start-up.

[261] See BESTUFS 2 (2007), p.137-138: Cyclone Couriers in York (UK); see TURBLOG_D3.1 (2011), p.55-59: LA PETITE REINE.

[262] See Lewis/Fell/Palmer (2010), p.34-35.

Phases	Support measures	Purpose
Pre-implementation	Lead and fund feasibility study and the UCC solution design	To identify the uncertainty and mitigate the risk
Facilities setup	Fund/co-fund/subsidise the setup of UCC and the procurement of related equipment (e.g., freight vehicles)	To minimise the initial capital expenditure
During operation	Permission to use the (un)loading bays for parking and goods delivery at target market	To improve the UCC's operational productivity and efficiency
	Establish dedicated facilities to assist the parking and goods deliver process at target market	
	Smooth the connection between UCC and urban infrastructure	
	Exemption of priced/tolled road use for UCC vehicles	
	Permission to use bus lanes, bus gates for UCC vehicles	
	Permission to enter urban areas (including environmental zones) without time restriction or in a wider delivery window for UCC vehicles	
	Information campaign to increase the awareness	To increase UCC's attractiveness and customers' participation
	Stronger enforcement of existing access restriction regulations	
	Tighten the delivery window for non-UCC vehicles	
	Provide incentives to target customers (such as reduced business taxation)	
	Mandate the use of UCC for new business	
	Mandate the use of UCC for existing business	
	Provide incentives or subsidies to the UCC operators	To sustain the initial start-up until the UCC breaks even

Table 17: UCC support measures

Source: summarised from Lewis/Fell/Palmer (2010), p.89-90.

2.4.2. UCC reference cases

2.4.2.1. Data sources

A UCC reference case is hereby defined as a practice of the UCC concept in a city within its specific context. It consists of research/feasibility studies, pilot/trials, and projects that have been stopped and are still in operation. In order to have a comprehensive overview of as many examples as possible, more data sources with reference to UCCs, besides major data source stated in section 2.3.1.1, are cited in this section (summarised in Table 18). Other data sources including published papers, doctoral thesis, project reports and websites of reference cases also provide additional information and evidence to support the discussion of UCC practice. In total, 102 reference cases were identified, 56% of which were put into operation, 11.8% were in pilot/trial and the rest 32.4% were in the feasibility/research phase (for a list of all the UCCs identified see Appendix 3).

Data source	# UCCs recorded	Briefing
Browne et al. (2005)	67	The work carries out a scoping study to identify the potential for the development of urban consolidation centres (UCCs).
Quak (2008)	15	The doctoral thesis focuses on the sustainability of urban freight transport and reviews 104 initiatives in a structured way.
Lewis/Fell/Palmer (2010)	9	The research reviews the freight consolidation centres in the UK and analyses the costs and benefits under different scenarios.
SEStran (2010)	6	The study examines the functions and benefits of freight consolidation centres to the SEStran area (South East Scotland Transport Partnership) and the potential to combine them with dry ports.
Panero/Shin/Lopez (2011)	39	The report examines the model of urban distribution centres (UDCs) as a means to solve the last mile problem of urban freight, and the potential applicability to the New York metropolitan region.
City Logistics Conference 2003, 2005, 2009, 2011[263]	13	The conference has been held every two years since 1999 and aims at providing the opportunity to exchange knowledge and experience in the research area of city logistics.

Table 18: Data source for UCC reference cases

2.4.2.2. A chronological overview of UCC practice

Since the birth of the UCC concept, both public and private sectors have made massive effort to achieve greater efficiency in city logistics. Overall, the UCC development can be divided into four periods (see Figure 14):

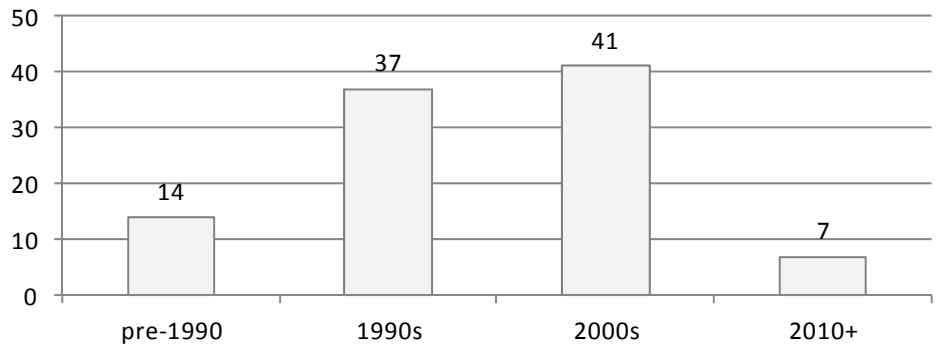

Figure 14: A chronological overview of UCC practice[264]

1) Birth before 1990

The birth of UCC can be traced back to the 1960s, when two freight platforms for urban distribution were laid out in the Paris region in response to urban congestion during 1967-1969.[265] In the 1970s, other effort was made to examine the possibility of putting the UCC concept into practice to realise its potential benefits. A research project was first conducted in 1972 in the USA to determine the impact of

[263] The author has no access to the publications of the conferences held in 1999, 2001 and 2007.

[264] Two UCC projects are exempted here as no information in terms of start year is provided.

[265] See BESTUFS 2_D2.3 p1 (2007), p.96 and Annex V – 4.

consolidated pick-up and delivery operation in Columbus (Ohio).[266] Similar projects were also undertaken in Vancouver (Canada) and many British cities to study the UCC's impacts on urban freight transport and examine the feasibility of implementation.[267] However, the effort did not proceed beyond the investigation stage. Then, the Tenjin Joint Distribution System was started in Fukuoka (Japan) in 1978 to centralise delivery and collection services in the city in order to alleviate traffic congestion and improve the environment, and is still in operation today.[268] During the 1980s, Arnhem (Netherlands)[269] and Monaco joined the UCC group and put into practice the UCC solution. The UCC in Monaco has achieved a great deal of success and is often cited as a good example for other cities.[270]

2) Boom in 1990s

During the 1990s, the UCC solution attracted increasing interest from many well-developed European countries.[271] UCC concerning goods collection and delivery became a prominent topic in connection with city logistics activities.[272] Approximately forty UCC reference cases are recorded for this decade. While other cities from France, the UK and Belgium continued to investigate the impacts and feasibility of implementation, a large number of German, Dutch, Swiss and Swedish cities began to set up pilot and demonstration projects for the UCC concept. The German (including Swiss) and Dutch models of the UCC operation process provided the initial indications of how to operate UCC projects. The former was carried out based on cooperation between different freight carriers, and the latter adopted a licensing model whereby a limited number of freight forwarders were licensed in a city. Their depots in the city were then used as UCCs to consolidate the goods shipment from other forwarders that were not licensed. During the initial phase of operation the projects in Germany and the Netherlands reported positive results, which was the catalyst for getting more cities to study and practice UCC within their own contexts. However, most operational UCC projects were eventually stopped[273] due to various financial problems.

3) Extension in 2000s

Although the quick development of UCCs had slowed down in many European countries by the end of the 1990s, in particular in Germany and the Netherlands, they experienced a revival across a wider region from 2000 to 2009. An increasing number of cities from the countries discussed above and from

[266] See McDermott (1975).

[267] See Browne et al. (2005), p.109-111.

[268] See BESTUFS 2_D2.3 p1 (2007), p.124-126.

[269] See Browne et al. (2005), p.148.

[270] See Van Rooijena/Quak (2010).

[271] See TURBLOG_D3.6 (2011), p.33-39: Tokyo (Japan) is the only exception in this decade, where the Shinjuku Matenro Staff (a joint delivery system) was started as a private arrangement to create a quicker and more frequent delivery of smaller packages of goods to the high-rise buildings in the business centre.

[272] See BESTUFS 2_D2.3 p1, p.96.

[273] The CityMobil/Citylogistik in Münster (Germany) was stopped after 5 years of operation; RegLog in Regensburg (Germany) was abandonded in 2012 after 14 years.

other European countries[274] like Austria, Latvia, Poland, Portugal, Slovenia and Spain began to test this innovative solution to tackle the ever-increasing traffic congestion and emissions in populated urban areas. Beyond the typical operational models in German and Dutch cities that took freight carriers as the users/customers of UCCs, new models were introduced that focussed on the needs of retailers. Both the UK and Sweden provide a series of good examples. Among these projects, retailers in airports, tenants in shopping centres, retailers in city centres, construction sites within urban areas, and municipal institutes often served as the customers of UCCs.

4) Further development in 2010 onwards

In order to attain more successes, the UCC knowledge and experience accumulated in the past decades has been extended to and shared with more cities across the globe. Large cities like Barcelona (Spain), Belo Horizonte (Brazil), New York, Tokyo as well as several Western Swedish cities conducted studies to examine the feasibility of implementing UCC in their cites. It is believed that the UCC solution will continue to attract attention and greater effort will be made to realise its potential benefits.

2.4.2.3. Effort from different countries

The increasing urban freight transport and city logistics is criticised, on one hand, as the creator of problems such as traffic congestion and environmental pollution in densely populated cities, but is understood as a necessity and guarantor of a competitive urban economy, on the other.[275] Being related to large populations (over 75% of the population living in urban areas) and sustained economic growth in urban areas, the significance of city logistics is growing in Europe. The UCC solution, aiming at consolidating the many small loads prior to delivery to the urban centre, may have the greatest potential for environmental improvements. It has thus attracted a great deal of attention and financial support from EU programmes and sub-programmes.[276] In fact, almost 90% of the published UCC reference cases are taking place in European countries. In addition, Japan (6), the USA (2) and Canada (1) are the remaining industrial countries where UCC projects have been started. China (1) and Brazil (1) are the only representatives from emerging economies (see UCC practice in relevance of countries in Figure 15).

[274] Beijing Tobacco Logistics Centre (China) and Motomachi Urban Consolidation centre in Yokohama (Japan) are two exceptions from the non-European region.

[275] See PORTAL (2003), p.6.

[276] See EC (2006).

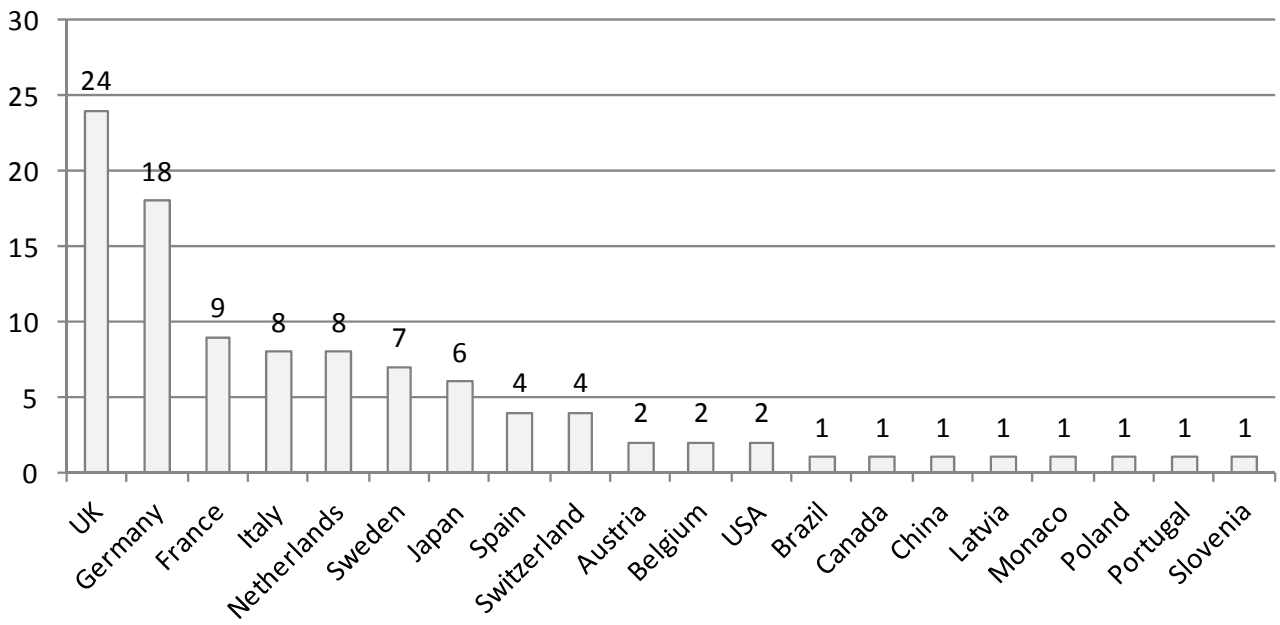

Figure 15: An overview of UCC practice in relevance of countries

1) European countries: the UK, Germany, France, Italy, the Netherlands, Sweden, Spain, Switzerland, Austria, Belgium, Latvia, Monaco, Poland, Portugal and Slovenia

   Compared to other regions, Europe is more active in both studying and implementing UCCs. Large amounts of effort and funding have been invested into supporting UCC-related activities. Of all European countries, the most reference cases have been identified in cities from the UK, Germany, France, Italy, the Netherlands and Sweden.

   - The UK has a long history of funding urban freight studies. During the period between 1996 and 2008, 30 UK urban freight studies were identified.[277] UCC, one of the prominent solutions tackling the challenges faced by urban freight, has gained support both from local (e.g., Transport for London) and national authorities (e.g., UK Department for Transport). Since the initial UCC initiatives in the early 1970s, 24 reference cases have been recorded in total, among which 12 were implemented and 11 are still in operation. That makes the UK the most significant country with broad experience in terms of UCC practice.
   - Germany is another country that has spent massive resources on UCCs, particularly in the 1990s when the development of UCC was included in the program of "Mobility in Urban Areas" of the Ministry for Education and Research.[278] In reaction to the national program, a high number of city logistics[279] projects and initiatives were conducted in around 70 to 100 cities or regions to consolidate and coordinate transport flows of different freight carriers into urban areas.[280] Nevertheless, very few are still in operation today.

[277] See Browne et al. (2010).

[278] See Eibner (2012).

[279] "City logistics" (City-Logistik in German) is used as a terminology in German language to describe the UCC concept.

[280] See BESTUFS 2_D2.3 p1 (2007), p.115-116: but due to the limitation of data sources, only a few of them can be identified as reference cases.

- Following the first UCC trial in Paris prior to 1990, a new and growing interest in urban freight in France was born in the 1990s mostly through "TMV" (Urban Freight Movement), a national research program of the Ministry of Transport. The UCC, one of the more efficient approaches to achieve a sustainable urban environment and a higher quality of urban life, was promoted by local and national policies. More than 20 UCC projects have been discussed in French Urban Mobility Master Plans since the 1996 Clean Air Act.[281] However, being opposed by one of the main professional transport operator organisations and due to heavy costs, very few projects materialised.[282] The La Rochelle UCC and La Petite Reine in Paris are two operational examples that are still going.[283]
- Italy was the first country to include the UCC development in its national policies to improve the efficiency and sustainability of Italy's urban freight distribution network in the early 1990s.[284] However, it was not until the 2000s when several UCC projects were implemented in Italy, supported by the Transport and Logistics Strategic Initiative of the Italian Ministry of Infrastructure and Transport.[285] The Interportos[286] have been mainly realised not far away from urban areas together with EFVs.[287]
- The Netherlands is one of the countries to have engaged in UCC practice from prior to 1990 and introduced UCC on a national agenda. In spite of a lack of success in the initial phase, continuous effort was made to promote UCC implementation. Today several licensed UCCs under the Dutch model and Binnenstadservice.nl (BSS) are still in operation.[288]
- Furthermore, knowledge and experience spread slowly from Western European countries to other areas in Europe. Sweden, Spain, Switzerland, Austria, Belgium, Latvia, Monaco, Poland, Portugal and Slovenia, being inspired by the benefits achieved by their neighbouring countries, started to examine the possibility to transfer UCCs within their own specific context.

2) Other industrial countries: Japan, the USA and Canada
   - Japan is the only industrial country outside Europe that has been actively engaged in UCC research and practice for several decades. In 1997, a set of national policies entitled the "Comprehensive Program of Logistics Policies" concerning urban freight transport as well as inter-city and international freight transport was issued in Japan. Joint collection and delivery in the form of voluntary cooperation (the Japanese form of UCC) was incorporated as one of the favourable measures to be promoted.[289] Besides three projects focusing on a UCC study and pilot program, three other UCC projects were realised and have remained in operation.
   - Although UCC projects were undertaken in the early 1970s to investigate the impacts of UCC in both Vancouver and Columbus, there had been little interest in multi- or inter-company UCCs in the

[281] See Datier (2006).

[282] See BESTUFS 2_D2.3 p1 (2007), p.115.

[283] See Datier (2006): in some case, the UCC in Monaco is also reviewed as one in France because of the similar background of the two countries.

[284] See Visser/van Binsbergen/Nemoto (1999).

[285] See Gragnani/Valenti/Valentini (2004).

[286] The common term used to describe the UCC concept in Italy.

[287] See BESTUFS 2_D2.3 p1 (2007), p.116.

[288] See BESTUFS 2_D2.3 p1 (2007), p.116.

[289] See Visser/van Binsbergen/Nemoto (1999).

USA and Canada until only recently. A study project was sponsored by the State of New York in 2011 to examine the UCC model and its applicability to the New York metropolitan region.[290] In the same year, a study project focusing on urban freight was carried out in the Greater Toronto and Hamilton area to identify possible actions to improve freight efficiency and capacity. In the end, UCC was recommended as one of the seventeen actions.[291]

3) Emerging economy countries: China and Brazil
   - Brazil and China are two representative countries featuring a high growth in economy and urbanisation in the past few decades. However, their growing urban populations and environment are still being challenged by the increasing urban traffic flow and its related environmental impacts. UCC is understood as a potential measure to tackle these issues. Under the support of Brazil's National Council of Scientific and Technological Development, freight carriers and retailers recently conducted the first UCC study in the city of Belo Horizonte to examine a UCC's potential economic and environmental impacts as well as adoption.[292] In addition, embodied in the worldwide case studies of the TURBLOG project, the Beijing Tobacco Logistics Centre was established in 2004 to centralise the storage and delivery of tobacco products to its 30,000+ retailers in the city of Beijing. Both reference cases indicate the UCC's potential to improve the urban freight efficiency and reduce its environmental impacts either theoretically or practically. Therefore, it is believed the UCC concept will attract attention and investment from more cities in emerging economic countries like Brazil and China.

2.4.3. Lessons learnt

2.4.3.1. Review of operational UCC projects

As stated earlier in total there are 57 UCC projects in operation around the world, with most being in Europe and Japan the only exceptions. Germany (18) and the UK (12) are the most active countries in which far more UCC projects were implemented than in any other. They are followed by Italy (7), the Netherlands (4), Sweden (4), Japan (3) and other six countries. However, the actual results from some projects were disappointing after the initial enthusiasm.[293] In fact approximately 37% of all operational projects were halted including two temporarily implemented ones in Berlin and London. In Germany (16/20) most projects failed once the funding period had come to an end due to the lack of a consistent business model, which makes the country noted for having a "bad experience"[294] with UCC. The remaining projects were stopped in the UK, the Netherlands, Switzerland and Italy. In the rest of the UCC continues, it has not performed as well as expected. Based on these practical experiences and relevant evaluation studies, valuable lessons can be summarised as indications for the late-starter cities that plan to adopt UCC to tackle their congested urban areas. The next section focuses on the stopped and not-well-performing UCC projects and aims to identify general barriers that hinder a UCC from being operated successfully. The section after will look at the projects still in operation and then summarise the "critical successful factors" for UCC practice in future (see operational UCCs in Table 19).

[290] See Panero/Shin/Lopez (2011).

[291] See METROLINX (2011).

[292] See Correia/De Oliveira/Guerra (2012) and De Oliveira et al. (2012).

[293] See Koehler (2004) and Van der Poel (2000).

[294] See Eibner (2012).

Country	Germany	UK	Italy	Netherlands	Sweden	Japan	France	Switzerland	Belgium	China	Monaco	Spain	In total
Stopped	16	2	0	1	0	0	0	1	0	0	0	0	20
Ongoing	2	10	7	4	4	3	2	1	1	1	1	1	37
In total	18	12	7	5	4	3	2	2	1	1	1	1	57

Table 19: Overview of operational UCCs

2.4.3.2. Barriers to implement UCC successfully

To successfully implement a UCC project in a city depends on all kinds of conditions. Also, each barrier alone can lead that to failure. Therefore, it is of critical importance to identify all the barriers hindering a UCC from realising its potential benefits.

1) High initial investment

It is clear that a large amount of investment is required to prepare the infrastructure, facilities, and human and technical resources including freight vehicles.[295] Although many ex-ante evaluations indicate the implementation of UCC will be financially feasible[296], the assumed hypothesis (such as the participation rate) might be suspicious because such innovative projects are usually accompanied by uncertainty and complexity of the involved stakeholders. This is a critical risk that will influence the rentability of a UCC project after its implementation. Due to the high initial investment and risk, many UCC plans were abandoned without implementation.

2) Low participation rate of target customers

The volume of goods throughput handled by a UCC is a decisive factor that determines, on one hand, whether incremental efficiency (such as load factor) can be achieved and, on the other, the operational cost per unit shipment. A UCC requires a certain volume to share the fixed costs and keep the operation at break-even so that it can be financially feasible. Experiences extracted from the halted projects show that many UCCs stopped due to low volumes of goods throughput.[297] The low participation rate of target customers is hereby this issue's root cause, which has various reasons behind:

- First, there is generally potential from a citywide perspective to improve the operational efficiency of urban freight traffic by using a consolidation centre. However, freight carriers already consolidate many goods shipments in individual cases when they reach a high quantity level (such as retail chains or large producers).[298] This pre-consolidation level varies considerably among different types of goods and recipients/shippers, which will limit the benefits of a UCC and attract little interest from freight carriers or even resistance in the establishment of a UCC.[299]

[295] See BESTUFS2 (2007), p.71.

[296] See Marcucci/Daniels (2008).

[297] See BESTUFS2 (2007), p.60.

[298] See Browne et al. (2005), p.5.

[299] See Panero/Shin/Lopez (2011), p.19.

- Disadvantages of the UCC model include the loss of a direct interface between freight carriers and goods recipients and the potential of creating monopolistic situations[300], which may considerably influence a company's competitive advantage. Many carriers therefore lack the willingness to participate in such UCC projects, particularly within a fiercely competitive environment.[301]
- All goods handled by a UCC should share the high setup costs. If there are no governmental subsidies or only limited volume is available in the early years when not many customers are interested in using the UCC services, the initial costs have to be added to the operational costs of each goods shipment. This will substantially reduce a UCC's attractiveness and hold back target customers.[302]
- Poor operational performance is a fourth reason for the low participation rate of target customers. Private companies tend to get involved in UCC projects in order to gain benefits such as reducing operational costs and fulfilling their social responsibility of reducing environmental impacts, but not at the price of harming service quality. However, longer lead times[303] and a lack of a quick response to customers' immediate requirements caused by non-appropriate selection of the UCC location, freight vehicles or operators, and ineffective organisation were observed in some UCC cases. This is one of the main reasons for the declining interest among target customers.[304]

3) Lack of enforcement of accompanying regulations and policies

To increase the attractiveness of UCC services and promote its implementation, local authorities often draw up and issue accompanying regulations and policies such as access restriction. The aim is to force more freight carriers or retailers to participate in the UCC. However, not all of the planned regulations or policies can be enforced exactly as planned due to various reasons such as high enforcement costs. In the case of La Rochelle (France) and Malaga (Spain), similar legislation was planned and issued to restrict HGVs from entering historic centres,[305] which would HGVs to leave their goods at the UCC to be delivered by the UCC freight vehicles to the city centre. Nevertheless, the access restriction was not strictly enforced.[306] Many HGVs continued to enter the city centre illegally instead of participating in the UCC scheme. This resulted in a low utilisation rate of the capacity of UCC and lower-than-expected financial performance.

4) Selection of non-appropriate freight vehicles

[300] See BESTUFS2 (2007), p.71.

[301] See Browne et al. (2005), p.127: in the case of Cologne (Germany), the UCC project was stopped because large retailers and parcel carriers were reluctant to participate because of competition and to protect their own logistics operations.

[302] See BESTUFS2_D2.3 (2007), Annex VI – 11: in the case of Schaffhausen (Switzerland), the UCC project failed because nobody wanted to bear the additional costs.

[303] See BESTUFS1_D2.4 (2004), p.224-230: in the case of UCC in Leiden (Netherlands), local entrepreneurs and potential users were reluctant to participate because the e-vehicles slowed down traffic on main roads.

[304] See Koehler (2004): a decline in interest from freight carriers was found in Kassel after the implementation of the city logisics project.

[305] See SUGAR (2011), p.148: no trucks above 3.5 tonnes are allowed to enter the historic centre of La Rochelle after 7:30; see Browne et al.(2005), p.155: the access of freight vehicles (except for e-vehicles from the UCC) to the historical centre has been banned in Malaga.

[306] See Quak (2008), p.67: lack of the enforcement in La Rochelle; see Browne et al. (2005), p.155: Malaga.

The freight vehicles are the physical facilities that distribute the goods from UCCs to end customers. Their performance is of critical significance for the productivity and efficiency of last-mile delivery. EFVs such as e-vehicles are often preferred to conventional ones by public stakeholders and combined with UCC schemes to fulfil the task of delivering goods to end customers aiming at realising the ambitious goals of zero-emission traffic. However, EFVs are still have disadvantages such as high procurement costs, lower load capacity and limited travel velocity, which are great barriers to performing last-mile delivery in an economic and efficient manner. The choice of using non-appropriate e-vans in Leiden (Netherlands) was a major cause of the low profitability of the terminated UCC project.[307]

5) Inconsistent financial support from public authorities

The study results of UCC business cases based on cost benefit analysis show that governmental subsidy is strongly needed to improve the low financial viability.[308] In fact, local subsidy remains necessary in most operational projects.[309] Public authorities usually arrange dedicated funding to help set up the UCC facilities and equipment, and subsidise its operation during the initial years. However, financial support from public authorities is not always available. In some cases (like Kassel[310] and Aachen[311]) public funding was stopped before a UCC could attract a sufficient number of users to participate in the scheme and generate throughput to cover the fixed investment. That can reduce the operational sustainability of a UCC and even lead to failure[312] if there are no alternative income sources or effective measures to increase the goods throughput.

6) Unsuitable UCC location

Choosing the right location is of great importance to a successful UCC operation. An unsuitable location can considerably impede operational productivity and may then lead to failure. The evidence from the stopped UCC project in Leiden (Netherlands) stands by the argument, where the UCC was located far from the highway. Another bad example is the still-ongoing UCC project in Nijmegen (Netherlands). The UCC location is badly connected to highways.[313]

2.4.3.3. Critical successful factors

Although many operational UCC projects have been stopped and even more plans have been scrapped without implementation, there are still some active ones in operation, which allow a summary to be made of their "critical successful[314] factors (CSF)"[315] as measures to overcome the barriers for cities interested in UCC practice.

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[307] See van Duin et. al (2010).

[308] See van Duin/Quak/Munuzuri (2008) and van Duin/Quak/Munuzuri (2010).

[309] See SUGAR (2011), p.250-251.

[310] See van Duin et. al (2010).

[311] See C-LIEGE (2013b), sheet 75: CLAIX: City Logistik Aachen (Germany).

[312] See SUGAR (2011), p.249: many UCC projects closed down when subsidies from municipalities were no longer available.

[313] See van Duin et. al (2010).

[314] Successful is hereby used to describe the UCC projects still active which are either self-financially sustained or funded by additional parties.

1) Ways to cover the high setup costs

The high initial investment to facilitate a UCC is a major barrier preventing many UCC plans from being implemented. Using existing logistics facilities can substantially reduce the amount of initial investment and are often taken as a measure to mitigate the relevant risks. The involvement of the public sector and "rich" private companies (like property developers) is another means to attract sufficient capital to establish a UCC. In practice, public-private joint ventures are the developers of many UCCs in Italian cities[316]; BAA, the landlord of London Heathrow Airport, developed the UCC nearby the airport[317]; and Bristol Council is the owner of the Freight Consolidation Platform.[318]

2) Measures to increase the number of UCC users

The number of users is the most important factor in all success and failure cases.[319] Measures used to attract more users usually focus on improving the efficiency of a UCC's services and reducing the operational costs per unit.

- Target the right customers
  The UCC concept has the potential to benefit target customers both economically and environmentally, which is highly dependent on the pre-consolidation level of potential customers. UCCs should not target those already served by good logistics and supply chains like major supermarkets that operate their own distribution centres and have a high utilisation rate of their vehicles' load capacities, or freight transport companies that provide a consolidation service for a specific region or urban site. UCCs should focus more on companies with lower pre-consolidation levels like retailers that have not yet built up efficient supply chains or freight carriers providing small, multi-drop deliveries[320] to those located in city centres where movement is strictly regulated (e.g., restricted access windows, limited (un)loading bays).[321]
- Selection of the appropriate UCC operator
  In most cases, professional logistics companies, equipped with the necessary industrial expertise and operational experience to perform UCC services in an efficient and effective way, run UCCs. A public bidding system can be observed in use by some UCC projects (in many British cases[322]). Meanwhile, all the related logistical activities tend to be carried out by an LSP (in some Japanese cases[323]) that is not involved in the upstream or inbound logistics (not a competitor of the freight

[315] See Heinemann/Schwarzl (2010), p.92: CSFs are those factors whose influence makes a decisive contribution the success of an enterprise.

[316] See Vaghi (2010).

[317] See TRAILBLAZER_O2.1 (2010a).

[318] See TRAILBLAZER_O2.1 (2010b).

[319] See van Duin et al. (2010).

[320] See Boerkamps/van Binsbergen (1999): UCCs are most suitable for small shipments.

[321] See Browne et al. (2005), p.34.

[322] It includes UCC projects in London Heathrow Airport, Bristol, Regen Street (London), Bluewater Shopping Centre in Kent, Manchster Airport, etc.

[323] E.g., Motomachi UCC in Yokohama.

carriers that unload their goods shipments to the UCC) to generate a better acceptance from the UCC's users.[324]

- Subsidies to lower the operational costs
  Governmental subsidies are seen as an important factor for success. Most UCC cases have received subsidies from public authorities (local, national, or international authorities like EC) or other institutions[325] in particular during the initial period of implementation in order to sustain a UCC's operation and attract customers at a competitive price. Although there are a few exceptions like the Tenjin Joint Distribution System in Fukuoka (Japan), which is run commercially without subsidies,[326] the availability of funding from public agencies will considerably increase a UCC's potential[327] and even assures its viability.[328] It is argued that governments should seriously consider the amount of subsidies based on the environmental improvements achieved by a UCC.[329]
- Support measures to increase the attractiveness
  Besides subsidising a UCC's operation, public authorities can also issue a package of regulations and policies to ease a UCC's logistical activities and improve its operational efficiency, so that more customers can be encouraged to use its services. Actually, there are various options like elaborating specific regulations to prioritise carriers using UCC services[330], extend the restricted time window for UCC vehicles, or set up dedicated (un)loading bays for parking and unloading goods at retailers and shops.[331] Albeit these support measures are no guarantees for success, their existence can possibly help to acquire more customers for a UCC.[332]
- Beyond the measures recommended above, private companies can also be encouraged to participate in a UCC scheme through direct personal contacts; wider dissemination of benefits; provision of quick-win solutions and appealing to a sense of corporate social responsibility.[333]

3) Enforcement of compulsory obligation to use UCC services

For the majority cases customers participate in a UCC scheme voluntarily, because the legal framework in most countries prohibits banning freight companies delivering goods directly to recipients except in some specific cases.[334] However, obligation has been proved to be an effective way to increase the participation rate of target customers through forcing them to use UCC services in a short period. The UCC projects of Monaco, London Heathrow Airport, and Hammarby Construction (Stockholm) are

[324] See SUGAR (2011), p.250-251.

[325] E.g., BAA, the owner of London Heathrow Consolidation Centre and the landlord of the users of UCC services; the shopkeepers' association in the case of Motomachi UCC in Yokohama (Japan).

[326] See BESTUFS2_D2.3 (2007), p.124-126.

[327] See Browne et al. (2005), p.40.

[328] See Patier (2006).

[329] See Boerkamps/van Binsbergen (1999).

[330] See SUGAR (2011), p.250-251.

[331] See more measures in section 2.4.1.6.

[332] See van Duin et al. (2010).

[333] See START (2009), p.52-53.

[334] See Panero/Shin/Lopez (2011), p.10.

examples of successful cases. However, the obligation was enforced within a specific context. The local authority of Monaco, also a sovereign state occupying a comfortable financial position, enforced strict regulations in combination with the provision of huge subsidies, which amounted to more than the total payment from private customers.[335] Security was a critical factor in the case of London Heathrow Airport. All contractors on the housing project in the case of Hammarby Construction were obligated to use the UCC because the transport of building materials had huge impacts in the city.[336] All of these conditions make it difficult to transfer the experience to a wider region.

4) Selection of appropriate vehicles

The productivity of freight vehicles is a decisive factor influencing the efficiency of last-mile delivery. Furthermore, the costs of procurement, maintenance and depreciation are major components of a UCC's operational costs. Even though EFVs can attain better performance in terms of environmental protection such as in the case of La Rochelle (France)[337], the selection of the right type of vehicles should meet the unique requirements of the site (including goods volume, the accessibility of the customers, vehicle regulation, etc.). The freight vehicles should be determined for every UCC separately not only considering their environmental performance, but also economic viability and productivity.[338] In most cases, conventional vehicles are still more popular for transporting goods from UCCs to recipients in urban areas, as they are advantageous compared to EFVs in terms of economic and productive performance.

5) Selection of the right UCC location

Choosing the right location will substantially benefit the implementation of a UCC and generate goods throughput. In fact, most successful UCCs are located in close proximity to their target customers, well connected and also accessible to inbound traffic flows.

6) Provision of additional services and organisation form

A UCC's ability to provide value-added services to create more value for customers is another CSF that can, on one hand, increase the number of customers by meeting customers' requirements and, on the other, generate more revenue to sustain its own development when no governmental subsidies are available. Furthermore, how the organisation of the UCC is set up can be as identified as a CSF. It is argued that it is possible for privately organised UCCs to be successful.[339]

Learning from UCC practice in the past few decades, the ways to cover the large initial investment, measures to increase the number of customers, enforcement of obligations, selection of appropriate freight vehicles, selection of appropriate UCC location, as well the provision of additional services and organisation form are all

[335] See Quak (2008), p.67.

[336] See Browne et al. (2005), p.157.

[337] See SUGAR (2011), p.148-152.

[338] See van Duin et. al (2010).

[339] See van Duin et al. (2010).

CSFs influencing a UCC's operational as well as commercial performance. They do not guarantee success, but they are important to consider as the initial steps towards achieving it.

3. City logistics in China

Chapter 3 shifts the focus of researching city logistics in theory and practice onto China. It aims to address the third research question from a country perspective, namely what is the macro-environment of city logistics in China. After the introduction of China as a typical EME country in the first section, this chapter touches upon all the important external environments of city logistics in China including economic growth, urbanisation, urban industries, environmental restrictions, political environment and logistics development in the following sections. The chapter ends with a summary of the impacts of these external environments on China's city logistics development. The research structure of this chapter is depicted in Figure 16.

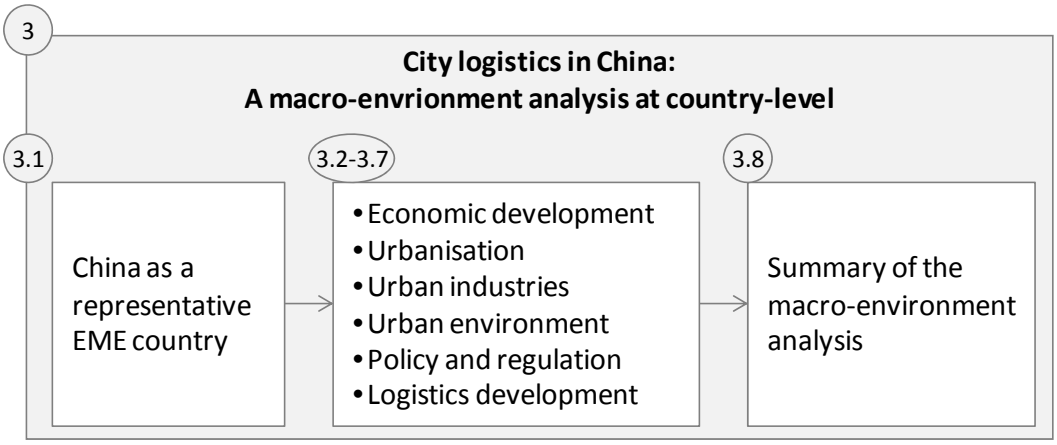

Figure 16: Research structure of Chapter 3

3.1. China as a representative EME country

The term emerging market economy (EME) was first coined in the 1980s by Antoine W. van Agtmael of the International Finance Corporation of the World Bank.[340] It describes an economy comprising mainly low to middle per-capita income, undergoing economic liberalisation, experiencing rapid economic growth and industrialisation, and pursuing economic development and extensive reform programs to become globally competitive.[341] It appears that EMEs lie at the intersection of developing and developed status with an expanding middle class, and improving standards of living, social stability and tolerance. Comprising the majority of the world's population and land, and spearheading the world economic growth as engines of regional or world economy, EMEs have become the focus of sustained research.[342] EMEs vary considerably by country size. Both China and India, deemed the world's economic powerhouse, are lumped into the same category as much smaller economies with far fewer resources like Tunisia.

Characterised by rapid economic growth, emerging groups of middle class, economy reform, as well as a significant and continuing process of industrialisation and urbanisation, China is a representative EME country. It is ranked as the largest in terms of economy scale, population and geographical area.

[340] See Van Agtmael (1984), p.308.

[341] See Roztocki/Weistroffer (2007).

[342] See Kearney (2012).

However, little research and practice focusing on city logistics in EME countries can be found in the English-language literature published during the last few decades.[343] Indeed EME countries may require more effort and attention in order to create a better understanding of their city logistics, as they are experiencing faster growth in economic development and urbanisation. This thesis takes China as a representative EME country and attempts to provide a framework for developing city logistics in EME countries. The following sections will focus on investigating China's macro-environment for developing city logistics and its implications for economic development, urbanisation and domestic consumption, urban industries, urban environment, policy and regulation, and logistics development (see Figure 17).

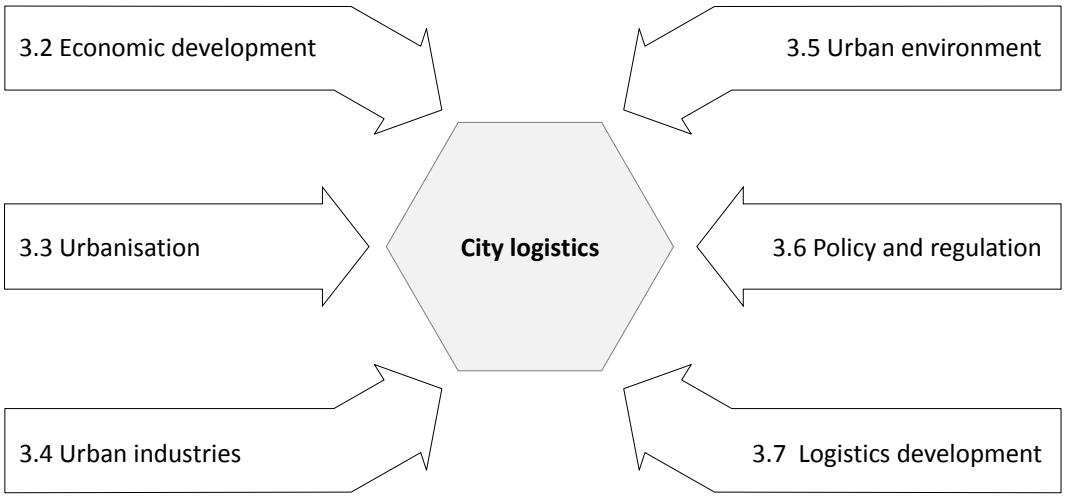

Figure 17: Macro-environment of city logistics

3.2. Economic development

3.2.1. High economic growth and achievements

Since the Opening and Reform Policy, China has experienced rapid economic growth and moved from being isolated from the global economic system to being integrated with it. In 2012 China was ranked as the largest EME and the 2nd largest economy after the US overall.[344] Measured by certain indicators, China has already surpassed the USA in terms of manufacturing output exports, fixed investment, energy consumption, automobile sales, mobile phones sales and 15 other indicators. Moreover, China was estimated to have overtaken the USA to become the world's largest economic power overall in 2018 (assumed with annual growth of 7.75%).[345]

Over the past few decades, China's economy has relied heavily on fixed investment and exports, both of which are considered key drivers of economic growth. A huge amount of funding has been invested annually in the construction of roads, railways, seaports, airports, power stations, urban and rural infrastructure facilities and

[343] There are certain exceptions: city logistics study in Brazil: Magalhães (2010), De Oliveira/Nunes/Novaes (2010), Correia/De Oliveira/Guerra (2012) and De Oliveira et al. (2012); city logistics study in China: Qiu/Yang/Yang (2006) and Bu et al. (2012); city logistics study in Mexico: Lozano et al. (2006), Antún (2010), Betanzo-Quezada/Romero (2010), Lozano et al. (2010), Alarcón/Antún/Lozan (2012) and Lyons et al. (2012).

[344] See STATISTA (2013).

[345] See Economist (2013b).

residential houses in order to promote industrialisation, enhance productivity, and stimulate the economy, particularly after the 2008 global financial crisis. Following in the footsteps of other Asian economies such as Japan, South Korea, Hong Kong, Taiwan and Singapore, China has been adopting an economic policy of export-led growth. It was estimated that a 10% increase in exports resulted in a 1% increase in GDP in the 1990s.[346] Following its entry into the WTO in December 2001, the contribution of exports to China's GDP has seen a rapid and consistent rise. Since 2009 China has been the world export champion and reached a record of 2049 billion US dollars (annual growth of 8%) in 2012, which accounted to 11.5% of the world's total export value.[347]

3.2.2. Challenges faced by the current economic growth model

While China's current growth model has brought economic growth at a 10% annual average for the last thirty years, the direction in which the model has shifted over time has made it unsustainable, considering the constraints on fixed investment and the limits to export-led growth.[348]

Fixed investment plays a critical role in sustaining China's economic growth. Compared with the world average of less than 20%, China spends about 50% of its GDP on fixed investments. In 2012, this ratio increased to 70%.[349] Measured against evidence from many Asian countries, China is over-investing.[350] Even in the private sector, evidence for over-investment has been found for all types of companies using data from a group of Chinese firms.[351] Furthermore, the efficiency of fixed investment to drive economic growth is declining. The capital factor productivity ratio[352] fell to 7:1 from 3:1 at the beginning of the 20th century.[353] Too much investment may lead to over-production, generate inefficiency and harm profitability. The evidence from calculating the investment efficiency of the private sector shows negative results especially in association with over-investment.[354] Although an external crisis, which has been experienced by many other EME countries, appears unlikely to occur in China, the large burden of financing high investment has to be located at the regional and local government levels, and has to be borne by households.[355] Moreover, high investment is also accompanied with inflation risk and may damage the quality and sustainability of economic development.

The export-led growth model is also shrouded in doubt in terms of maintaining rapid growth. As China already accounts for more than a tenth of global exports, it is unlikely to continue to increase at the same rate in future. In contrast, China faces challenges from both, internal and external factors.[356] First, the comparative advantages of exports particularly in low-skilled manufacturing are threatened by rising wages and other factor inputs,

[346] See Lin/Li (2003).

[347] See WTO (2013).

[348] See Zhu/Kotz (2011).

[349] See NBSC (2013).

[350] See Lee/Syed/Liu (2012).

[351] See Ding/Guariglia/Knight (2010).

[352] It is calculated as the amount of capital inputs required to produce one additional dollar of output.

[353] See Lee (2012).

[354] See Ding/Guariglia/Knight (2010).

[355] See Lee/Syed/Liu (2012).

[356] See Coates/Horton/McNamee (2012).

especially raw material. Besides, the appreciation of Renminbi exchange rates makes China's products less competitive. External factors, sluggish demand from advanced economies such as the EU and the USA, and the emergence of other competitors such as Vietnam, Thailand, Bangladesh, etc., are challenging China's status of global export champion. Indeed, a sharp drop was caused by the recent global recession following 2008. China's exports fell by 16% in 2009. Further, the export growth rate fell substantially from 20.3% in 2011 to 7.9% in 2012 due to a contracting European economy and weak recovery in the USA.[357]

3.2.3. Transition of economic growth model

Acknowledging that the current growth model cannot be sustained, the Chinese government is looking to change its economic growth model. Alongside fixed investment and exports, domestic consumption has been proposed as the 3rd driving factor for underpinning economic growth. A series of policies and measures have been set up to boost the domestic demand. In November 2008, the 2008–2009 Chinese economic stimulus plan including ten major measurements was issued by the State Council to stimulate domestic consumption in order to minimise the impact of the global financial crisis.[358] In March 2013, the State Council, as a long-term policy for China's economic development, renounced boosting domestic demand.[359] Strategic targets have also been planned by Chinese policymakers. As China aims to expand its retail sales of consumer goods to approximately 32 trillion RMB by 2015 with an average annual grow rate of 15%.[360]

However, before China can realise its strategic targets, there are numerous challenges that need to be resolved, such as widespread pollution, growing income disparities, an underdeveloped social security system, the freedom of the market economy and soaring property prices. Slowly but surely, China has been making progress. In 2011, domestic consumption contributed over half (51.8%) of China's economic growth, which was higher than fixed investment and net exports (see the right picture in Figure 18). The tertiary industry's share (service sector) in GDP increased by 11.4% to 44.6% in 2012 compared to 2000 (see the left picture in Figure 18).[361] In order to sustain China's economic growth, considerable resources and effort have been invested into boosting its domestic market, in particular sales of consumer goods, which presents on one hand a huge demand for the logistics sector, but on the other hand relies on the efficiency of the logistics network and transport infrastructure.

[357] See NBSC (2013).

[358] See China State Council (2008).

[359] See China State Council (2013e).

[360] See China Daily (2012b).

[361] See NBSC (2000-2012).

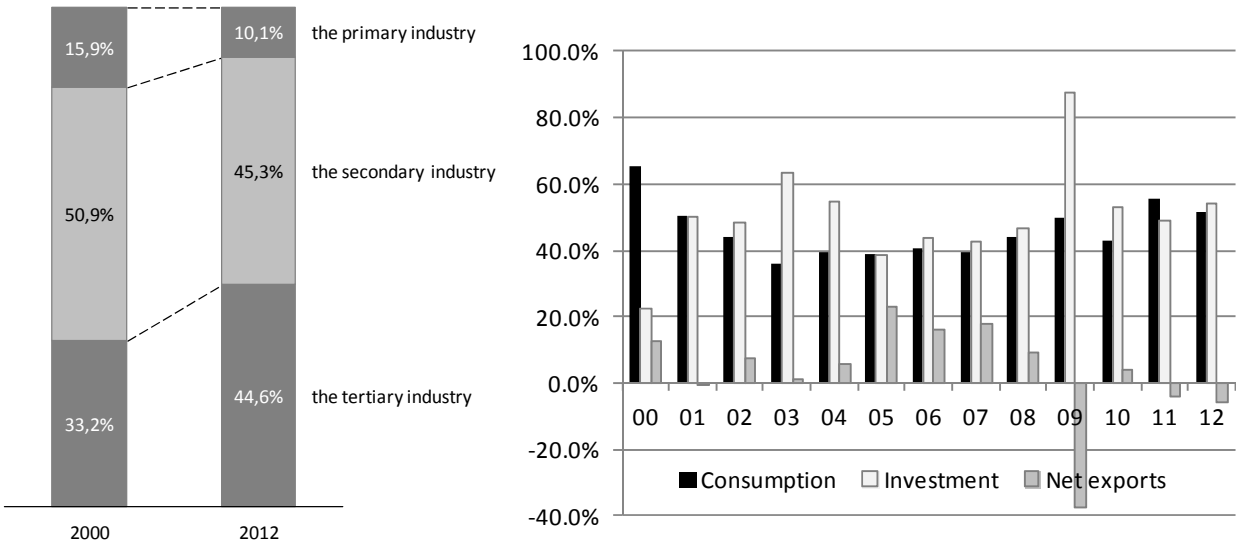

Figure 18: Composition of three industries in the GDP and three driving factors' contribution to China's economic growth

Source: NBSC (2000-2012).

3.3. Urbanisation and domestic consumption

3.3.1. Urbanisation's significance for economic growth model transition

Considering the contributions in the areas of promoting consumption, attracting investment, creating job opportunities, enriching the lives of rural residents and benefiting urban residents, urbanisation has been understood as the main driver for growth of the domestic economy and set as a policy priority by China's leadership today and in the coming years.[362] Following this prioritised policy, China plans to spend 40 trillion RMB to realise the target of the urbanisation process and bring 400 million Chinese from the countryside to live in cities over the next decade.[363]

China has been experiencing a rapid urbanisation process. In 2011, China's urban population surpassed its rural population for the first time in its history. The urbanisation rate doubled in 2012 compared to 1990, and reached 52.6%. Over 700 million Chinese now live in urban areas. Furthermore, this rapid urbanisation process is expected to continue.[364] Forecasted by the Chinese Academy of Social Sciences, the urbanisation rate will rise to 70% by 2030 when one billion people will be living in Chinese cities (see Figure 19).[365]

[362] See Li (2012).

[363] See Wang/Stanway (2013).

[364] See NBSC (2012).

[365] See Yang (2013).

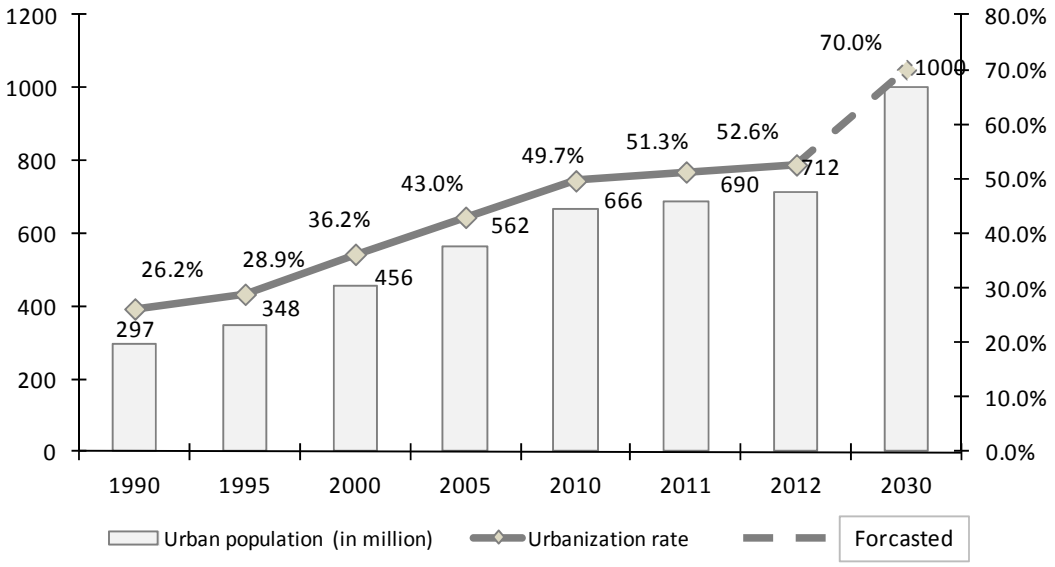

Figure 19: China's urbanisation process 1990 – 2030

Source: NBSC (2000-2012) and Yang (2013).

3.3.2. Results of rapid urbanisation process

During the high-speed urbanisation process increasing numbers of large cities are being formed. The Chinese cities with a population greater than one million amounted to 113 in 2010. Following the current urbanisation process, this number is estimated to grow to 252 by 2025.[366] Among them, eight Chinese cities will be populated with over 10 million citizens, which will account for nearly 21.6% of the total population of global megacities (see Figure 20).[367]

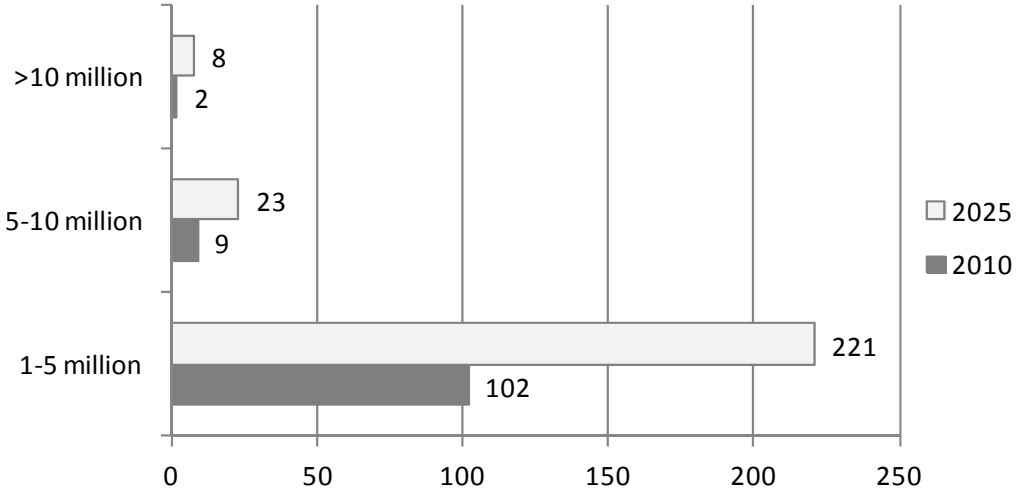

Figure 20: China's megacities 2010 – 2025

Source: China Development Research Foundation (2011) and MGI (2009).

[366] See China Development Research Foundation (2011) and MGI (2009).

[367] See UN (2012), p.6: "megacity" is used to describe a city with a population greater than ten million.

The urbanisation process also resulted in a continuous growth of household income. In 2012, the disposable income per capita of China's urban residents rose by 9.6%, after deducting for inflation, to 24,565 RMB, which was nearly four times higher compared to 2000.[368] Driven by the rapid urbanisation and increasing household income, the total retail sales of consumer goods[369] in China grew from 3.4 trillion RMB in 2000 to 20.7 trillion RMB in 2012. The automobile industry is one of the biggest beneficiaries from the booming urbanisation and retail growth. The Chinese automobile market has been the world's largest since 2009 and over 19 million cars were sold in 2012.[370] Following the automobile sector, in 2012 China overtook the USA as the world's largest food and grocery market as well.[371]

3.3.3. Challenges faced by urbanisation

In spite of its great achievements, China's urbanisation is still under pressure due to economic, social and environmental issues. Chinese urban residents use 3.6 times as much energy as rural ones. Also, their demand is still rising alongside the economic growth, which requires a sustainable supply of more resources; however, China is a poor country in terms of resources owned per capita. The shortage of resources and energy significantly influences the effectiveness of urbanisation in China.[372] As a result of the scarcity of available land and increasing demand, people have to bear soaring costs for living in cities. Regional imbalance is another challenge facing China's urbanisation. The urbanisation rates vary from China's coastal areas to those inland.[373] Cities are the best places to view examples of economic inequality, and China is no exception. Shanty towns can often be spotted near to skyscrapers, particularly in China's megacities. The hukou system is criticised as a great challenge to social equality, as it divides Chinese people into rural and urban residents. Despite living in Chinese cities for many years and being calculated in the urbanisation rate, many migrant workers do not receive the same privileges as ordinary urban citizens with all the social benefits offered by a city such as healthcare, education and a pension. Furthermore, various environmental issues, such as air, water, and noise pollution, exist and threaten urban residents' living quality.[374]

To tackle all the issues elaborated above, a great deal of effort and resources are required, not only from the public sector but from the private sector as well. Above all, building up a reliable goods supply for the incoming one billion urban citizens will be a high priority, in order to ensure the effectiveness of the urbanisation process and good living standards for the growing urban population.

3.4. Urban industries and development trends

There is no doubt that the growing domestic consumption and rapid urbanisation are closely related to urban freight traffic and logistics flow volumes. As a result of urban population growth and the booming domestic

[368] See NBSC (2012).

[369] Total retail sales of consumer goods refers to the amount obtained by enterprises (units, familiy-run businesses) through direct sales of non-production and non-business physical commodities to individuals and social institutions, and revenue from providing catering services.

[370] See China Association of Automobile Manufacturers (2013).

[371] See EIU (2012).

[372] See World Bank (2008).

[373] See Roland Berger (2011).

[374] This will be discussed further in section 3.4.

consumption, the demand on various logistics service is increasing. Five major groups of objects were identified in section 2.1.1.2. Due to its larger significance in terms of demand on city logistics and external impacts[375], consumer goods need to be given more attention than the other four groups. Therefore, this section will focus on analysing the current situation and the developing trends in future.[376]

3.4.1. Retail industry

Being underpinned by a massive population, rapid urbanisation and healthy disposable income growth, the retail industry has become an important component of China's economy after undergoing a dramatic development over thirty years. The total retail sales of consumer goods in urban areas leapt in 2012 to 18.24 trillion RMB, which was nine times the amount in 2000 (see Figure 21). Also, sales in urban areas accounted for 86.7% of total sales in China.[377]

The Chinese retail industry is highly competitive. All kinds of retail formats can be found in China's market, varying from department stores, supermarkets, convenience stores, chain stores, shopping malls/shopping centres, specialty stores, as well as traditional grocery stores.[378]

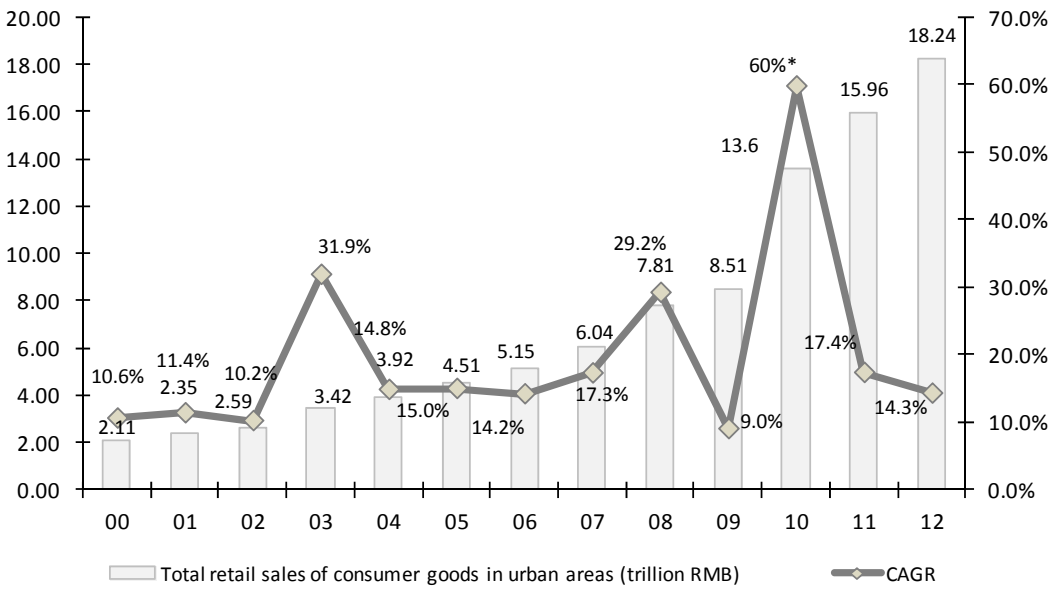

Figure 21: Total retail sales of consumer goods in urban areas 2000 – 2012[379]
Source: NBSC (2000-2012).

[375] See Table 2 in section 2.1.1.2: Objects served by city logistics.

[376] Building materials is another critical group besides consumer goods in China and needs to be studied further, as the construction industry plays a significant role in China's economy and contributed 6.9% of the total GDP in 2012. It is expected to further benefit from the growing fixed investment and the rapid urbanisation process. Numerous construction projects will be located in Chinese cities to build roads and houses, which places a heavy logistics demand on building materials. Nevertheless, due to limited time and resources, it is excluded from this study and recommended for further detailed research.

[377] See NBSC (2013).

[378] See AQSIQ/SAC (2004).

[379] 60%*: total retail sales of consumer goods in urban areas was redefined by the National Bureau of Statistics of China in 2010. Since then, the scope of urban areas has been enlarged as retail sales in urban areas of Chinese rural regions are also included.

China's retail market is deregulated. It consists of nearly 60,000 registered business enterprises[380] plus numerous small ones like family-run businesses. 97% of the 60,000 enterprises are domestic players, including state-owned, collective-owned, joint ownership, and private enterprises; the remaining 3% are multinational retailers.[381] This results in a high fragmentation rate of China's retail market.[382] The top 100 retailers in China accounted for 9% of total retail sales of consumer goods in 2011. In the sector of fast-moving consumer goods, even international giants like Wal-Mart, Carrefour, TESCO, Metro and Auchan together could only account for 17.2% of the total revenue of the top 100 retailers in China.[383]

Looking forward, the following new retail trends with implications for city logistics are expected in the future:

1) Rising costs and declining profitability

   Rising costs are a major challenge faced by most retail companies in China, as the two major factors of operation, rent and labour costs increased by 10% and 26%, respectively, in 2011. The trend is expected to continue over the next few years. This trend is expected to continue over the next few years. Pressure from rising costs and inflation has led to a decline in profitability for retail companies.[384] Optimising the supply chain and improving logistics efficiency are hereby considered as alternative solutions to resolving the challenge. Many companies tend to select outsourcing logistics services in order to reduce distribution time and operating costs and enhance their competitiveness. For instance, German retailer Metro signed a strategic cooperation agreement with Shuanghui Logistics[385] and chose it as Metro's exclusive logistics service provider for Metro's frozen goods in 2011. The aim was to improve operating efficiency, reduce Metro's logistics costs of fresh goods and enhance its price competitiveness.[386]

2) Continued growth but slower

   Despite the rising costs and declining probability, the retail industry is expected to continue growing. Today China's household consumption expenditure only contributes 51.8% of its total GDP, which is relatively lower than figures of other large economies.[387] There is hence huge room left for China to benefit from its high economic growth and the emergence of middle-income groups in the near future. It was estimated that China will overtake the USA to become the world's largest retail market by 2016 and its retail will grow twice as much as the USA's by 2022.[388] Therefore, the retail industry remains the centre of city logistics in China.

3) Market centralisation

[380] It includes only the enterprises above the designated size, which refers to those enterprises with an annual revenue greater than 5 million RMB.

[381] See NBSC (2012).

[382] The sector of household appliance is an exception, which is dominated by giants like Suning and Gome, listed in the Shenzhen Stock Exchange and Hong Kong Stock Exchange respectively.

[383] See Deloitte (2012).

[384] See Deloitte (2012) and PwC (2009).

[385] Shuanghui Logistics is the logistics subsidiary of Shuanghui Group, which is one of China's largest meat processing companies.

[386] See Shuanghui Logistics (2011).

[387] See OECD (2013): Household consumption expenditure contributed over 70% to its GDP in 2011.

[388] See EIU (2012).

The Chinese retail industry is competitive and quite fragmented. Statistical evidence indicates that the market is being centralised and the bigger players seem to have more power. The contribution of the top 100 retailers to total retail sales of consumer goods increased from 6.8% in 2003 to 9% in 2011. In addition, M&A activities are quite active in China's retail industry. Those at the top are trying to expand their network and achieve a scale effect. In 2011, the number of M & A transactions grew by 20% and reached 159 with a total value of 37.4 billion RMB (15% more than the previous year).[389] Consequently, this will lead to more requirements on the logistics network.

4) Moving beyond traditional tier-1 cities[390]

For decades, retail investment capital was centralised in China's tier-1 cities in coastal areas. However, with the increasing entry of new retailers, the market tends towards being saturated and competition gets even fiercer. In contrast, the retail market in 2nd-, 3rd- and even 4th-tier cities has stronger potential to grow, but lacks a sufficient supply. Retail investors and retailers alike thus started consciously to expand their foothold, seeking new business opportunities in lower-tier cities in central and western China.[391] Meanwhile, their geographic coverage is enlarged, which requires a more effective logistics network to serve end customers across China. Outsourcing the logistics services to professionals can be considered a solution in terms of saving capital investment and being more convenient.

3.4.2. Wholesale industry

Wholesale trade is defined as "*the activities of a wholesaler selling wholesale commodities for daily use and capital goods to enterprises of wholesale and retail trades and other enterprises, institutions and government offices, including the activities of wholesaler engaged in import and export and acting as a trade agent.*"[392]

Over the past few decades, the wholesale industry has made a massive contribution to China's economic growth. Firstly, it is a major component of the Chinese domestic trade system. As the modern retail chains cannot reach all households across China's huge landscape, wholesale markets play the role of serving the less-populated areas, particularly rural ones. In 2011 all the registered wholesale enterprises above a designated size[393] recorded total sales of over 28.8 trillion RMB, which is 1.5 times higher than the total retail sales of consumer goods.[394] All kinds of commodities and goods including agricultural products and by-products, articles for daily life, industrial consumer goods, and capital goods can be traded in wholesale markets. In addition, the wholesale industry is regarded as a major source of fiscal revenue and a driving force of local economic growth. Research indicates that the coefficient of elasticity of the development of the wholesale industry and economic growth is

[389] See Deloitte (2012).

[390] According to classification of Chinese Academy of Social Sciences (CASS), Chinese cities are classified:

- Tier-1: Beijing, Shanghai, Tianjin, Chongqing, Guangzhou, Hong Kong, Taipei, Macao
- Tier-2: Shenyang, Wuhan, Zhengzhou, Hangzhou, Nanjing, Fuzhou, Changsha, Ji'nan, Chengdu, Shenzhen, Qingdao, Dalian, Xiamen, Suzhou, Wenzhou and Ningbo
- Tier-3: other capital cities of China's provinces, and Dongguan, Zibo and Taizhou
- Tier-4: cities with a population over one million

[391] See Jones Lang LaSalle (2012).

[392] See NBSC (2012).

[393] It refers to those wholesale enterprises with annual sales greater than 20 million RMB.

[394] See NBSC (2012).

0.58.[395] A healthy development of wholesale markets has a positive influence on local economic development, For instance, the active wholesale industry has helped Yiwu become the world's purchasing centre of small commodities. It grew into a county-level city with a population greater than one million.[396] Furthermore, the wholesale industry is China's primary job creator. Nearly 67,000 wholesale enterprises above a designated size provided jobs to over 3.7 million people in 2011.[397] Finally, the wholesale industry also receives praise as it offers a good connection between China's manufacturers and their end customers, in particular for agricultural products. Through the wholesale markets, numerous agricultural products can be sold from Chinese farmers in remote rural areas to urban customers in cities.

In spite of its massive contribution, the wholesale industry is also criticised because of its negative external effects. Usually, wholesale markets are located in the suburbs of many Chinese cities. Resulting from the expansion of China's urbanisation and urban sprawl, their locations have become parts of city centres and living areas for urban residents. The existence of wholesale markets seems incompatible with their new neighbours. Due to the market size and transaction volumes, numerous passengers and freight vehicles have to enter and exit the wholesale markets, which results in large volumes of traffic and leads to many negative external effects such as traffic congestion, air pollution and noise pollution, etc.

Having recognised this issue, many municipalities have initiated action. Moving the wholesale markets outside of city centres is one of the most popular policies taken by Chinese cities. Changsha, Chengdu, Guangzhou, Harbin, Ningbo, and Zhengzhou issued similar policies and plans, and started to move their wholesale markets outside urban areas to the less congested outskirts, which will, on one hand, reduce pollution in the urban environment and alleviate the burden of rising costs on wholesale markets, on the other.

Following this trend, the wholesale markets will need more reliable logistics management to sustain the huge transaction volumes and connect suppliers and customers, especially considering those further away in city centres. It will take several years before all of the wholesale markets can be moved out of city centres, more sustainable logistics solutions are required to minimise the negative external effects and satisfy their neighbours.

3.4.3. E-commerce industry

As part of the global economy, China's e-commerce industry has grown in accordance with the global e-commerce boom in the past decade.

Compared with traditional bricks-and-mortar merchants, this new sales channel is becoming more and more popular in China due to its many comparative advantages. For instance, products online are usually sold at much lower prices. It is more convenient for users to shop online as they only need to click and pay from the comfort of their home without having to travel or even bargain. Accordingly, China's e-commerce market soared to a total transaction value of 1.26 trillion RMB and was ranked as the world's 2nd largest market in 2012, after an astonishing development of a compound annual growth rate of 87% from 2005.[398] The significance of e-

[395] See Ma/Tao/Luo (2012).

[396] See Yiwu (2012).

[397] See NBSC (2012).

[398] See CNNIC (2013).

commerce has also increased immensely, as the percentage of online sales to total retail sales grew from 0.3% in 2006 to 6% in 2012 (see Figure 22).[399]

Unlike other large e-commerce markets, where the independent merchants have a dominant prevalence (e.g., all the US independent merchants accounted for 76% of online market in 2011), China's online industry is shaped by its unique context. Marketplaces concentrate the market. In 2011, marketplaces such as Taobao and Tmall[400] accounted for 90% of China's total e-commerce market. Independent merchants like 360buy, Amazon and Suning, made up the rest[401]. Although the amount of product categories available online is getting closer to counterparts offline, Chinese online shoppers intend to buy more apparel, and recreational, educational and household products. These three categories collectively account for 70% of the total market size.

Looking forward, China's e-commerce market is expected to grow further, even though online retail sales accounted for 6% of total retail sales in 2012, which is a bit higher than the same indicator for the USA (about 5%). Several arguments were identified to underpin the continued growth: China has the world's largest online population; broadband and 3G penetration is expanding; there is economic growth and household disposable income growth. It was thus estimated that the market will reach 2.7 to 4.2 trillion RMB by 2020, which is roughly equivalent to the collective size of today's markets in the USA, Japan, the U.K, Germany and France.[402]

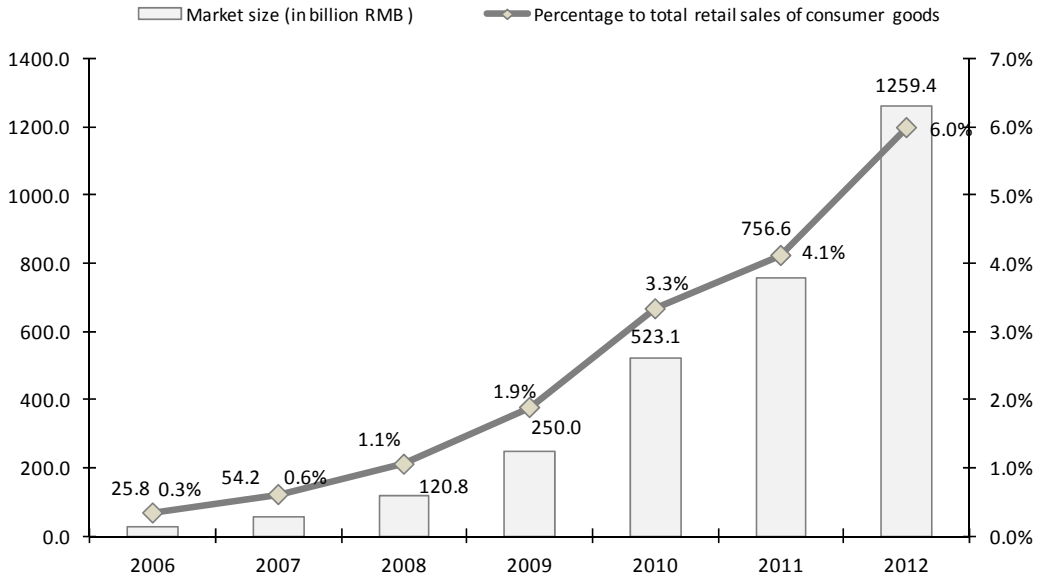

Figure 22: China's e-commerce market 2006 – 2012

Source: CNNIC (2013) and NBSC (2007-2013).

[399] See NBSC (2013).

[400] Taobao and Tmall are two subsidiaries of Alibaba group with the former ranked as China's largest C2C marketplace and the latter the largest B2C marketplace.

[401] 360buy and Suning are China's leading B2C merchants.

[402] See MGI (2013).

In relation to logistics, the booming e-commerce market, on one hand, places a tremendous demands on logistics services. Indicated by the market's unique context – dominated by marketplaces, most e-merchants are innovative SMEs[403] that tend to outsource their logistics services because of their capital limitation and focus on core competitiveness. Even big independent players, such as 360buy and Suning, have to outsource the last-mile delivery, as their logistics network cannot cover every corner of China. Along with China's online market continuing to boom, the increasing demands on logistics services is beyond doubt. This will generate over 4 billion parcel shipments in the coming years.[404] On the other hand, logistics is a major component of e-business. It is considered as a critical success factor influencing online shoppers' satisfaction level, as it is the delivery worker, who is the one actually meeting the customer in person and handling the products. The reliability and quality of logistics in the last mile are hereby considered quite significant. More innovative solutions are required to improve service quality and operating efficiency. In addition, whether the expansion of e-commerce can unfold smoothly relies heavily on the capacity and efficiency of existing logistics facilities and networks, which so far have not kept pace with the growth of the e-commerce market due to the huge amount of long-term capital investment required. Effective solutions may be found in strategic cooperation between marketplaces, professional logistics service providers, and e-merchants.[405] Indeed, at the beginning of 2013, it was reported that Alibaba[406] would lead a strategic partnership with Fuxin Group, Yintai, and China's six largest private express-delivery companies and invest hundreds of billions of RMB to build up a smart logistics network to meet the growing demand.[407]

3.5. Urban environmental issues

3.5.1. Status quo

China's current economic growth model is regarded as a classic extensive pattern. It comes at a cost of huge manufacturing inputs, high-energy consumption and heavy environmental pollution. The rapid economic growth is exerting immense pressure on the country's natural environment. Indeed, environmental pollution has already become a critical issue during China's rapid urbanisation process, as it jeopardises a city's attractiveness for investment, affects competitiveness, and poses a massive threat for inhabitants.

Above all, urban air pollution is cited as the prime issue. According to a report by China's Ministry of Environmental Protection, the air quality of half of China's 74 cities was found to be below acceptable standards in the 1st quarter of 2013. Beijing endured its worst air pollution in recent years. Smoggy skies and people wearing masks were often to be observed on the capital city's streets. Residents were officially warned to stay at home and avoid doing exercise outdoors. Even worse, it was reported by a study published recently in The Lancet that outdoor air pollution linked to the premature deaths of more than 1.2 million people, equivalent to about 40% of the total deaths caused by dirty air.[408]

[403] SMEs: small and medium enterprises.

[404] See A.T. Kearney (2011).

[405] See A.T. Kearney (2011).

[406] Alibaba is the parent company of China's largest C2C marketplace and largest B2C marketplace.

[407] See Reuters Chinese (2013). The Fuxin Group is considered a capital provider and Yintai an active e-merchant of Alibaba's B2C marketplace – Tmall.

[408] See The New York Times (2013b).

Water pollution is another major environmental issue faced by most Chinese cities. The high price for "Made in China" over the last three decades has been the widespread dumping of toxic chemicals and industrial wastewater poisoning China's rivers and groundwater. It was reported by Greenpeace that 320 million Chinese people do not have access to clean water while another 190 million have to drink water that is severely contaminated with hazardous chemicals.[409] 90% of the groundwater in cities was polluted to different degrees according to a study completed in 2011 by the Ministry of Environmental Protection and the Chinese Academy of Engineering. Another survey, conducted by the Ministry of Housing and Urban-rural Development in 2009, found that 1000 of China's total 4000 water treatment plants could not meet acceptable standards.[410]

A 3rd issue caused by the economic growth and the rapid urbanisation process is shrinking of green space in Chinese cities. Along with the expansion of urban sprawl, an increasing amount of arable land has been used to build office buildings, houses, living facilities and urban infrastructural constructions. As a result less and less green space can be found, which is obvious when comparing satellite photos of China's Pearl River Delta[411] between 1979 and 2004 (see Figure 23).

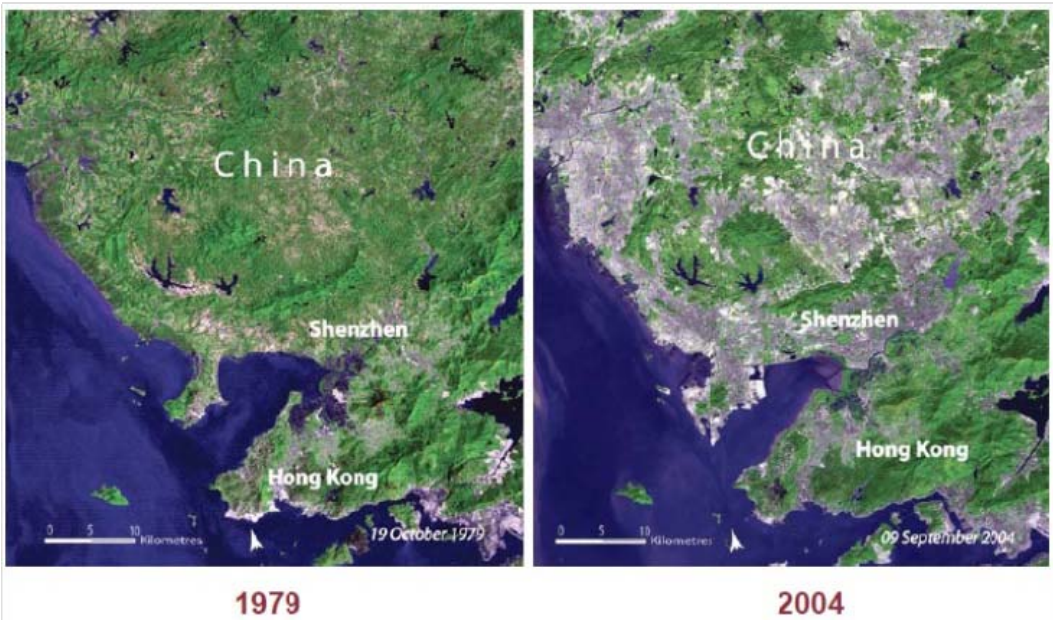

Figure 23: Urbanisation of Pearl River Delta 1979 and 2004

Source: Loh (2007).

Traffic congestion continues to worsen, especially in densely populated cities like Beijing, Guangzhou and Shenzhen. The construction of urban roads and public transportation systems has not kept up with the rapid growth of automobile sales in Chinese cities. If all the automobiles in some large cities were lined up, it would stretch a great deal further than the length of all roads in China's urban areas combined.[412] By the end of 2012, only 16 of China's 113 large cities with a population greater than one million were running urban rail systems.

[409] See Greenpeace (2012).

[410] See Economist (2013a).

[411] The Pearl River Delta is considered one of China's three major well-developed economic zones.

[412] See DHL/Siemens/CDI (2011), p.14-15.

The average track length per thousand capita is 10.7 m.[413] According to a report published by the Chinese Academy of Sciences, Chinese citizens in the surveyed 50 cities have to spend 39 minutes on average each day travelling to work. Beijing is ranked number 1 with 52 minutes as a result of its traffic congestion.[414] In spite of the dramatic improvement in the public traffic system, traffic congestion has become a perennial problem, not only in tier-1 cities, but also in many tier-2 and even tier-3 cities.

Additionally, the garbage that is left to pile up in Chinese cities and the noise, dust and smoke pollution are other issues challenging China's fragile urban environments and their sustainability. Assessed in a study by the Chinese Academy of Environmental Planning, which is part of the Ministry of Environmental Protection, the cost of environmental degradation in China in 2010 was about 1.54 trillion RMB, three times that in 2004. This was equivalent to 3.8% of the national total gross product.[415]

3.5.2. Urban environmental restrictions towards logistics

As explicated above, urban environmental issues are the price to pay for China's rapid economic growth and urbanisation expansion. Tracing back to the root causes, transport and logistics is listed as one of them besides industrial manufacturing, energy generation and households' daily consumption. Vehicle emissions, including carbon monoxide (CO), nitrogen oxides (NO_x), hydrocarbon (HC), carbon dioxide (CO_2), and particulate matter (PM_{10}) are the main air pollutants. In 2009, the transportation and logistics sector consumed 19% of global energy and generated 23% of the world's carbon dioxide (CO_2) emissions. Even worse, the emissions were estimated to have increased by about 50% by 2030 following the current trends.[416] In China, pollution caused by vehicle emissions has increased remarkably. According to an annual report released by the Ministry of Environmental Protection, vehicle emissions together with coal combustion have become the primary sources of China's urban air problems, as China has been the leader in vehicle production and sales since 2009. A total of over 52 million tonnes of pollutants were emitted in 2010. Compared to passenger vehicles, freight vehicles represent a far smaller percentage of China's total vehicle volume. However, they generate a much higher level of emission due to consuming more polluted fuel, higher levels of utilisation and larger vehicle size.[417]

Urban environment is one of three pillars of China's sustainable urbanisation. Having realised the gravity of environmental issues and the urgency of environmental protection, China's policymakers have been putting in place policies and measures to tackle the issues and enhance its cities ability to protect urban environments. A series of measures addressed the transportation and logistics sector with the aim of reducing its negative environmental effects and improve sustainability.

[413] The 16 cities include (ranked according to the current length of urban rail) Beijing, Shanghai, Guangzhou, Shenzhen, Chongqing, Tianjin, Nanjing, Dalian, Wuhan, Changchun, Hangzhou, Chengdu, Foshan, Suzhou, Xi'an, and Kunming. It was calculated based on published data from the yearbooks of individual cities.

[414] See China Daily (2012c).

[415] See The New York Times (2013a).

[416] See IEA (2009).

[417] See Ministry of Environmental Protection of China (2011).

Developing effective, energy-efficient public transportation systems has been proposed as the focus of future policies.[418] Indeed, China's policymakers have prioritised the urban environment due to their favourable attitude toward it.[419] After approving 25 urban rail projects worth more than 800 billion RMB in September 2012, by the end of the year the National Development and Reform Commission had authorised another urban rail project of 456 km of subway in Changsha and allowed similar projects in Fuzhou and Urumqi as well. Related tax breaks and fuel subsidies are expected to follow in order to assist the expansion of mass transit vehicles in Chinese cities. Along with accompanying measures, further restrictions have also been issued to limit actions that generate heavy pollution. In February 2012, the State Council planned to put forward strict new fuel standards that would come into force this June, which oil companies had blocked for years.[420] Other restrictions are issued directly by Chinese city governments. Beijing has limited the use of private vehicles on designated days based on their license plate numbers and is planning to build a road-congestion charging system. Other cities like Shanghai, Guangzhou and Guiyang have imposed restrictions on vehicle ownership.

3.6. Political and regulatory environment

Logistics and transportation are of critical importance for China's economy. They not only have a significant effect on gross domestic production, but are also essential for achieving sustainable economic growth and keeping pace with rapid urbanisation. As an integral component of the logistics and transportation industry, the political and regulatory environment of city logistics should be investigated from a broader system perspective.

3.6.1. A policy framework of three decision levels

Three hierarchy decision levels make up the policy framework of city logistics in China (see Table 20):[421]

Decision level	Government	Roles & main responsibilities
National level	The central government	• Develop national development plans and guidance • Develop national policies and regulations • Arrange resources at national level
Regional level	Provincial governments	• Develop regional policies and plans within jurisdiction • Arrange resources at regional level • Coordinate local municipalities
City level	Local municipalities	• Follow and execute plans, policies and regulations of central government and provincial governments • Detail the local plans, policies and regulations • Arrange local resources to support the execution of detailed plans, policies and regulations

Table 20: Policy framework of city logistics in China

Source: in reference to Qiu/Yang/Yang (2006).

[418] See Zhou et al. (2012).

[419] See China State Council (2013a).

[420] See China State Council (2013c).

[421] See Qiu/Yang/Yang (2006).

Among the three decision levels, the central government and local municipalities are the most active in issuing policies and regulations in the field of city logistics.

3.6.2. The central government

Due to its massive contribution to the economic growth, logistics is attracting increasing attention from China's central government. After the release of the first document issued by six ministries in March 2001,[422] the central government has set further detailed policies to promote the development of logistics as one of China's 10 most important industries.

In 2011 the State Council set city logistics high on its agenda[423] as it has the potential to enhance the development of the logistics industry, guarantee goods supply to Chinese urban residents, and reduce traffic volumes and optimise the utilisation of urban infrastructure.[424] Furthermore, it encourages the usage of advanced technology and the employment of innovative logistics solutions to improve the efficiency of city logistics. The Ministry of Commerce selected 9 Chinese cities for pilot projects, each receiving 15 million RMB in sponsorship.[425] Moreover, all important ministries were involved during the formulation of the policies. For instance, the Ministry of Housing and Urban-Rural Development was one such government department supporting the development of city logistics as it deals with delivery/loading bays within urban areas, thus giving it a connection to the issue. All the relevant policies and regulations are depicted in Table 21.

[422] See China State Council (2001).

[423] See China State Council (2009a) and China State Council (2009b).

[424] See China State Council (2013e).

[425] See Ministry of Commerce (2012): the 9 cities include Chengdu, Hefei, Guiyang, Guangzhou, Lanzhou, Nanning, Xiamen, Wuhan and Yinchuan.

Year	Topic	Issued by	Relevance to city logistics
2013.02	Guidance of Promoting and Improving the Administration of Urban Distribution[426]	Lead by Ministry of Transportation and six other ministries	• Emphasised the significance of city logistics for logistics development, urbanisation and urban traffic • Set up the overall objectives of city logistics administration • Developed detailed policies to assist the objectives
2013.01	The Comprehensive Work Program to Reduce Distribution Costs and Improve the Distribution Efficiency of Retail Industry	State Council	• Set up objectives of reducing distribution costs and improving distribution efficiency of the retail industry • Developed a series of detailed support measures
2012	Guidance of Promoting the Application of Advanced Logistics Technology and Joint Distribution[427]	Ministry of Commerce	• Emphasised the significance of city logistics for the retail industry • Set up support measures to encourage the application of advanced technology and the implementation of innovative logistics solutions • Selected 9 cities for pilot projects
2011	Policies and Measures for Promoting the Development of the Logistics Industry	State Council	• Developed related policies to support the prioritised development of logistics • Highlighted the significance of city logistics from a national perspective
2009	Adjustment and Revitalisation Plans of Logistics Industry	State Council	• Prioritised the logistics industry as one of China's ten most important industries
2004	2nd Guidance to Developing Advanced Logistics in China	Lead by National Development and Reform Commission and eight other ministries	• Developed related policies to support the development of the logistics industry
2001	1st Guidance of Developing Advanced Logistics in China	Lead by the State Economic & Trade Commission and five other ministries	• Set a clear vision for the logistics industry in China

Table 21: Policies issued by China's central government

3.6.3. Local municipalities

From a city perspective, city logistics is moving towards becoming the primary interest of local municipalities. This is because Chinese cities, in particular the well-developed coastal ones, consider city logistics as a potential measure for improving their competitiveness, ensuring the growing demand for logistics services for the urban population, easing traffic congestion and reducing environmental pollution.

Under the guidance of the central government, local municipalities have been engaged in developing local policies and regulations. First, a logistics office was set up by many cities and tasked with coordinating all related governmental-level departments as well as resources from the private sector. This was in response to city authorities becoming aware of the cross-functional nature of logistics. The logistics office usually reports to the vice-mayor or mayor of the city. However, its level of independence differs from city to city. An overview of the structure of the logistics offices in selected Chinese cities is provided in Table 22.

[426] See China State Council (2013d).

[427] Joint distribution is defined by the NTCLSAC (2007) as distribution activities organised by more than two companies. A 3rd party is usually responsible for providing logistics/distribution services through a distribution centre in order to reduce logistics costs and improve operational efficiency.

City	Located in	Report to
Wuhan	Independent	Mayor
Chengdu	Independent	Vice Mayor
Ningbo	Development and Reform Commission	Vice Mayor
Wuxi	Economic and Information Technology Committee	Vice Mayor
Guiyang	Bureau of Commerce	Vice Mayor
Guangzhou	Transportation commission	Vice Mayor
Shenzhen	Transportation commission	Vice Mayor

Table 22: Structure of the logistics offices in selected Chinese cities

In addition, further detailed policies have been developed or are being formulated by many logistics offices to achieve the objectives set by China's central government. Many cities also started early on or later to issue policies to restrict freight vehicles:

- Restriction based on time windows: in order to ease traffic congestion, no trucks are allowed to enter urban areas during peak hours.
- Restriction based on road utilisation: freight vehicles have to bid for an entry license to enter urban areas
- Restriction based on vehicle standards: some Chinese cities issued technical standards about freight vehicles within urban areas. Trucks failing to meet those standards are not allowed to enter city centres.
- Restriction based on areas: many cities have set up their business centres as designated truck-free areas within urban areas to ease the traffic burden.

Also, various measures are taken to assist the private sector to improve the efficiency of city logistics. Some related policies from selected cities are provided in Table 23.

- Assistance for logistics innovation: two cargo taxi companies are favoured due to their innovative organisational form and are therefore authorised to work within urban areas without restriction.
- Assistance for equipment set up and use: purchasing green trucks with lower emissions is supported financially by local municipalities.
- Assistance for financial support: some cities have allocated dedicated financial funds to reward good performance within the private sector and to support its growth.
- Assistance for certain sectors: in order to ensure Chinese citizens' daily requirements for high-quality agricultural products and reduce total costs, China's central government, led by the Ministry of Agriculture, started a "Shopping Basket Program" in 1988. Detailed policies were developed under this master program by local municipalities. The related logistics activities are supported with preferential taxation policies.[428] The warehouse can be provided with water and electricity at a lower price. Freight vehicles are not required to pay tolls and can work within urban areas without restriction.

[428] See China State Council (2010), China State Council (2011a) and China State Council (2013a).

Type of policies	Content of policies	Representative city
Restriction	Restriction based on time windows	Chengdu, Ningbo
Restriction	Restriction based on road utilisation	Chengdu
Restriction	Restriction based on vehicle standards	Beijing, Shanghai
Restriction	Restriction based on geographic area	Changsha, Nanchang, Wuhan
Assistance	Assistance for logistics innovation	Ningbo, Suzhou
Assistance	Assistance for equipment set up and use	Beijing, Guiyang
Assistance	Assistance for financial support	Chengdu, Xiamen
Assistance	Assistance for certain sectors	Overall in Chinese cities

Table 23: Existing policies of Chinese cities

3.7. Logistics development

Logistics plays a key role in sustaining China's economic development, since it connects producers through different distributors with end customers across China's 9.6 million km^2 and the rest of the world.

3.7.1. Status quo

Over the past few years, China's logistics market has kept pace with its economic growth. In 2012, the total value of social logistics[429] totalled 177.3 trillion RMB, up 9.8% on the previous year (see the left picture in Figure 24). The total value-added of the logistics industry[430] grew by 9.1% to 3.6 trillion RMB (see the right picture in Figure 24), which accounted for 15.3% of the tertiary industry and 6.8% of China's total gross domestic product.[431]

Overall, China's logistics performance is assessed as good as the result of a long period of fixed investment in its infrastructure. It is one of the world's top 30 countries and was ranked 26 on the World Bank's Logistics Performance Index, better than most other EME countries.[432] Yet, there is still a large gap in terms of logistics efficiency between China and well-developed countries ranked above it.

The total expense of social logistics as a percentage of GDP is considered as an index to assess the efficiency of a country's logistics sector. After having experienced a decline during the period 2006 – 2011, the ratio slowly

[429] Total value of social logistics is an indicator used in China (by National Bureau of Statistics of China) to reflect the scale of the logistics demand of a country or region for a certain period. It is calculated as: Total value of social logistics = Social logistics value of industrial goods + Social logistics value of agricultural goods + Social logistics value of imported goods + Social logistics value of recycled materials + Social logistics value of commercial and personal goods.

[430] Total added value of the logistics industry is an indicator used in China (by National Bureau of Statistics of China) to reflect the scale of value created by the logistics industry in a country or region during a certain period.

[431] See China State Council (2013b).

[432] See World Bank (2012), p. viii.

climbed in 2012 to 18% (see Figure 25), which is much higher than other large economies.[433] This indicates that China has a great deal of catching up to do regarding the difference in efficiency.

On the subject of industrial concentration, the logistics industry is characterised by extremely fragmented and fierce competition. Thanks to deregulation[434], newcomers both from China's domestic private sector as well as abroad can be found year by year seeking business opportunities in the growing logistics market. It was reported the 5 million registered truck companies in China own only 1.5 trucks on average.[435] China's top 50 logistics companies accounted for 20.2% of the total logistics market.[436]

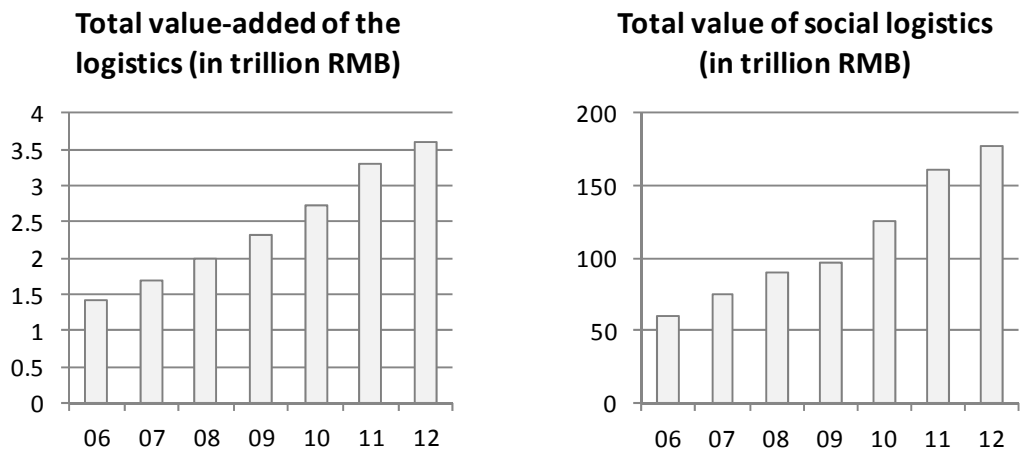

Figure 24: Market size of logistics in China 2006-2012

Source: CLFP (2013) and China State Council (2013b).

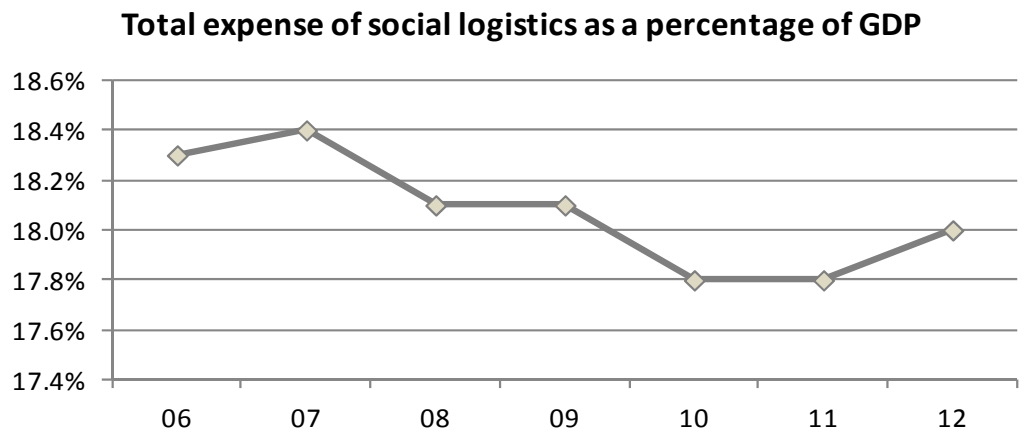

Figure 25: Total expense of social logistics as a percentage of GDP 2006-2012

Source: CFLP (2013), NBSC (2012) and China State Council (2013b).

[433] See Burnson (2012): the total expense of social logistics as a percentage of the US GDP was 8.5% in 2011. See KPMG: the ratio was 11% in Japan and 7% in EU respectively in 2008.

[434] See Liu et al. (2013), p.28: China's logistics market was first open to foreign-funded enterprises after its entry to the WTO in 2001. Also, it became fully open after 2006.

[435] See DHL/Siemens/CDI (2011), p.21.

[436] See China Logistics Information Centre (2012).

Compared to all other developed countries, the professional 3PLs have a relatively lower penetration in China's logistics market, which was only 7% in 2010, far lower than the 30% in Western Europe.[437] Most logistics services are served in-house or partly combined with outsourcing. The reason, why companies, especially international ones, not outsource their logistics services, is that there is lack of reliable service providers. Indicated by a survey conducted by a leading consulting company in China, 69% of surveyed companies did not use any contract logistics at all in China. Respondents across all industries hold a critical view on the performance of the current logistics market. Over 70% of respondents rated sub-segments like quality management, staff qualifications, just-in-time delivery, security standards and risk management as average to poor.[438] Others like large supermarket companies, retail chains and B2C e-commerce retailers kept logistics as an in-house function, because they consider logistics one of their competitive advantages and tend to manage their logistical network in-house.[439]

Although the business scale of logistics enterprises has noticeably increased in recent years, their profitability is under high pressure from added investment in new equipment and technology; increasing costs of fuel, labour, warehouse rent; as well as the burden of tax. Meanwhile, hampered by the intensive market competition and limited capability of providing value-added services, logistics companies could find it difficult to raise their fees. As a result, the operating cost of China's major logistics companies increased by 31% during the period January to November in 2012, which was 5.1% higher than the growth rate of business income. This leads to a thin profit margin of 4.72%, which would fall further to 3.71% if the port companies with relatively higher profit margins were not considered.[440]

3.7.2. Development trends

Looking forward, there is a diverse set of challenges to be faced by the logistics industry in the coming decades:[441]

- Logistics costs: the rising wages, water and electricity costs, as well as the appreciation of warehouse rentals and the shortage of land for warehouses, are considered major factors damaging many logistics operators' profitability.
- Transportation: transportation is a major part of the logistics industry in China. In 2012, transportation fees made up 52% of the total social logistics spending in 2012.[442] While, road transportation contributed 76.3% of the total freight turnover in 2011.[443] However, the large toll road network is challenging road transportation. It was reported by a report from the World Bank that over 100,000 km of highways are subject to tolls in China, which is a massive proportion of over 70% of the total tolled roads in the world.[444] In addition, many cities have also started to issue specific requirements for in-

[437] See Goodman (2012), p.5.

[438] See PwC (2012), p.15-22.

[439] See Ma/Li (2012).

[440] See China State Council (2013b).

[441] See Hatherley/Ma/Choi (2011), He (2012) and Li & Fung Research Centre (2012).

[442] See CFLP (2013).

[443] See NBSC (2012).

[444] See China Daily (2012a).

town trucking services, such as congestion charges. The toll, the upcoming charges, plus increasing fuel costs all accumulate, which puts a great deal of pressure on the logistics industry.

- Market fragmentation: as the market remains highly fragmented, many logistics operators have to compete fiercely with others in terms of low cost. Also, it is quite costly and ineffective to meet a company's requirements across a nationwide logistics network because enterprises have to deal with numerous logistics companies with local know-how.
- External economic environment: the stagnation in the EU since the European debt crisis and the sluggish recovery of the US economy, as well as the appreciation of the Chinese currency, have has wide-ranging effects on China's trade industry and reduced its export volume.
- Infrastructure: although China is well ranked because of its well-built infrastructure, it is divided by its large population and broad area, and thus the density still needs to be increased. Additionally, similar to its economic imbalance, the logistics sector also faces a disparity problem, with the development of all main ports, airports and highways concentrated in coastal areas, but the infrastructure development in inland China lags behind.
- Modern logistics facilities: a high level of operational efficiency depends on the use of modern logistics facilities. Yet, the logistics industry faces issues such as lack of temperature-controlled storage for cold chain goods, not enough loading docks for trucks and a low adoption of automation technology within warehouses. As a result of the low level of integration of IT technology into operations, customers have difficulty accessing inventory control or real-time information of goods.
- Besides, an inefficient supply of qualified manpower, regional protectionism, and a low level of nationwide standardisation for logistics equipment or facilities, are also criticised as further issues challenging the logistics industry in China.

Still, logistics is expected to continue its current expansion pace. Because healthy economic growth, rising income and growing domestic consumption, strong retail sales, booming e-commerce, and favourable policies are all positive factors driving continued growth. In addition, in spite of the low penetration level of professional 3PLs, there is a progressive acknowledgement that outsourcing logistics services has the potential to help manufacturers and retailers improve operational efficiency and to concentrate on their core business. In fact, revenue for contract logistics, a sub-segment of the logistics industry, was forecasted to reach 182 billion US dollars by 2016, which will be larger than the market size of both the USA and the EU.[445]

As China has been moving progressively towards a more consumption-driven economy, retail sales seem more promising to induce increasing logistics demand. However, the logistics process of the retail industry is quite complex. Compared to industrial goods, consumer goods are more sensitive to logistics costs as well as delivery time. They are dealt with in smaller amounts and usually transported by trucks. Second, more specific facilities and technology are required to protect the goods, on one hand, and increase the visibility of inventory control and share real-time information, on the other. Third, as the end customers are scattered all over the country, nationwide networks are required in order to get access to all selling points of retailers in China. Furthermore, the increasing requirement towards reverse logistics makes the logistics process of consumer goods even more complex. [446] Therefore, more integrated, intelligent and sophisticated solutions, rather than simple transport and

[445] See Goodman (2012): the contract logistics market was worth 127 billion US dollars in the US and 146 billion US dollars in the EU.

[446] See He (2012).

storage of goods, shall be provided by professional logistics companies to effectively combine goods production, distribution, and consumption, and create more value-added services in shared-work processes.[447]

3.8. Summary

China is the world's largest EME country in terms of economy and population. The development of city logistics is closely related to China's macro-environment, and an investigation of this macro-environment provides here a better understanding of the situation of city logistics in China.

1) Economic development

   After rapid economic growth over the past thirty years, China has achieved admirable successes in terms of domestic gross production, exports and the development of a logistics infrastructure better than most other EME countries. However, its current economic growth model seems strained considering the constraints on fixed investment and limits to export-led growth. Thus, the Chinese government is looking to change the growth model and positions domestic consumption as the 3rd driving factor underpinning economic growth. In relation to logistics, this huge transition has a notable requirement: Logistics players are expected to focus not only on connecting China's production with its customers abroad, but also more on consumers in China's cities.

2) Urbanisation and domestic consumption

   Considering the contributions in the areas of promoting consumption, attracting investment, creating job opportunities, enriching the lives of rural residents and benefiting urban residents, urbanisation has been understood as the main driver for growth of the domestic economy. Indeed, China has been experiencing a rapid urbanisation process and its urban population surpassed its rural population for the first time in its history in 2011. Furthermore, this rapid urbanisation process is expected to continue with the urbanisation rate forecasted to rise to 70% by 2030 when it is estimated that one billion people will be living in Chinese cities. During this process, the number of Chinese cities populations greater than one million will rise from 113 in 2010 to 252 by 2025, which will surely sustain a continuous growth of domestic consumption. An incredibly important task thus placed on the logistics sector is to build up a reliable goods supply for the incoming one billion urban citizens to ensure the effectiveness of the urbanisation process and good living standards for the growing urban population.

3) Urban industries

   Benefiting from urban population growth and an increase in income, China's urban industries have been experiencing a period of rapid growth, which is closely related to urban freight traffic and logistics flow volumes. Retail, wholesale and e-commerce are the most significant urban industries, all of which have been growing very quickly and are expected to continue to boom in the coming decades. This has resulted in a huge demand for various city logistics services and makes them, retail in particular, the centre of city logistics in China. However, logistics is understood differently within different urban industries. Logistics players should take account of these differences and individual requirements, and customise solutions to sustain a healthy development of urban industries.

4) Urban environmental issues

[447] See PwC (2012).

As the price for China's rapid economic growth and urbanisation expansion, urban environmental issues, ranging from air pollution to traffic congestion, have become serious issues jeopardising the attractiveness of Chinese cities for investment; moreover, it negatively affects competitiveness and poses a massive threat for inhabitants. Transport and logistics is listed as one of the major root causes of these problems besides industrial manufacturing, energy generation and households' daily consumption. Therefore, China's policymakers have been putting in place policies and measures to tackle the issues and enhance its cities' ability to protect urban environments. A series of measures were addressed to the transportation and logistics sector with the aim of reducing its negative environmental effects and improve sustainability. Thus, cities are expected to develop effective, energy-efficient and environmental-friendly solutions, and restrict unhealthy activities.

5) Policy and regulation

Three hierarchy decision levels including central government, provincial governments and local municipalities constitute the policy framework of city logistics in China. Having realised the significant effect on the gross domestic production, which is essential for sustainable economic growth and rapid urbanisation, China's policymakers, the central government and local municipalities in particular, have created a favourable political and regulatory environment for developing city logistics under the umbrella of logistics and transportation. A series of policies and detailed regulations as well as planning have been worked out to promote the employment of advanced technology and implementation of sustainable solutions to develop better city logistics.

6) Logistics development

Functioning as a key foundation connecting producers and end customers across China's 9.6 million km^2 and the rest of the world, logistics has made a tremendous contribution to sustaining China's economic growth and improving the quality of life of its citizens. Also, the logistics market has kept pace with the country's development and made some remarkable achievements. Yet, the logistics sector still needs improving by assessing its efficiency and comparing its performance with well-developed countries. In addition, logistics faces massive challenges, such as rising costs, an extremely fragmented market, imbalanced development of infrastructure, etc. Looking forward, Chinese cities not only need to take advantage of their professional logistics service providers, but also gain support from other related stakeholders in order to seize the opportunities of increasing demand in city logistics induced by booming domestic consumption and urbanisation expansion.

Summing up, city logistics faces a complex macro-environment involving both weighty challenges and great opportunities. The challenges facing the logistics industry and the complexity of the logistics process of consumer goods combined with urban environmental restrictions, all make it questionable whether organising city logistics activities and improving operational efficiency in China can be achieved. A joint effort is hereby expected from both the private and public sector to develop innovative solutions to satisfy all relevant parties. More integrated, intelligent and sophisticated solutions, rather than simple transport and storage of goods, shall be provided to effectively combine goods production, distribution and consumption, and create more added value in shared-work processes to satisfy cities' demand in a sustainable manner.

4. City Logistics in Chengdu

This thesis selects Chengdu for exploring the development of city logistics from a city-perspective because:

- Chengdu, characterised by rapid economic growth and a large population, is a representative emerging megacity in China. It is positioned as the trade and logistics centre for Western China and places significance in logistics development.
- A cooperation with local government, especially the Logistics Office, allows access to data and provides support for conducting a survey of over 100 retailers.

Chapter 4 conducts a more comprehensive study of city logistics in Chengdu, aiming at answering the fourth research questions: What is the visionary master plan of the city logistics system in Chengdu? Which factors influence users' participation and how do they impact their decisions? The first section investigates the current situation of city logistics in Chengdu using the SWOT analysis approach. Based on the results of the situational analysis, a visionary master plan for a city logistics system is recommended in the second section. The third section focuses on the key factors influencing retailers to use UCC services and carries out an empirical study using a structural equation modelling technique. The research structure of this chapter is depicted in Figure 26.

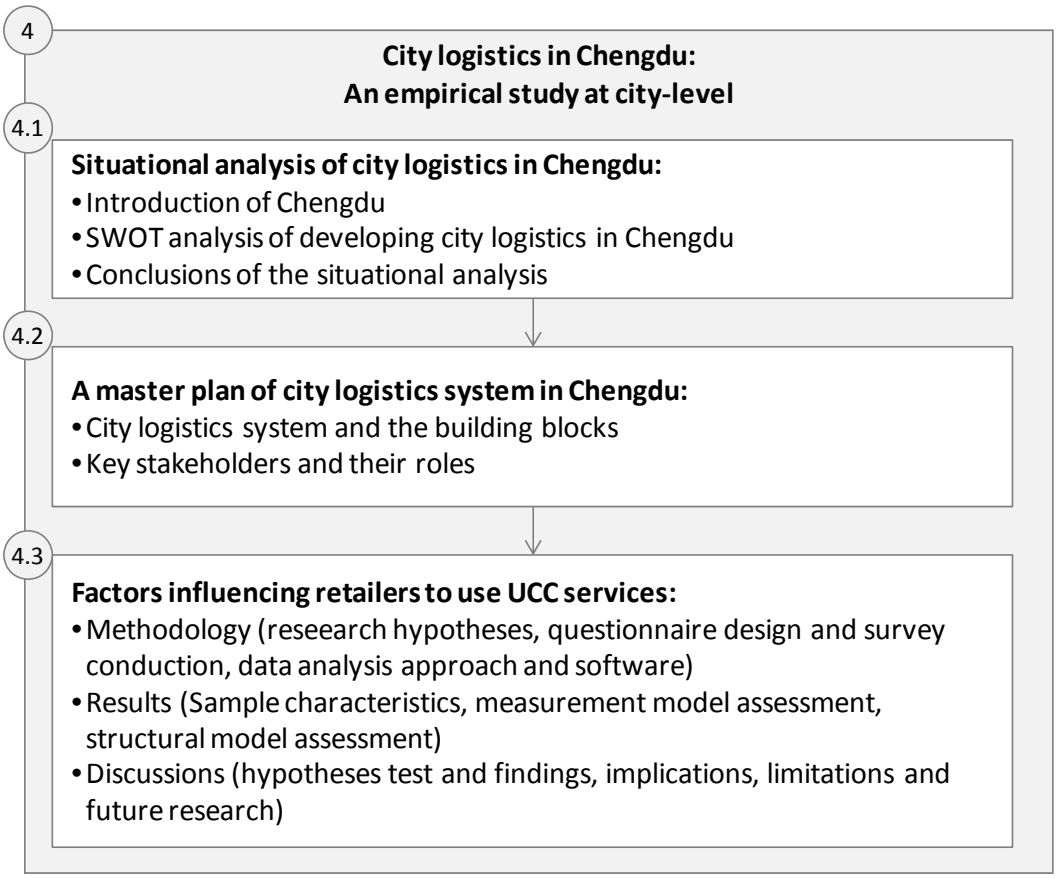

Figure 26: Research structure of Chapter 4

4.1. Situational analysis of city logistics in Chengdu

4.1.1. Introduction of Chengdu

Surrounded by numerous mountains, the city of Chengdu sits at the western edge of the Sichuan Basin. It is the capital of Sichuan province in Southwest China (see Chengdu's location in Figure 27). Over 14 million residents live in the city's 12,132 km^2, 67% of whom are living in an urban area of 551 km^2. With this population Chengdu is ranked the 2nd largest city in Western China after Chongqing.[448]

Despite being struck by an 8.0-magnitude earthquake in 2008, Chengdu's economy has recovered very fast. Compared to 2000, the gross domestic product in 2012 increased 7 times to 813.9 billion RMB (average annual growth rate of 17.7%), while GDP per capita reached 50 thousand RMB, growing 5 times (average annual growth rate of 14.4%).[449] Chengdu and Chongqing are the core cities of the Cheng-Yu Economic Zone, which has the potential to become China's 4th largest economic zone after the Pearl River Delta, Yangtze River Delta and Bohai Economic Rim. Chengdu is Sichuan's centre of economy, culture, politics, transport, commerce and trade. It thus also has influence in China's vast western region.[450]

In regard to logistics, Chengdu is the comprehensive transport hub and logistics centre of Western China. The logistics sector is defined as a key industry of the economy to realise the city's strategy of becoming China's trade and commerce centre, as well as high-tech industry and manufacturing base. Chengdu holds China's 5th busiest airport by annual passenger throughput. It handled 508 thousand tonnes of cargo and mail in 2012, 6.4% more than in 2011.[451] The logistics sector contributed 4.5% to the total value of the city's gross domestic product in 2011 and was ranked the fourth largest sector in the tertiary industry.[452]

[448] See Chengdu Bureau Of Statistics (2013).

[449] See Chengdu Bureau Of Statistics (2012) and Chengdu Bureau Of Statistics (2013).

[450] See National Development and Reform Commission (2011).

[451] See Civil Aviation Administration of China (2013).

[452] See Chengdu Bureau Of Statistics (2012).

Figure 27: Geographic location of Chengdu in China

4.1.2. SWOT analysis of developing city logistics in Chengdu

SWOT analysis is a structured management technique. Concerned with the analysis of an organisation's internal and external environment, this strategic planning tool is used for understanding internal strengths and weaknesses as well as identifying external opportunities and threats.[453] Originating from efforts at Harvard Business School to analyse case studies in the early 1950s, SWOT analysis was first introduced into the field of business management disciplines. Since then, the approach has become accepted as a valuable tool and is widely used to support strategic business decision making.[454] The application of the SWOT analysis varies from assisting an enterprise formulating strategic planning,[455] assessing the feasibility of the use of new technology[456], examining an industry's status-quo,[457] to supporting local governments to formulate regulations or issuing strategic planning.[458]

[453] See Schawel/Billing (2011), p.182-183.

[454] See Panagiotou (2003).

[455] See Houben/Lenie/Vanhoof (1999).

[456] See Mainali et al. (2011).

[457] See Çelik/Metin/Çelik (2012).

[458] See Yuan (2013) and Terrados/Almonacid/Hontoria (2007).

As demonstrated by evidence, a SWOT analysis is a better approach for investigating problems from a strategic perspective. It uses this management tool in section 4.1.1 to understand Chengdu's strengths of developing city logistics in order to take external opportunities and avoid any threats, while addressing weaknesses.

4.1.2.1. Strengths

Similar to many other Chinese cities such as Beijing, Chengdu's urban road network consists of four major ring roads and corridors connecting the ring roads.[459] The city ring defines geographically the area within it as the urban area and the area outside as suburban. The urban area is well connected with the suburban area by several corridors. The current layout of Chengdu's urban road network makes it easy to regulate and control any freight traffic within or outside the urban area.

In addition, Chengdu is positioned as the trade centre of Western China. The trade industry is well developed. It is Chengdu's key industry and plays a critical role in the local economy.[460] Since 2008, Chengdu's retail industry has experienced a double-digit growth rate of 18.4%. The total retail sales of consumer goods reached 331.8 billion RMB in 2012, which makes Chengdu the largest retail market in Western China.[461] Numerous goods are transported into and outside the city of Chengdu, which results in a large amount of logistics services. Alongside the growth of the retail industry, the demand for logistics services is expected to increase.

Furthermore, the urban area generated over 72% of Chengdu's total retail sales of consumer goods in 2012 with an annual growth rate of 19%, although it covers less than 4% of the city's total area.[462] Besides, most of the important commercial facilities including department stores, supermarkets and shopping malls are clustered into six business districts, which are all located within Chengdu's 3rd ring road. This leads to a high density of sales volume as well as geographic concentration of end customers. Above all, it facilitates the consolidation of deliveries of different sectors and business units, as they are located in the same area geographically.

Finally, promoting the development of logistics has been set as a high priority in the city's 12th five-year plan. The Chengdu Modern Logistics Development Leading Group Office[463] was consequently designated in 2003 by the Chengdu Municipality Government to coordinate all stakeholders. Dedicated funds have been arranged each year to assist the Chengdu Logistics Office in realising the ambitious targets planned in the 12th five-year plan.[464]

All these together set a firm foundation for developing city logistics in Chengdu.

[459] See Chengdu Municipality Government (2011b).

[460] See Chengdu Municipality Government (2011a).

[461] See Chengdu Retail Business Association/Chengdu University of Technology (2013).

[462] See Chengdu Bureau Of Statistics (2013).

[463] This is abbreviated to Chengdu Logistics Office.

[464] See Chengdu Municipality Government (2011c) and Chengdu Municipality Government (2011d).

4.1.2.2. Weaknesses

In contrast to the strengths, Chengdu has its own weaknesses in regard to developing city logistics. First, the supply capability of city logistics is limited. The market is dominated by individual transportation enterprises, which usually own only one truck and are unable to provide reliable service sustainably.[465]

Second, the application of automation and information technology is quite low. Only a limited number of logistics companies are equipped with warehouse-management and transportation-management systems. Most actors in the market are unable to monitor the goods flow across the whole supply chain. Warehouses facilitated with high racks are rare. The logistics market lacks automated and temperature-controlled warehouses. This hinders a company's capability of improving operational efficiency and accuracy and meeting its customers' requirements of increasing the transparency of the whole supply chain.

Third, the efficiency of freight vehicles is questionable. Small vehicles dominate with a load capacity of less than 2 tonnes. Since individuals, who do not sign long-term contracts with their customers, but spontaneously look for business opportunities, own most freight vehicles their utilisation level is quite low. Many freight vehicles are to be found parked on the street beside a wholesale market waiting for business.

Fourth, although Chengdu Logistics Office is designated to coordinate all related stakeholders to promote logistics development in Chengdu, it is other departments that are the actual regulators. For instance, the Traffic Management Bureau is responsible for all regulations and policies relating to the issue of permits allowing certain types of freight vehicle to enter the city centre, while the Urban Administration Bureau is responsible for the establishment of loading bays and parking lots. Different departments implement regulations and policies in regard to city logistics individually.

4.1.2.3. Opportunities

From the external perspective, Chengdu has good opportunities to develop city logistics. China's central government has created a favourable political environment in which to operate. A series of policies has been issued jointly by the departments of the central government aiming at introducing modern technology and innovative solutions to improve the efficiency of city logistics in China.[466] In Chengdu, the local municipality has also being busy establishing detailed policies and regulations. In June 2012, "The Program of Modern Logistics Technologies and Joint Distribution of Chengdu" was set out and Chengdu was chosen by the Ministry of Commerce as one of nine pilot cities to lead the implementation of innovative city logistics solutions in China. A dedicated source of financial support has also been prepared.[467]

Moreover, its growing economy has seen Chengdu become Western China's logistics centre. An increasing number of international and Chinese logistics companies have been attracted by the market. By 2012, 43 leading logistics companies had their footprint in Chengdu, including Deutsche Post DHL, UPS, FedEx, Maersk, and YCH[468]. It is expected that the number of large logistics companies will grow to 100 by 2015, which will be half

[465] See selected pictures regarding the current situation of city logistics in Chengdu in Appendix 5.

[466] See the policies in detail in section 3.2.5.2.

[467] See Ministry of Commerce (2012).

[468] YCH: a leading logistics service provider from Singapore.

of the total number in Western China.[469] The arrival of newcomers brings competition, but more importantly the know-how, international experience and technology, which cannot be provided by individual local companies.

4.1.2.4. Threats

However, the city is still under threat from many other factors in its quest to develop city logistics.

As a result of urban sprawl and rapid economy growth, the available land space for warehouse facilities is becoming smaller, particularly that near to urban areas with good traffic connections. Within urban areas, the shortage of sufficient parking spaces and loading bays is another challenge affecting the efficiency of city logistics operation.

In spite of the continuous large investment in building new urban roads, the urban traffic network is heavily burdened, as the number of total vehicles grows even faster. Chengdu is China's 2nd largest city in terms of total number of vehicles, as well as one of the most congested ones.[470] The average travel speed within urban areas decreased from 22 km/h in 2005 to 18 km/h in 2009. It will become even worse as the number of automobiles continues to grow. Indeed it was forecasted that the average travel speed would decrease to 8.5 km/h by 2013 following the downward trend during 2005-2009.[471] The traffic congestion can prolong every city logistics delivery trip and influence service quality and customer satisfaction.

Cost is another factor threatening the development of city logistics in Chengdu. The increasing fuel cost and the existence of road tolls are two major elements affecting the transportation costs. The shortage of available land space for warehouse facilities, parking lots and loading bays will also add to the costs of utilisation. These threaten a company's capability to reduce logistics costs.

Moreover, many retailers are getting used to their current city logistics operational models. They are reluctant to change or accept any new ones, because they either fear uncertainty or increasing logistics costs.

4.1.3. Conclusions of the situational analysis

Through carrying out a thorough SWOT analysis, the results of both internal and external conditions of developing city logistics in Chengdu are presented in Table 24. In order to understand the conditions more fully, the major findings are categorised according to the three major stakeholders involved.

[469] See Chengdu Municipality Government (2011c).

[470] In reference to Xinhua Net (2013):Chengdu was ranked as the 2nd largest city with approximately 3.1 million motor vehicles after Beijing in 2012.

[471] See News Sichuan (2009).

Internal conditions	External conditions
Strengths • The current layout of the urban road network aids in regulating freight traffic into and out of urban areas • The booming retail industry places an increasing demand on city logistics services • The geographic concentration of commercial facilities creates favourable conditions for the implementation of consolidated deliveries • The existence of a logistics office provides an organisational basis for creating a regulatory environment	Opportunities • Both the central government and local municipality have issued a series of policies to promote the development of city logistics, which establishes a favourable governmental basis • The arrival of leading logistics companies both from abroad and within China bring know-how, experience and technology to Chengdu's logistics market
Weaknesses • The logistics market is dominated by small and individual players and their capability of providing reliable services is limited • The application of modern logistics technology and information is low • The utilisation of freight vehicles' load capacity is low • The current administration model towards city logistics in ineffective	Threats • The shortage of available land space for logistics facilities is becoming serious • The congested traffic in urban areas threatens the operational efficiency of city logistics activities • The rising logistics costs weaken logistics companies' competitiveness • The retailers are usually reluctant to change their current operational model to adopt new ones

Table 24: Results of SWOT analysis of developing city logistics in Chengdu

1) Retailers are placing an increasing demand on city logistics due to the booming retail industry, which has not yet been satisfied.

   Total retail sales of consumer goods have doubled within the five years from 2008 to 2012 and are expected to grow further. According to a survey covering over 100 retailers in Chengdu, 83% of all respondents are planning to expand their store footprint in Chengdu with the majority expecting continued double-digit growth over the next 3 to 5 years. To achieve the expected business growth, retail companies are struggling to keep up with distribution frequency and service levels at reasonable cost. 80% of retailers interviewed by the research team explained they were discontented with their logistics performance and indicated there was potential to improve. They attributed the surge in fuel prices, expensive labour and serious traffic congestion as key reasons for higher freight distribution costs. Unconsolidated deliveries to stores by individual suppliers have worsened the situation. At certain supermarket stores, vehicles have to queue for as long as 4 hours to unload their goods and hand them over to the recipients.

2) Nevertheless, Chengdu's logistics market is far behind the level it needs to be.

   In Chengdu, inner-city freight distribution is usually carried out by small and private freight vehicles, which are contracted straight from the street. A review of freight vehicle ownership in Chengdu shows that over 70% are registered to individuals. This restricts a company's ability to catch up with the booming retail industry. In addition, among all the freight vehicles registered in Chengdu, almost 70% are equipped with load capacities of less than 2 tonnes. Consumer goods tend to be delivered in small shipments, which naturally lead to higher traffic flows on the urban road network and longer queues at loading bays near recipients. Moreover, most retailers take an operational model that allows every supplier to deliver goods individually. The goods are stored separately in the warehouses of suppliers or distributors. However, a consolidation process is lacking. Many local logistics companies are unable to

fulfil the task of consolidating all the deliveries from suppliers due to their low capacity and the current state of their facilities.

3) The current policy relating to city logistics is ineffective, therefore further regulations are required.

   As elaborated in section 4.1.1.4, Chengdu is one of China's most congested cities. Reducing traffic flow and alleviating traffic congestion has been given high priority on Chengdu Municipality Government's agenda. Since 2008, it has followed a policy of "City Entry Permit" relating to freight vehicles in order to restrict and regulate the freight traffic flow. Freight vehicles have to bid for the permit every year to be allowed to enter urban areas during daytime. However, this policy causes, on one hand, a financial burden of operational costs, and brings, on the other, unnecessary pressure and wastage both to retail and logistics companies. Since the number of permits put up for auction is far less than required, many freight vehicles have to be parked on the street or rescheduled to carry out business outside urban areas if they cannot bid for the permits. Even worse, retail companies have to renew their cooperation contracts with their logistics service providers annually and have to find new contractors if they fail to secure a sufficient number of permits. As a workaround for the "City Entry Permit" policy, many passenger vehicles (with a load capacity of less than 1 tonne) are converted into freight vehicles illegally and used to deliver goods within urban areas during daytime, which is much less efficient than normal freight vehicles and accompanied with traffic risk at the same time. Even though the official number of authorised freight vehicles is decreasing year by year as government reduces the annual "City Entry Permit" quota, the actual number of freight vehicles travelling in the city is not reduced. Above all, the traffic congestion in Chengdu has not yet been improved after the execution of the "City Entry Permit" policy, as the total number of freight vehicles only accounts to less than 6% of the number of passenger vehicles.

To address the challenges elaborated above, taking advantage of Chengdu's internal strengths and external opportunities, a systematic approach is taken by the research team towards city logistics planning and management to establish a comprehensive city logistics system involving all the important stakeholders.

4.2. A master plan of the city logistics system in Chengdu

4.2.1. City logistics system and its building blocks

Following the concept of the city logistics system illustrated in section 2.2.1, the city of Chengdu is recommended to establish a masterplan of the city logistics system consisting of four major building blocks (see Figure 28). The core of the city logistics system is the evolution of operational model. Two types of models are included in the operational model. However, it has to overcome many existing complexities in terms of massive stakeholders with various interests, different sectors of sales channels and goods, large geographic coverage, and time span of the whole development. Hence, infrastructure network, governmental support measures and information platform are necessary conditions enabling the change of current the operational model towards the recommended ones.

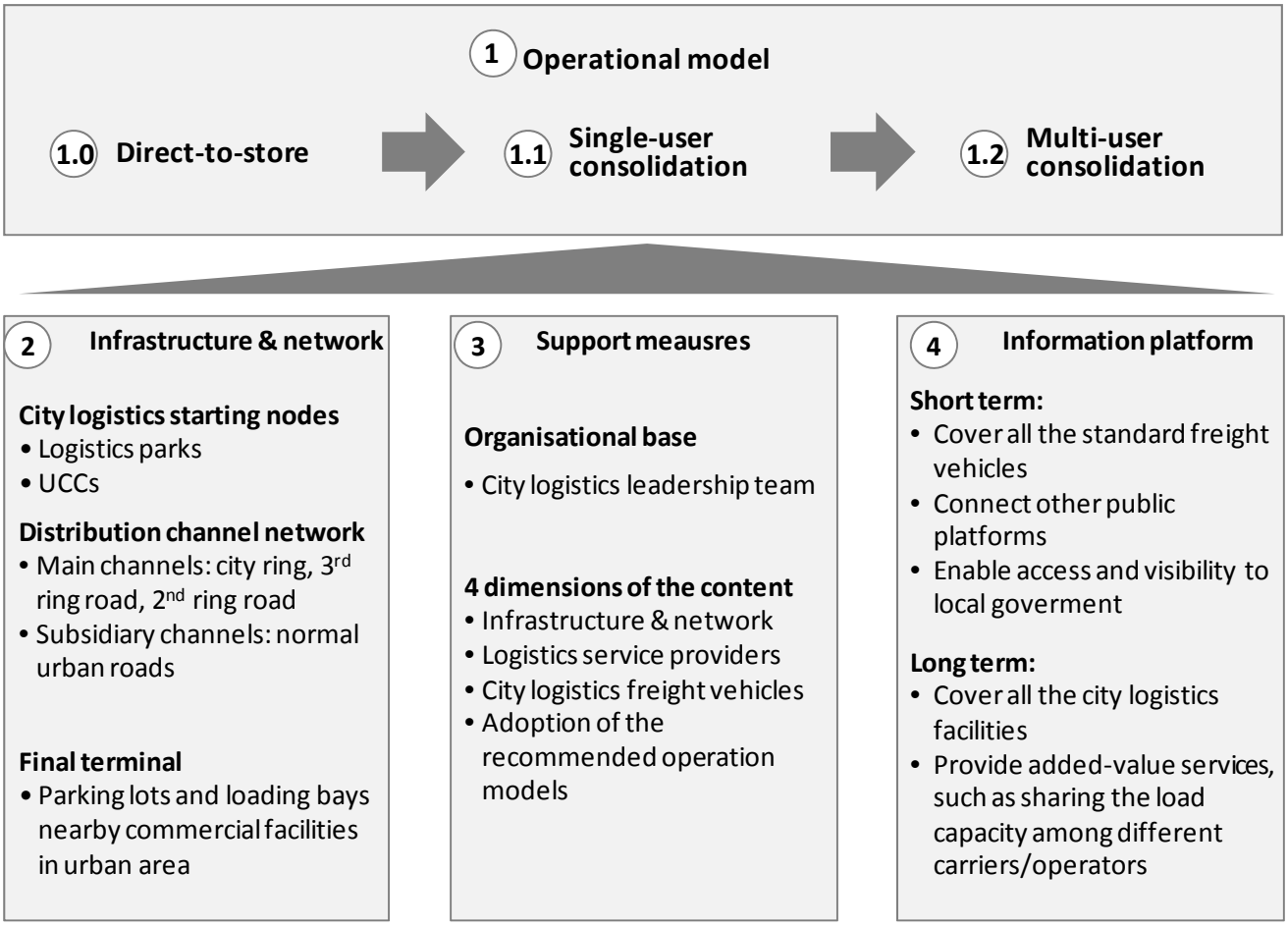

Figure 28: Master plan of the city logistics system in Chengdu

4.2.1.1. City logistics operational model

The core concept of operational model is consolidation of numerous goods deliveries from individual shippers or carriers to achieve economy of scale. The operational model is an integral process involving the UCC, last-mile delivery and reverse logistics.

Large shipments are first organised and transported via transport means with large load capacities such as trains, aeroplanes, ships and large container trucks from manufacturers and distribution centres in China to designated logistics parks outside urban areas in Chengdu. The UCCs then play the role of city logistics hub and facilitate the transfer of the goods loaded from large-scale transport means to standard freight vehicles[472] for city logistics in Chengdu. Goods loads from different shippers and carriers are unloaded and collected at UCCs. After that, following the laid-out plans and customer demand, the goods are either stored in UCCs, or consolidated according to their destinations. Besides the function of storing goods like a normal warehouse, UCCs are here attributed as having more logistical functions such as goods sorting, picking-packing, labelling/ticketing, cross-docking, wrapping, and recall services are also in the scope. The use of advanced technology and modern

[472] Standard freight vehicles are referred to the trucks that meet the standards required by the local municipality and engage in inner-city distribution of goods in Chengdu.

automatic systems will improve the operational efficiency of UCCs when goods loads grow into large quantities and generate economic benefits as labour costs continue to grow.

As the final leg of the supply chain in the urban area, a last-mile delivery network needs to be established to connect the UCCs with end customers. This requires the right vehicle fleet at the right time and travelling along the routes and stops to realise last-mile delivery of sending goods to end customers. In recent years in Chengdu, along with the worsening traffic congestion and strengthening of people's environmental protection awareness, vehicle fleets are gaining increasing attention from the local government as well as citizens. This is because they generate much higher emission levels compared to passenger vehicles[473] and are more likely to cause traffic jams or even accidents on congested urban roads due to their size and carrying loaded pallets or containers of goods. Therefore, strict technology standards in terms of load capacity, vehicle length and emission standards are drawn up to restrict the freight vehicles serving city logistics within urban areas in Chengdu, except particular ones serving construction projects and gas stations. Besides, environmentally friendly vehicles including hybrid, compressed-natural-gas and e-vehicles are more encouraged to be put into practice with financial assistance. According to the required volume of goods shipment and traffic accessibility, different freight vehicle standards will be assigned the task of last-mile delivery and scheduled to send consolidated goods from the UCCs to points of sales of end customers. At certain special areas, such as traffic-free zones, tricycles or hand trucks will be used to reach the end customers.

Reverse logistics is a process dealing with goods and related information from points of consumption to points of origin for the purpose of recapturing value or proper disposal. The concept has been applied in promoting resources recycling and customer service.[474] Actually it is an operational practice to achieve a green supply chain and plays a decisive role in influencing customer satisfaction levels. Two functions are covered by reverse logistics. When unwanted or broken items are required to be sent back to manufacturers, the first function of reverse logistics is to provide return and repair services. The other function lies in recycling management and waste collection. Due to increasing concern regarding environmental protection and the rise in raw materials costs, reverse logistics has been charged with dealing with packaging materials in order to capture residual value or facilitate their proper disposal. Reverse logistics is included as a dedicated function in the operational system. The capacity of empty freight vehicles after unloading goods for sale and their distribution network are used for the purpose of picking up goods for return and/or collecting recycled packaging material.

During the development process, the current operational model is expected to evolve into phases with increasing levels of consolidation (see Figure 29). The consolidation level will increase as the UCCs grow from serving all POS of a single customer to the same destination zones covering different customers or sectors. The increased level of consolidation will bring about an efficiency gain, i.e. increase vehicle load factor, reduce travel distance per delivery trip and reduce vehicle waiting time during loading and unloading.

- Current phase (dominant model): suppliers (either manufacturers, distributors or their logistics service providers) are responsible for goods storage and delivering them to retailers' POS

[473] See China Vehicle Emission Control Annual Report, 2010, Beijing

[474] See Rogers/Tibben-Lembke (1999), p.2-3 and Schatteman (2003) .

- Phase I – single-user consolidation: the UCC is set up to serve only one customer. All goods are collected centrally at the UCC. The UCC is responsible for consolidating the goods and delivering them to all POS of the same customer.
- Phase II – multi-user consolidation across sectors: taking advantage of the expanding network and capacity of the UCC, other customers will be included within the scope of UCC. The UCC will serve the POS of different customers at the same destination zones.

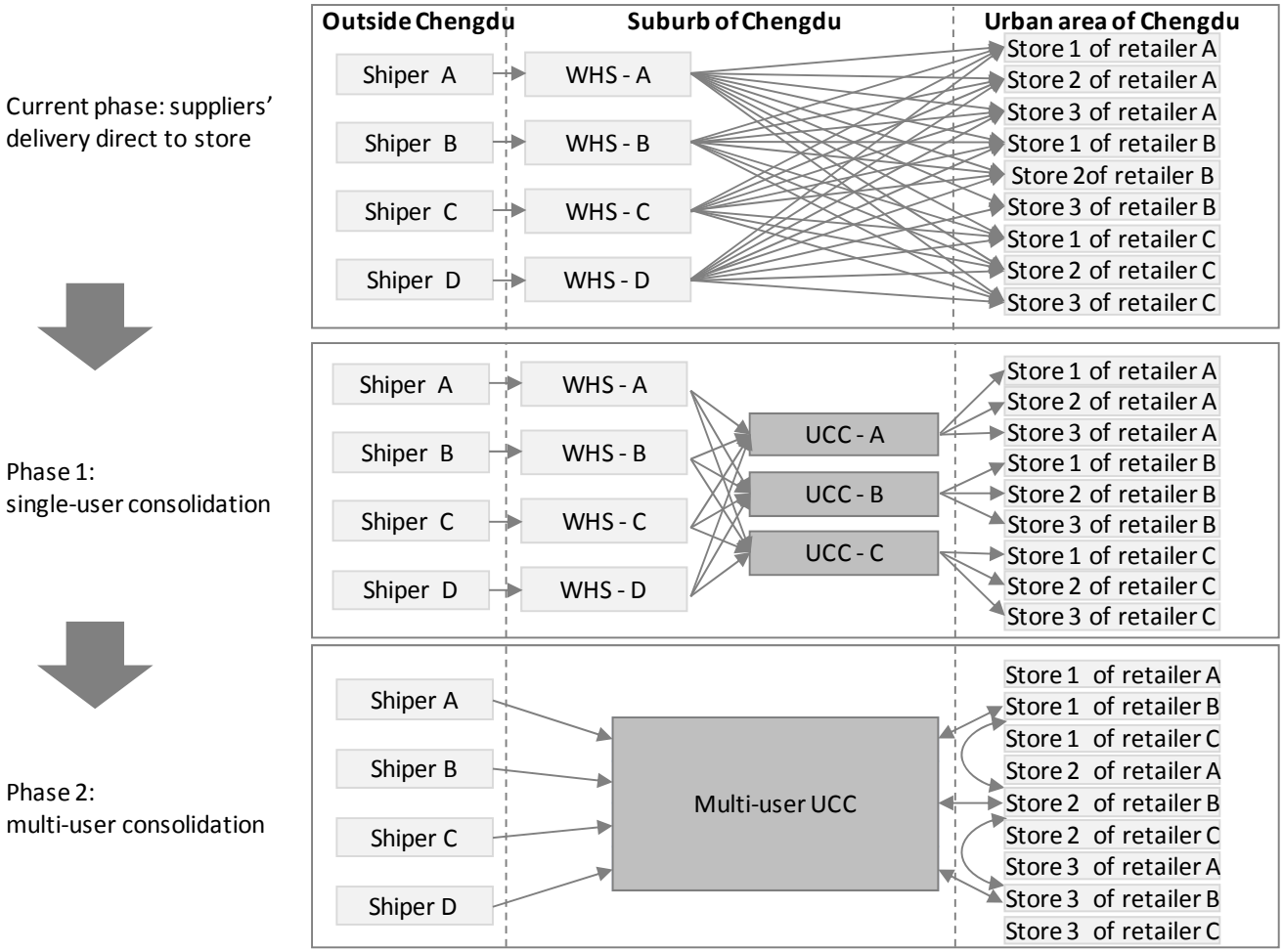

Figure 29: Evolution map of operational models

Note: "WHS" stands for warehouse.

4.2.1.2. City logistics infrastructure network

The infrastructure network is of decisive importance for logistics as a production factor. It entails all the fixed assets that serve the goods and/or passenger movement. In addition, it can be broken down into travel channels and connection points. Railways, roads, waterways, airways as well as pipelines are five major forms of travel channel, while connection points are built to connect the same or different travel channels.[475] The infrastructure network is a major element of city logistics and provides a conditional input. Its reliability influences the

[475] See Ihde (2001), p.111-113.

performance of city logistics[476] as one of the four components of the city logistics system in Chengdu, the infrastructure network consists of logistics parks, a distribution network connecting the end customers, parking lots and loading bays in urban areas near to end customers.[477]

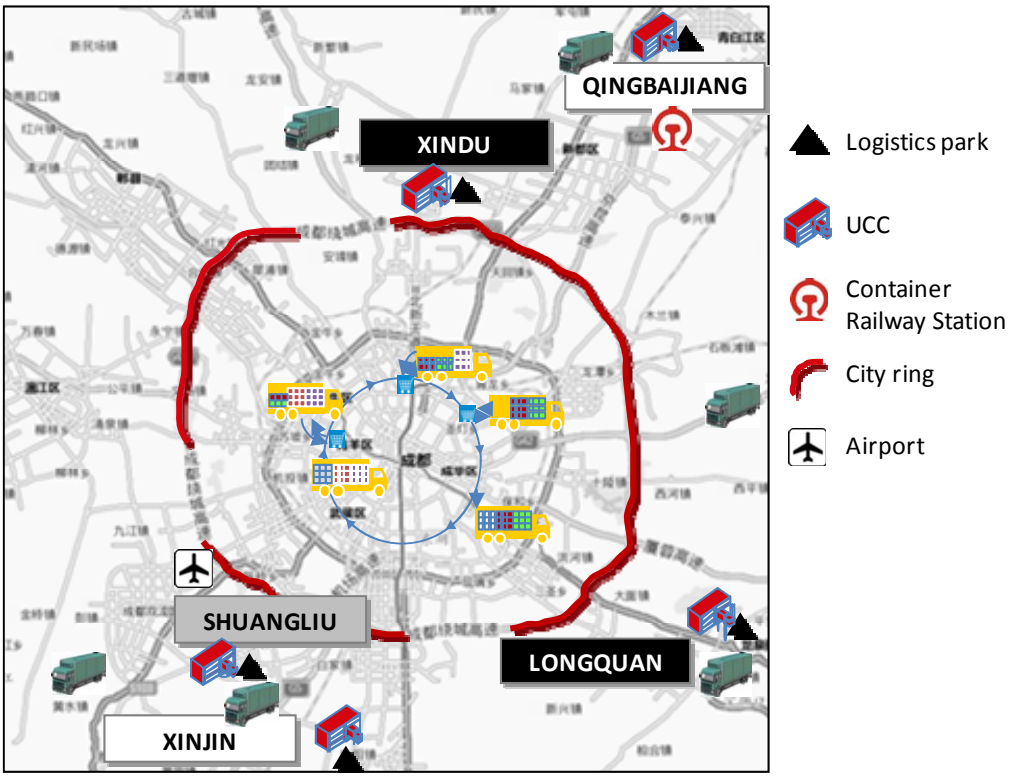

Figure 30: Layout of logistics parks in Chengdu

Logistics parks are the connection points of city logistics. Regarded as geographic clusters of different UCCs, they are built up with good connectivity to Chengdu's main highways, rail stations and airports. Moreover, they are the starting points of the last-mile delivery of city logistics in Chengdu. Five logistics parks (XINDU, LONGQUAN, SHUANGLIU, XINJI and QINGBAIJIANG) have been planned in Chengdu's Modern Logistics Development Plan.[478] Their geographic location in Chengdu is depicted in Figure 30. However, the five existing logistics parks perform differently in terms of connectivity to urban areas, geographic advantage, cost advantage, availability of land space for business expansion, and other criteria. Table 25 summarises their current status and evaluates their fitness for the implementation of the city logistics system in Chengdu.

[476] See Paluca/Raicu/Popa (2006).

[477] See Chengdu Transport Committee (2009), p.49-52.

[478] See Chengdu Municipality Government (2011c).

Index	XINDU	LONGQUAN	SHUANGLIU	XINJIN	QINGBAIJIANG
Geographic advantage[479]	High	High	High	Middle	Middle
Connectivity to traffic network	Good connectivity to highways	Good connectivity to highways	Good connectivity to highways and airport	Good connectivity to cargo railway station	Good connectivity to cargo railway station
Advantage of logistics facilities[480]	High	Middle	High	Low	Low
Availability of land space for business expansion	Low	High	Low	High	Low
Cost advantage[481]	Middle	Middle	High	Low	Low

Table 25: Evaluation of the five logistics parks in Chengdu

As a result of the evaluation of the status quo, the five logistics parks are categorised into three tiers:

- 1st tier: XINDU, LONGQUAN as principal geographic clusters of UCCs to concentrate the goods storage as well as deliveries
- 2nd tier: SHUANGLIU as the logistics park for only selected sectors aiming to best utilise its strategic location near the airport and create economic benefits
- 3rd tier: XINJIN, QINGBAIJIANG as the ones to be leveraged when the above resources become insufficient in the future

Within the assigned logistics parks, different UCCs serving different customers are established as the core facilities to connect suppliers, retailers and the city's end customers throughout the supply chain. Based on the facility's function, UCCs can be differentiated into those serving only ambient goods and serving goods requiring special temperature conditions, when equipped with cold chain technology.

Starting from the UCCs within logistics parks, the distribution network covers Chengdu's urban area and reaches the end customers of the final leg. Considering the current status of Chengdu's urban traffic network, the roads will be primarily used to serve the inner-city distribution. From a long-term perspective, the city's booming urban metro infrastructure may be used to provide an additional travel channel to connect the UCCs and their end customers within the city centre.

After the freight vehicles reach their designated destinations, parking lots and loading bays are required to assist the vehicles' parking and goods unloading, before they can be handed over to the end customers. The facilities can be differentiated into off-street and on-street ones. Off-street parking lots and loading bays can be further divided into freight-dedicated ones or ones shared with passenger vehicles, depending on the availability of resources near to commercial facilities. On-street parking lots and unloading bays are principally not encouraged to be set up. They are usually designed based on the principle of not disturbing normal urban traffic. Therefore, certain parts of streets are temporarily allowed to be used to serve as parking lots and unloading bays to complete the last process of city logistics.

[479] The geographic advantage is calculated according to the distance from the logistics park to Chengdu's centre – TIANFU Square.

[480] The advantage of logistics facilities is evaluated based on the available warehouse space of each logistics park.

[481] The cost advantage is evaluated based on the average rent level of warehouses in each logistics park.

4.2.1.3. City logistics support measures

The government plays a critical role in promoting the successful implementation of city logistics solutions and realising the objectives of city logistics to build urban sustainability. In the case of Chengdu, a leadership team under the supervision of the Municipality Government first needs to be established as the organisational base from which to coordinate all the related municipal departments (see Figure 31). All the related departments are separated into two groups (executive and supportive departments) based on their contribution and involvement level in the development of Chengdu's city logistics. The former ones, including the Logistics Office, Bureau of Commerce, Transport Committee, Traffic Management Bureau, City Management Bureau, are the most relevant departments to city logistics and are thus required to arrange resources and effort to formulate the content of all support measures. For instance, it is the responsibility of the Traffic Management Bureau to draw up city entry policies regulating the flow of freight traffic. Whereas those in the latter group, ranging from the Commission of Rural Affairs to the Administrative Committee of Logistics Parks, are supposed to provide their expertise and authority to support the procedures of designing, publicising, executing, monitoring as well as evaluating all regulations and policies. Above all, the existing logistics office, as the coordinator of Chengdu's logistics sector, will also play an active role in the field of city logistics, supplying the leadership team that will carry out routine tasks and duties, and to move forward the development of Chengdu's city logistics.

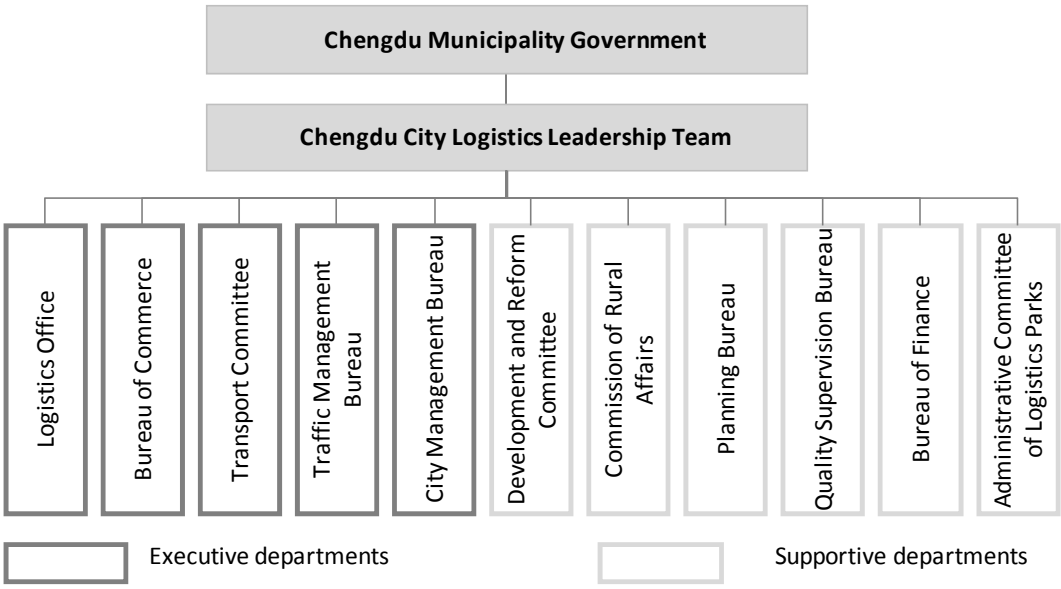

Figure 31: Organisational chart of the city logistics leadership team in Chengdu

Second, all the support measures of city logistics in Chengdu cover the four dimensions of infrastructure development, logistics service providers, city logistics freight vehicles, and retailers' adoption of the recommended operational models.

Infrastructure development consists of UCC construction, parking-lot and loading-bay design, and setup of the information platform. Starting from designing technical standards of these facilities, the leadership team will issue regulations and policies in terms of construction and usage. For instance, from the private sector, either logistics companies or retailers will be subsidised based on the investment size and encouraged to build up and use the standard UCCs within the planned Logistics Parks. In addition, the local government will cover the

majority of the initial setup cost of the information platform; however it is expected to be operated in a commercial way in the long term.

The capability and performance of logistics service providers are decisive factors influencing the efficiency of city logistics. Their industry experience, logistics facilities and equipment, information technology and management systems all play a role and together are responsible for the performance of city logistics services. Therefore, the leadership team will draw up the market entrance policy, city logistics service standards, and standards for cold chain logistics. This is so that the companies that meet the required prerequisites will be supported with financial and regulatory means. They will be subsidised in order to expand their capability to extend the consolidation coverage. Their freight vehicles can also be freed of all restrictions to work inside the city centre.

Freight vehicles are the physical carriers of all the goods demanded by urban residents. They are the production factors of city logistics services, on one hand, but on the other cause many negative effects such as emissions, noise pollution, traffic congestion and even traffic accidents. In Chengdu's city logistics market, all kinds of vehicles can be found providing these services, varying from uneconomic and small vans with load capacity of only one tonne, to large heavy-polluting trucks. In regard to this situation, technical standards of city logistics freight vehicles will be drawn up to normalise the carriers in terms of length, load capacity, emission, safety, and other areas. Further subsidies will be issued to promote the procurement and usage of the standard freight vehicles. Existing vehicles that fail to meet the technical standards will be gradually restricted in terms of city entrance and kept out of urban areas.

Retail companies are the goods recipients within the city of Chengdu. They are usually the decision makers in regard to which operational models are used for city logistics. Their support and adoption of the recommended models are essential to the models' successful implementation. The leadership team will hereby facilitate meetings between retailers and logistics companies. Policies will be implemented that are favourable to retailers in terms of opening new stores in Chengdu if they are willing to change their current operational model to the recommended ones. The additional expense caused by changing their operational models can also be partially covered by the government subsidy.

4.2.1.4. City logistics information platform

The information flow, combining goods flow with financial flow, constitutes the three principle flows of a supply chain. It involves transmitting orders from different customers, processing status, and updating the status of the goods shipment. The development of advanced information technology provides a practical means of accessing the information.

The information platform is the technical base on which to build a complete city logistics system. The successful implementation of any city logistics solutions requires an integrated information platform, which presents an innovative tool combining and supporting all applications, data flow and processes of goods storage, consolidation and last-mile deliveries. It does not just include solutions at individual level, but provides a public platform for all participants in the city logistics system so that they are able to send and receive information in a more efficient manner and reduce any communication failures.

From a short-term perspective, the information platform in Chengdu is designed to cover all the standard freight vehicles involved in the city logistics system. It aims to connect other public platforms, such as the traffic information platform, so that the freight vehicles can be provided with dynamic traffic information within the city centre to optimise their travel routes. Moreover, the platform will grant the local government a means to access and visualise the performance of freight vehicles in terms of travel distance, travel speed, emission levels, traffic accidents, and so forth, with which they will be able to adjust their policies and regulations regarding city logistics. In addition, local government can also issue temporary restrictions on certain roads or during certain periods to guide the freight traffic flow.

From a long-term perspective, the information platform is expected to coordinate and optimise the utilisation of all city logistics facilities and infrastructure such as UCCs, road networks, parking lots, cargo stations, as well as the warehouses / distribution centres of goods shippers. The platform will offer a way to share the load capacity of freight vehicles among different customers. Also, the freight vehicles' utilisation of parking lots and loading bays can be scheduled to avoid conflicts with peer groups.

4.2.2. Key stakeholders and their roles

The efficiency of fully operative city logistics system is subject to all the involving various stakeholders and should obtain their acceptance and support. City authorities as representatives from public sector constitute the framework of the system. They decide the regulatory environment, provide basic logistics network as a public service and lead the coordination with different industries and institutes. Retail companies from the private sector raise their demand and specify individual requirement on city logistics services. Logistics companies use their resources and produce the services required by retailers within the given framework.[482]

Within the context of the city of Chengdu, three groups of key stakeholders investigated and allocated with relevant responsibilities:

- Retailers, as well as manufactures or distributors, who generate an increasing demand on various city logistics services, remain the centre of city logistics. They raise individual requirements over the services, and place orders with their goods suppliers (either manufactures or distributors) including information such as goods quantity, destinations and date/time for delivery. They decide the quality level, type and quantity of logistics services to increase their competitive advantages and support business growth. They're the players that are most likely to influence the decision to change the operational model.[483] In the reality of Chengdu's retail market, either retailers or suppliers are responsible for organising logistics activities to guarantee a reliable goods supply for the end customers. As the level of consolidation increases during the development of operational models, suppliers are proposed to take the responsibility of sending the goods in a large quantity to designated areas, whereas retailers, large ones in particular, are proposed to be the city logistics users and take the responsibility of managing relevant activities. Services providers can thereby take advantage of scales of economy and deliver the consolidated goods in a more efficient way based on the retailers' orders. The costs used to providing the services should then be paid by the retailers as well.

[482] See Wagner (2001), p.285.

[483] See Browne et al (2005), p.35-36.

- Logistics companies are the providers of city logistics services in Chengdu. They utilise their own resources and organisations to move the designated goods from origins to destinations based on commissioned ways. Actually, to provide reliable city logistics services at a reasonable price needs effective cooperation between different types of logistics players involving logistics property developers, professional and experienced 3PLs, small and private transportation companies. The logistics property developers can use their resources to focus on developing suitable logistics facilities for goods storage or parking freight vehicles in the planned logistics parks. It is proposed that 3PLs take the lead in providing city logistics services for retailers using their expertise and industry experience. These small and private transportation companies can hereby be integrated by 3PLs to conduct last-mile delivery in a commissioned quality level. Further, as the level of consolidation increases, 3PLs can develop more value-added services to benefit retailers' business growth, on one hand, and grow revenue for themselves, on the other.
- Local government, under guidance from the central government and province government, is first of all responsible for formulating policies and issuing regulations to constitute Chengdu's political and regulatory framework of city logistics development, which will include all the supported measures discussed in section 4.2.1.3. In addition, local government should also lead the coordination, involving different partners from both the public and private sector in order to discuss all the relevant issues in the field of city logistics and promote the implementation of sustainable solutions. Third, local government should also take responsibility for initiating the establishment of the information platform for city logistics and support, by providing the initial investment and public information. Furthermore, the infrastructure plays a key role as an essential component of Chengdu's city logistics system. Local government is hereby expected to design the planning and arrange necessary resources to support the construction.

  With regard to the organisational level, the city logistics leadership team under supervision of the Chengdu municipality government should be allocated the above-discussed responsibilities. Accordingly, the Logistics Office will carry out routine tasks and duties through this leadership team to promote the development of city logistics in Chengdu.

Finally, besides every actor tending to their own individual responsibilities, coordination and regular communication are expected to take place among all the involved stakeholders to discuss any unresolved city logistics issues and facilitate the implementation of any innovative solutions for developing city logistics in Chengdu.

4.3. Factors influencing retailers to use UCC services

4.3.1. Introduction

A UCC has the potential to reduce a city's goods traffic flows and improve the operational efficiency of city logistics by combining separate goods shipments from different shippers.[484] Besides primary services including last-mile delivery and goods storage, a range of value-added services can also be provided to support a customer's pre- and post-sales activities. Hereby, UCCs are recommended as the core of the master plan of Chengdu's city logistics system. However, as indicated by numerous UCC reference cases all over the world,

[484] See discussions in section 2.4.1.

high initial investment, low participation rate of target customers, lack of enforcement of accompanying regulations and policies, selection of non-appropriate freight vehicles, inconsistent financial support from public authorities, and unsuitable UCC location are major barriers hindering a UCC from realising its potential benefits. The number of UCC services users is the most critical factor all success and failure cases.[485] Therefore, it is crucial to achieve sufficient users in order to increase the possibility of a successful implementation.

To achieve this objective of persuading potential customers to change their current operational model and use UCC services, it is of critical significance to understand the driving forces underlying their decision and how they influence the decision process. There is a growing number of studies on this topic (see Table 26), which provide a basic insight into how potential customers value differently the service components offered by UCCs and the impacts of their industrial properties on their choices.

However, the impacts of external factors from local governments, as well as their satisfactory level of the current operational models, were usually not taken into account, which actually might play an important role in influencing potential customers to use UCC services.

This section addresses this issue and attempts to examine the key influential factors and their impacts on the potential customers' choice of using UCC services in Chengdu from a retailer's perspective, as retailers are recommended as the primary customers of UCC services in a city logistics system. In particular, using structural equation modelling (SEM) and the approach of partial least squares path modelling (PLS-PM), this study investigates the causal relationship of key factors affecting the use of UCC services and their interactions based on an empirical survey of over 100 retail companies in the city of Chengdu.

Author	Research focused on	Method
Wagner (2001)[486]	Investigating motivations of various industries' intention to participate in city logistics	Empirical survey
Oexler (2002)[487]	Analysing the preference of different groups of target customers (including business customers like transport companies, retailers or craft sector, hotel and gastronomy businesses, as well as private end customers) towards city logistics services	• Hybrid conjoint analysis • Benefits segmentation • Choice-based conjoint analysis • Simulation and optimisation calculation
Marcucci/Daniels (2008)	Investigating how transport decisions are made by receivers or by transport operators about the potential use of an urban freight consolidation centre	Stated-choice method
De Oliveira et al. (2012)	Assessing the adoption of both carriers and retailers to use a UCC	Stated preference technique

Table 26: Overview of research focusing on customers' intention to use UCC services

[485] See van Duin/Quak/Munuzuri (2010).

[486] See Wagner (2001), p.285-289.

[487] See Oexler (2002), p.153-254.

4.3.2. Methodology

4.3.2.1. Research model and hypotheses

It is generally believed that companies choose supply chain partners on the basis of their distinctive value propositions, which also holds true when retailers decide whether or not to use UCC services. Indeed, this managerial process can be interpreted to a decision process towards an inter-organisational cooperation between individual companies. Highlighted by the cooperation theory, driving factors influencing inter-organisational cooperation derive from benefits potentially associated with the cooperative activity. Three major observations are summarised as determinants of such an inter-organisational cooperation:[488]

- Resource scarcity or performance distress (caused by increasing costs, scarce labour supplies or higher manpower training requirements) will force organisations to seek out or be receptive to inter-organisational cooperation.
- Value expectancy (e.g., costs saving, better service, higher satisfactory level of customers) from inter-organisational cooperation will induce organisations in the direction of participating in the competitive activities.
- Powerful external sources including governments and third-party organisations will motivate organisations to pursue such cooperative activities through impacting organisations' scare resource or performance, the value delivered by the cooperation, or cooperative activities between organisations.

Besides, inter-organisational cooperation is still associated with a set of potential costs (e.g., loss of decision-making autonomy, unfavourable ramifications for organisational image or identity, the direct expenditure of scarce organisational resources) that may be incurred by participating organisations.[489] Hence, organisations must evaluate the risk caused by the potential costs from management perspective and find strategic fit with their business, so as they can gain sufficient support and commitment from top management. The strategic fit is hereby defined as a fourth determinant aside from the three major motivators.

So far, the four determinants influencing inter-organisational cooperation together establish a sound theoretical foundation for examining a retailer's decision towards the usage of UCC services. Within the context of the UCC solution, the key factors are interpreted into: performance of a retailer's current operational model in terms of city logistics activities, perceived value from the UCC, external sources particularly local government, and strategic fit. Their impacts on a retailer's decision are depicted in Figure 32, which provide the basis of assumed hypotheses. And the four individual factors and associated indicators will be further discussed in the rest part of this section.

[488] See Schermerhorn, Jr. (1975): dicsussions are depicted in section 2.1.2.1.

[489] See Schermerhorn, Jr. (1975).

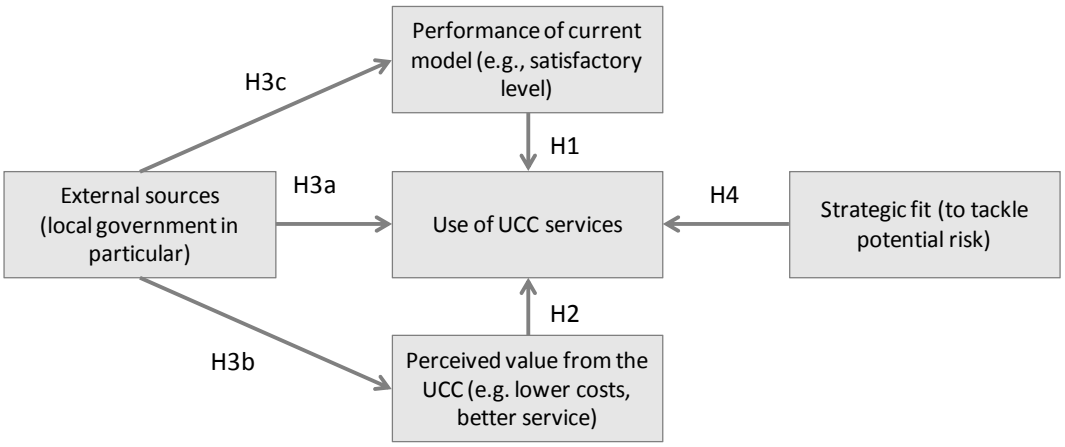

Figure 32: Proposed model - key factors influencing a retailer to use UCC services

Note: "H" stands for hypothesis.

1) Performance of current model (PCM)

Retailers, either large or small, should have their own supply chains dealing with goods from factories or suppliers to their outlets, shops or other points of sales (POS) within city centres. The performance of this model is the first crucial factor influencing the decision regarding usage of UCC services. In general there are three major operational models: suppliers deliver the goods directly to POS, retailers keep the logistics activities in-house, and logistics activities are outsourced to professional logistics service providers.

Actually in Chengdu's retail industry market, the operational model of logistics activities varies from one sector to another and from one retail company to another. For instance, the household appliance sector, which is dominated by several large domestic retail chains, tends to keep logistics services within the scope of their own responsibility, while department store sector requires suppliers to deliver the goods directly to outlets in shopping malls individually; foreign enterprises (e.g., Yum and Starbucks) tend to outsource their supply chain or logistics services to 3PLs, while large state-owned enterprises (such as Hongqi and Wudongfeng[490]) tend to keep logistics in-house. A common phenomenon is that most last-mile deliveries are accomplished by Chengdu's extremely fragmented private transport companies due to their competitive advantage in terms of service price.

Faced with fierce business competition and the opportunity of market growth as well, retail companies place increasing importance on logistics and supply chain in order to create competitive advantages and meet customers' requirements. A retailer's choice of operational model must realise these objectives. Distressful performance of the operational model will force retailers to seek out other options.

Satisfaction is *a judgment that a product or service feature, or the product or service itself, provided (or is providing) a pleasurable level of consumption-related fulfilment, including levels of under-or over-fulfilments.*[491] It is an important topic that has been extensively studied in the marketing literature. The notion encompasses both (dis)confirmation of expectations and an effective response.[492] Satisfaction is closely linked to companies' economic benefits and loyalty. Study results indicate that high level of

[490] Hongqi and Wudongfeng are two large state-owned enterprises in the sector of supermarket and convenience stores from Chengdu.

[491] See Oliver (1997), p.8-9.

[492] See Davis (2006), p.37-38.

satisfaction can lead to high profitability and positive customer loyalty.[493] It is no exception in terms of satisfaction towards logistics services.[494] Therefore, retailers' satisfactory level towards logistics service performance is hereby proposed as a reflective indicator to measure the performance of their current models. In addition, along with economic growth and domestic consumption expansion in Chengdu, logistics should also be able to sustain a retailer's growing business and satisfy its future requirements. The retailer's evaluation regarding the current model's capability to meet the requirement in the next 3-5 years is proposed as another major indicator to measure the PCM. Therefore, the following hypothesis is proposed:

H1: The performance of the current model has a negative effect on retailers using UCC services.

And satisfactory level of the retail company towards the current model and the retailer's evaluation regarding the model's capability to meet the requirement in the next 3-5 years are hereby proposed as two indicators to measure the construct of PCM.

2) Perceived value of UCC services (UCC-V)

The concept of perceived value is concerned with the interaction between a consumer and a product (or service). It is defined as *the consumer's overall assessment of the utility of a product (or service) based on perceptions of what is received and what is given.*[495] Perceived value is a multi-dimensional construct in which a variety of notions (such as perceived price, quality, benefits, and sacrifice) are all embedded rather than a mere rational assessment of utility. The value is relative by virtue of its comparative, personal, and situational nature. And it is preferential, perceptual, and cognitive-affective in nature. High perceived value has a positive impact on a consumer's purchasing behaviour of a product or service.[496]

In regard of participating in a UCC project, the perceived value created by using UCC services (UUC-V) is proposed as the second factor influencing a retailer's decision. UCC was introduced as an innovative solution to realise a city's vision of building up sustainable goods supply. They can create benefits for the public sector as well as achieve value for the private sector including retail companies through providing a range of logistics services. Traditionally, professional 3PLs have offered customers three primary competitive benefits:[497] reduced cost, faster delivery and improved reliability. UCC is no exception, as it provides the possibility to help users reduce logistics costs, improve service quality, and increase reliability.[498] That is all the utility that one UCC users (retailers) pursue. For this reason, UCC-V is proposed as a multi-dimensional construct together with the three attributes (lower logistics costs, better services quality, more reliable services as formative factors to measure the UCC performance.

Retail and logistics are concerned with product availability. Traditionally, logistics is just responsible for helping a retailer get the right products to the right place at the right time.[499] However, within the context of a modern retail market in a dynamic business environment, the role of logistics should not

[493] See Anderson/Fornell/Lehmann (1994).

[494] See Stank/Goldsby/Vickery (1999).

[495] See Zeithaml (1988).

[496] See Sánchez-Fernández/Iniesta-Bonillo (2007).

[497] See Voss et al. (2006).

[498] See De Oliveira et al. (2012).

[499] See Fernie/Sparks (2009), p.2.

only be measured on the traditional logistics scale, but also from the measures of a retail company as a whole-primarily profitability and growth. It is argued that logistics should be a valuable resource leading to a retailer's sustainable competitive advantage.[500] Therefore, the UCC's innovation capability in regard to providing value-added services[501] and the potential to introduce advanced information technology for better planning, control and visibility of the supply chain is the fourth indicator that is proposed to measure UCC-P. The third hypothesis is then proposed:

H2: The perceived value provided by UCC services has a positive effect on retailers using UCC services.

Also, it employs four indicators to measure this construct: lower logistics costs, better services quality, more reliable services and potential to provide added value.

3) External sources

Local government is one powerful external source in terms of city logistics. Having recognised the contribution of city logistics to the urban economy and its impacts on a city's sustainable development, city authorities are becoming more active and investing more resources in this area. On one hand, they can use economic and regulatory measures to promote the development of innovative and sustainable solutions to improve the efficiency of city logistics (e.g., UCC); on the other hand, they can design and issue regulations and policies to restrict the impact of goods movement within urban areas.[502] Regarding the implementation of a UCC solution, the role of local authorities is one key factor.[503] They can induce a retailer's participation directly using governmental incentives, or issue measures or regulations to impact the perceived value of UCC and the retailer's current model indirectly. Thereof, the impacts from local government are hereby split into three constructs: governmental incentives, governmental support measures, and access restriction regulations towards the current model, which will be elaborated further.

3a) Governmental incentives (GI)

After interviewing governmental departments relevant to city logistics in Chengdu, two primary measures are found that can be introduced to motivate retailers: financial subsidy to make up for the initial costs caused by changing operational models of logistics activities[504] and preferential policies for business expansion (e.g., open new outlets in Chengdu). Based on these findings the following hypothesis is proposed:

H3a: Governmental incentives have a positive effect on the retailers to use UCC services.

Also financial subsidy and preferential policies are introduced here as two formative factors to measure the construct of GI, as they directly decide the impacts of the construct of GI towards retailers' decision.

[500] See Abrahamsson/Rehme (2010).

[501] See in section 2.4.1.3.

[502] See Browne et al. (2007), p.29-32.

[503] See Browne et al. (2005), p.4.

[504] See SEStran (2010), p.8-9 & 13-14: for instance, financial aid is provided by public authorities in both Bristol (UK) and Monaco to share the operational costs of UCC together with the users.

3b) Governmental support measures (GSM)

Support measures are designed with the desire of increasing the possibility of successful implementation of any UCC. The measures aim to lower the average cost of services offered by the UCC by subsidising the initial investment for setting up logistics facilities and purchasing logistics equipment and technology;[505] improving service quality by granting access to enter urban areas without restrictions;[506] and increasing service reliability by choosing professional logistics service providers. Therefore, the following hypothesis is proposed:

H3b: Governmental support measures have a positive effect on UCC performance.

These measures will certainly result in the performance of UCC services including service cost, quality and reliability. Therefore, the three attributes are proposed hereby as reflective indicators to measure the construct of GSM.

3c) Access restriction regulations towards the current model (ARR)

The logistics system of a retail company is essentially built on the basic framework of a city's logistics network. The city's policies and regulations regarding transport and logistics should have an impact on the performance of retail companies' logistics systems.

In order to reduce traffic flow and alleviate traffic congestion, the "City Entry Permit" policy has been introduced to restrict freight traffic within Chengdu's urban areas. Along with worsening traffic congestion and urban environment, more access restriction regulations would be issued to restrict freight vehicles' delivery times, their technical standards (e.g., emissions, size and weight) and even environmental zones may be employed, which could considerably influence the performance of a retail company's current logistics system.[507] Therefore, the following hypothesis is proposed:

H3c Access restriction regulations have a negative effect on the performance of the current operational model.

As the impacts of regulations will result in retailers' current operational model in the field of logistics cost, service quality and reliability, these three attributes are proposed hereby as reflective indicators to measure the construct of ARR.

4) Strategic fit (SF)

In today's dynamic business environment, retail companies face keen competition and growing demand. They adopt their own corporate and competitive strategies based on the surrounding business environment, which can be divided into three major types: cost leadership, differentiation and focus.[508]

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[505] See SEStran (2010), p.8-9: for instance, the establishment of the consolidation centre (including procurement of electric vehicles) was 100 percent publicly funded during the initial phase with a time-limited (three years) funding from an EC-project in the case of Bristol (UK).

[506] See Panero/Shin/Lopez (2011), p.46-47: there is a good amount of cases where special privileges have been granted to UCC operators (their freight vehicles) such as in Aachen (Germany), Amsterdam (Netherlands), Ferrara (Italy) and Padua (Italy).

[507] See Panero/Shin/Lopez (2011), p.46: access restrictions to freight traffic have been applied in many cities, particularly in the situation of narrower streets, scarcer parking space, and more congested city centre.

[508] See Porter (1985).

Logistics is a corporate function dealing with all aspects of goods movement and storage from original suppliers through to end customers. The contribution of logistics services to value creation is not only limited to a single company, but to the whole supply chain. Good logistics management can help a company achieve corporate goals by improving efficiency, increasing productivity, reducing operation costs, improving customer satisfaction and performing its social responsibilities in regard to environmental protection.[509]

Theoretically, within the context of corporate and competitive strategies, logistics plays a role of combining a resource-based view and an industrial organisation approach. It is proposed that logistics should aim to help modern retailers achieve profitability as well as support business growth and market expansion.[510]

Moreover, logistics is also bestowed the responsibility of realising a company's vision of sustainable development, which has become a strategic issue and is given top management commitment, as private companies are expected to be more active in the fields of environmental protection and corporate social responsibility.[511] More sustainable operational models of logistics should be preferred by retailers as they have the potential to achieve sustainable corporate visions and improve the retailer's image among the public.

As part of logistics and supply chain management, a retailer's logistics activities within a city and their operational models should comply with its comprehensive strategy. However, there are certain arguments against retailers to participate in a UCC project, which include indispensability of their corporate identity, incompatibility with the comprehensive strategy, the associated switching costs and sluggishness for innovation.[512] Therefore, the usage of UCC services must strategically fit with the retail company's corporate and competitive strategy, logistics and supply chain strategy, as well as sustainable development, so as to acquire top management support and resources to achieve success. Their strategic fit is a crucial factor impacting a retailer's decision towards the usage of UCC services. Therefore, the following hypothesis is proposed:

H4: Strategic fit has a positive effect on retailers using UCC services

This construct is then measured by the strategic fit of the usage of UCC services with a retailer's corporate and competitive strategy, logistics and supply chain strategy, as well as sustainable development.

5) Willingness to use UCC services (W-UCC)

Willingness to use UCC services is hereby used to describe a retailer's decision towards the usage of UCC services. It is a result of a multi-dimension consideration process as internal and external factors. This construct is reflected by two proposed indicators: a retailer's interest in discussion about the usage of UCC services and its intention to become a commercial customers of the UCC.

[509] See Pfohl (2004), p.49-70.

[510] See Abrahamsson/Rehme (2010).

[511] See Cetinkaya et al. (2011), p.20-28.

[512] See Oexler/Röhle/Wartenberg (1999).

Summarised, seven constructs (latent variables) are proposed in this empirical study including six independent factors and one dependent factor together with six research hypotheses. Each construct is assigned with more than one indicator respectively. That makes it 19 indicators in total. Table 27 presents an overview of all the relevant constructs and respective indicators.

- **H1:** The performance of the current model has a negative effect on retailers using UCC services.
- **H3:** The perceived value provided by UCC services has a positive effect on retailers using UCC services.
- **H3a:** Governmental incentives have a positive effect on the retailers to use UCC services.
- **H3b:** Governmental support measures have a positive effect on UCC performance.
- **H3c** Access restriction regulations have a negative effect on the performance of the current operational model.
- **H4:** Strategic fit has a positive effect on retailers using UCC services

Latent variable/Construct	Indicator	Description
Performance of current model (PCM)	PCM1	Satisfactory level of current performance
	PCM2	Evaluation regarding current model's capability in the next 3-5 years
Perceived value of UCC services (UCC-V)	UCC-V1	Lower service price (for both transport and storage)
	UCC-V2	Better service quality (e.g., shorter lead time, fewer broken goods)
	UCC-V3	More reliable service (e.g., more punctual)
	UCC-V4	More added value through innovation and employment of advanced technology
Governmental incentives (GI)	GI1	Financial subsidy for the usage of UCC services
	GI2	Preferential policies for business expansion
Governmental support measures (GSM)	GSM1	Reduce operational costs
	GSM2	Improve service quality
	GSM3	Increase service reliability
Access restriction regulations (ARR)	ARR1	Increase the operational costs
	ARR2	Reduce service quality
	ARR3	Damage service reliability
Strategic fit (SF)	SF1	Strategic fit with corporate and competitive strategy
	SF2	Strategic fit with logistics and supply chain strategy
	SF3	Strategic fit with sustainable development
Willingness to use UCC services (W-UCC)	W-UCC1	Interest in discussion (e.g., feasibility study)
	W-UCC2	Intention to become a customer of UCC

Table 27: Overview of key factors and related indicators

4.3.2.2. Data collection and questionnaire design

In order to test the proposed hypotheses and structural model, it is important to choose the appropriate research tool to gather ample reliable data. Generally there are two types of data sources, either primary or secondary research. Primary data are new data added to the existing store of social knowledge, which are collected for any specific research topics at hand using procedures that fit the research problem best; while secondary data refer to

the material created by other researchers for reuse by the general research community.[513] Since there are no suitable secondary data available for reuse to answer the present research question, it is necessary to use an appropriate research tool to gather primary data for this study.

Actually researchers can use different techniques such as survey, observation and content analysis to gather primary data.[514] Among them, survey is the most widely used data collection tool for empirical research. Through asking different people the same set of questions in a predetermined order (questionnaire), researchers are able to gather answers from respondents to form valuable data.[515] This study uses this research tool and aims to collect primary data from different retail companies to measure the structural model and hypotheses proposed in the previous section.

Questionnaires reflect a designer's view of the world. It is a skilful process developing individual high-quality questions that can capture the values, perceptions and interests of the respondent as much as possible. Each question should be phrased in ways that are clear, concise and unambiguous.[516] The above-proposed hypotheses constitute the backbone of the questionnaire. Overall, the questionnaire consists of five segments. In the first segment, the survey is briefly introduced with its purposes, target respondents, time required to finish the questionnaire and a statement of confidentiality. Questions regarding general information of the corresponding company are arranged in the second segment to acquire its sector attribute, company size and legal ownership. The third segment asks respondents about their current operational models of logistics activities and their performance, as well as the impacts of access restriction regulations. Before listing the key questions regarding strategic fit, perceived value of UCC services, and governmental support measures, brief descriptions will be provided to help respondents have a right understanding of the UCC and its services. It closes in the fifth segment with questions about retailers' willingness to use UCC services and governmental incentives.

All the questions are set in a consequential and logical sequence. In order to increase reliability, more than one question is designed to measure each construct.[517] All the questions are raised in a closed form to provide respondents with structure to their answers and make it easier and quicker to fill out the questionnaire. To analyse answers in the questionnaire requires a means of measurement, which should be consistent for all related questions to ease the following data analysis and comparison. This study adopts a form of scale questions to measure all the indicators of the key six factors. All related items are measured on a five-point Likert-type scale with different content related to factors influencing retailers to use UCC services.

The language barrier is usually seen as a critical factor for international studies. The survey aims to collect answers from managers of retail companies located in the city of Chengdu. Not all the target respondents are expected to be able to answer questions directly in English. Therefore, the questionnaire was firstly formed in Chinese in order to increase acceptance and motivation of respondents. After the questionnaire was formulated, a pre-test with 9 local retailers was conducted in prior to check the questionnaire regarding inconsistencies,

[513] See Hox/Boeije (2005).

[514] See Nieschlag/Dichtl/Hlrschgen (2002), p.319.

[515] See Gray (2009), p.337-338.

[516] See Gray (2009), p.340.

[517] See Gray (2009), p.341.

misleading formulation and logical errors. Afterwards, the questionnaire was finalized after some small adjustments.[518]

4.3.2.3. Database and survey conduction

This empirical study in this section aims to investigate the influences of key factors on retailers to use UCC services and their interactions in the city of Chengdu. Theoretically, retail companies conducting business in Chengdu all have the potential to become UCC customers and should be brought into the scope of the study. However, it is impossible to cover all sectors and retailers within one study due to limited resources and time. After a pre-study regarding the market share of Chengdu's retail industry among different sectors, nine sectors were chosen from the retail market as the focus respondents: convenience stores and supermarkets, department stores, electronics, catering, fashion and apparel stores, furniture stores, home appliances stores, pharmacies, and automotive outlets. The nine sectors in total contributed 74.2% of the total sales of all chain stores in Chengdu from January to September in 2012 and play significant roles in Chengdu's city logistics system.[519]

The survey, as one part of a city logistics planning research for the city of Chengdu, received important support from local government, in particular the Chengdu Logistics Office. Three sources form the database of this survey and frame a sample of approximately 1160 retailers.[520]

- Source A: Chengdu Retail Business Association, which provided a list of 68 members
- Source B: Chengdu Commerce Bureau, which provided a list of 140 large retail companies
- Source C: Chengdu Industry & Trade Bureau, which provided a list of over 1000 retail companies of small and medium size

In general, there are a set of ways to conduct a survey including internet and web, email, post, face-to-face interview and telephone. Each has advantages and disadvantages.[521] Considering the resources available and target respondents' customs, the techniques of email, post and telephone are combined and used to conduct the survey. The questionnaires were first sent to companies of source A and source B by email and delivered to other interviewees by post. A dedicated team of seven members was organised to contact the interviewees by telephone in order to provide necessary guidance and collect the filled-out questionnaires.

The survey was completed in two months. The total number of returned responses was 158, of which 18 questionnaires were omitted due to incompleteness, making a return of 140 usable questionnaires. Therefore, the overall response rate was 12.07%.

4.3.2.4. Data analysis approach and software

SEM and selection of PLS PM

[518] See the final version of the questionnaire in English in Appendix 4.

[519] See Chengdu Commerce Bureau (2012).

[520] There are 48 retailers that are included both by source 1 and source 2.

[521] See Nieschlag/Dichtl/Hlrschgen (2002), p.442.

SEM is a statistical methodology used by many researchers from different scientific disciplines for the quantification and testing of substantive theories. Including several elements that are different to multivariate regression analysis, it can simultaneously explain the pattern of a series inter-related dependence between a set of constructs (latent/unobservable variables), each measured by one or more indicators (observable variables).[522] Moreover, SEM is applied as a powerful method for estimating causal relationships as it allows for the analysis of multiple relationships simultaneously, provides measures of overall model fit and explains the significance of each of the relationships between the variables.[523]

For the analysis of structural equation models with latent variables, several techniques have been developed, which fall into 2 categories: covariance-based techniques such as linear structural relations (LISREL) and Analysis of Moment Structures (AMOS), and variance-based techniques that combine theoretical and empirical knowledge to maximise the variance explained, of which PLS PM is the most prominent representative.[524] Actually, PLS PM has been used by a growing number of researchers from various disciplines including strategic management [525], management information system [526], organizational behaviour [527], customer behaviour[528], and marketing[529]. Literature indicates that PLS PM is more suitable compared to CBSEM, when at least one of the following prerequisites is met:[530]

- The research involves certain predications
- The research topic is new and no proven measurement indicators are available
- The model is complex and consists of many indicators
- No multinomial distribution of the data is given
- The observable values are not independent
- The sample size is relatively small
- The model consists of latent variables, which are measured by formative models

This present study features many conditions listed above supporting the application of the SEM technique of PLS PM. First, it is assumed that both external and internal factors influence retailers to use UCC services. The research issue presented in this study is still new in the field of city logistics. Hence, there are no proven measurement scales available in this area to test the relationships between latent variables. Furthermore, the sample size of 140 usable questionnaires is relatively small and the proposed model is complex, consisting of many indicators.

PLS PM

[522] See Hair et al. (2006) in reference to Cheng/Tsai (2009).

[523] In reference to Cheng/Tsai (2009).

[524] See Fornell/Larcker (1981).

[525] See Hulland (1999) for instance.

[526] See Dibbern et al. (2004) for instance.

[527] See Higgins/Duxbury/Irving (1992) for instance.

[528] See Mikulic/Prebezac (2011) for instance.

[529] See Eggert (2007) for instance.

[530] See Chin/Newsted (1999), p.336.

Originally developed by Wold (1966, 1982, 1985) and Lohmöller (1989), PLS PM has been proposed as an alternative technique to the more prominent CBSEM to SEM. Unlike the classical covariance-based approach, which focuses on estimating model parameters in order to minimize discrepancy between the estimated and sample covariance matrices, PLS PM aims at maximising the explained variance of the endogenous latent variables by estimating partial model relationships in an iterative sequence of ordinary least squares regressions.[531] Furthermore, it should be mentioned that PLS PM is used more as an exploratory approach than as a confirmatory one, where no strong assumptions (with respect to distributions, sample size and measurement scale) are required.[532]

A PLS path model is formally defined by two groups of linear equations: the outer model (or measurement model) and the inner model (or structural model). The outer model focuses on the relationships between latent (or unobservable) variables and their manifest (or observable) variables, whereas the inner model focuses on relationships between latent variables and constitutes a causal chain system. An example of the PLS path model is depicted in Figure 33. The outer model can be further distinguished between a reflective measurement model and a formative one. Whereas a reflective mode specifies a causal relationship from the latent variables to its manifest variables in its block, a formative mode inversely relates a causal relationship from the manifest variables to their latent variable.[533] The selection of a certain mode should be based on theoretical arguments.[534]

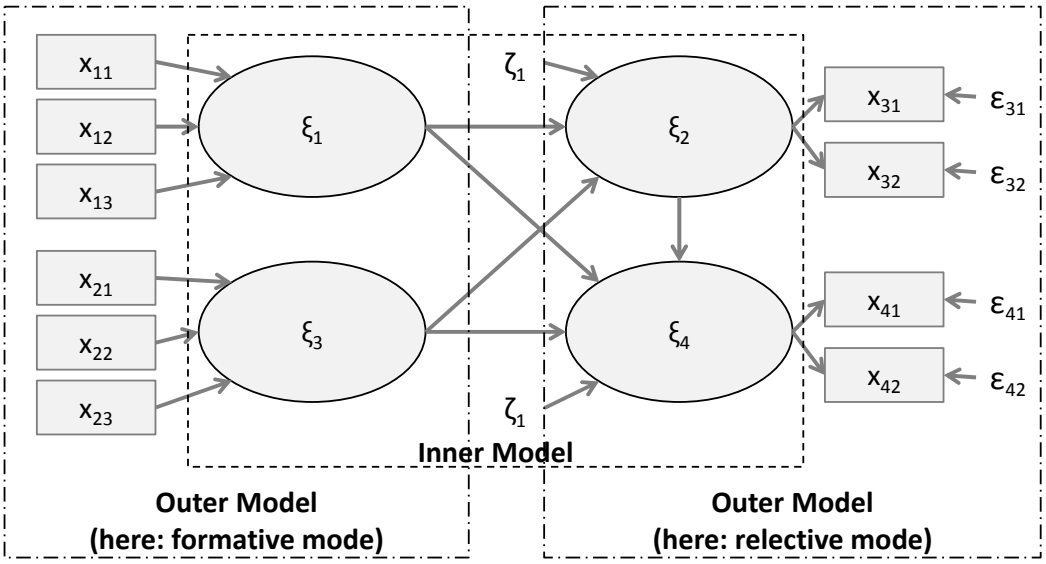

Figure 33: Example of a PLS path model

Source: Henseler/Ringle/Sinkovics (2009).

Based on the discussions and assumed hypotheses in section 4.3.2.1, the PLS model is accordingly presented and depicted in Figure 34, in which the round boxes refer to the latent variables, the rectangular boxes refer to all the relevant indicators, and the straight arrows between round boxes indicate causal relationships in the same direction. In other words, all the round boxes and the arrows linking them constitute the inner model, while the round boxes, the rectangular boxes and the arrows between them constitute the measurement models. More

[531] See Hair/Ringle/Sarstedt (2011).

[532] See Vinzi/Trinchera/Amato (2010).

[533] See Henseler/Ringle/Sinkovics (2009).

[534] See Diamantopoulos/Winklhofer (2001).

specifically, the type of reflective measurement model is employed for latent variables of PCM, GSM, PCM and W-UCC. The values of these unobservable constructs are measured by their reflective indicators, whereas the type of formative measurement model is used to depict the relationships between latent variables (SF, UCC-V and GI) and their related indicators. Hereby, all the formative indicators are supposed to form the values of the latent variables. Therefore, the direction of the arrows between the round boxes and relevant rectangular boxes expresses the type of measurement model.

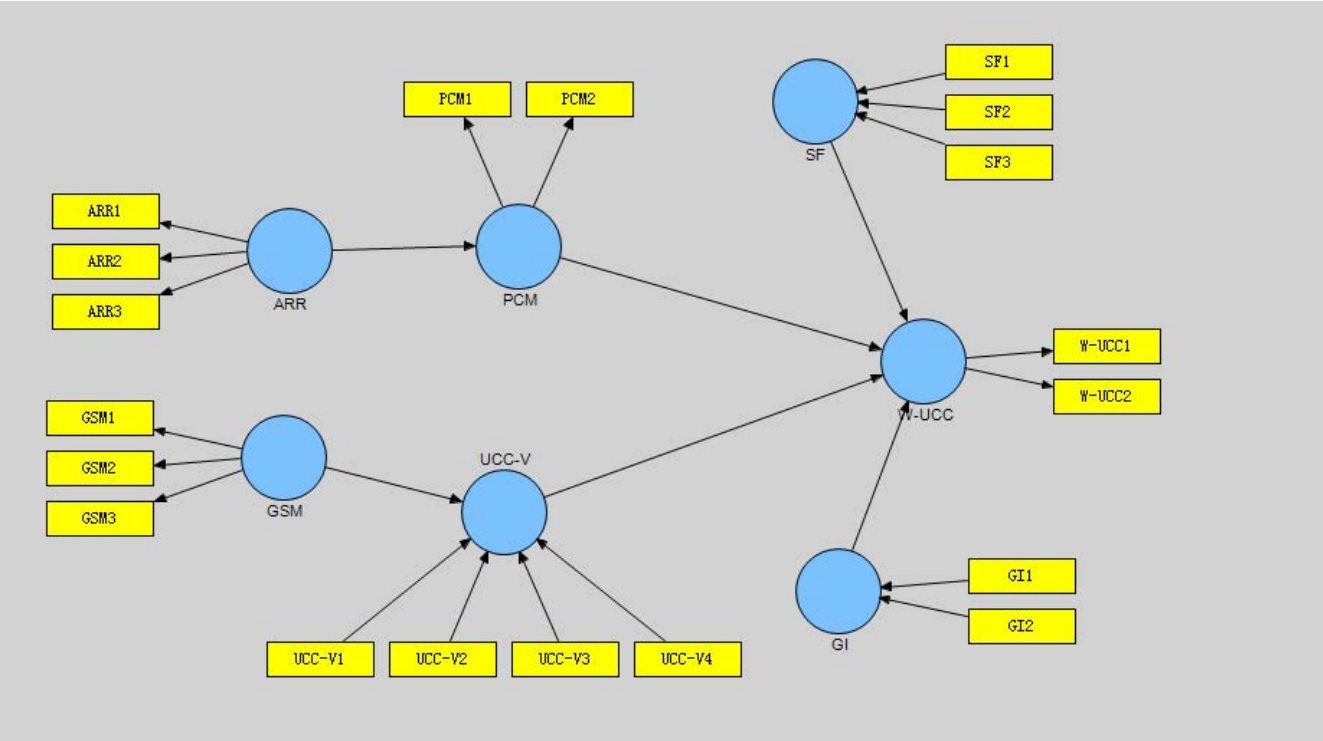

Figure 34: Proposed PLS path model

Evaluation of PLS PM results

Although there are no unified global goodness-of-fit criteria provided to evaluate the results of a PLS path model, a two-step approach has been proposed following the notion of an underlying covariance-based latent-variable-generating mechanism (see Figure 35). It focuses on the assessment of the measurement model in the first step by estimating the reliability and validity of item measures used in the proposed model, and then in the second step assesses the path coefficients in the structural model.[535]

[535] See Chin (2010).

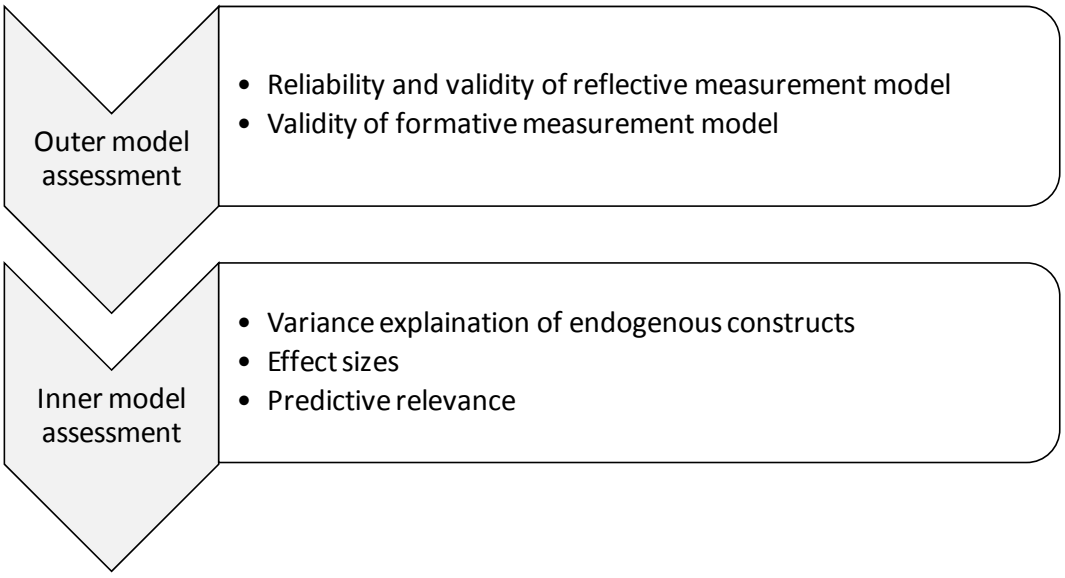

Figure 35: A two-step approach of estimating PLS PM results

Source: Henseler/Ringle/Sinkovics (2009).

Reflective measurement models in a PLS path model should be assessed in terms of reliability (including internal consistency of latent variables and reliability of all indicators/manifest variables) and validity (including both convergent and discriminant validity). A reliable and valid measurement model should meet all the criteria discussed below:

1) Reliability assessment (internal consistency of latent variables and indicator reliability)
   - Composite reliability (ρ_c) is an indicator used to measure the internal consistency of latent variables. It takes into account indicators with different loadings and can be interpreted in the same way as Cronbach's a. In order to remain at a satisfactory level, the value should be above 0.7 in a study's early stage and above 0.8 or 0.9 in more advanced stages.[536]
   - It is postulated that a latent variable should explain a substantial part of each indicator's variance (usually at least 50%). Therefore, the absolute correlations (e.g., the absolute standardised outer loadings) between a construct and each of its indicators should be higher than 0.7 so that all the indicators are reliable.[537]
2) Validity assessment (convergent validity and discriminant validity)
   - Average variance extracted (AVE) was developed as an index to measure the amount of variance that a latent variable captures from its indicators relative to the amount due to measurement error. This index was suggested to measure a reflective model's convergent validity.[538] Ideally, an AVE value should be greater than 0.5 meaning that a latent variable is able to explain 50% or more of the variance of the relative indicators on average.[539]

[536] See Nunnally/Bernstein (1994), p.34.

[537] See Chin (1998), p.295.

[538] See Fornell/Larcker (1981).

[539] See Götz/Liehr-Gobbers/Krafft (2010).

- Discriminant validity is the extent to which a latent variable is different from other latent variables. The Fornell-Larcker criterion, postulating that a latent variable shares more variance with its assigned indicators than with any other latent variable, is often used to measure the discriminating validity. To ensure a satisfactory level, the AVE of each latent variable should be higher than the latent variable's highest squared correlation with any other latent variable.[540]

In respect of formative measurement model, the reliability is argued as an irrelevant criterion for assessing measurement quality. Conventional procedures used to assess the validity and reliability of reflective indicators are not appropriate for indexes with formative indicators.[541] Different assessing steps and criteria are accordingly proposed to secure the validity:

- Nomological validity is suggested as a first examination of the validity of formative indicators using theoretical rationale and expert opinions: Does the formative index behave within a set of hypotheses as expected? Is there sufficient research that strongly supports the relationships between the formative indicators and the constructs?[542]
- Statistical analyses are suggested as the second step to assess the validity of formative constructs, which should consist of both the construct level and indicator level. The external validity, significance of weights and multi-collinearity are three important criteria to assess formative measurement models.[543] The significance of the estimated indicator weights can be determined by means of bootstrapping. It should be accepted when the t-value is greater than 1.96 based on a two-tailed test and greater than 0.98 based on a one-tailed test.[544] In addition, the index of variance inflation factor (VIF) was introduced to assess the degree of multi-collinearity among formative indicators.[545] Any VIF greater than 1 indicates multi-collinearity.[546]

Moreover, it is worth mentioning that formative indicators should never be discarded simply because of statistical outcomes, otherwise it may substantially change the content of the formative index.[547] Researchers hence suggested keeping both significant and insignificant formative indicators in the measurement model as long as it is conceptually justified.

Reliable and valid measurement models permit an assessment of the structural model. A set of typical criteria were proposed to assess the inner model and examine the assumed hypotheses:

- The determination coefficient (R^2) reflects the share of the latent constructs' explained variance and therefore measures the regression function's "goodness of fit" obtained by manifest items. R^2 values of 0.67, 0.33, and 0.19 in PLS path models are described as substantial, moderate, and weak, respectively.

[540] See Fornell/Larcker (1981).

[541] See Diamantopoulos (2006).

[542] See Rossiter (2002).

[543] See Henseler/Ringle/Sinkovics (2009).

[544] See Chin (1998).

[545] See Diamantopoulos/Winklhofer (2001).

[546] See Henseler/Ringle/Sinkovics (2009).

[547] See Jarvis/MacKenzie/Podsakoff (2003).

Moderate R^2 may be acceptable when the structural model explains an endogenous latent variable by only a few (e.g., one or two) exogenous latent variables. However, the R^2 values should exhibit at least a substantial level if the endogenous latent variable relies on several exogenous latent variables.[548]

- However, the R^2 values only take into account the fit of each regression equation in the structural model. The R^2 index alone is not sufficient to evaluate the overall model. Therefore, the effect size f^2 was developed to examine the change in the endogenous variable's determination coefficient, which is calculated as the increase in R^2 relative to the proportion of variance of the endogenous latent variable that remains unexplained. It is indicated that f^2 values of 0.02, 0.15, and 0.35 can be viewed as a gauge of whether an exogenous latent variable has a weak, medium or large effect on the particular endogenous variable, respectively.[549]
- The individual path coefficients of the structural models are interpreted as standardised beta coefficients of ordinary least squares regressions. Their values indicate the strengths of the relationships between different constructs and are used to test the prior-formed hypotheses. It should both estimate the hypothesized path model of direct effects and analyse the mediating and moderating effects of additional involving factors.[550] The goodness of the path coefficients in PLS path models is often tested by means of asymptotic t-statistics using resampling techniques such as bootstrapping. The significance should be accepted when the t-value is greater than 1.96 based in a two-tailed test and greater than 0.98 based on a one-tailed test.
- A fourth assessment of the structural model involves the model's capability to predict, which can be realised by measuring Stone-Geisser's Q^2 using blindfolding procedures. Caution should be taken that the blindfolding procedure is only applied to endogenous latent variables that have a reflective measurement model. If the value of Q^2 is greater than zero, this will indicate that the explanatory variables provide predictive relevance.[551]

Software for the estimation

Since the use of PLS PM has been recently widely accepted, a set of software packages (PLS-GUI, Visual PLS, PLS-Graph, SmartPLS, SPAD-PLS) was developed as alternatives to Lohmöller's LVPLS package, which provides a clear improvement particularly in terms of user-friendliness.[552] SmartPLS is Java based and independent of the user's operation system. It has strengths in terms of user-friendliness and supports the estimation of interaction effects. Considering these advantages as well as its availability, SmartPLS 2.0 was used for estimation of the empirical study using the path weighting scheme to calculate the inner weights.[553] The data from questionnaires filled out by retailers were initially coded in numerical order in an Excel spreadsheet for easy data entry purposes before being transferred to SmartPLS. All data were first scanned and treated for errors and missing values. The mean replacement algorithm was selected to substitute missing values.

[548] See Chin (1998).

[549] See Cohen (1988).

[550] See Henseler/Ringle/Sinkovics (2009).

[551] See Tenenhaus et al. (2005).

[552] See more information regarding the comparisons of the softwares in Temme/Kreis/Hildebrandt (2010).

[553] See Ringle/Wende/Will (2005).

4.3.3. Results

4.3.3.1. Sample characteristics

All 140 respondents belong to ten diverse retail sectors. Among them, the sector of fashion and apparel stores provided the most respondents (21.4%), whereas the sector of department stores provided the least (ca. 3%). Respondents from each of the remaining sectors contributed approximately 10% on average. Details are presented in Table 28.

Serial number	Sector	# of respondents	% in total
1	Automotive outlets	10	7.1%
2	Convenience store & supermarket stores	14	10.0%
3	Department stores	4	2.9%
4	Electronics	12	8.6%
5	Catering	14	10.0%
6	Fashion & apparel stores	30	21.4%
7	Furniture stores	17	12.1%
8	Home appliances stores	15	10.7%
9	Pharmacies	11	7.9%
10	Others (e.g., stores of books, glasses etc.)	13	9.3%

Table 28: Distribution of respondents among sectors

Legal ownership	# of resp.	% in total	Annual sales (RMB)	# of resp.	% in total
Chinese Enterprise	125	89.3%	<10 mil.	79	57.7%
JVs	9	6.4%	10 mil. - 100 mil.	25	18.2%
WFOEs	4	2.9%	100 mil. - 500 mil.	18	13.1%
Others	2	1.4%	500 mil. - 2 bil.	7	5.1%
In total	140	100%	>2 bil.	8	5.8%

Table 29: Overview of legal ownership and business scale[554]

Note: "Resp." stands for respondents; "JVs" stands for Joint Ventures; "WFOEs" stands for Wholly Foreign-Owned Enterprises.

In regard to legal ownership, 89.3% of respondents are Chinese enterprises, 6.4% are joint ventures (JVs) and 2.9% are wholly foreign-owned enterprises (WFOEs) (see the left part of Table 29). This reveals that China's retail market is dominated by local companies, which is in accordance with China's retail industry in general.[555] A predominant percentage (57.7%) of respondents had sales of less than 10 million RMB in their last fiscal year, whereas 18.2% had between 10 million to 100 million. The remaining 24.1% were greater than 100 million (see the right part of Table 29). Usually either annual sales or employee numbers can be used as indicators to determine an enterprise's size. In this empirical survey, since only 41.4% of respondents provided information regarding their employee numbers, their annual sales (in RMB) are hereby employed as the only indicator to split respondents into three groups: small retail companies (less than 10 million), medium-sized (10 million –

[554] Three of all the 140 respondents didn't answer the question regarding annual sales.

[555] See discussions in section 3.4.1.

100 million) and large (greater than 100 million). Furthermore, over 84% (107/127) of respondents have plans to open new stores in Chengdu.

The survey examined the current operational model of city logistics in Chengdu in two parts: goods storage and transportation/last-mile delivery. The operational models differ slightly from one sector to another (see Table 30). One common phenomenon identified by the survey results is that most goods storage activities are kept by retailers in-house (61.3%) with exception of home appliance stores (33.3%) and automotive (40%), whereas most transportation/last-mile-delivery-related activities are outsourced (62.4%) with the exception of department stores, where the suppliers often take the responsibility and deliver the goods to stores within the city. A more detailed description of transportation is presented in Table 31 in terms of distribution frequency, distribution model and load factor.

Sector	Goods storage				Transportation/last-mile delivery			
	Outsourcing	In-house	Supplier	Mixed	Outsourcing	In-house	Supplier	Mixed
	% (#)	% (#)	% (#)	% (#)	% (#)	% (#)	% (#)	% (#)
1	10.0% (1)	40.0% (4)	40.0% (4)	10.0% (1)	11.1% (1)	11.1% (1)	66.7% (6)	11.1% (1)
2	7.1% (1)	85.7% (12)	7.1% (1)	0.0% (0)	64.3% (9)	14.3% (2)	7.1% (1)	14.3% (2)
3	0.0% (0)	50.0% (2)	50.0% (2)	0.0% (0)	0.0% (0)	0.0% (0)	50.0% (2)	50.0% (2)
4	8.3% (1)	58.3% (7)	33.3% (4)	0.0% (0)	75.0% (6)	0.0% (0)	25.0% (2)	0.0% (0)
5	0.0% (0)	57.1% (8)	28.6% (4)	14.3% (2)	57.1% (8)	0.0% (0)	21.4% (3)	21.4% (3)
6	17.2% (5)	65.5% (19)	10.3% (3)	6.9% (2)	73.3% (22)	0.0% (0)	13.3% (4)	13.3% (4)
7	5.9% (1)	64.7% (11)	17.6% (3)	11.8% (2)	70.6% (12)	0.0% (0)	17.6% (3)	11.8% (2)
8	33.3% (5)	33.3% (5)	13.3% (2)	20.0% (3)	64.3% (9)	0.0% (0)	14.3% (2)	21.4% (3)
9	10.0% (1)	80.0% (8)	10.0% (1)	0.0% (0)	80.0% (8)	0.0% (0)	10.0% (1)	10.0% (1)
10	8.3% (1)	66.7% (8)	16.7% (2)	8.3% (1)	61.5% (8)	0.0% (0)	23.1% (3)	15.4% (2)
In total	11.7% (16)	61.3% (84)	19.0% (26)	8.0% (11)	62.4% (83)	2.3% (3)	20.3% (27)	15.0% (20)

Table 30: Overview of current operational models

Distribution frequency	% in total	Distribution model	% in total	Load factor	% in total
Several times/day	26.7%	Milk-run	49.2%	<50%	5.8%
Once/day	21.5%	Point to point	30.3%	50-70%	27.3%
Several times/week	26.7%	Mixed	20.5%	75-90%	37.2%
Once/week	14.1%			90-100%	24.8%
Once/weeks	11.1%			100%	5.0%

Table 31: Overview of distribution frequency, distribution model and load factor

The ratio of logistics costs/sales is applied in this survey to measure a retailer's management efficiency of its logistics activities. The results are presented in Table 32. Overall, over 60% of respondents spent less than 5% of their annual sales revenue to accomplish their requirements in logistics services. Also 15.4% spent 5-10% of their annual sales revenue, whereas the rest had to spend more than 10% of their annual sales revenue to sustain their goods supply. In addition, the value of this index varies subject to a retailer's size and sector. As illustrated in Table 32, large retailers perform relatively better than small and medium-sized ones: the logistics costs of over 72% of large retailers account for less than 5% of their annual sales, whereas the corresponding amount of small and medium-sized ones is 59% and 57%, respectively. With regard to sectors, convenience stores &

supermarkets (sector 2), department stores (sector 3), electronics market (sector 4), home appliance stores (sector 8) and others (sector 10) are better in terms of the percentage spent which is less than 5% of annual sales revenue. Looking forward, nearly 80% of respondents expect more spending in their logistics services in the next 3-5 years.

Logistics costs/sales		**<3%**	**3-5%**	**5-10%**	**10-15%**	**>15%**
Company size	Small	28.6%	28.6%	17.1%	24.3%	1.4%
	Medium	31.8%	27.3%	13.6%	22.7%	4.5%
	Large	41.4%	31.0%	6.9%	10.3%	10.3%
Sector	1	33.3%	33.3%	22.2%	11.1%	0.0%
	2	33.3%	50.0%	0.0%	8.3%	8.3%
	3	75.0%	25.0%	0.0%	0.0%	0.0%
	4	63.6%	27.3%	0.0%	9.1%	0.0%
	5	33.3%	8.3%	8.3%	33.3%	16.7%
	6	14.8%	33.3%	33.3%	14.8%	3.7%
	7	6.7%	26.7%	33.3%	33.3%	0.0%
	8	42.9%	28.6%	7.1%	14.3%	7.1%
	9	14.3%	14.3%	14.3%	57.1%	0.0%
	10	50.0%	25.0%	0.0%	25.0%	0.0%
In total		31.7%	28.5%	15.4%	20.3%	4.1%

Table 32: Overview of logistics costs/sales among different company size and sectors

4.3.3.2. Measurement model assessment

The reflective measurement model provides a high degree of reliability and validity (see Table 33).

- The composite reliability scores for all reflectively identified variables are above 0.7, indicating high internal consistency.
- All of our constructs exhibit sufficient levels of internal consistency reliability, as the minimal standardised indicator loading of each reflective construct exceeds the recommended threshold of 0.7.
- All AVE values are above the critical value of 0.50, which indicates that all constructs are unidimensional, thus implying convergent validity (see the results of Cronbach's alpha and the AVE in Table 33)
- Comparing the maximum squared correlation with the value of AVE shows that the Fornell-Larcker criterion is met. Therefore, discriminant validity can also be confirmed.

Latent variable	**Composite reliability score**	**Min. standardised indicator loading**	**AVE**	**Cronbach's alpha**	**Max. squared correlation with latent variables**
ARR	0.8895	0.7277	0.7305	0.8086	0.2904
GSM	0.8589	0.7561	0.6706	0.7831	0.2013
PCM	0.8771	0.8765	0.7811	0.7199	0.5213
W-UCC	0.9397	0.9326	0.8863	0.8724	0.5213

Table 33: Assessment of the reflective measurement model

With regard to the formative measurement model, the data also provide positive results (see Table 34):

- The non-parametric bootstrapping procedure (5000 samples) yielded t-values indicating significance of all the latent variables, and of most of the formative indicators except one indicator of governmental incentives (noted in italics and underlined). Three indicators of perceived value of UCC services (noted in underlined) are significant based on a one-tailed test, but not based on a two-tailed test.
- Moreover, the variance inflation factors (VIF), calculated using the SPSS linear regression function, do not indicate redundancy of any of the indicators.

Latent variable/indicator	Bootstrap t-values	VIF
Strategic fit (SF)	2.096	n.a.
SF1 -> SF	5.844	1.011
SF2 -> SF	4.767	1.021
SF3 -> SF	3.632	1.022
Perceived value of UCC services (UCC-V)	5.472	n.a.
UCC-V1 -> UCC-V	6.138	1.454
UCC-V2 -> UCC-V	*1.648*	1.407
UCC-V3 -> UCC-V	*1.527*	1.435
UCC-V4 -> UCC-V	*1.481*	1.464
Governmental incentives (GI)	2.711	n.a.
GI1 -> GI	20.105	1.039
GI2 -> GI	*0.922*	1.039

Table 34: Assessment of the formative measurement model

Note: "n.a." stands for not applicable.

4.3.3.3. Structural model assessment

Regarding the structural model, the study assessed the reliability and validity of the proposed criteria. The results summarised in Table 35 show satisfactory indications:

- The R^2 values of all three endogenous variables vary considerably: the value for W-UCC indicates a substantial inner path structure, whereas the other two (PCM and UCC-V) indicate an above-weak one.
- The f^2 effect size, calculated based on the $R^2_{included}$ and $R^2_{excluded}$, indicate that W-UCC, PCM and UCC-V have a large, medium and weak effect at the structural model, respectively.
- The cross-validated redundancy measure Q^2, calculated using the blindfolding procedure, exceeds zero for all inner model variables, thus indicating predictive relevance of their explanatory variables.
- Finally, t-values indicate that the path coefficients of all latent variables are significant based on a two-tailed test. Also, the values of all path coefficients are depicted in Figure 36.

LV	R^2 of EV	Effect size f^2	Cross-validated redundancy measures Q^2	Bootstrap t-values	Significance of PC	Hypotheses testing results
ARR	n.a.	n.a.	n.a.	7.822	-	Supported
GI	n.a.	n.a.	n.a.	2.711	+	Supported
GSM	n.a.	n.a.	n.a.	7.143	+	Supported
PCM	0.289	0.091	0.222 (7)	8.314	-	Supported
SF	n.a.	n.a.	n.a.	2.096	+	Supported
UCC-V	0.201	0.042	0.595 (7)	5.472	+	Supported
W-UCC	0.681	0.359	0.599 (7)	n.a.	n.a.	

Table 35: Assessment of the structural model

Note: "LV" stands for latent variable; "EV" stands for endogenous variable; "PC" stands for path coefficients; significance of PC from latent variables to higher-order latent variables, not to indicators or preceding latent variables; "n.a" stands for not applicable.

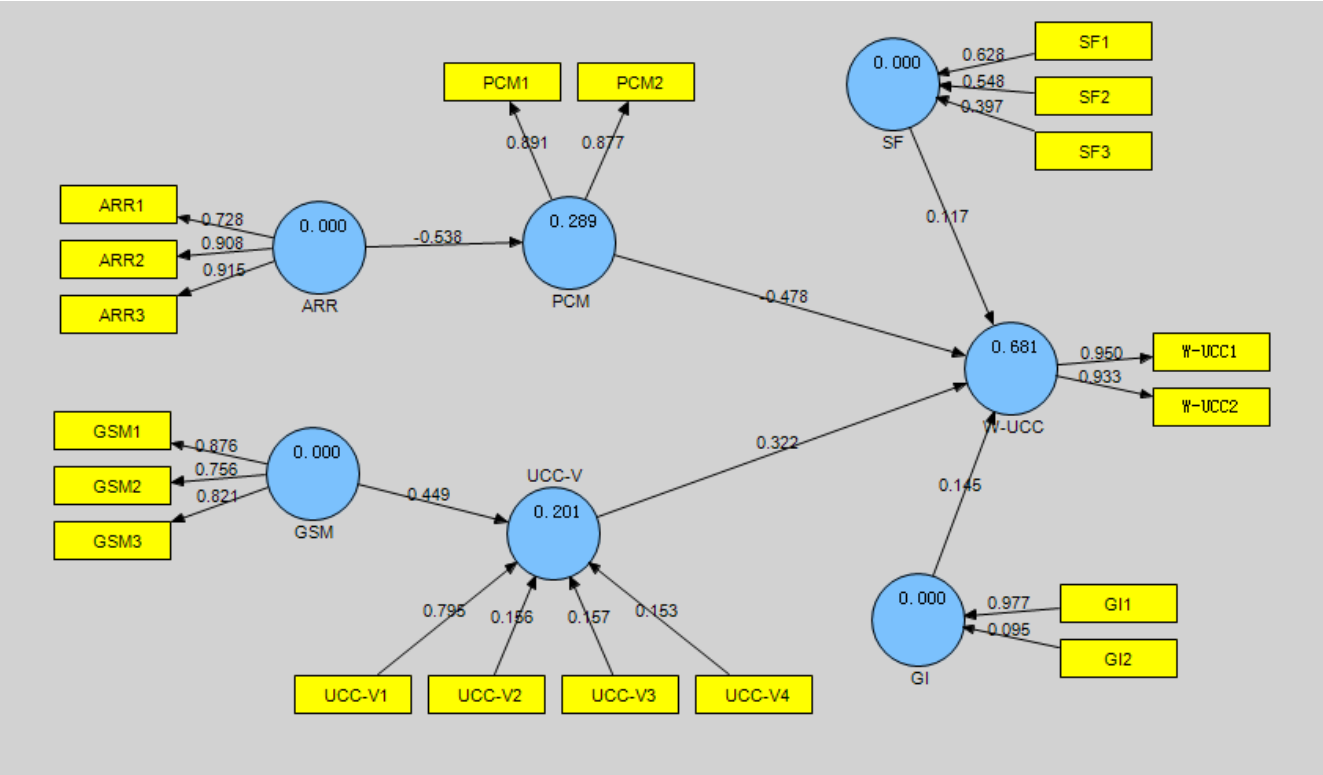

Figure 36: PLS PM model results

Besides all the key factors, the control factors such as retail sector attribute, legal ownership and company size could also play a role in the company's decision regarding the use of UCC services. Actually, the questionnaire was designed with the purpose of acquiring the respective information of retailers. However, the statistical results do not allow a further study involving all the control factors, since there are no sufficiently large samples for each category except company size (79 small, 25 medium-sized and 43 large). The study then conducted a PLS PM for the three groups and the results are presented in terms of path coefficients and t-values in Table 36. Actually, significant differences were identified when comparing the results of the inner model:

- The effect of access restriction regulations on the performance of current models and their indirect effect on retailers' willingness to use UCC services are all noticeably significant for all three groups, but are perceived as more powerful by medium-sized retailers than the other two.
- The difference in terms of the effect of governmental incentives on a retailer's use of UCC services is remarkable among the three groups: significant for medium-sized retailers, moderate for small and quite weak (insignificant) for large.
- The effect of governmental support measures on the perceived values of UCC services and their indirect effect on retailers' willingness to use UCC services are considered much higher by small and medium-sized retailers than large ones.
- The effect of current models on the use of UCC services is significant for all groups, with only slight differences in terms of how strong the effect is.
- Furthermore, all three groups perceive a weak effect of the strategic fit on the use of UCC services.
- Finally, large retailers play a much more important role in the effect of the values of UCC services than small and medium-sized ones.

Moderation effect	Path coefficients				t-values			
	Small	Medium	Large	Total sample	Small	Medium	Large	Total sample
ARR -> PCM	-0.477	-0.736	-0.459	-0.5375	6.166	19.019	7.033	7.814
ARR -> W-UCC	0.241	0.461	0.249	0.2567	5.224	6.791	7.065	6.577
GI -> W-UCC*	0.097	0.285	*0.006*	0.1448	1.437	4.602	*0.099*	2.740
GSM -> UCC-V	0.480	0.422	0.254	0.4487	7.418	4.412	1.143	6.891
GSM -> W-UCC*	0.1421	0.065	0.1052	0.1445	3.422	1.978	1.217	3.923
PCM -> W-UCC	-0.505	-0.627	-0.543	-0.4776	6.657	8.790	11.663	8.113
SF -> W-UCC	*0.046*	*0.016*	*0.063*	0.117	*0.676*	*0.276*	1.151	2.063
UCC-V -> W-UCC	0.296	0.154	0.493	0.3221	4.060	2.325	7.755	5.457

Table 36: Influence of company size

Note: the ones noted in italics and underlined are not significant; *: the indirect effects are calculated by multiplying the relevant path coefficients (e.g., path coefficients of GI -> W-UCC = path coefficients of ARR -> W-UCC and path coefficients of ARR -> PCM)

4.3.4. Discussions

4.3.4.1. Hypotheses test and findings

The UCC solution was suggested as an effective way to improve the efficiency of city logistics and reduce its negative externalities. Chengdu's specific environment for developing city logistics makes the solution more important. This study addresses issues relevant to UCC implementation, attempts to identify the key factors affecting retailers to use UCC services, and examines the causal effects relationships of these factors.

The proposed PLS path model was successfully validated by assessing the measurement models and the structural model. All the hypotheses test results are summarised in the far-right column of Table 35. The results from the PLS path model confirm that all hypotheses are supported. More specifically, strategic fit and perceived value of UCC services affect a retailer's decision positively, whereas the performance of a retailer's current model has a negative impact on the use of UCC services. With regard to the influence of local government, it can be concluded that the government can have a direct positive effect on a retailer's decision

regarding UCC services through issuing incentive measures. Furthermore, it can also impact a retailer's decision indirectly through measures such as access restriction regulations towards the current models and support measures towards UCC-related activities. The test results support the two related hypotheses and confirm that access restriction regulations have a negative impact on the performance of a retailer's current logistics model and governmental support measures have a positive effect on the perceived value of UCC services.

Although the test results show statistical significance for all the hypothesized paths (in terms of total example), the strength of path coefficient varies from one factor to another (see Table 36), which allows the conclusion of the first principal finding. In terms of direct effects, retailers' willingness to use UCC services is primarily influenced by the performance of current models (negative effect), perceived values of UCC, strategic fit and governmental incentives. A look at the path structure in the inner model reveals that the former two factors have a much stronger impacts than the latter two. With regard to indirect effects, access restriction regulations and governmental support measures can influence a retailer's decision through the performance of current models and perceived value of UCC services, respectively. The strength of their influence indicates it to be significant.

A second principal finding can be concluded from the results of formative measurement models. All three formative indicators of strategic fit were tested as found to be reliable and valid. However, comparing their outer weights indicated that retailers consider strategic fit with corporate and competitive strategy, and logistics and supply chain strategy more important than sustainable development (see Figure 36). With regard to perceived value of UCC services, although the outer weights confirm the significance of the formative indicators, retailers consider reducing logistics cost to be substantially more significant than the other three formative indicators. Also, the two formative indicators of governmental incentives were noted as having remarkably different outer weights. The comparison revealed that financial subsidy is an outstanding indicator, whereas the indicator of preferential policies is quite weak.

Furthermore, comparing the results of the inner model of the three groups can help formulate a third principal finding of this study. Overall, they confirmed that company size has a significant impact on retailers taking the decision to use UCC services. Small retailers perceive the significance of the latent variables PCM, UCC-V, ARR, GSCM, GI and SF from substantial to weak. While large and medium-sized retailers ranked them in terms of significance as PCM, ARR, GI, UCC-V, GSM to SF, and from PCM, UCC-V, ARR, GSM, SF to GI, respectively.

4.3.4.2. Managerial implications

This study highlights issues that are directly relevant to the implementation of UCC projects and presents a practical application of PLS PM to a set of hypotheses for a retailer to use UCC services. Results extracted from this study contribute several implications for practice and research, and can influence managerial decisions in the related areas.

Overall, this empirical study would help cities and managers to understand that retailers use a multi-factor-based decision-making process when considering using UCC services. The results of PLS PM revealed that all the key factors identified (including performance of the current models, perceived value of UCC services, strategic fit, governmental incentives, access restriction regulations and governmental support measures) play a significant role in impacting a retailer's process of decision making from a comprehensive perspective. However, the influence levels of these factors differ considerably and vary subject to company size.

The performance of a retailer's current model of city logistics is the most important factor, which negatively impacts a retailer's decision to use UCC services. Cities and managers must recognise the significance of this factor. They should hence first evaluate retailers' logistics performance and focus on those retailers that have a lower satisfactory level and expect a better performance from their logistics in order to implement the UCC solution successfully.

Perceived value of UCC services is testified as a second key influencing factor. The level of importance varies across company sizes. It should be considered as especially vital for large retailers. Therefore, the value of UCC services should be emphasised during discussions with any large retailers. Among the formative indicators, the results clearly demonstrated that service cost is consistently the strongest driver of perceived value of UCC services. By providing a range of consolidation services, UCC operators could create economies of scale by reducing operational costs, which could become an incentive to attract more retailers. However, gradual increases in the costs of fuel, labour and other input factors cause difficulties in reducing logistics cost. Thus, UCC operators should evaluate the cost structure of the UCC and adopt appropriate investment strategies in order to provide the most economically sound cost-saving solution for service users.

With regard to the role of local government, it could assist in the implementation of a UCC project using means to influence a retailer directly and indirectly. Regulations aiming to restrict freight vehicles' access to urban areas are one factor with a significant impact on a retailer's use of UCC services through its logistics performance. So local government could effectively increase the participation ratio of retailers (especially medium-sized retailers) in UCC projects. In addition, government support measures are another meaningful factor that can influence a retailer (both small and large) to use UCC services directly. Local government can issue favourable measures to support the operation of UCC projects to increase the efficiency and lower costs to increase the attractiveness of UCC services. Furthermore, the direct factor of governmental incentives is also meaningful, in particular relating to medium-sized retailers to use UCC services. Subject to the outer weights, governmental subsides' impact is much stronger than preferential policies. Cities should hereby consider this indication when issuing detailed incentives.

Cities and managers should also take note of the importance of strategic fit. The strategic objective of retailers to develop logistics management, realise sustainable development and create the company's value chain and remain competitive also plays an important role in retailers using UCC services in city logistics. Therefore, cities and managers should maintain close relationships with potential users and investigate retailers' real demand in order to identify possible strategies for implementing UCC projects to get the support from top management.

4.3.4.3. Limitations and future research

City logistics has received more and more attention in literature as well as in practice. This study initiated an empirical study relating to one of the most important solutions of city logistics (UCC) and attempts to examine the key factors and their impacts using the technique of PLS PM for the first time. However, there are still some limitations to this study that are summarised below. Also, corresponding directions for future research are recommended.

First, the list of key factors (latent variables) and their indicators may not be exhaustive. This study identified a salient group of key factors and relevant indicators to measure these factors within the context of a Chinese city.

However, since it was the first study using PLS PM to examine the issue regarding factors influencing retailers to use UCC services, other salient factors and relevant indicators may have been overlooked. Thus, future effort could be made either in a much wider context to employ more significant factors consistent for all contexts or in the direction of a deeper single context to seek some specific indicators that have been overlooked.

Second, this empirical study was conducted within the context of a Chinese city. Its specific environment of developing city logistics may raise doubt regarding the reliability and validity of the results and findings in a more general condition. Therefore, similar studies need to be conducted in other Chinese cities to investigate the results' ubiquity in China.

Third, this study did not explore the extent to which retailer-related variables might account for differences in the weights of the various influential factors. Company characteristics (such as sector attribute, legal ownership, operational model, etc.) may also play a role in the level of importance of key factors. Therefore, this could be another direction for future research.

Finally, this study only focused the factors influencing retailers to use UCC services due to Chengdu's special situation. In a wider extent, other city logistics stakeholders can also become users of UCC services, which include transport companies, hotels and private e-business customers. Future research could be conducted focusing on these potential users to examine their key factors and causal relationships.

5. Business case analysis of the UCC solution

One major factor in city logistics solutions including UCC influencing their sustainability is their economic continuity. Most solutions showing interesting results (in terms of traffic and emission reduction) during trial even pilot phases were found that could not survive once the financial support from public sectors was stopped. Actually, commercial performance is crucial for both private and public sectors to ensure a sustainable implementation of any city logistics solutions.[556] Therefore, it is important to define and examine the solution's commercial performance. In a response to the fifth research question – Is the solution of urban consolidation centre commercially durable? – Chapter 5 contains another empirical study from the corporate perspective. It takes a supermarket company as the user of UCC services and a 3PL as the service provider. The approach of business case analysis is used in this chapter attempting to find out the commercial feasibility of implementing the UCC solution and also its major impacts. The research structure of this chapter is depicted in Figure 37.

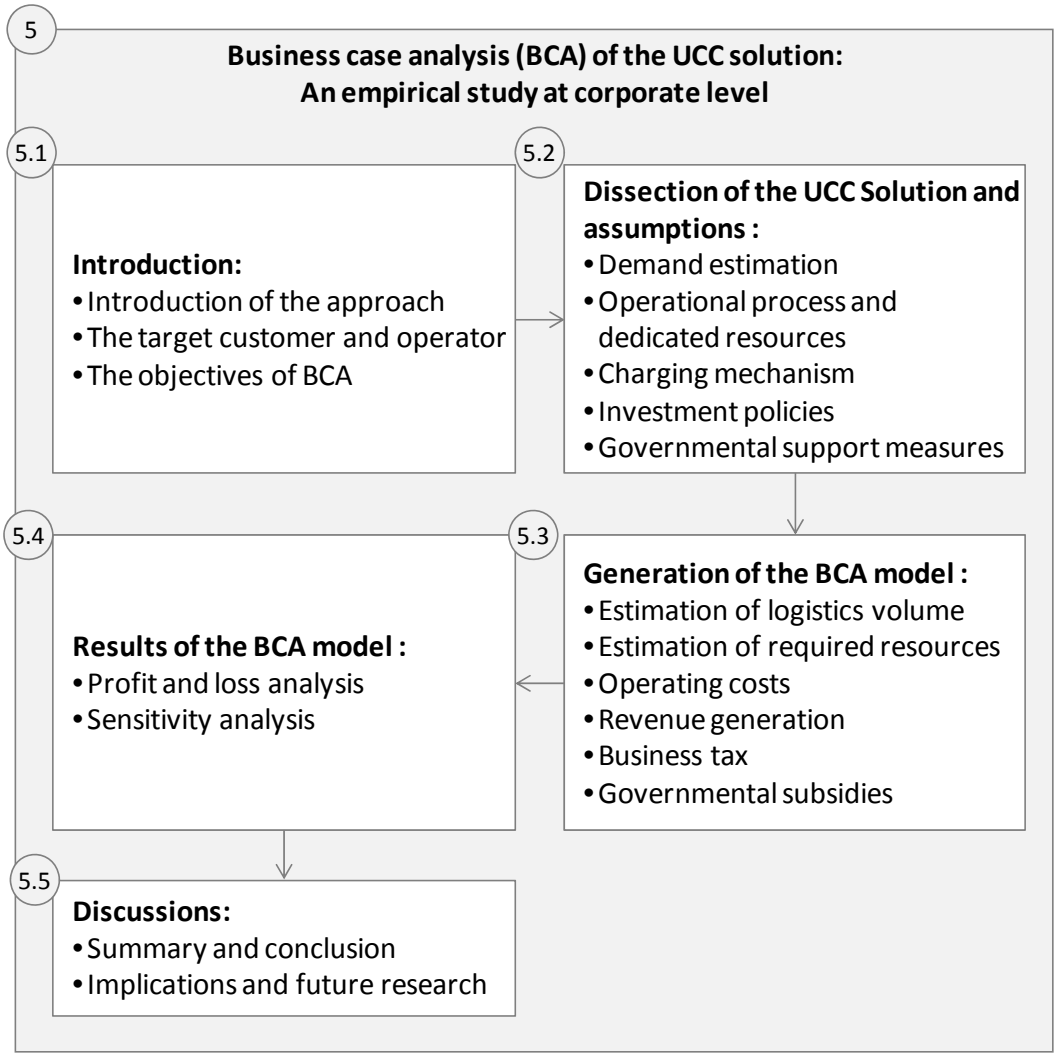

Figure 37: Research structure of Chapter 5

[556] See Gonalex-Feliu/Morana (2010).

5.1. Introduction

5.1.1. Introduction of the approach

A business case is defined:[557] a *recommendation to decision makers to take a particular course of action for the organisation, supported by an analysis of its benefits, costs and risks compared to the realistic alternatives, with an explanation of how it can best be implemented.*

Different to a business plan, it mainly answers questions such as what happens if a certain course of action is taken. It addresses questions about investment in market expansion and product launches.[558] Due to limitations of resources and time, a business case cannot examine all possible alternatives. A business case is usually developed based on a certain framework and used to study a selection of the most practical alternatives. The results of a business case analysis (BCA) can later be taken as inputs to develop a business plan.

The business case is considered a successor to cost-benefit analysis. Compared to cost-benefit analysis, BCA puts more emphasis on strategic, indirect costs, risks, as well as social and organisational factors, rather than only financially oriented ones.[559] It is a management tool to support decision making and planning. Through analysing the benefits, costs and risks of proposed alternative actions and demonstrating their inherent value, the approach of business case analysis is usually used to support the process of making strategic decisions. Credibility, practical value and accuracy are three major indexes used to evaluate the success level of a BCA. The inputs, data as well as assumptions should be credible. The proposed alternatives are realistic and can be implemented well. The analysis results are accurate. In other words, a good business case should be able to help a decision maker choose the right action with confidence.[560]

The approach of BCA has become an important management tool for practitioners, as a result of its simplicity to apply and effectiveness at enabling decision making. Beyond that, the application of this approach can also be found in scientific literature. The BCA was identified as a successful approach to guiding investment.[561] Featuring these advantages, BCA is hence selected as the way to help examine the commercial feasibility of the UCC solution and its main influencing factors.

5.1.2. The target customer and operator

SuperRetailerChina is a multinational retailer chain in China listed as one of the largest hypermarket chains in the world.[562] Since its entry into China in 1995, SuperRetailerChain has undergone a rapid expansion process. In 2012, it emerged as one of the top 10 supermarket companies. Overall, it operates 218 stores in 67 cities and towns, which are located in 24 provinces[563] throughout China. [564]

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[557] See Gambles (2009). p.1-2.

[558] See Harvard Business School Publishing (2011), p.4-5.

[559] See Van Putten (2013), p.60.

[560] See Schmidt (2009), p.3-5.

[561] See Ross/Beath (2002) and Ward/Daniel/Peppard (2008).

[562] The name of the supermarket company and also the data have been modified to ensure anonymity.

[563] Hong Kong, Macau and Taiwan are not calculated here.

[564] See its annual report. Due to anonymity, the name of used reference is not given.

A wide range of food and non-food products can be found in each of SuperRetailerChina's 218 stores in China. Numerous product items are delivered everyday by thousands of suppliers within China and abroad to serve the customers all over the country.

As a representative multinational supermarket company, SuperRetailerChina has been following an expansion strategy for its business in China, which is expected to keep pace with the country's rapid urbanisation process and booming domestic consumption by opening new stores. Resulting from the high level of market saturation and fierce competition in most large cities, the supermarket company has been extending its retail networks more widely to cover smaller 3rd- or 4th-tier cities or towns all over China.

On the subject of supply chain and logistics strategy, SuperRetailerChina tailored its strategy to China's practices, adopting a "direct-to-store" strategy.[565] It is its suppliers or their logistics service providers that are responsible for establishing a logistics network and delivering all of their products to each store.

Due to Chengdu's strategic importance and location, SuperRetailerChina has made the city its regional centre for Central and Western China. It operates 13 supermarket stores within the city centre and in remote areas of Chengdu with retail space of each store varying from 9000 m^2 to 12,000 m^2, of which 8 stores are located within Chengdu's city ring, namely the urban areas. With annual sales of over 1.8 billion RMB in 2011, SuperRetailerChina is one of the top retail chains in Chengdu. Beyond that, SuperRetailerChina maintains its national business strategy and plans to open more stores in urban areas as well as towns in suburban areas of Chengdu.

LogChina is a leading multinational company in the field of logistics.[566] It has been operating in China as a 3rd-party logistics company for over 20 years. With its worldwide logistics expertise and experience as well as local insight, it offers a comprehensive suite of services to customers across all industry sectors ranging from renewable energy to the consumer and retail industry.

Similar to SuperRetailerChina, LogChina has invested heavily in Chengdu and considers the city a regional centre. It operates two logistics sites with a total warehouse space of more than 8500 m^2. In addition, a 3rd logistics site with 87,000 m^2 is under construction to serve the growing market in Chengdu.

With the local experience and facilities, combined with worldwide expertise and practice, LogChina is recommended as the logistics service provider for SuperRetailerChina in Chengdu. Furthermore, it includes all stores in the city of Chengdu as the target area.

[565] The growing sales volume gives SuperRetailerChina a strong bargaining advantage over its suppliers. Although the adoption of a "direct-to-store" strategy offers SuperRetailerChina many benefits like cost saving, this model seems unsustainable from a long-term perspective. Suppliers have to wait up to 4 hours before they can unload just a single individual shipment for a single store. Each store has to deal with numerous shipments from different suppliers on a daily basis. That often leads to serious congestion in the surrounding area and generates a massive amount of communication activity. The situation could become even worse in the near future as a result of the city's economic growth and urban population expansion. As a result, the top management of SuperRetailerChina has started to consider changing its current model and to seek solutions.

[566] The name of the logistics company and also the data have been modified to ensure anonymity.

5.1.3. The objectives of BCA

Overall, this chapter attempts to answer the question:

- Is the UCC solution commercially feasible?

It makes use of the BCA approach to investigate the commercial feasibility of the UCC solution, identify all the relevant factors impacting the commercial results and how these factors influence the commercial feasibility of the UCC solution. To achieve the overall objective, the chapter is organised as follows:

- The UCC solution will be dissected in section 5.2. The demand analysis of the target supermarket company will be presented first. The operation process, service scope as well as responsibilities will be then brought forth. After that, all the required resources and their productivity will be discussed. Following the analysis of the charging mechanism and service tariffs, the investment policies of the UCC solution will be introduced as a basis for estimating the operating costs. Following this the governmental support measures will be discussed.
- A BCA model is then generated in section 5.3 to estimate the logistics volume, all the required resources for the UCC solution, the operating costs consisting of capital expenditure and other expenses, expected revenue, business tax and the value of the governmental subsidy.
- The results of the BCA model are concluded in section 5.4. Beyond that, the method of sensitivity analysis will be used to identify all the relevant input parameters influencing the commercial results and to examine their sensitivity to the profit and loss of the UCC solution.

5.2. Dissection of the UCC Solution and assumptions

5.2.1. Demand estimation

Chengdu is positioned as the commercial trading centre of Western China. The retail industry is crucial to Chengdu's urban economy. It experienced a high growth rate from 2000 to 2012 with an average annual growth rate of 16% in the whole city, and 17% in urban areas.[567] Alongside the growing urban population, booming domestic consumption and healthy economic development, the retail industry is expected to continue growing.[568] The supermarket sector covers almost every type of consumer good in the retail industry. Therefore, it reviews the historical data of Chengdu's retail industry and projects it as the annual sales growth rate of SuperRetailerChina in Chengdu for the next 5 years, which is assumed will have an annual growth rate of 15%. In addition, the average value of CPI during the period 2000-2012 amounts to 2.55%, calculated based on the statistical data of consumer price indices (CPI) in Chengdu. Accordingly, the CPI is projected as 3% for the next 5 years. The sales growth without inflation is then projected as 12% for the coming 5 years.

Usually, volume and weight are two logistics units used for measuring the scale of demand on logistics services. However, as a result of SuperRetailerChina's current supply chain strategy there are no data recorded either in volume or in weight, but only the total sales results. In order to calculate the scale of the logistics demand, a model is proposed here to estimate the logistics volume based on the given sales volume:

[567] See Chengdu Bureau Of Statistics (2012) and Chengdu Commerce Bureau (2013).

[568] See Chengdu Commerce Bureau et al. (2013).

Logistics volume[569] = Sales / Ratio

The ratio refers to the value per logistics volume. It is calculated based on data provided by logistics experts from two local supermarket chains, which run their own logistics operations. The ratio is projected as 2270 RMB/m^3.

5.2.2. Operational process and dedicated resources

5.2.2.1. The operational process and responsibilities allocation

The UCC solution proposed for SuperRetailerChina uses the concept of consolidating the deliveries to all stores of the same individual business customer. It adopts a centralised strategy: Only one UCC will be facilitated to serve all stores of SuperRetailerChina (see Figure 38). Compared to the current "direct-to-store" model the goods from different suppliers will be transported first in large quantities to the UCC located[570] in suburban areas. After a quality and quantity check, the goods will be received, identified and unloaded at the UCC. Some will be stored for a certain number of days until an order arrives, while others will be packed together into consignments based on destination, and sent direct to supermarket shelves in the city.

During this process, the responsibilities are allocated among the relevant parties:

- The suppliers or their logistics companies are responsible for the inbound part of transporting the goods from the factories or DCs to the UCC, following the orders of the UCC operator or the supermarket company.
- The UCC operator, namely LogChina, is responsible for the operations after receiving the goods from suppliers. Its operational activities within the UCC range from goods' quality and quantity check, cross-dock or storage, pick and pack, consolidation, and any other value-added services required by the customer. In addition, arranging freight vehicles to deliver the consolidated set of various goods items is another major responsibility of the UCC operator.
- The supermarket company is responsible for issuing goods orders to suppliers and the UCC operators and for coordinating all the related stakeholders along the entire supply chain.

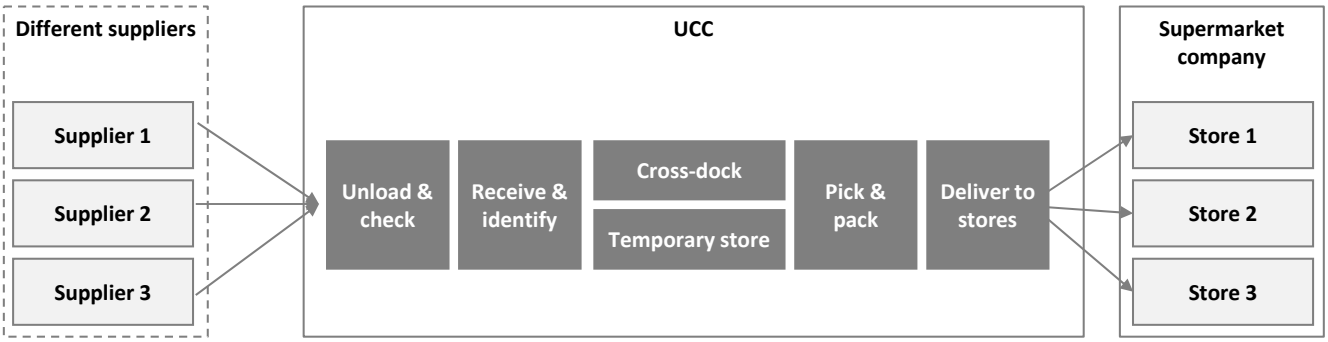

Figure 38: Operational process of the UCC solution

[569] Because all products sold by the supermarket are consumer goods, and they are delivered by enclosed freight vehicles, volume is proposed here as the unit to measure the scale of logistics demand.

[570] The UCC will be located in one of the 5 logistics parks planned by the local municipality.

5.2.2.2. Dedicated resources

In general, a UCC is able to deal with all kinds of goods with dedicated facilities and equipment.[571] Yet, it is proposed that only ambient temperature goods are included within the UCC operation. The chilled and frozen goods are not within the scope of this phase due to the involved operational complexity and limited volume[572]. The goods transported by suppliers to the UCC are either loaded in pallets or cases. According to the worldwide experience of LogChina, it is assumed that:[573]

- 20% of the goods are received in pallets with an average size of 1.8 m^3
- The rest 80% are received in cases with an average size of 0.036 m^3

As explicated in section 5.2.2.1, part of all received goods requires temporary storage. According to the experience of LogChina, it is assumed that:

- 35% of the received goods need temporary storage
- The duration of storage is 12 days on average

In order to enable all the operational activities of the UCC, it is required that dedicated logistics facilities, equipment as well as human resources should be arranged. The resources listed below are required to enable the activities within the UCC:

1) Logistics facilities:
   - Warehouse space for cross-dock, plus related facilities like storage racks, shelves
   - Warehouse space for temporary storage, plus related facilities like storage racks, shelves
2) Logistics equipment:
   - Counterbalance trucks, reach trucks, hand trucks, and trolleys
3) Human resources:
   - Administrators like team leaders or supervisors for different groups of operators
   - Operators like the forklift drivers, operators for goods cross-dock and storage

Also, further resources are required to fulfil the last-mile delivery:

- Logistics facilities: parking lots
- Logistics equipment: two types of freight vehicles, 2-tonne and 5-tonne trucks with load capacities of 16.8 m^3 and 22.7 m^3, respectively[574]

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[571] In the case of the London Heathrow Airport Consolidation Centre, both ambient temperature goods as well as chilled and frozen goods are under operational control.

[572] According to the expert interview, chilled and frozen goods contribute less than 10% of the total sales volume, and the share of ambient goods amounts to 90% of the total sales volume.

[573] The pallet size is 1m*1.2m*1.5m, and is able to load 50 cases on average.

[574] Usually, freight vehicles with larger loading capacity bring more productivity. However, large freight vehicles are restricted in many Chinese cities, because they can exacerbate traffic congestion, on one hand, and on the other not be able to access their target destinations in city centres. According to the draft version of Chengdu's technical specifications of freight vehicles for urban freight deliveries, two types of freight vehicles are proposed to conduct the last-mile deliveries.

- Human resources: truck drivers, assistants for loading and unloading

Besides all the above-listed resources, the UCC requires a general manager and professional IT systems. Dedicated WMS and TMS[575] are proposed to support the cross-dock and storage activities within the UCC, and fleet management of the last-mile delivery separately, and connect the systems of the supermarket company and its suppliers.

Following the business hour of SuperRetailerChina in Chengdu, the operation time of the UCC is proposed below:

- 7 days/week
- 365 days/year
- 2 shifts/day both for operations within the UCC as well as last-mile delivery[576]
- 8 hour/shift: 1st shift: 6:30 – 14:30; 2nd shift: 14:30 – 22:30

5.2.2.3. Productivity of the UCC

Productivity is a crucial factor that influences the operation efficiency directly and the commercial feasibility of the UCC solution indirectly. Adopting the practical expertise of LogChina in China, the productivity of each segment is discussed below.

The productivity of cross-dock

Compared to the goods storage, more space is usually needed to cross-dock the same volume of goods. It is assumed here that each square metre of space is able to cross-dock 0.19m^3 goods. Since neither the equipment nor human resources are able to work without breaks or errors for a whole year, the work efficiency of logistics equipment and human resources are assumed to be 90% and 85%, respectively. Under this condition, the dedicated equipment, namely the counterbalance trucks and hand trucks, can handle every year ca. 236000m^3 and 25000m^3 goods, respectively. Each operator within the UCC is able to handle ca. 3000m^3 of goods every year. In order to guide and supervise the jobs of operators, certain team leaders are required here and each is assumed to have the capability of leading 12 operators. In addition, professional workers with driving licenses are required to operate counterbalance trucks. The drivers are assumed to take one day/week plus 11 public holidays off. Therefore, each counterbalance truck needs to be allocated 2.42 drivers on average, or in other words, each forklift driver is able to operate 0.41 counterbalance trucks. The productivity of cross-dock is presented in Table 37.

[575] WMS refers to warehouse management system; TMS refers to transportation management system.

[576] See further discussions about the operation hour of last-mile delivery in section 5.2.5 – governmental support measures.

Resource type	Factor	Unit	Value
Logistics facilities	Warehouse space	m^3 goods/m^2	0.19
Logistics equipment	Counterbalance truck	m^3 goods/unit*year	235,718
	Hand truck	m^3 goods/unit*year	24,662
Human resources	Operator	m^3 goods/person*year	2,981
	Team leader	#operators/person*year	12
	Forklift driver	forklifts/person	0.41

Table 37: The productivity of cross-dock

The productivity of storage

In order to save space and increase the utilisation factor, storage will be designed with high racks with a total height of 10 metres. Therefore, each square metre of warehouse space will be able to store 1.3m^3 goods. In line with cross-dock, the work efficiency of logistics equipment and human resources are assumed the same. Under this condition, the productivity of dedicated equipment, as well as the operators, is assumed as listed in Table 38.

Resource type	Factor	Unit	Value
Logistics facilities	Warehouse space	m^3 goods/m^2	1.30
Logistics equipment	Counterbalance truck	m^3 goods/unit*year	579,474
	Reach truck	m^3 goods/unit*year	350,606
	Hand truck	m^3 goods/unit*year	15,997
	Trolley	m^3 goods/unit*year	37,252
Human resources	Operator	m^3 goods/person*year	2,103
	Team leader	#operators/person*year	12
	Forklift driver	forklifts/person	0.41

Table 38: The productivity of storage

The productivity of last-mile delivery

As explicated in section 5.2.2.2, two types of trucks will be used to fulfil the task of delivering the consolidated goods from the UCC to supermarket stores. It is assumed that the 2-tonne trucks carry 50% of the goods, while the 5-tonne trucks carry the rest. The load factor for both 2-tonne and 5-tonne trucks is assumed to be 75%. The trucks will use a point-to-point delivery model, which can minimise the lead time per trip and increase operating efficiency. Based on an average distance between the UCC and stores of 37.5km and an average travel speed of 30km/h, the lead time sums to 4 hours per trip and consists of 2 hours for travelling, 1 hour for loading/unloading and 0.5 hour for waiting outside the supermarket stores.

In addition, one driver, combined with one loading assistant, is required to complete one delivery trip. The trucks will work two shifts of 16 hours per day. The drivers and loading assistants are assumed to take one day/week plus 11 public holidays off. Therefore, each truck needs to be allocated 2.42 drivers and 2.42 loading assistants on average. Conversely, each driver or loading assistant is able to operate 0.41 trucks on average. The assumed parameters regarding the productivity of last-mile delivery are listed in Table 39.

Resource type	Factor	Unit	Value
Logistics equipment	Load capacity of a 2-tonne truck	m^3	16.8
	Load capacity of a 5-tonne truck	m^3	22.7
	Load factor		75%
	Lead time/trip	hour/trip	4
	Delivery volume of a 2-tonne truck	m^3 /unit*year	18,350
	Delivery volume of a 5-tonne truck	m^3 /unit*year	24,904
Human resources	Driver	trucks/person	0.41
	Loading assistant	trucks/person	0.41

Table 39: List of charged services

5.2.3. Charging mechanism

Through restructuring the supply chain model, all suppliers do not have to enter the congested city centre to carry out inefficient operations such as small pick-ups and deliveries, and queuing for (un)loading, which can help to massively reduce the lead time. Besides, they can use larger freight vehicles to transport the goods to the UCC out of the city centre more economically. They can therefore save on the transportation cost from last-mile delivery and increase productivity using larger freight vehicles and shortening the travel and waiting time.

The supermarket company can also benefit a great deal from the UCC solution. It does not have to employ many employees to deal with every supplier individually regarding quality check, goods handover as well as goods identification. The surplus employees can be released to support the opening of new stores. In addition, the UCC is located not far away from its stores and is well connected through frequent deliveries. Each store can then lower its minimum inventory level and free up expensive space as a temporary warehouse to promote sales. Furthermore, the congestion level of neighbouring traffic can be effectively reduced, which will benefit the supermarket company's image.

The city, neighbouring areas of stores in particular, is another large beneficiary of the innovative solution, with less freight traffic flow, lower traffic emissions, and a better urban environment as well as good city image.

The benefits created by the UCC solution towards these three major parties are hereby considered the sources for the operating costs to keep the UCC commercially running. Since the UCC solution proposed here adopts a market-oriented mechanism. Also, it is difficult to quantify all the benefits for the public sector and to monetise them using a reasonable method, the benefits towards public sectors will be repaid through issuing governmental support measures.[577] It is the private sector, both suppliers and supermarket, which will be charged for the services based on their potential benefits. Principally, there are two options available for charging for the services provided by the UCC, which are depicted in Table 40:

- Charging mechanism 1: the suppliers or their logistics companies use the saved transportation costs to pay the goods operation fees within the UCC and the fees of last-mile delivery to stores.

[577] This will be discussed further in 5.2.5.

- Charging mechanism 2: the supermarket company is considered as the only customer. It will negotiate with its suppliers and draw their benefits, and combine its own benefits to pay for the services provided by the UCC.

Paying users	Pros	Cons
Suppliers	• Suppliers are well aware of the savings of transportation costs	• Difficult to implement, as the UCC operator does not have sufficient power to negotiate with each supplier individually and influence their supply chain model • The benefits to suppliers will not be enough to cover the costs of the UCC without financial support from the supermarket company
Supermarket company	• Easier to implement, as the UCC operator needs to negotiate with only one party • The supermarket company has the power to influence its suppliers • The benefits of the UCC solution both to suppliers and the supermarket company shall be considered	• The supermarket company needs to calculate its own benefit from the UCC solution • The supermarket company needs to negotiate with its suppliers and ask them to help cover the costs of the UCC

Table 40: Types of charging mechanism

In practice, both charging mechanisms have reference cases.[578] However, considering the advantages of its easy implementation, the 2nd alternative is proposed as the charging mechanism for the UCC solution. The supermarket company will be the only customer of the UCC paying for the services within the UCC and last-mile delivery. Based on the practice and experience of LogChina in Chengdu, SuperRetailerChina will be charged the handling fees within the UCC according to the goods volume, a storage fee according to the goods volume and storage duration, and the last-mile delivery fees according to the amount of deliveries and type of freight vehicles. The fees charged are listed in Table 41. In addition, the price will increase by 3% every year in line with inflation as a result of the growing operating costs.

Charged services	Charged unit	Price proposed
Inbound handling fee	RMB/m^3	11.1
Outbound handling fee	RMB/m^3	11.1
Short-term storage fee	RMB/m^3/day	1.5
Last-mile delivery per 2-tonne truck	RMB/trip	320
Last-mile delivery per 5-tonne truck	RMB/trip	405

Table 41: List of charged-for services tariff

5.2.4. Investment policies

Although the UCC solution has the potential to improve the efficiency of city logistics and benefit suppliers, the supermarket company as well as the city and many practical projects have been implemented, it is still a new concept in China and many uncertainties remain. It is desirable to keep the initial cost base low to establish a

[578] Representatives for the 1st charging meachnism include UCC projects in many German cities (e.g., Kasel and Regensburg) and Japanese cities (e.g., Motomachi UCC and Tenjin Joint Distribution System); whereas examples for the 2nd are projects in London Heathrow Airport (Retail) and Bristol.

successful start trial. In order to minimise any risks caused by the uncertainties and remain consistent with the corporate investment strategy, LogChina adopts a light asset investment policy regarding the UCC solution. It will invest as few fixed assets as the market allows. Also, the investment policy regarding the detailed types of asset is listed in Table 42.

Resource type	Sub-type	Investment policy
Logistics facilities	Warehouse space for cross-dock	Lease
	Related facilities incl. pallets, shelves, storage racks	Purchase
	Warehouse space for storage	Lease
	Related facilities incl. pallets, shelves, storage racks	Purchase
Logistics equipment	Counterbalance trucks	Lease
	Reach trucks	Lease
	Hand trucks	Purchase
	Trolleys	Purchase
	Freight vehicles: 2-tonne trucks	Purchase
	Freight vehicles: 5-tonne trucks	Purchase

Table 42: Investment policy

5.2.5. Governmental support measures

Governmental support is a critical factor of many successful implementations of city logistics solutions. Local municipalities can assist with the implementation of all city logistics solutions through providing financial or regulatory support. They can also issue certain restrictions to improve the attractiveness of the solutions over those offered by competitors.

According to the "Procedures for Chengdu's dedicated funds for the modern logistics industry", the local municipality can assist in the realisation of the UCC solution through:

1) Financial assistance:
   - Subsidy for the setup of logistics facilities and equipment:
     The subsidy rate depends on the scale of the initial capital expenditure. The part above 5 million RMB shall be subsidised with 5% of the initial capital expenditure, and the part below 5 million shall be subsidised with 4% of the initial capital expenditure.
   - Subsidy for the use of logistics facilities, e.g., renting the warehouse in planned logistics parks:
     20% of the rental fees will be subsidised for a duration of three years.
   - Subsidy for the procurement of freight vehicles:
     5% of the total procurement price for each truck will be subsidised, and no more than 20,000 RMB for each.
   - Subsidy for the business achievement:
     0.5 million RMB will be subsidised for an annual revenue greater than 30 million; 0.3 million RMB for between 10 million and 30 million RMB; and 0.2 million RMB for 5 million and 10 million RMB.
2) Regulatory assistance:

- Authorise the logistics facilities to consume electricity under the tariff for general industry[579]
- Authorise the freight vehicles to work within urban areas without any time restrictions

5.3. Generation of the BCA model

5.3.1. General introduction

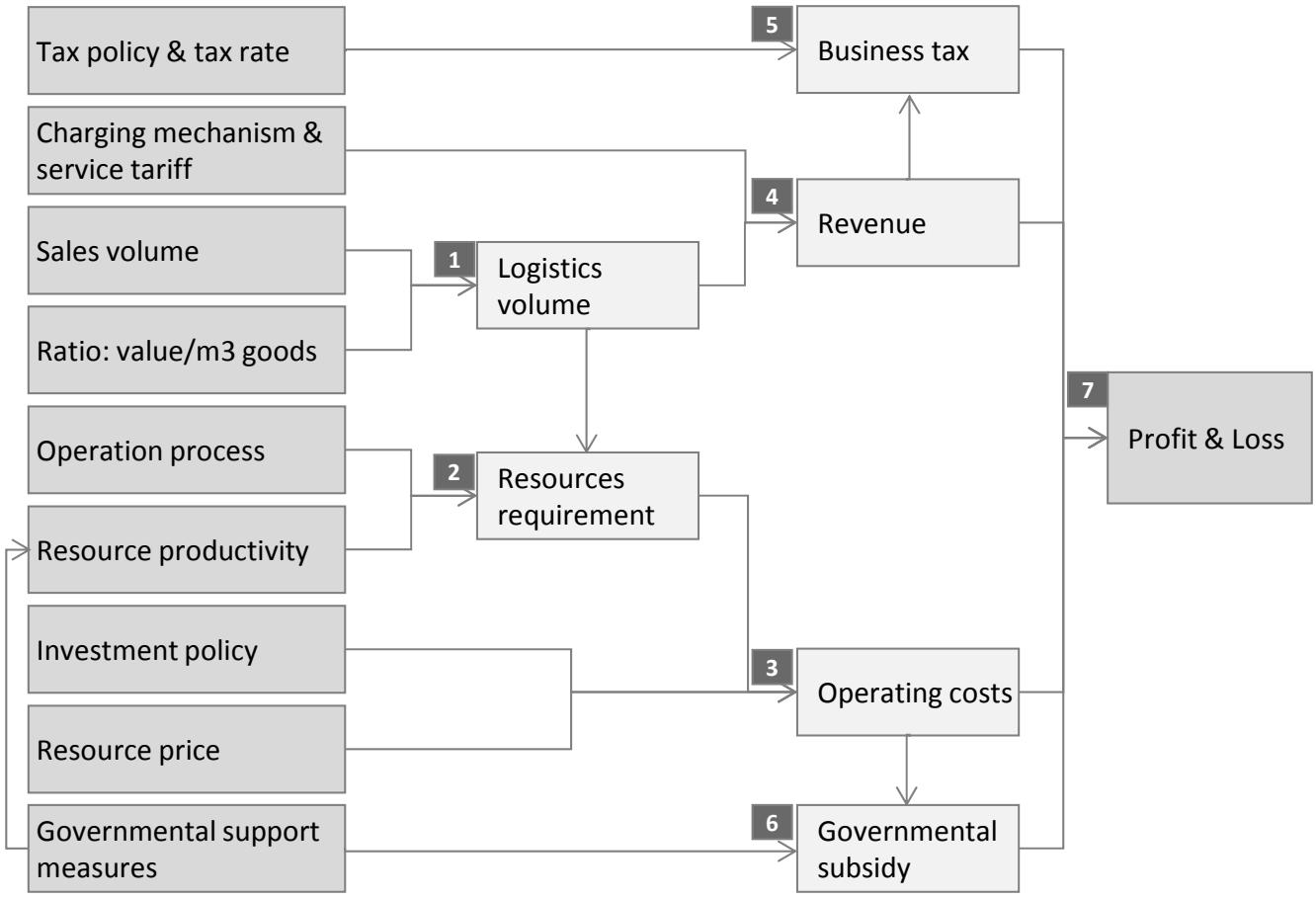

Figure 39: The business model of the UCC solution

The BCA model is generated based on the operational process and business objectives. The profit and loss estimation process will follow the steps proposed below (see Figure 39):

1) First, the logistics volume will be estimated in section 5.3.2 based on the projected sales volume and the assumed ratio of goods value per cubic metre;
2) Second, following the operational process and productivity of different resources, the amount of required resources for all the logistical activities including cross-dock, storage and last-mile delivery will be calculated in section 5.3.3;

[579] Companies from different industries are charged by different tariffs in China for eletricity consumption. Under the tariff for general industry, the UCC operator can save a greater electricity expense than under the tariff for non-resident and commerce. For a list of the actual tariff for electricity consumption see Chengdu Electric Power Bureau (2013).

3) Third, taking the results calculated in the 2nd step, combining with the investment policy and the price of resources, in section 5.3.4 the operating costs of the UCC will be estimated, which will consist of capital expenditure and other expenses;
4) The total revenue will be calculated in section 5.3.5 in the 4th step based on the service tariff and the scale of different services;
5) Furthermore, the tax policy and tax rate will be used in section 5.3.6 together with the revenue scale to generate the business tax that needs to be paid;
6) Following the governmental support measures, in section 5.3.7 the total value of governmental subsidy as a contribution to profit will be calculated;
7) Finally, the profit and loss results will be shown in section 5.4.1.

5.3.2. Estimation of logistics volume

Following the model proposed in section 5.2.1, a set of formulae are generated to calculate the logistics volume:

$$V^X = \frac{S^0 * (1+r)^X}{R} * \beta, \text{ x = 1, 2, 3, 4, 5}$$

$$V^X_{C-D} = V^X; V^X_S = V^X * s, \text{ x = 1, 2, 3, 4, 5}$$

The symbols used above represent:

- V^X: total logistics volume (throughput) of ambient goods for year x, x = 1, 2, 3, 4, 5
- S^0 : sales of SuperRetailerChina in China for year 0
- β: share of ambient goods of total sales
- r : annual growth rate of the sales of SuperRetailerChina
- R : value of one cubic metre goods
- s = percentage of the total logistics volume that requires temporary storage
- V^X_{C-D}: total logistics volume (throughput) for cross-dock of year x, x = 1, 2, 3, 4, 5
- V^X_S: total logistics volume (throughput) for cross-dock of year x, x = 1, 2, 3, 4, 5

Calculated based on the input data in 5.2.1 and 5.2.2.2, the scale of logistics demand over the next 5 years is estimated. Also, the results are listed in Table 43.

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales without inflation factor (mil. RMB)	3004.5	3365	3769	4221	4728
Sales of ambient goods without inflation (mil. RMB)	2704	3029	3392	3799	4255
Logistics volume (mil. m^3)	1.19	1.33	1.49	1.67	1.87
Logistics volume for storage (mil. m^3)	0.42	0.47	0.52	0.59	0.66

Table 43: Logistics volume for the next 5 years

5.3.3. Estimation of required resources

5.3.3.1. Resources requirement for cross-dock

The resources required to fulfil each cross-dock task are estimated based on productivity and total logistics volume:

Logistics facility:

$$WS_{C-D} = \frac{MAX\,(V^{X}_{C-D})}{365} * T_{C-D} * \frac{1}{C^{C-D}_{WS}}\ , x = 1, 2, 3, 4, 5$$ [580]

Logistics equipment:

$$N^{X}_{CBT} = ROUNDUP(\frac{V^{X}_{C-D}}{P^{C-D}_{CBT}}, 0)\ , x = 1, 2, 3, 4, 5$$

$$N^{X}_{HT} = ROUNDUP(\frac{V^{X}_{C-D}}{P^{C-D}_{HT}}, 0)\ , x = 1, 2, 3, 4, 5$$

Human resources[581]:

$$N^{X}_{O} = ROUNDUP(\frac{V^{X}_{C-D}}{P_{O}}, 0), x = 1, 2, 3, 4, 5$$

$$N^{X}_{TL} = ROUNDUP(\frac{N^{X}_{O}}{P_{TL}}, 0, x = 1, 2, 3, 4, 5$$

The symbols used above represent:

- WS_{C-D} : required warehouse space for cross-dock
- V^{X}_{C-D}: total logistics volume (throughput) for cross-dock of year x, x = 1, 2, 3, 4, 5
- T_{C-D} : turn around time for cross-dock
- C^{C-D}_{WS} : capacity of warehouse space of cross-dock for handling goods volume
- N^{X}_{CBT} : required amount of counterbalance trucks for year x, x= 1, 2, 3, 4, 5
- P^{C-D}_{CBT} : productivity of the counterbalance truck
- N^{X}_{HT} : required number of counterbalance trucks for year x, x= 1, 2, 3, 4, 5
- P^{C-D}_{HT} : productivity of the hand truck
- N^{X}_{O} : amount of required operators for cross-dock for year x, x= 1, 2, 3, 4, 5
- P^{C-D}_{o}: yearly productivity of each operator
- N^{X}_{TL} : amount of required team leaders for cross-dock for year x, x= 1, 2, 3, 4, 5
- P^{C-D}_{TL} : productivity of each team leader

[580] It is proposed here to rent warehouse space based on the largest logistics volume within the next 5 years at the beginning in order to simplify negoations with the warehouse provider.

[581] As explicated in section 5.2.2.2, certain forklift drivers are required to operate the counterbalance trucks. As there is no skill difference between operating the counterbalance trucks for cross-dock and storage, the total amount of required forklift drivers both for cross-dock and storage will be estimated together in section 5.3.2.3.

Taking the data given in 5.2.2.3 and 5.3.2, the amount of resources required is summarised in Table 44:

		Year 1	Year 2	Year 3	Year 4	Year 5
Warehouse space (1000 m^2)	WS_{C-D}	13.9	13.9	13.9	13.9	13.9
Counterbalance truck	N^X_{CBT}	6	6	7	8	8
Hand truck	N^X_{HT}	49	55	61	68	77
Operator	N^X_O	400	448	502	562	629
Team leader	N^X_{TL}	34	38	42	47	53

Table 44: Resource requirement for cross-dock in the next 5 years

5.3.3.2. Resources requirement for storage

The resources required to fulfil each task of storage are estimated based on productivity and total logistics volume:

1) Logistics facility:

$$WS_S = \frac{MAX\,(V^X_S)}{365} * T_S * \frac{1}{C^S_{WS}} \text{ , x = 1, 2, 3, 4, 5}$$ [582]

2) Logistics equipment:

$$N^X_{CBT} = ROUNDUP(\frac{V^X_{C-D}}{P^{C-D}_{CBT}}, 0) \text{ , x = 1, 2, 3, 4, 5}$$

$$N^X_{RT} = ROUNDUP(\frac{V^X_S}{P^S_{HT}}, 0) \text{ , x = 1, 2, 3, 4, 5}$$

$$N^X_{HT} = ROUNDUP(\frac{V^X_S}{P^S_{HT}}, 0) \text{ , x = 1, 2, 3, 4, 5}$$

$$N^X_T = ROUNDUP(\frac{V^X_S}{P^D_T}, 0) \text{ , x = 1, 2, 3, 4, 5}$$

3) Human resources:

$$N^X_O = ROUNDUP(\frac{V^X_{C-D}}{P_O}, 0), \text{ x = 1, 2, 3, 4, 5}$$

$$N^X_{TL} = ROUNDUP(\frac{N^X_O}{P_{TL}}, 0), \text{ x = 1, 2, 3, 4, 5}$$

$$N^X_{FD} = ROUNDUP(\frac{M^X_{CBT}}{P_{FD}}, 0) \text{ , x = 1, 2, 3, 4, 5}$$

The symbols used above represent:

[582] It is proposed here to rent warehouse space based on the largest logistics volume within the next 5 years at the beginning in order to simplify negotiations with the warehouse provider.

- WS_S : required warehouse space for cross-dock
- V_S^X: total logistics volume (throughput) for cross-dock of year x, x = 1, 2, 3, 4, 5
- T_S : turnaround time for storage
- C_{WS}^S : capacity of warehouse space of cross-dock for handling goods volume
- N_{CBT}^X : required amount of counterbalance trucks for year x, x= 1, 2, 3, 4, 5
- P_{CBT}^S : productivity of the counterbalance truck
- N_{RT}^X : required amount of reach trucks for year x, x= 1, 2, 3, 4, 5
- P_{RT}^S : productivity of the reach truck
- N_{HT}^X : required amount of hand trucks for year x, x= 1, 2, 3, 4, 5
- P_{HT}^S : productivity of the hand truck
- N_T^X : required amount of trolleys for year x, x= 1, 2, 3, 4, 5
- P_T^S : productivity of the trolley
- N_O^X : amount of required operators for cross-dock for year x, x= 1, 2, 3, 4, 5
- P_O^S : yearly productivity of each operator
- N_{TL}^X : amount of required team leaders for cross-dock for year x, x= 1, 2, 3, 4, 5
- P_{TL}^S : productivity of each team leader
- M_{CBT}^X : total amount of required counterbalance trucks for both cross-dock and storage for year x, x= 1, 2, 3, 4, 5
- N_{FD}^X : total amount of required forklift drivers for counterbalance trucks for both cross-dock and storage for year x, x= 1, 2, 3, 4, 5
- P_{FD} : productivity of each forklift driver

Taking the data from section 5.2.2.3 and section 5.3.2, the amount of required resources is summarised in Table 45:

		Year 1	Year 2	Year 3	Year 4	Year 5
Warehouse space (1000s m^2)	WS_S	16.6	16.6	16.6	16.6	16.6
Counterbalance truck	N_{CBT}^X	1	1	1	2	2
Reach truck	N_{RT}^X	2	2	2	2	2
Hand truck	N_{HT}^X	27	30	33	37	42
Trolley	N_T^X	12	13	15	16	18
Operator	N_O^X	199	223	249	279	312
Team leader	N_{TL}^X	17	19	21	24	26
Forklift driver	N_{FD}^X	3	3	4	5	5

Table 45: Resources requirement for storage in the next 5 years

5.3.3.3. Resources requirement for last-mile delivery

The resources required to fulfil each task of storage is estimated based on productivity and total logistics volume:

1) Logistics equipment:

$$N_{2t}^X = \text{ROUNDUP}\left(\frac{V^X * \alpha}{C_{2t} * LF_{2t} * \frac{n}{LT_{2t}} * 365}, 0\right), \; x = 1, 2, 3, 4, 5$$

$$N_{5t}^{X} = \text{ROUNDUP}\left(\frac{V^{X} * (1-\alpha)}{C_{2t} * LF_{5t} * \frac{n}{LT_{5t}} * 365}, 0\right), \; x = 1, 2, 3, 4, 5$$

2) Human resources

$$N_{D}^{X} = \text{ROUNDUP}\left(\frac{N_{2t}^{X} + N_{5t}^{X}}{P_{D}}, 0\right)$$

$$N_{LA}^{X} = N_{D}^{X}$$

The symbols used in the formulae above represent:

- V^{X} : the amount of total logistics volume that requires to be delivered to all the supermarket stores for year x, x= 1, 2, 3, 4, 5
- α : percentage of total logistics volume carried by 2-tonne trucks
- 1-α : percentage of total logistics volume carried by 5-tonne trucks
- N_{2t}^{X} : amount of required 2-tonne trucks for year x, x= 1, 2, 3, 4, 5
- N_{5t}^{X} : amount of required 5-tonne trucks for year x, x= 1, 2, 3, 4, 5
- C_{2t} : load capacity of the 2-tonne truck
- C_{5t} : load capacity of the 5-tonne truck
- LF_{2t} : load factor of the 2-tonne truck
- LF_{5t} : load factor of the 5-tonne truck
- n: work hours of 2-tonne and 5-tonne trucks every day
- LT_{2t} : average lead time of the 2-tonne truck every delivery trip
- LT_{5t} : average lead time of the 5-tonne truck every delivery trip
- N_{D}^{X} : number of required drivers for both 2-tonne and 5-tonne trucks for year x, x= 1, 2, 3, 4, 5
- N_{LA}^{X} : number of required drivers for both 2-tonne and 5-tonne trucks for year x, x= 1, 2, 3, 4, 5
- P_{D} : productivity of driver, namely the number of trucks that one driver can operate

Taking the data in section 5.2.2.3 and section 5.3.2, the amount of resources required is summarised in Table 46:

		Year 1	Year 2	Year 3	Year 4	Year 5
2-tonne truck	N_{2t}^{X}	33	37	41	46	52
5-tonne truck	N_{5t}^{X}	24	27	31	34	38
Driver	N_{D}^{X}	138	155	175	194	218
Loading assistants	N_{LA}^{X}	138	155	175	194	218

Table 46: Resources requirement for last-mile delivery in the next 5 years

5.3.4. Operating costs

5.3.4.1. Summary of required resources

The amount of required warehouse space is summarised in Table 47:

	Year 1	Year 2	Year 3	Year 4	Year 5	Investment policy
WS for cross-dock (1000s m^2)	13.9	13.9	13.9	13.9	13.9	Rent
WS for storage (1000s m^2)	16.6	16.6	16.6	16.6	16.6	Rent
WS in total (1000s m^2)	30.5	30.5	30.5	30.5	30.5	Rent

Table 47: Warehouse space requirement for the next 5 years

Note: "WS" stands for warehouse space.

The amount of required logistics equipment is summarised in Table 48:

	Year 1	Year 2	Year 3	Year 4	Year 5	Investment policy
Counterbalance truck (unit)	7	7	8	10	10	Lease
Reach truck (unit)	2	2	2	2	2	Purchase
Hand truck (unit)	76	85	94	105	119	Lease
Trolley (unit)	12	13	15	16	18	Purchase

Table 48: Equipment requirement for the next 5 years

The number of required trucks is summarised in Table 49:

	Year 1	Year 2	Year 3	Year 4	Year 5	Investment policy
# 2-tonne truck (unit)	33	37	41	46	52	Purchase
# 5-tonne truck (unit)	24	27	31	34	38	Purchase
Total trucks (unit)	57	64	72	80	90	Purchase

Table 49: Trucks requirement for the next 5 years

The amount of required human resources is summarised in Table 50:

	Year 1	Year 2	Year 3	Year 4	Year 5
Manager	1	1	1	1	1
Team leader[583]	51	57	63	71	79
Operator[584]	599	671	751	841	941
Forklift driver	3	3	4	5	5
Driver	138	155	175	194	218
Load assistant	138	155	175	194	218

Table 50: Staff requirement for the next 5 years

[583] The number of team leaders is calculated both for cross-dock and storage, as they will be paid the same salary.

[584] The number of operators is calculated both for cross-dock and storage, as they will be paid the same salary.

5.3.4.2. Capital expenditure

Guided by the investment policy, the UCC solution requires a large sum of investment to facilitate the setup of the UCC, including facilities for cross-dock and storage, logistics equipment in the UCC, freight vehicles for last-mile delivery as well as IT systems.

Capital expenditure (capex) for cross-dock and storage facilities

Based on the practice and experience of LogChina, the setup cost of the facilities in the UCC per square metre is assumed as follows:

- Cross-dock facility setup cost per sqm (RMB/m^2): 70
- Warehouse facility setup cost per sqm (RMB/m^2): 356

Considering the amount of required warehouse space summarised in section 5.3.3.1, a total investment of nearly 7 million RMB is required. Taking a straight-line depreciation method of 8 years with a residual value amounting to 3% of the initial capex, the depreciation of logistics facilities for the coming 5 years is summarised in Table 51:

	Capex	Depreciation				
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Logistics facilities for cross-dock (1000s RMB)	971	118	118	118	118	118
Logistics facilities for storage (1000s RMB)	5925	718	718	718	718	718
In total (1000s RMB)	6895	836	836	836	836	836

Table 51: Capex for facilities for the next 5 years

Capex for logistics equipment in the UCC

Besides the investment for the logistics facilities, further capital expenditure needs to be arranged to purchase the logistics equipment. The price to purchase one unit of each kind of logistics equipment is assumed:

- Reach truck per unit (1000s RMB): 2.5
- Trolleys per unit (1000s RMB): 1.5

The total amount of capex is then calculated based on the assumed price and the amount summarised in section 5.3.3.1. It takes a straight-line depreciation method of 5 years with a residual value amounting to 5% of the initial capex. The estimation results are presented in Table 52.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Hand truck (1000s RMB): capex	190	22.5	22.5	27.5	35	
Trolley (1000s RMB): capex	18	1.5	3	1.5	3	
Hand truck (1000s RMB): depreciation		36.10	40.38	44.65	49.88	56.53
Trolley (1000s RMB): depreciation		3.42	3.71	4.28	4.56	5.13
Equipment in total (1000s RMB): depreciation		39.52	44.08	48.93	54.44	61.66

Table 52: Capex for equipment for the next 5 years

Capex for freight vehicles

Taking the inputs from experts from LogChina, the price of the freight vehicles is assumed as follows:

- 2-tonne truck per unit (1000s RMB): 20
- 5-tonne truck per unit (1000s RMB): 30

The total amount of investment is then estimated based on the assumed price and the summarised amount in section 5.3.3.1. It takes a straight-line depreciation method of 5 years with a residual value amounting to 5% of the initial capex. The estimation results are presented in Table 53.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
2-tonne truck (1000s RMB): capex	660	80	80	100	120	
5-tonne truck (1000s RMB): capex	720	90	120	90	120	
2-tonne truck (1000s RMB): depreciation		125.4	140.6	155.8	174.8	197.6
5-tonne truck (1000s RMB): depreciation		136.8	153.9	176.7	193.8	216.6
Trucks in total (1000s RMB): depreciation		262.2	294.5	332.5	368.6	414.2

Table 53: Capex for trucks for the next 5 years

Capex for IT systems

Finally, the IT systems require further investment and a straight-line depreciation method of 10 years with residual value amounting to 3% of the initial capex is used here. The results are presented in Table 54.

	Capex	Depreciation				
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
WMS (1000s RMB)	500	48.5	48.5	48.5	48.5	48.5
TMS (1000s RMB)	500	48.5	48.5	48.5	48.5	48.5
In total (1000s RMB)	1000	97	97	97	97	97

Table 54: Capex for IT systems for the next 5 years

5.3.4.3. Other expenditures

Beyond the capex, other expenditures are also necessary to implement the solution. These are rent expense for warehouse space for cross-dock and storage, lease expense of logistics equipment, maintenance expense, fuel expense of freight vehicles, overheads within the UCC, and staff expense.

The rent expense of warehouse space

Based on the given data of rent prices of available warehouse space, it is assumed that rent for warehouse space of the UCC is 23 RMB/m^2*month[585]. The total rent expense is then calculated together with the required amount summarised in 5.3.3.1. The results are summarised in Table 55.

	Year 1	Year 2	Year 3	Year 4	Year 5
Rent expense for cross-dock (1000s RMB)	3827.7	3942.5	3942.5	3942.5	3942.5
Rent expense for storage (1000s RMB)	4593.2	4731.0	4731.0	4731.0	4731.0
Total rent expense (1000s RMB)	8420.9	8673.5	8673.5	8673.5	8673.5

Table 55: Rent expense for the next 5 years

The lease expense of logistics equipment

Based on the experience of LogChina in Chengdu, the monthly cost of leasing one counterbalance truck and one reach truck per month is 7400 RMB and 7000 RMB, respectively. This is then multiplied by the amount summarised in section 5.3.3.1. The total lease expense of logistics equipment is calculated as shown in Table 56:

	Year 1	Year 2	Year 3	Year 4	Year 5
Counterbalance truck (1000s RMB)	621.6	621.6	710.4	888	888
Reach truck (1000s RMB)	168	168	168	168	168
Lease expense in total (1000s RMB)	789.6	789.6	878.4	1056	1056

Table 56: Lease expense for the next 5 years

The maintenance expense

In order to keep the logistics facilities, equipment as well as the trucks in good condition and in working order, it is necessary to repair and maintain the items regularly, which generates expense. The maintenance expense of the different items is assumed as a certain percentage of the initial capex:

- Facilities maintenance expense as a percentage of initial capex: 5.0%
- Equipment maintenance expense as a percentage of initial capex: 1.0%
- Truck maintenance expense as a percentage of initial capex: 1.0%

Together with initial capex calculated in section 5.3.3, the maintenance expense is estimated in Table 57:

	Year 1	Year 2	Year 3	Year 4	Year 5
Facilities (1000s RMB)	344.8	344.8	344.8	344.8	344.8
equipment (1000s RMB)	2.1	2.3	2.6	2.9	3.2
Trucks (1000s RMB)	13.8	15.5	17.5	19.4	21.8
Maintenance expense in total (1000s RMB)	360.6	362.6	364.8	367.0	369.8

Table 57: Maintenance expense for the next 5 years

[585] As the logistics market in Chengdu is booming as a result of economic growth, the rent price of warehouses is expected to rise. It is therefore assumed that the rent price will increase by 3% every year in accordance with inflation.

Fuel expense of freight vehicles

Fuel is one of the largest parts of transportation cost. The fuel expense of freight vehicles is calculated by multiplying the total travel distance and the average fuel expense each kilometre, which is assumed to be 0.8 RMB/km[586] based on the truck fleet management experience of LogChina in Chengdu.

	Year 1	Year 2	Year 3	Year 4	Year 5
Travel distance in total (1000s km)	6241.5	7008	7884	8760	9855
Fuel expense in total (1000s RMB)	4993.2	5774.6	6691.3	7657.8	8873.5

Table 58: Fuel expense for the next 5 years

Overheads within the UCC

Overheads include the utility expense and other overheads like office supplies, telephone and miscellaneous fees. Based on LogChina's experience, these two types of overheads are assumed to account for 1% and 2% of total revenue, respectively.

Staff expense

This includes the direct staff expense calculated based on the total salaries of all employees, and indirect staff expense for cleaning and security, which is here assumed to be 5% of the total direct staff expense. With the yearly salary for different types of employees and the amount summarised in section 5.3.3.1, the total staff expense is estimated in Table 59:

	Year 1	Year 2	Year 3	Year 4	Year 5	Salary[587]
Manager (1000s RMB)	204	210	216	223	230	204
Team leader (1000s RMB)	4,590	5,284	6,015	6,983	7,769	90
Operator (1000s RMB)	27,314	31,516	36,331	41,906	46,888	46
Forklift driver (1000s RMB)	144	148	204	262	262	48
Driver (1000s RMB)	6,624	7,663	8,912	10,175	11,434	48
Load assistant (1000s RMB)	5,796	6,705	7,798	8,904	10,005	42
Indirect staff expense in total (1000s RMB)	2,234	2,576	2,974	3,423	3,829	
Staff expense in total (1000s RMB)	46,906	54,103	62,450	71,875	80,418	

Table 59: Staff expense for the next 5 years

[586] The price of every litre of fuel is expected as a result of economic growth. The average fuel expense each kilometre is therefore assumed to increase by 3% every year in accordance with the inflation rate.

[587] The salary tariff is proposed based on LogChina's human resource policy in 2012. It is assumed that it will grow 3% every year in accordance with inflation.

5.3.5. Revenue generation

The revenue is generated based on the services provided by the UCC. It is charged based on volume scale and price per unit. Taking the input data in section 5.3.2.1 and section 5.2.3, the revenue expected for the next 5 years is estimated as follows:

	Year 1	Year 2	Year 3	Year 4	Year 5
Cross-dock fees[588] (1000s RMB)	26444	30506	35192	40598	46833
Storage fees (1000s RMB)	7505	8657	9987	11521	13291
Last-mile delivery (1000s RMB)	29609	34249	39768	45452	52633
Revenue in total (1000s RMB)	63558	73413	84947	97571	112757

Table 60: Revenue for the next 5 years

5.3.6. Business tax

According to China's current tax law, logistics companies need to pay business tax according to the business scale. There are two tariffs for different services provided by logistics companies:

- Business tax for warehouse services as a percentage of the business scale: 5%
- Business tax for transportation services as a percentage of the business scale: 3%

Together with revenue estimated in section section 5.3.5, the business tax for the next 5 years is estimated in Table 61:

	Year 1	Year 2	Year 3	Year 4	Year 5
Business tax for warehouse services (1000s RMB)	1697	1958	2259	2606	3006
Business tax for transportation services (1000s RMB)	888	1027	1193	1364	1579
Business tax in total (1000s RMB)	2586	2986	3452	3970	4585

Table 61: Business tax for the next 5 years

5.3.7. Governmental subsidies

Taking the policies of governmental subsidy in 5.2.5 and the basic data in section 5.3.3.1, section 5.3.3.2 and section 5.3.4, the value of the financial assistance is estimated for the next 5 years. The results will be considered as a contribution to cover the costs of keeping the UCC operating without paying any tax. The results are presented in Table 62.

	Year 1	Year 2	Year 3	Year 4	Year 5
Subsidy for facilities setup (1000s RMB)	355	-	-	-	-
Subsidy for trucks' procurement (1000s RMB)	69	9	10	10	12
Subsidy for warehouse rent (1000s RMB)	1,684	1,735	1,735	-	-
Subsidy for business (1000s RMB)	500	500	500	500	500
Subsidy in total (1000s RMB)	2,608	2,243	2,245	510	512

Table 62: Governmental subsidy for the next 5 years

[588] The cross-dock fee includes the inbound handling fee and outbound handling fee.

5.4. Results of the BCA model

5.4.1. Profit and loss analysis

Following the formula below, the results of profit and loss in the next 5 years is formulated and summarised in Table 63:

- EBIT[589] = Revenue – Operating costs
- Net profit = EBIT – Business tax + Governmental subsidy
- Net profit margin = Net profit / Revenue, which is considered here as the major index of the commercial feasibility of the UCC solution

It can be observed from Table 63 that the EBIT grows continually in the 5 years alongside the growth of total revenue. It will take two years until the UCC can break-even. Due to the sharp reduction of the governmental subsidy, the net profit margin falls to almost zero in the 4th year. Although the net profit margin increases to 4% in the 5th year, the value of this index in the total 5 years amounts to less than 1%, which does not seem satisfactory from a commercial perspective. If the financial expense of the capex is taken into consideration, the commercial result of the UCC cannot be positively accepted.

		Year 1	Year 2	Year 3	Year 4	Year 5	Sum	% of sum
Revenue (1000s RMB)	**Cross-dock fees**	26,444	30,506	35,192	40,598	46,833	179,574	41.5%
	Storage fees	7,505	8,657	9,987	11,521	13,291	50,960	11.8%
	Last-mile delivery	29,609	34,249	39,768	45,452	52,633	201,712	46.7%
	Revenue in total	63,558	73,413	84,947	97,571	112,757	432,246	100.0%
Operating costs (1000s RMB)	**Staff expense**	46,906	54,103	62,450	71,875	80,418	315,752	75.4%
	Lease expense	790	790	878	1,056	1,056	4,570	1.1%
	Maintenance expense	361	363	365	367	370	1,825	0.4%
	Rent expense	8,421	8,673	8,673	8,673	8,673	43,115	10.3%
	Fuel expense	4,993	5,775	6,691	7,658	8,874	33,990	8.1%
	Overheads	1,907	2,202	2,548	2,927	3,383	12,967	3.1%
	Depreciation & Amortisation	1,235	1,272	1,314	1,356	1,409	6,586	1.6%
	Costs in total	64,612	73,177	82,920	93,913	104,183	418,805	100.0%
EBIT (1000s RMB)		*-1,054*	236	2,027	3,658	8,574	13,441	
Business tax (1000s RMB)		2586	2986	3452	3970	4585	17,578	
Governmental subsidy (1000s RMB)		2608	2243	2245	510	512	8,118	1.9%
Net profit (1000s RMB)		*-1031*	*-507*	820	198	4501	3,981	
Net profit margin		*-1.6%*	*-0.7%*	1.0%	0.2%	4.0%	0.9%	

Table 63: Profit and loss in the next 5 years

As depicted in the pie chart (see Figure 40), the last-mile service contributes the largest part of total revenue – almost half; the cross-dock fees and storage fees make up the other half. Although the local municipality can

[589] EBIT refers to earnings before interest and tax. According to the investment policy, it will take a source of own capital, so there is no interest expense required to be paid. However, it increases LogChina's expectations regarding the net profit margin.

assist with the UCC operation using several financial means, the total contribution of financial assistance is limited, which is less than 2% of the charged revenue from the private customer.

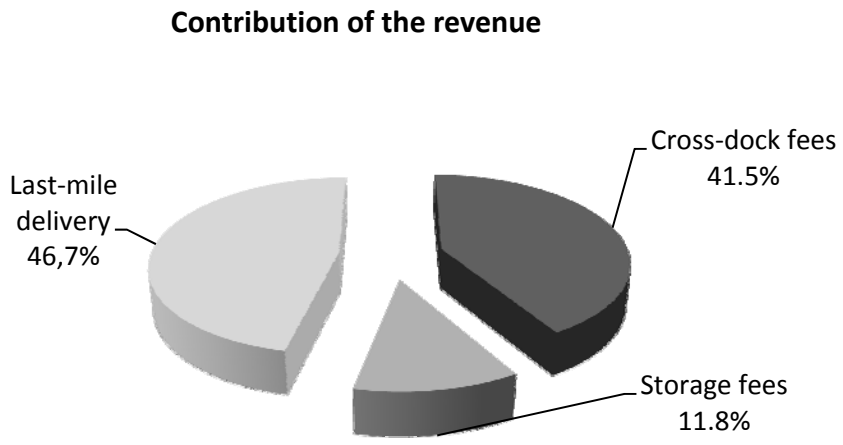

Figure 40: Contribution of various services to the revenue in the next 5 years in total

While studying composition of the operating costs, the staff expense plays a significant role, which takes up more than 75% of the total costs (see Figure 41). This is a result of the light asset investment policy, which leads to hiring many staff members to fulfil the manual jobs within the UCC. Of the staff expense, the expense of operators within the UCC makes up the largest proportion, which amounts to nearly 60%. The expense of truck drivers and load assistants for the last-mile delivery is 25% together of the total staff expense and the 2nd largest proportion. The rest of the expenses of team leaders, forklift drivers and manager, as well as the indirect staff expense account for 15% in total (see Figure 42).

In addition, the rent expense of warehouse space and the fuel expense are other important items of operating costs. The two items add up to 19% of the total value. Despite their small proportion, the expenses for leasing equipment, overheads, as well as purchasing and maintaining facilities and equipment shall not be neglected (see Figure 41).

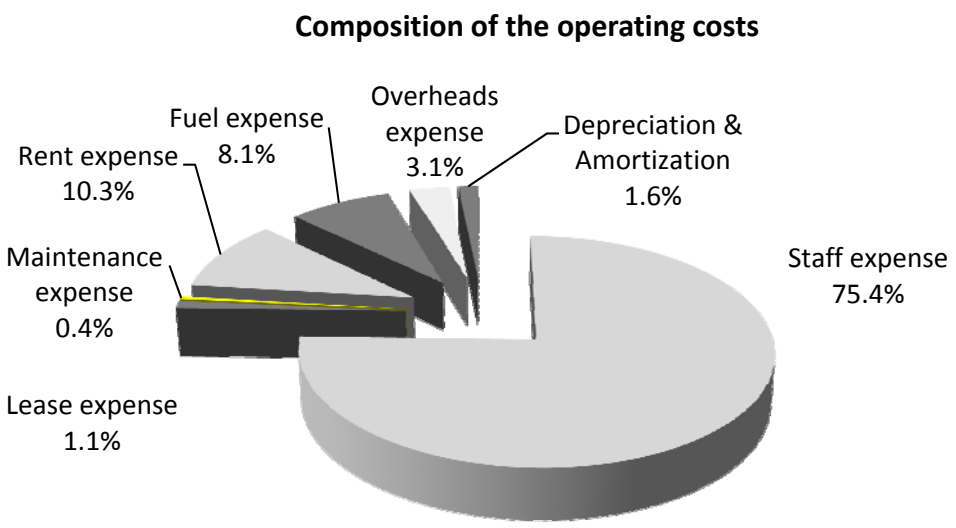

Figure 41: Composition of the operating costs in the next 5 years in total

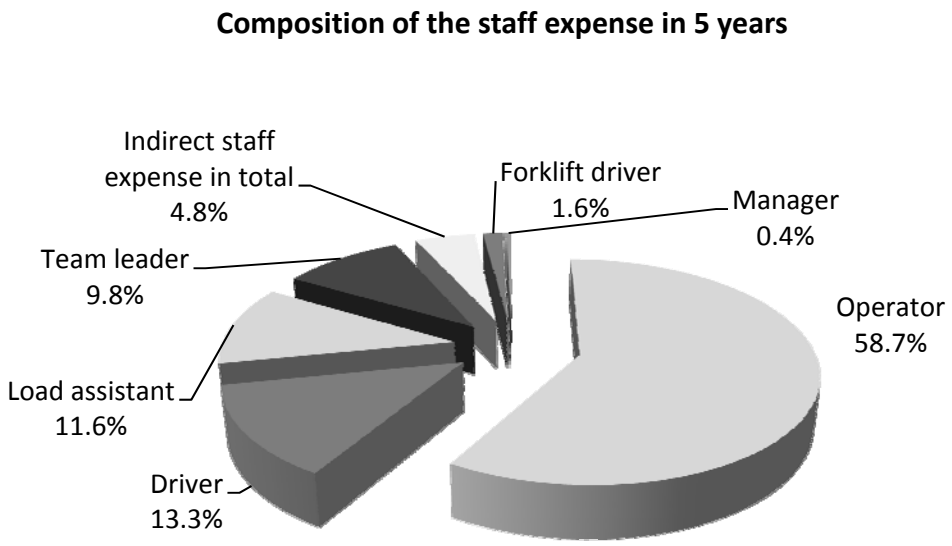

Figure 42: Composition of the staff expense in the next 5 years in total

Overall, the results of the BCA model are not that satisfactory because of the large amount of operating costs. So the commercial feasibility of implementing the UCC solution is quite doubtful based on the condition of the current value of all the assumed or proposed input parameters. In spite of this, the commercial numbers listed in Table 63 offer a positive signal that the net profit margin is expected to grow further as the revenue grows faster than the operating costs.

5.4.2. Sensitivity analysis

5.4.2.1. Introduction of the method

The values of input parameters of a model are often subject to change or error. Sensitivity analysis (SA) is broadly defined as the investigation of the effect of the potential change or error of a given input parameter on the output of the given model.[590] It is used for assessing how the output of a given model depends on the input parameters. It is an important method for ascertaining the sensitivity or robustness of the given model to variations in its input factors.[591]

SA is found to be useful in a wide range of literature. It can help make decisions or develop recommendations (e.g., through identifying critical values, thresholds or break-even values where the optimal strategy changes), communicate (e.g., through allowing decision makers to select assumptions), increase the understanding or quantification of the system (e.g., through developing hypotheses for testing), and develop models (e.g., through testing the model for validity or accuracy).[592] Above all, SA is considered as a powerful technique for understanding systems and particularly helpful for modelling systems with uncertainty. It is able to tell which of the parameters or inputs are the most important or likely to affect the behaviour and/or value of the model.[593]

SA is usually difficult and time consuming, because it requires a large amount of time, resources and patience to test exhaustively a great many variables.[594] The next section will therefore firstly review the model and the parameters that were introduced in section 5.3, and identify all the relative input parameters relevant to the profit and loss, and then use the SA method to examine how the change of these parameters' content affects the commercial results of the UCC solution.

5.4.2.2. Identification of key input parameters

Following the structure of the BCA model depicted in section 5.3.1, all the input parameters are grouped into five dependent variables including logistics volume, resource requirement, operating costs, revenue, business tax and governmental subsidy, although some input can influence more than one dependent variable[595]. The comprehensive list of input parameters is depicted in Table 64. The change of one input parameter's value can impact the output of its dependent variable either positively or negatively, which will continue to impact the net profit margin of the UCC solution. In total, thirty parameters are identified from the BCA model, which are coded according to the groups.

[590] See Saltelli et al. (2004), p 42-43.

[591] See Saltelli/Chan/Scott (2000), p.504.

[592] See Pannell (1997).

[593] See Smith et al. (2008).

[594] See Clemson et al. (1995).

[595] For instance, 2.9 – storage duration doesn't only impact the output of resource requirement, but also the logistics volume for storage.

Dependent variables		Input parameters	Serial number	Impact relationship
Logistics volume		Annual growth rate	1.1	+
		Ratio: value/m^3 goods	1.2	-
		% of volume requiring temporary storage	1.3	+
Resource requirement	Resources requirement for cross-dock	Turnaround time for cross-dock	2.1	+
		Capacity of warehouse space of cross-dock	2.2	-
		Productivity of logistics equipment, incl. counterbalance trucks and hand trucks	2.3	-
		Productivity of operators, team leaders & forklift drivers	2.4	-
	Resources requirement for storage	Capacity of warehouse space of storage	2.5	-
		Productivity of logistics equipment, incl. counterbalance trucks, reach trucks, hand trucks and trolleys	2.6	-
		Productivity of operators, team leaders & forklift drivers	2.7	-
		Storage duration	2.8	+
	Resources requirement for last-mile delivery	% of total volume carried by 2-tonne trucks	2.9	+
		Load factor	2.10	-
		Lead time per trip	2.11	+
		Work hour of trucks	2.12	-
		Staff productivity of drivers and loading assistants	2.13	-
Operating costs	Capex, and depreciation & amortisation	Facilities setup costs of cross-dock and warehouse	3.1	+
		Unit price of equipment of reach trucks and trolleys	3.2	+
		Unit price of 2-tonne and 5-tonne trucks	3.3	+
		Capex for WMS and TMS	3.4	+
		Depreciation policy for facilities, equipment, trucks and IT systems	3.5	**[596]
	Rent expense	Rent for warehouse space	3.6	+
	Lease expense	Unit lease of counterbalance trucks and reach trucks	3.7	+
	Maintenance expense	Logistics facilities, equipment, trucks as % of initial capex	3.8	+
	Fuel expense	Average fuel cost per km	3.9	+
	Overhead expense	Utility and other overhead expense as % of total revenue	3.10	+
	Staff expense	Salary for managers, team leaders, operators, forklift drivers, drivers and loading assistants	3.11	+
Revenue	Service tariff	Service tariff for cross-dock, storage and last-mile delivery	4.1	+
Business tax	Tax rate	Tax rate for transportation and logistics services	5.1	+
Governmental subsidy	Subsidy policy	Subsidy rate for facilities setup, warehouse space rent, trucks' procurement, and business operation	6.1	+

Table 64: List of input parameters

However, due to limited time and resources, it is impossible to examine the sensitive impacts of all the input parameters regarding the commercial result. An evaluation approach consisting of two criteria are hereby developed to quantify the relevance of the input parameters.

1) Significance, which refers to the importance of input parameters towards the commercial result.

[596] The impacts of depreciation policy on operating costs vary from one to another.

Explicated in section 5.4.1, all three kinds of service are important to the total revenue. The staff, rent and fuel expense are the three most significant parts of the operating costs. Therefore, the significance of all the relevant input parameters is ranked as medium or high. The significance of the rest parameters is then ranked as low.

2) Uncertainty, which refers to the potential to change the value of the input parameters.
   To some extent, one parameter's level of uncertainty depends on the reliability of the assumed value of the input parameters. The substitutability of one parameter can increase the uncertainty level.

A low, medium and high level is proposed to scale both criteria. All the listed input parameters are then evaluated and assigned to a certain category based on two criteria. As shown in Figure 43, the input parameters with an above-medium level of both significance and uncertainty are recognised as the most relevant parameters that will be further examined using the SA method in the next section. Two groups are listed in Table 65. Since the expense of operators is the largest part of the staff expense, the productivity of operators is chosen as representative parameters of 2.4 and 2.7. Since the service consists of four parts, 4.1 is then divided into 4.1.1 cross-dock fee, 4.1.2 storage fee, 4.1.3 last-mile delivery fee per 2-tonne truck, and 4.1.4 last-mile delivery fee per 5-tonne truck.

Dependent variables		Serial number	Input parameters	Significance	Uncertainty	Relevance level
Logistics volume		1.1	Annual growth rate	high	medium	Level 1
Resources requirement	Cross-dock	2.4	Productivity of operators	high	medium	
	Storage	2.7	Productivity of operators	high	medium	
	Last-mile delivery	2.9	% of total volume carried by 2-tonne trucks	medium	high	
		2.12	Work hour of trucks	medium	high	
Revenue	Service tariff	4.1.1	Cross-dock fee	High	medium	
		4.1.2	Storage fee	High	medium	
		4.1.3	Last-mile delivery fee per 2-tonne truck	High	Medium	
		4.1.4	Last-mile delivery fee per 5-tonne truck	High	Medium	
Logistics volume		1.3	% of volume requiring temporary storage	medium	medium	Level 2
Resource requirement	Storage	2.8	Storage duration	medium	medium	
Operating costs	Rent expense	3.6	Rent for warehouse space	medium	medium	
	Fuel expense	3.9	Average fuel cost per km	medium	medium	

Table 65: List of key input parameters

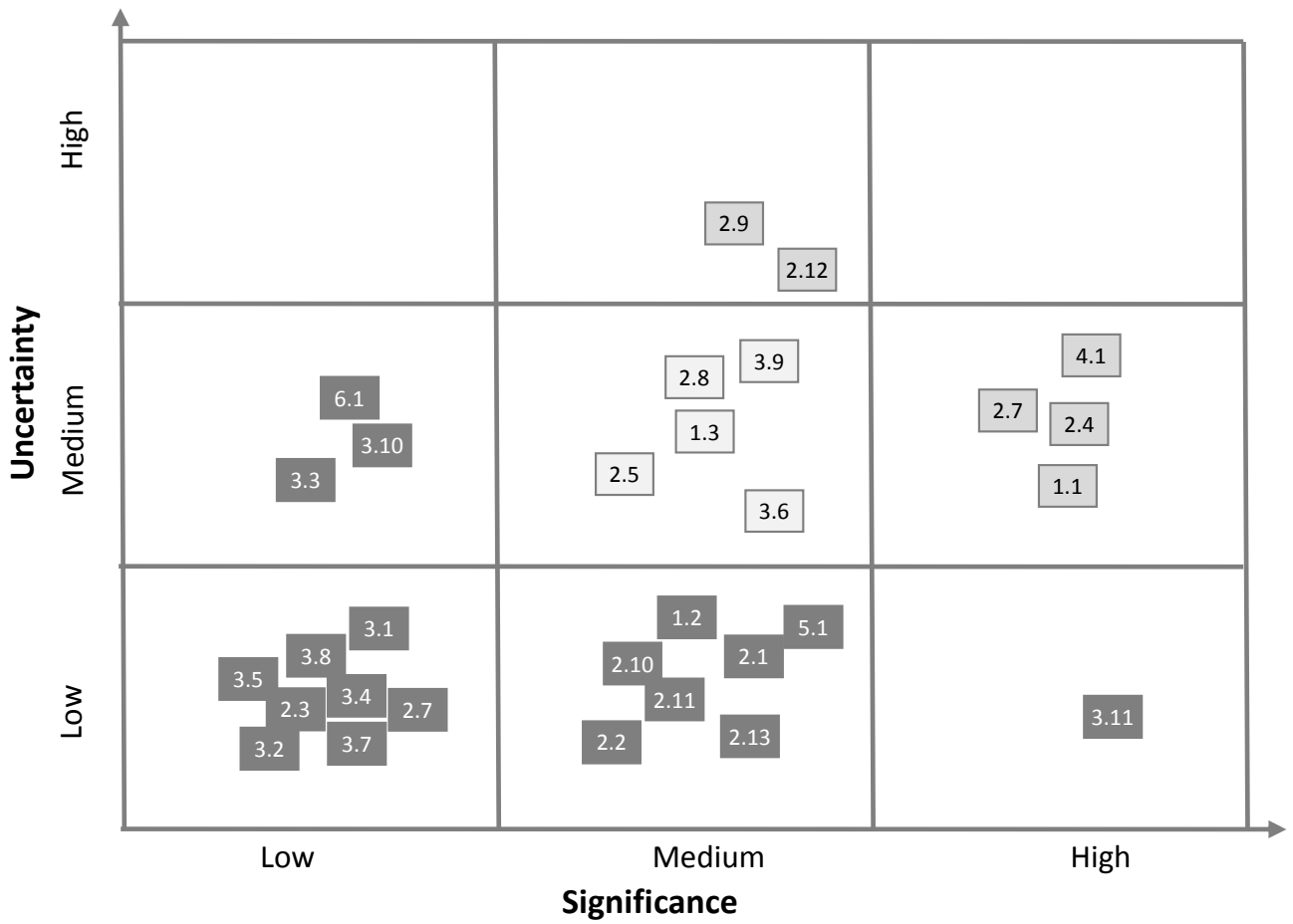

Figure 43: Identification of key input parameters[597]

5.4.2.3. Processing of SA results

It is supposed that the value of all the grouped input parameters changes from -30% to 30%. The net profit margin in total and net profit margin in year 5 are chosen as the final dependent variables.

SA of the group of level 1

Although the annual growth rate is expected to have the potential to impact the commercial outputs, Table 66 presented below reveals a converse result. The annual growth rate has a low level of sensitivity towards the net profit margin.

Change level	-30%	-20%	-10%	0%	10%	20%	30%
1.1 Annual growth rate	8.4%	9.6%	10.8%	12%	13.2%	14.4%	15.6%
Net profit margin in total	1.56%	1.16%	1.12%	0.92%	0.74%	0.54%	0.30%
Net profit in year 5	4.22%	3.70%	3.96%	3.99%	3.88%	3.69%	3.69%

Table 66: SA of annual growth rate

[597] In order to save space, the serial numbers of all the identified input parameters are used in Figure 43. Please refer to Table 65 to find the corresponding parameters.

As can be observed in Table 67 below, the productivity of operators for cross-dock and storage has a significant influence on net profit margin both in total and in year 5. The improvement of the operators' productivity can effectively increase the commercial feasibility of the UCC solution. Compared with the operators' productivity for storage, net profit margin is more sensitive to the change of operators' productivity for cross-dock.

	Change level	-30%	-20%	-10%	0%	10%	20%	30%
2.4	Net profit margin in total	-13.96%	-7.77%	-2.96%	0.92%	4.10%	6.71%	8.94%
2.7	Net profit margin in total	-6.49%	-3.40%	-1.00%	0.92%	2.47%	3.77%	4.92%
2.4	Net profit in year 5	-10.55%	-4.53%	0.19%	3.99%	7.09%	9.64%	11.82%
2.7	Net profit in year 5	-3.32%	-0.27%	2.09%	3.99%	5.47%	6.77%	7.88%

Table 67: SA of operators' productivity

Trucks with a larger load capacity are usually more economical and have a higher level of productivity. So the net profit margin will be increased if fewer goods can be allocated to 2-tonne trucks and more to 5-tonne trucks. However, the results summarised in Table 68 below reveal that the sensitivity level is still limited.

Change level	-30%	-20%	-10%	0%	10%	20%	30%
2.9 – % of total volume carried by 2-tonne trucks	35.00%	40.00%	45.00%	50.00%	55.00%	60.00%	65.00%
Net profit margin in total	1.74%	1.53%	1.24%	0.92%	0.69%	0.44%	0.13%
Net profit in year 5	4.66%	4.53%	4.23%	3.99%	3.70%	3.57%	3.19%

Table 68: SA of % of total volume carried by 2-tonne trucks

In the BCA model, it is assumed that the trucks will work 16 hours with 2 shifts every day. However, all freight vehicles are restricted in terms of entry to the city centre in Chengdu. In particular during peak hours, no trucks, even those with entry licenses, are allowed to utilise the urban roads to service their customers. This will actually limit the trucks' productivity and reduce the commercial feasibility (see the results of SA of trucks' working hours in Table 69). So it is extremely necessary to obtain the authority of entering the urban areas without any temporary restrictions.

Change level	-30%	-20%	-10%	0%	10%	20%	30%
2.12 Working hours of trucks	11.2	12.8	14.4	16.0	17.6	19.2	20.8
Net profit margin in total	-2.61%	-1.15%	-0.03%	0.92%	1.75%	2.42%	2.91%
Net profit in year 5	0.37%	1.94%	2.94%	3.99%	4.77%	5.41%	5.85%

Table 69: SA of trucks' working hours

As shown in Table 70, a very effective way to improve the UCC solution's commercial feasibility is to increase the service tariff, as all four types of service fees have a significant impact on net profit margin. Among them, the output of the net profit margin is the most sensitive to the change in cross-dock fee, followed by last-mile delivery fee per 2-tonne truck and 5-tonne truck. Nevertheless, it will on the other hand increase the difficulty of persuading the target supermarket company to become a customer.

	Change level	-30%	-20%	-10%	0%	10%	20%	30%
4.1.1	Net profit margin in total	-12.05%	-7.33%	-3.03%	0.92%	4.55%	7.91%	11.01%
4.1.2	Net profit margin in total	-2.42%	-1.28%	-0.17%	0.92%	1.98%	3.02%	4.03%
4.1.3	Net profit margin in total	-6.35%	-3.80%	-1.38%	0.92%	3.12%	5.21%	7.21%
4.1.4	Net profit margin in total	-5.82%	-3.47%	-1.22%	0.92%	2.97%	4.93%	6.81%
4.1.1	Net profit in year 5	-8.54%	-3.98%	0.18%	3.99%	7.50%	10.74%	13.74%
4.1.2	Net profit in year 5	0.77%	1.87%	2.94%	3.99%	5.02%	6.02%	7.00%
4.1.3	Net profit in year 5	-3.07%	-0.60%	1.75%	3.99%	6.12%	8.16%	10.10%
4.1.4	Net profit in year 5	-2.50%	-0.24%	1.93%	3.99%	5.97%	7.86%	9.67%

Table 70: SA of service tariff

Among all the input parameters in the group of level 1, the cross-dock fee and operators' productivity for cross-dock are the most significant parameters. A change in their values can lead to a dramatic climb or decline of the net profit margin. The impacts of annual growth rate and % of total volume carried by 2-tonne trucks on the commercial outputs are moderate. The results of SA of all input parameters of level 1 are depicted in Figure 44.

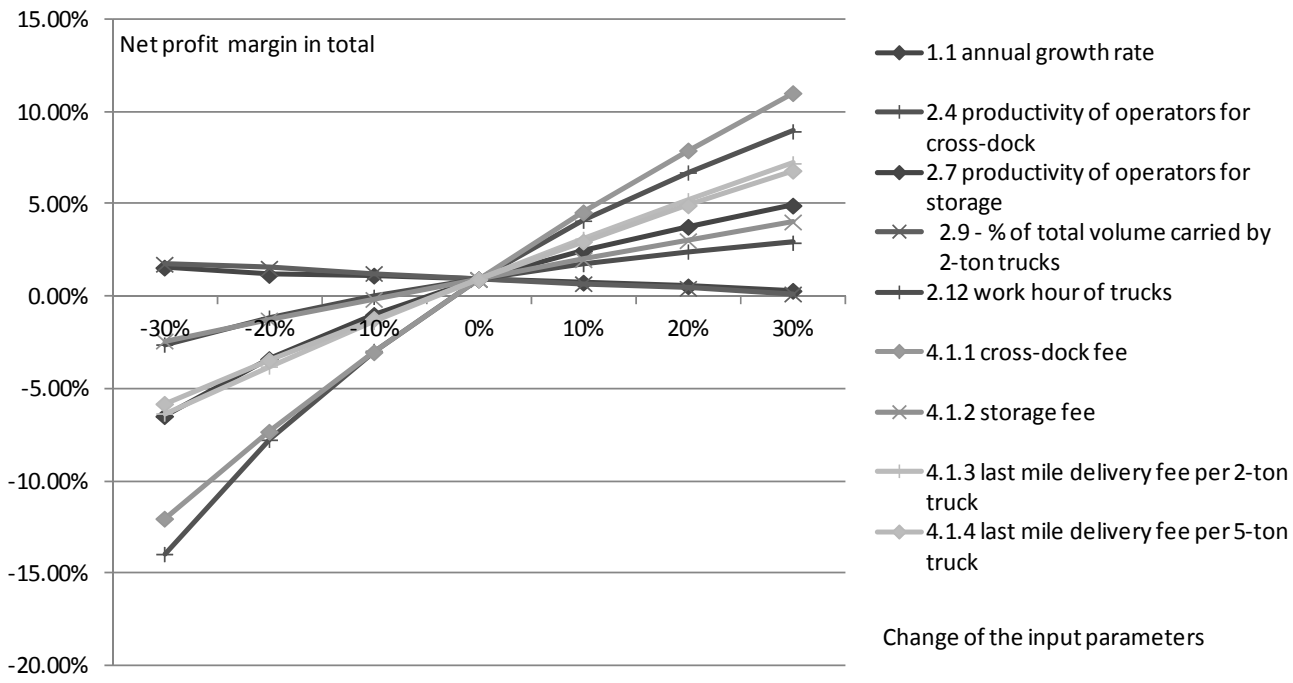

Figure 44: SA of the group of level 1

SA of the group of level 2

Compared with the input parameters in the group of level 1, those of the 2nd group are expected to have fewer impacts on a change of net profit margin. Presented in Figure 45 below, the change of storage duration has a positive impact on the change of output, while the other three parameters have a negative impact. On the subject of sensitivity level, the one for storage duration is moderate, whereas rent for warehouse space and average fuel cost per km is still higher and % of volume requiring temporary storage can have quite a significant impact on the change of net profit margin.

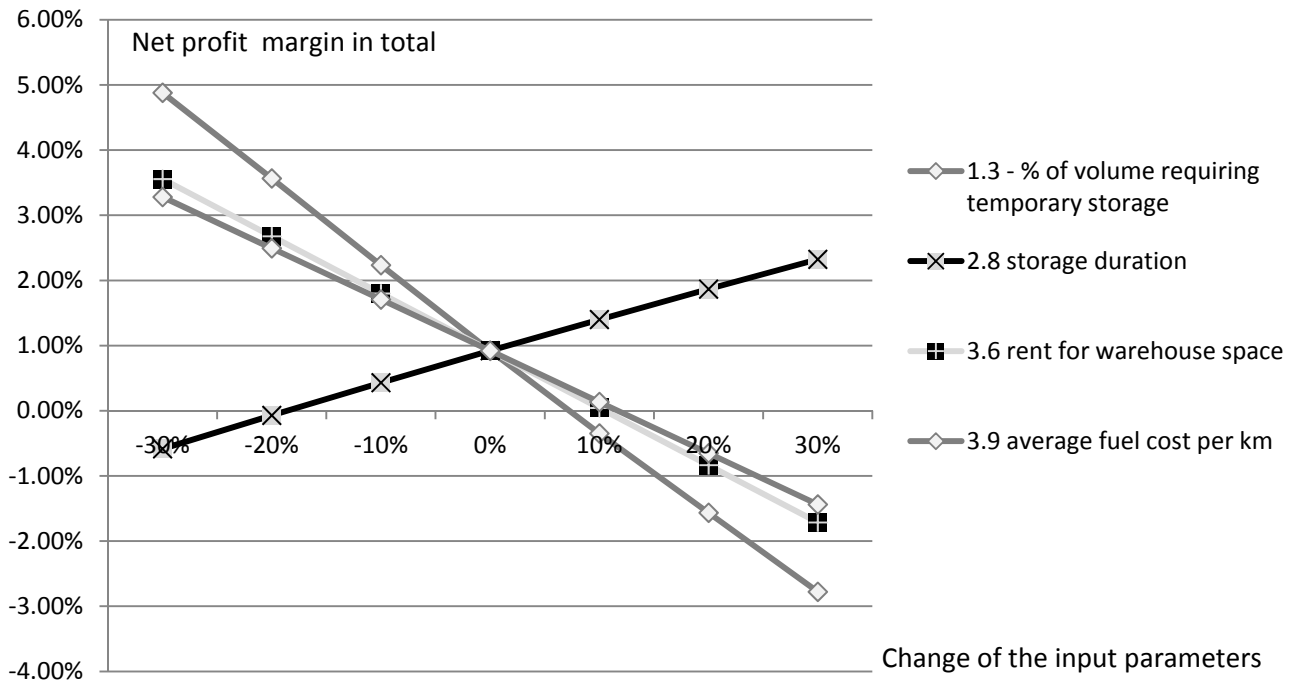

Figure 45: SA of the group of level 2

5.5. Discussions

5.5.1. Summary and conclusion

Taking advantage of the BCA approach, this chapter examines the commercial feasibility of the UCC solution. Before the generation of the BCA model, the UCC solution was first of all dissected into separate parts including demand estimation, operation process and dedicated resources, charging mechanism, investment policies and governmental support measures. Using the experience and expertise of LogChina in Chengdu, China and other regions, it assigned reliable values to all the relevant input parameters. The BCA model was then generated in the following section, using the values assumed previously, the logistics volume, all required resources, the operating costs, the total revenue, business tax as well as the governmental subsidy were estimated. After that, the profit and loss of the UCC solution was concluded. Net profit margin was chosen as the major index demonstrating the commercial feasibility. Beyond that, the SA approach was utilised to identify all the input parameters and their influence on the commercial result of the UCC. Summing up, the following can be concluded:

- The EBIT and net profit margin of the UCC solution continue to grow in the next 5 years. However, the results, namely the net profit figure (0.9%), yielded during the study, is lower than the predicted outcome. This reveals a questionable commercial feasibility of the UCC solution under the current conditions and the assumed value of all the input parameters.
- The operating costs represent the major barrier to the financial index becoming acceptable. Of the total costs, the staff expense plays the biggest role as a result of the light-asset investment policy.
- Even though the local municipality can assist with the implementation of the UCC through various means of subsidies, its total contribution is limited. However, its regulatory assistance of exempting the

freight vehicles of the UCC from any time restrictions is valuable, because this will improve the productivity of last-mile delivery and thereby reduce the cost burden.

- The commercial feasibility of the UCC solution depends on all kinds of input parameters. Compared to others, the input parameters of service tariff and productivity such as operators' productivity for cross-dock and storage are the most significant. The output of the UCC solution is quite sensitive to changes of these parameters. In addition, the rents for warehouse space and the average fuel cost per km are also important, as they are the major determinants of the rent and fuel expense.

5.5.2. Implications and future research

As the results discussed above are not quite positive, it is necessary to seek effective measurements to improve the commercial feasibility of the UCC solution. Implicated from the study carried out above, the following measurements are recommended:

- The net profit margin is quite sensitive to the change of service tariff, so increasing the service tariff will be an effective means to help the UCC solution commercially feasible. Under the current conditions, the total revenue of the UCC amounts to 2.2% of the served retailer's sales volume. This is still at a low level; however, it will make it more difficult for the supermarket company to become a customer.
- Improving productivity is another measurement to increase commercial feasibility. Through hiring professional employees and providing regular training opportunities, it can improve the operators' productivity and thus reduce the requirement towards human resources. To introduce automation equipment and technology is another means to improve productivity. It can on one side improve the operational efficiency and accuracy, and on the other side reduce the demand for human resources. However, the initial capital expenditure can be a challenge and may become risky if the demand of the supermarket company is not as stable as expected.
- Reducing operating costs will be a third means to increase the commercial feasibility. It is necessary to consider different staff policies such as labour dispatch or personnel leasing[598] because the staff expense is the largest part of the operating costs. Extending the contract period may become an effective means to reduce the monthly rent price of warehouse space. Thirdly, the fuel expense can be saved if the drivers can be trained and freight vehicles are equipped with power-saving technology. However, the rise of labour, property and fuel expense is a general challenge facing China's logistics industry.
- Training drivers and procuring trucks with advanced technology offer a fourth choice. Currently, each truck is assigned one driver and one assistant for each shift, which generates a large amount of staff expense. If the drivers were trained in how to load and unload goods with the assistance of automated machinery, it would substantially reduce the expense of staff wages through having to dedicate only a driver to each truck.
- The local municipality, as a major beneficiary of the UCC solution, is supposed and willing to assist in the implementation of the UCC solution. Indeed, both the local municipality and China's central government have allocated dedicated funding to subsidise the implementation of any innovative solutions. So more subsidies, in particular, for the initial phase will be effective.

Besides, more research and negotiations need to be completed before the UCC solution can be put into practice:

[598] See Standing Committee of the National People's Congress (2008).

- Although SuperRetailerChina is introduced as the target customer of the UCC solution, the input data provided the company are limited. It will thus be helpful to analyse the demand of all stores individually and arrange the required resources accordingly. This would then increase the reliability of the results of the study.
- The supermarket company and its suppliers will both benefit from the UCC solution. The former is expected to be the only customer of the UCC and to be charged for the services. It is thus necessary to detail and quantify their benefits separately, so that the services provided by the UCC can be charged for in a reasonable way.

6. Conclusion

This chapter first reviews the research questions raised at the beginning of the thesis. It then summarises the key findings and indicates implications for both research and practice. Finally the thesis concludes by addressing the limitations of the study and recommending relevant directions for future research.

6.1. Review of the research

City logistics is a young research area. It has experienced a period of over three decades of development since its conception in the last century. It is believed to have the potential to support the realisation of building up sustainable cities. After a successful development in the past three decades, China has been seeking a more healthy economic growth model that relies on urbanisation and domestic consumption. This is because one billion citizens are expected to be living in Chinese cities by 2030. Logistics is hereby given the mission to assist this transition by establishing a reliable goods supply, on one hand, and improving people's quality of life, on the other, so as to build sustainable urbanisation. This thesis thus addresses this issue aiming to answer the following question:

- Is the concept of city logistics suitable and applicable for China's cities to build up a sustainable urbanisation?

In order to provide a reliable answer to this question, a great amount of effort needs to be invested into finding a solution that also takes into consideration China and the particular environment and requirements of its cities. Above all, the attitudes and engagement of individual stakeholders, the users of city logistics services in particular, should be emphasised. Derived from this framework of analysis, this main research question is accordingly divided into five sub-questions, which are posed sequentially throughout this thesis and together provide a structured way to answer the main question:

1) Exploration of theory: What is the conceptual framework of city logistics?
2) Exploration of practice: What lessons were learned in the past decades from trials or implementations of city logistics solutions?
3) Country-level empirical study: What is the macro-environment of city logistics in China?
4) City-level empirical study: What is the visionary master plan of the city logistics system in Chengdu? Which factors influence users' participation and how do they impact their decisions?
5) Corporate-level empirical study: Is the solution of urban consolidation centre commercially durable?

6.2. Key findings and implications

The research is designed according to the structure of the sub-questions. The key findings and relevant implications derived from this thesis are summarised and presented in response to each sub-question respectively.

1) Theoretical exploration of city logistics:
   - The first sub-question was answered in the first two sections of Chapter 2, where city logistics was theoretically explored based on a conceptual framework including the concept of city logistics, its objectives, and the full range of objects served by city logistics as well as its characteristics. Further,

Chapter 2 reviewed city logistics from a systematic perspective and built up a city logistics system consisting of four sub-systems that are functionally related. Moreover, a city logistics system involves different kinds of stakeholders with different interests, which makes it more complex.

- In terms of implications, this part of the thesis firstly provides a sound theoretical foundation for cities and managers to capture the content of city logistics and understand how to develop it within its own context. Secondly, the systematic perspective requires cities and managers to view components of city logistics comprehensively rather than separately, taking the interests of different stakeholders into consideration.

2) Practical exploration of city logistics:
   - The second sub-question was answered in the last two sections of Chapter 2. Despite its short history, city logistics has attracted increasing attention and resources from both the public and private sector, in particular in developed countries. This resulted in a massive amount of effort being invested into searching for the best solutions needed to realise cities' ambitions of building up sustainability, which generated a great deal of valuable results. Using all the important available data sources, this part reviewed all the solutions of city logistics and reference cases. Furthermore, the UCC solution, due to its great potential to help a city build urban sustainability, was specifically elaborated in a comprehensive way. Worthwhile lessons regarding barriers and critical success factors were then concluded from over 100 reference cases and formed a base for the empirical study in Chengdu.
   - With respect to implications, the extensive overview of city logistics solutions as well as the reference cases summarised from the past thirty years provides Chinese cities and cities in other EME countries, which are looking for solutions to develop better city logistics,[599] with a comprehensive overview of city logistics, a snapshot of solutions and best practices, and recommendations regarding transferring the best practices.[600] In addition, the elaborate examination of the UCC solution, plus all the summarised barriers and critical successful factors, can be used as valuable expertise and experience for cities and managers considering an implementation of the UCC solution.[601]
3) Country-level empirical study – city logistics in China
   - Chapter 3 shifted the research from city logistics in general to China and answered the third sub-question. After the introduction of China as a representative EME country, the chapter investigated its macro-environment of city logistics development. In brief, city logistics faces a complex macro-environment that abounds with challenges and opportunities. Hereby a joint effort is desired from both the private and public sector to create more integrated, intelligent and sophisticated solutions rather than simple transport and storage of goods. These solutions should combine goods production, distribution and consumption in a shared work process to resolve the challenges facing the logistics industry. Moreover, they should reduce the complexity of the logistics process of consumer goods and overcome urban environmental restrictions, on one hand, and take advantage of the opportunities and satisfy cities' increasing demand in a sustainable way, on the other.

[599] See detailed implications in section 2.3.9.

[600] See section 2.3.6: such as the TURBLOG project.

[601] See details in section 2.4.3.2 and section 2.4.3.3.

- The development of city logistics is closely related to the macro-environment. The findings in this chapter provide a better understanding of the current state of city logistics and their impacts in China. The approach to investigate the macro-environment can be also used in similar research in other EME countries.

4) City-level empirical study – city logistics in Chengdu
   - The research in Chapter 4 was designed to answer the fourth sub-question. A situational analysis of city logistics using the SWOT approach was first conducted to identify Chengdu's internal strengths and weaknesses, as well as external opportunities and threats.[602] Based on the concluded findings and implications from the theoretical and practical exploration in Chapter 2, a visionary master plan developing a city logistics system was recommended for the city of Chengdu emphasising the importance of the evolution of operational models. Furthermore, an application of the methodology of PLS PM helped identify the key factors influencing retailers to use UCC services and quantify the causal effects of their inter-relationships.
   - With respect to the implications, the findings of Chengdu's situational analysis firstly provide managers with an elaborate investigation for developing city logistics. The approach can also be used for similar studies in other Chinese cities. Second, the findings of the study of PLS PM indicate that the decision of a retailer regarding the use of UCC services is a process influenced by multiple factors. Cities and managers should notice the difference of the effects of key factors and the moderated effect of other factors such as company size in order to take the right measures to implement the UCC solution successfully.[603]
5) Corporate-level empirical study – the commercial feasibility
   - Commercial factors have been identified as the primary reason for many UCC projects in past years. Chapter 5 addressed this issue and focused on exploring the commercial feasibility of the UCC solution from a corporate perspective using the approaches of BCA and SA. The results of the business case analysis reveal that the commercial feasibility of the UCC solution is questionable under the current conditions and the assumed value of all the input parameters, although the EBIT and net profit margin will continue to grow in the next 5 years. The operating costs, staff wages in particular, represent the major barrier, as the contribution of the various subsidies from local municipality is limited.
   - In regard to managerial implications, the BCA study helps cities and managers acknowledge the commercial feasibility of implementing the UCC solution in Chengdu and its influential factors together with their impacts. Although the results, namely the net profit figure (0.9%), yielded during the study, is lower than the predicted outcome, a series of measures have been recommended with the assistance of the SA study to increase profitability, such as improving productivity by introducing automation equipment and technology, increasing the amount of subsidies, etc.[604]

[602] See detailed findings in section 4.1.3.

[603] See detailed implications in section 4.3.4.2.

[604] See more information in section 5.5.2.

6.3. Limitations and future research

Like a great deal of other research in the field of social science, this study is also flawed and possesses limitations. This section indicates some of the limitations and recommends the directions for future research accordingly.

1) Focus on Chinese issues
   - This thesis was designed with the objectives to provide important implications for EME countries through conducting the empirical study in China and one of its cities. However, its contribution and value might be limited due to China's specific context and size.
   - Therefore, future research can take this into consideration and conduct similar studies in other EME countries and compare results in order to provide more representative knowledge and implications for cities and managers from EME countries.
2) Focus on the UCC solution
   - Although this thesis reviewed an extensive list of city logistics solutions and relevant reference cases, the deeper research including both the PLS PM study and BCA study were limited to the focus solution of UCC.
   - Therefore, it is recommended that future research could follow this direction and examine the possibility of applying other solutions in Chinese cities.
3) The study of factors influencing retailers to use UCC services
   - The empirical study was initiated using the technique of PLS PM for the first time to examine the key factors influencing retailers to use UCC services and their impacts. First, the list of key factors and their indicators may not be exhaustive due to the limited amount of available literature in this field. Second, this empirical study was conducted within the context of Chengdu. Its specific environment of developing city logistics may raise doubt regarding the reliability and validity of the results and findings in a more general condition. Third, the exploration of the moderated effect of retailer-related variables was limited to company size because of the statistical results of returned questionnaires. Finally, the study focused on retailers as the potential users of UCC services due to Chengdu's special situation. In a wider extent, other stakeholders of city logistics can also serve this role; these include transport companies, hotels or private e-business customers.
   - Thus, research effort in the future could be made either in a much wider context to employ more significant factors consistent for all contexts or in the direction of a deeper single context to seek some specific indicators that have been overlooked. Second, similar studies need to be conducted in other Chinese cities to investigate the results' ubiquity in China. Third, future research could also include company attributes such as sector attribute, legal ownership and operational model and examine their impacts on a retailer's decision process. Fourth, future research could focus on transport companies, hotels or private e-business customers as the users of UCC services.
4) The BCA study of the UCC solution
   - The conducted BCA study provides a better understanding of the commercial feasibility of the UCC solution from a corporate perspective. However, the results are still limited because of the limited data provided by the single target customer. In addition, the benefits of the suppliers were taken into consideration but not quantified. Moreover, the study was undertaken with the assumption of an operational model of a single user.

- Hence, future research could address these above-indicated limitations and deepen the study by analysing the demand of all stores individually so as to increase the reliability of the BCA results. Second, future research could try to involve suppliers and acquire necessary data to quantify their benefits by changing their operational models. In this way, they would be asked to share the costs of UCC services in a reasonable manner. Finally, future research could also consider a study based on a multi-user operational model. The results might be another direction for implementing a UCC.

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Appendix

Appendix 1: EC-funded city-logistics-related projects

Project	Full Name /Topic	Duration
COST 321	Urban goods transport	1994-1998
REFORM	Research on freight platforms and freight organization	1997-1998
FV-2000	Quality of Freight Village Structure and Operations	1998-1999
UTOPIA	Urban Transport: Options for Propulsion systems and Instruments for Analysis	1998-2000
IDIOMA	Innovative distribution with intermodal freight operation in metropolitan areas	1998-2001
PORTAL	Promotion Of Results in Transport ResearchAnd Learning	2000-2003
BESTUFS	Best Urban Freight Solutions	2000-2008
MOSCA	Decision Support System For Integrated Door-To-Door Delivery: Planning and Control in Logistic Chains	2001-2003
GIFTS	Global Intermodal Freight Transport System	2001-2004
e-DRUL	e-Commerce Enabled Demand Responsive Urban Logistics	2002-2004
CIVITAS	City-Vitality-Sustainability	2002-2016
CITY PORTS	Urban goods distribution	2003-2005
NICHES	New and Innovative Concepts for Helping European Transport Sustainability	2004-2007
FIDEUS	INTELLIGENT DELIVERY OF GOODS IN EUROPEAN URBAN SPACES	2005-2008
PROMIT	Promoting innovative intermodal freight transport	2006-2009
START	Short Term Actions to Reorganize Transport of Goods	2006-2009
SMART REIGHT	Smart freight transport in urban areas	2008-2011
SUGAR	Sustainable Urban Goods logistics Achieved by Regional and local policies	2009-2010
FREILOT	Urban freight energy efficiency pilot	2009-2011
C-LIEGE	Clean last mile transport and logistics management	2010-2013
TRAILBLAZER	TransportAnd Innovation Logistics by Local Authorities with a Zest for Efficiency and Realization	2010-2013
TURBLOG	Transferability of urban logistics concepts and practices from a worldwide perspective	2011-2013

Note: the projects are listed according to the start year.

Appendix 2: Overview of CIVITAS projects

Projects phase	Project name	Topic	Included cities
CIVITAS PLUS II (2012 – 2016)	CIVITAS DYN@MO	DYNamic citizens @ctive for sustainable Mobility	Aachen, Gdynia, Koprivnica, Palma
	CIVITAS 2MOVE2	New forms of sustainable urban transport and mobility	Stuttgart, Brno, Malaga, Tel Aviv – Yafo
CIVITAS PLUS (2008 – 2012)	CIVITAS ARCHIMEDES	Achieving Real CHange with Innovative transport MEasures Demonstrating Energy Savings	Aalborg, Brighton & Hove, San Sebastian, Iasi, Monza, Usti-nad-Labem
	CIVITAS ELAN	Mobilising citizens for vital cities	Ljubljana, Gent, Zagreb, Porto, Brno
	CIVITAS MIMOSA	Making Innovation in MObility and Sustainable Actions	Bologna, Funchal, Utrecht, Gdansk, Tallinn
	CIVITAS MODERN	Mobility, Development and Energy use Reduction	Craiova, Brescia, Coimbra, Vitoria-Gasteiz
	CIVITAS RENAISSANCE	Testing Innovative Strategies for Clean Urban Transport for historic European cities	Perugia, Bath, Gorna-Oryahovitsa, Szczecinek, Skopje
CIVITAS II (2005 – 2009)	CIVITAS SUCCESS	Smaller Urban Communities in CIVITAS for Environmentally Sustainable Solutions	Preston, La Rochelle, Ploiesti
	CIVITAS CARAVEL	Travelling Towards a New Mobility	Geneva, Kraków, Burgos, Stuttgart
	CIVITAS MOBILIS	Demonstrate the added value of developing and implementing broad integrated packages of policies and measures	Toulouse, Debrecen, Venezia, Odense, Ljubljana
	CIVITAS SMILE	Towards Sustainable Mobility for People in Urban Areas	Norwich, Suceava, Potenza, Malmö, Tallinn
CIVITAS I (2002 – 2006)	CIVITAS MIRACLES	Multi-Initiative for Rationalised Accessibility and Clean Liveable Environments	Barcelona, Cork, Winchester, Roma
	CIVITAS TELLUS	Transport and Environment Alliance for Urban Sustainability	Rotterdam, Berlin, Gothenburg, Gdynia, Bucharest
	CIVITAS VIVALDI	Visionary and Vibrant Actions through Local Transport Demonstration Initiatives	Nantes, Bristol, Bremen, Kaunas, Aalborg
	CIVITAS TRENDSETTER	Ameliorate urban air quality and reduce noise levels and congestion while supporting sustainable mobility and improving quality of life	Lille, Prague, Graz, Stockholm, Pécs

Appendix 3: Overview of all the UCC projects

City	Country	Phase	Period	Start	Name of concept	Status	Data source
Graz	Austria	Feasibility	2000s	2000	UCC Styrialog in Cargo Center Graz	n.a.	BESTUFS2_D2.3 p1 (2007)
Salzburg	Austria	Feasibility	2000s	2001	City Logistik Salzburg	n.a.	BESTUFS2_D2.3 p1 (2007)
Brussels 1	Belgium	Feasibility	1990s	1998	n.a.	n.a.	Panero/Shin/Lopez (2011)
Brussels 2	Belgium	Operational	n.g.	n.g.	Colruyt centralised storage and distribution centre (retail chain, Halle)	ongoing	BESTUFS2_D2.3 p1 (2007)
Belo Horizonte	Brazil	Feasibility	2010+	2011	n.a.	n.a.	De Oliveira et al. (2012)
Vancouver	Canada	Feasibility	pre-1990	mid-1970s	n.a.	n.a.	Browne et al. (2005)
Beijing	China	Operational	2000s	2005	Beijing Tobacco Logistics Centre	ongoing	TURBLOG_D3.7 (2011)
Arras	France	Feasibility	1990s	1990s	n.a.	n.a.	Panero/Shin/Lopez (2011)
Bordeaux	France	Feasibility	1990s	1990s	n.a.	n.a.	Browne et al. (2005)
Dijon	France	Feasibility	1990s	1990s	n.a.	n.a.	Browne et al. (2005)
La Rochelle	France	Operational	2000s	2001	Elcidis urban consolidation centre	ongoing	SUGAR (2011)
Lille	France	Feasibility	1990s	1990s	n.a.	n.a.	Browne et al. (2005)
Marseilles	France	Feasibility	1990s	1990s	n.a.	n.a.	Panero/Shin/Lopez (2011)
Paris 1	France	Pilot	pre-1990	1967-69	n.a.	n.a.	Browne et al. (2005)
Paris 2	France	Operational	2000s	2003	La Petite Reine	ongoing	Browne et al. (2005)
Toulouse	France	Feasibility	2000s	2005-2007	Clean urban logistics & goods distribution platform	n.a.	BESTUFS2_D2.3 p1 (2007)
Aachen	Germany	Operational	1990s	1997-2008	City-Logistik	stopped	C-LIEGE (2013b)
Augsburg	Germany	Operational	2000s	2006-2010	City-Logistik	stopped	Eibner (2012)
Berlin - Const	Germany	Operational	1990s	1992	Potsdamer construction	stopped	BESTUFS2_D2.3 p1 (2007)
Berlin 1	Germany	Operational	1990s	1994-2000	Kooperation Berliner Speditionen	stopped	Browne et al. (2005)
Berlin 2	Germany	Operational	2000s	2002	Establishing an inner-city logistics centre	ongoing	C-LIEGE (2013b)

Bremen	Germany	Operational	1990s	1990-2009	City Logistik	stopped	C-LIEGE (2013b)
Cologne	Germany	Operational	1990s	1994	n.a.	stopped	Panero/Shin/Lopez (2011)
Dusseldorf	Germany	Operational	1990s	1997-2001	Düsseldorf-Süd: Stadtlogistik	stopped	Wirtschaftsverkehr in Ballungsräumen (2013)
Essen	Germany	Operational	1990s	1997	Stadtlogistik Essen	stopped	BESTUFS2_D2.3 p1 (2007)
Frankfurt	Germany	Operational	1990s	1995	CITY LOGISTIC GmbH	stopped	Browne et al. (2005)
Freiburg	Germany	Operational	1990s	1993-97	City-Logistik	stopped	Panero/Shin/Lopez (2011)
Kassel	Germany	Operational	1990s	1994-2005	City Logistik	stopped	BESTUFS2_D2.3 p1 (2007)
Munich	Germany	Operational	1990s	1993	Ökologistik/Münchener Modell	stopped	Logistik Heute (2013)
Münster	Germany	Operational	1990s	1995-2000	CityMobil - Citylogistik Münster GmbH & Co	stopped	Eibner (2012)
Nuremburg	Germany	Operational	1990s	1996	ISOLDE (Innerstädtischer Service mit Optimierten Logistischen Dienstleistungen für den Einzelhandel)	ongoing	Van Rooijen/Quak(2010
Regensburg	Germany	Operational	1990s	1998-2012	REGLOG	stopped	RegLog (2012)
Stuttgart	Germany	Operational	1990s	1994-2002	City-Logistik	stopped	Panero/Shin/Lopez (2011)
Ulm	Germany	Operational	1990s	1995	n.a.	stopped	Panero/Shin/Lopez (2011)
Ferrara	Italy	Operational	2000s	2002	Coopser EcoPorto	ongoing	Browne et al. (2005)
Genoa	Italy	Pilot	2000s	2003-2010	n.a.	stopped	Gonalex-Feliu/Morana (2010)
Lucca	Italy	Operational	2000s	2007	Centre for Eco-Friendly City Freight Distribution (CEMD)	ongoing	SUGAR (2011)
Padua	Italy	Operational	2000s	2004	Cityporto	ongoing	SUGAR (2011)
Parma	Italy	Operational	2000s	2008	Ecologistics Parma	ongoing	SUGAR (2011)
Ravenna	Italy	Operational	2000s	2009	CONSAR: OBI/van-sharing	ongoing	START (2009)
Siena	Italy	Operational	1990s	1999	Urban Distribution Centre	ongoing	Browne et al. (2005)
Vicenza	Italy	Operational	2000s	2005	eco-logistic hub/UCC	ongoing	Browne et al. (2005)
Fukuoka	Japan	Operational	pre-1990	1978	Tenjin Joint Distribution System	ongoing	BESTUFS2_D2.3 p1 (2007)
Osaka	Japan	Pilot	n.g.	n.g.	n.a.	n.a.	Browne et al. (2005)

Tokyo 1	Japan	Operational	1990s	1992	Shinjuku joint delivery system	ongoing	TURBLOG_D3.6 (2011)
Tokyo 2	Japan	Pilot	2000s	2002	Marunouchi/Co-operative Distribution System	n.a.	Browne et al. (2005)
Tokyo 3	Japan	Feasibility	2010+	2011	n.a.	n.a.	Akiyama/Yano (2012)
Yokohama	Japan	Operational	2000s	2004	Motomachi urban consolidation center	ongoing	SUGAR (2011)
Riga	Latvia	Feasibility	2000s	2006-2009	Consolidation of deliveries	n.a.	START (2009)
Monaco	Monaco	Operational	pre-1990	1989	Plate-forme de frêt de Fontvieille	ongoing	BESTUFS2_D2.3 p1 (2007)
Amsterdam	Netherlands	Operational	1990s	1996	Licensed	stopped	Gonalex-Feliu/Morana (2010)
Arnhem	Netherlands	Pilot	pre-1990	1989	n.a.	n.a.	Browne et al. (2005)
Dutch cities (Nijmegen)	Netherlands	Operational	2000s	2008	Binnenstadservice.nl (BSS)	ongoing	SUGAR (2011)
Groningen	Netherlands	Operational	1990s	1995	Licensed	ongoing	BESTUFS2_D2.3 p1 (2007)
Hague	Netherlands	Pilot	2000s	2002	n.a.	n.a.	Browne et al. (2005)
Leiden	Netherlands	Operational	1990s	1997-2002	Stadsdistributiecentrum Leiden BV/Licensed	stopped	BESTUFS2_D2.3 p1 (2007)
Maastricht	Netherlands	Pilot	1990s	1991	Licensed	n.a.	Browne et al. (2005)
Utrecht	Netherlands	Operational	1990s	1994	Licensed/CDCs: GLS/DHL	ongoing	TURBLOG_D3.2 (2011)
Westpomeranian Region	Poland	Feasibility	2000s	2010-2011	n.a.	n.a.	Kijewska/Iwan/Kaczmarczyk (2012)
Evora	Portugal	Pilot	2000s	2000	Ecoefficient Distribution	n.a.	Browne et al. (2005)
Ljubljana	Slovenia	Pilot	2000s	2008-2012	Consolidation of deliveries	n.a.	START (2009)
Barcelona	Spain	Feasibility	2010+	2011	n.a.	n.a.	Roca-Riu/Estrada (2012)
Donostia	Spain	Feasibility	2000s	2008-2012	City distribution with cargo bikes, efficient goods distribution	n.a.	C-LIEGE (2013b)
Malaga	Spain	Operational	2000s	2002	Calle Camas	ongoing	BESTUFS2_D2.3 p1 (2007)
Vitoria-Gasteiz	Spain	Feasibility	2000s	2008-2012	Urban Freight Logistics	n.a.	C-LIEGE (2013b)

Borlänge	Sweden	Operational	2000s	2000	Consolidate food deliveries, public procurment municipalities of Gagnef, Säter, Borlänge, Falun, Ludvika	ongoing	TRAILBLAZER_O2.1 (2010c)
Goeteborg 1	Sweden	Pilot	1990s	1996-1998	n.a.	n.a.	Browne et al. (2005)
Goeteborg 2	Sweden	Operational	2000s	2009	Consolidation of deliveries	ongoing	START (2009)
Stockholm - Const	Sweden	Operational	2000s	2001	Hammarby Sjöstad	ongoing	BESTUFS2_D2.3 p1 (2007)
Stockholm - Old Town	Sweden	Operational	2000s	2006	Logistics centre for old town/Home2You	ongoing	C-LIEGE (2013b)
Uppsala	Sweden	Feasibility	2000s	2001	n.a.	n.a.	Browne et al. (2005)
Western Sweden	Sweden	Feasibility	2010+	2011	n.a.	n.a.	Olsson/Woxenius (2012)
Basel	Switzerland	Pilot	1990s	1993-1994	Basel City Logistik	stopped	BESTUFS2_D2.3 p1 (2007)
Schaffhausen	Switzerland	Operational	1990s	late 1990s	City Logistik Schaffhausen	n.a.	BESTUFS2_D2.3 p1 (2007)
Thun	Switzerland	Operational	2000s	2000	SpediThun	ongoing	SUGAR (2011)
Zurich	Switzerland	Pilot	1990s	1994	n.a.	n.a.	Browne et al. (2005)
Aberdeen	UK	Feasibility	1990s	1997	n.a.	n.a.	Browne et al. (2005)
Barnsley	UK	Feasibility	pre-1990	1976	n.a.	n.a.	Browne et al. (2005)
Bath	UK	Operational	2010+	2011	Freight Transhipment	ongoing	C-LIEGE (2013b)
Bradford	UK	Feasibility	pre-1990	1975	n.a.	n.a.	Browne et al. (2005)
Bristol	UK	Operational	2000s	2004	Consolidation of deliveries to Bristol city centre	ongoing	TRAILBLAZER_O2.1 (2010b)
Camberley	UK	Feasibility	pre-1990	1975	n.a.	n.a.	Browne et al. (2005)
Chester	UK	Feasibility	1990s	1997	n.a.	n.a.	Browne et al. (2005)
Chichester	UK	Feasibility	pre-1990	1975	n.a.	n.a.	Browne et al. (2005)
East Midlands Airport	UK	Operational	2000s	2000s	Airport consolidation	ongoing	Lewis/Fell/Palmer (2010)
Hammersmith	UK	Feasibility	pre-1990	1974	n.a.	n.a.	Browne et al. (2005)
Hull	UK	Feasibility	pre-1990	1976	n.a.	n.a.	Browne et al. (2005)

Kent - Bluewater	UK	Operational	2000s	2002	Blutewater shopping centre, Greenhithe	ongoing	Lewis/Fell/Palmer (2010)
London	UK	Feasibility	1990s	1997	City study	n.a.	Browne et al. (2005)
London -Heathrow Const	UK	Operational	2000s	2006-2009	London construction consolidation center	stopped	SUGAR (2011)
London – Regent Street	UK	Operational	2000s	2009	Regen Street Consolidation: Clipper/ARUP	ongoing	Lewis/Fell/Palmer (2010)
London - Heathrow Retail	UK	Operational	2000s	2001	Heathrow Airport Consolidation Centre	ongoing	BESTUFS2_D2.3 p1 (2007)
Manchester Airport	UK	Operational	2000s	2006	LSP: Norbert Dentressangle	ongoing	Lewis/Fell/Palmer (2010)
Newcastle	UK	Operational	2010+	2011	Tyne and Wear Freight Consolidation Centre	ongoing	C-LIEGE (2013b)
Norwich	UK	Operational	2000s	2008	Urban Freight Consolidation Centre	ongoing	Lewis/Fell/Palmer (2010)
Sheffield	UK	Operational	2000s	2001	Meadowhall Shopping Centre/Clipper Logistics	ongoing	Lewis/Fell/Palmer (2010)
Swindon	UK	Feasibility	pre-1990	1976	n.a.	n.a.	Browne et al. (2005)
Winchester	UK	Feasibility	1990s	1994	n.a.	n.a.	Browne et al. (2005)
Worcester	UK	Feasibility	pre-1990	1980s	n.a.	n.a.	Browne et al. (2005)
York	UK	Operational	n.g.	n.g.	Cyclone Couriers	stopped	BESTUFS2_D2.3 p1 (2007)
Columbus (Ohio)	USA	Feasibility	pre-1990	1972	n.a.	n.a.	Browne et al. (2005)
New York City	USA	Feasibility	2010+	2011	n.a.	n.a.	Panero/Shin/Lopez (2011)

Note: “n.a.” stands for not applicable; “n.g.” stands for not given.

Appendix 4: Survey questionnaire

Chengdu City Logistics Planning Research
—— A Survey to Retail Companies

This **RESEARCH** is conducted in the name of Chengdu Logistics Office and Chengdu Commerce Bureau. The survey aims to

- Acknowledge current situation of logistics development of the retail industry in Chengdu
- Include the findings to design the overall planning of city logistics in Chengdu
- Meet the increasing requirements of the retail industry on city logistics services

The **PARTICIPANTS** of this survey focus on retailers that have business in the city of Chengdu. It will last 20-30 minutes to complete the questionnaire.

Please send the filled-out questionnaires back to us before December 01st, 2012

- Email to: dany1987e4@gmail.com
- Fax to 028-61886116

If you need our assistance，please contact:

- *Research Team: Mr. Ma, 13917025255*
- *Chengdu Logistics Office: Mr. Deng, 028-61886112*
- *Chengdu Commerce Bureau: Mr. Ye, 028-61883693*

- CONFIDENTIALITY – All responses to the Questionnaire are considered extremely sensitive and confidential and will not be disclosed beyond the research team. Subsequent distribution of feedback reports, research, and benchmarking exercises for the benefit of the participants will incorporate statistical averages and trend curves to keep participant anonymity. The research team guarantees that no individual company data will be revealed. For this purpose, we separate this page from the questionnaire. Your contact data is only needed to send you the results of this study.

Name		**Mr.** ☐ **Ms.**☐
Position		
Department		
Company		
Tel.		
Email		

Thank you very much for completing the questionnaire!

1. Basic information

1.1. Which sector does your company belong to (please use the criterion of Chengdu Commerce Bureau)?

Automotive outlets	Convenience stores & supermarkets	Department stores	Electronics	Catering	Fashion & apparel stores	Furniture stores	Home appliances stores	Pharmacies	Others, pls. specify
☐	☐	☐	☐	☐	☐	☐	☐	☐	

1.2. What is the legal statement of your company?

Chinese enterprise	Joint venture	Wholly foreign-owned enterprise	Others, please specify
☐	☐	☐	

1.3. What is your annual sales revenue of last finance year (in RMB)

Less than 10 million	10 million-100 million	100 million-500 million	500 million-2 billion	More than 2 billion
☐	☐	☐	☐	☐

1.4. How much does your sales revenue in urban areas (including the six districts of Jinniu, Chengdhua, Wuhou, Gaoxin, Jinjiang and Qingyang) to the total in the city of Chengdu?

<20%	20%-40%	40%-60%	60%-80%	80%-100%
☐	☐	☐	☐	☐

1.5. What is your expectation of your sales growth rate in the next 3-5 years?

<0%	0%-10%	10%-30%	30%-50%	>50%
☐	☐	☐	☐	☐

1.6. Do you have any plans to open new stores in Chengdu? (Please specify the amount in each area)

No	Yes (Please specify the amount of new stores)		
	Within the 3rd Ring Rod	Between the 3rd Ring Road and City Ring	Outside the City Ring
☐			

1.7. How many employees do you have in your company?

<100	100-500	500-1000	1000-2000	>2000
☐	☐	☐	☐	☐

1.8. What is the ratio of your logistics / sales revenues in last finance year? (The logistics cost includes the expense given to transport, warehouse and related management)

<3%	3-5%	5-10%	10-15%	>15%
☐	☐	☐	☐	☐

1.9. What do you expect the ratio of logistics cost / sales revenue to develop in the next 3-5 years?

Decrease (<-20%)	Slightly decrease (between -20% and -5%)	Neutral (between -5% and -5%)	Slightly increase (between 5% and 20%)	Increase (>20%)
☐	☐	☐	☐	☐

2. Current situation of logistics activities

2.1. What are your current operational models of logistics activities?

	Outsourcing	In-house	Supplier take the responsibility	Mixed
Goods storage	☐	☐	☐	☐
Transportation	☐	☐	☐	☐

2.2. What is your distribution frequency?

More than once/day	Once/day	Several times/week (2-6)	Once/week	Once/several weeks
☐	☐	☐	☐	☐

2.3. What is your distribution model?

Milk-run (Distribution centre - outlets)	Point to point (Distribution center – one single outlet	Mixed
☐	☐	☐

2.4. What is the load factor of your current transportation on average?

<50%	50%-75%	75%-90%	90%-100%	100%
☐	☐	☐	☐	☐

2.5. Do you have any demand on reverse logistics (e.g., goods return or repair)?

No	Occasional (1-3 times / week)	Frequent (> 4 times/week)
☐	☐	☐

2.6. Satisfaction of the performance of current logistics services

	Satisfactory level				
	Very low	Low	Neutral	High	Very high
Are your satisfactory with the performance of your logistics?	☐	☐	☐	☐	☐
Will your current model satisfy your requirements in next 3-5 years?	☐	☐	☐	☐	☐

2.6.1. Areas to improve – Goods storage

	Satisfactory level				
	Very low	Low	Neutral	High	Very high
Inventory turnover	☐	☐	☐	☐	☐
Accuracy of goods storage	☐	☐	☐	☐	☐
Accuracy of goods pick-up	☐	☐	☐	☐	☐
Response to consumer complaints	☐	☐	☐	☐	☐
Utilisation rate of warehouse space	☐	☐	☐	☐	☐
Cost	☐	☐	☐	☐	☐
Accident rate	☐	☐	☐	☐	☐

2.6.2. Areas to improve – Transportation

	Satisfactory level				
	Very low	Low	Neutral	High	Very high
Delivery punctuality	☐	☐	☐	☐	☐
Goods accuracy	☐	☐	☐	☐	☐
Response to consumer complaints	☐	☐	☐	☐	☐
Cost	☐	☐	☐	☐	☐
Rate of damaged goods	☐	☐	☐	☐	☐

2.7. Impacts of access restriction regulations

	Possibility				
	Very low	Low	Neutral	High	Very high
Will they increase your logistics cost?	☐	☐	☐	☐	☐
Will they hurt the service quality?	☐	☐	☐	☐	☐
Will they reduce the service reliability?	☐	☐	☐	☐	☐

3. Urban Consolidation Centre (UCC) Services

3.1. Brief introduction

- The solution of Urban Consolidation Centre (UCC) is an innovative solution aiming to increase the operational efficiency of city logistics through consolidating numerous goods shipments from different suppliers.
- The UCCs are planned to be located in Chengdu's Logistics Parks (XINDU, LONGQUAN, SHUANGLIU, XINJIN and QINGBAIJIA). Your goods will be first unloaded to the UCCs and delivered by standard freight vehicles to your stores in the city of Chengdu according your required delivery window.
- The range of services consists of the primary part (goods storage and transportation) and value-added part before and after sales (e.g., removal of packaging, pricing/labelling, or products return and recycling).
- The UCCs are expected to be operated by professional logistics service providers with the support of Chengdu Municipality Government to reduce your logistics cost and improve the service quality in a sustainable way.

3.2. Strategic fit of the UCC services with your strategies

	Importance				
	Very low	Low	Neutral	High	Very high
The use of UCC services is strategically fit with our corporate and competitive strategy	☐	☐	☐	☐	☐
The use of UCC services is strategically fit with our logistics and supply chain strategy	☐	☐	☐	☐	☐
The use of UCC services is strategically fit with our sustainable development	☐	☐	☐	☐	☐

3.3. Value perceived of UCC services (Please specify the importance of following attributes of the UCC services)

	Importance				
	Very low	Low	Neutral	High	Very high
Lower service price (price for both transport and storage)	☐	☐	☐	☐	☐
Better service quality (e.g., shorter lead time, less broken goods)	☐	☐	☐	☐	☐
More reliable service (e.g., more punctual)	☐	☐	☐	☐	☐
More added-value through innovation and employment of advanced technologies	☐	☐	☐	☐	☐
Lower service price (price for both transport and storage)	☐	☐	☐	☐	☐
Better service quality (e.g., shorter lead time, less broken goods)	☐	☐	☐	☐	☐

3.4. Governmental support measures (Please specify the possibility of following statements)

	Possibility				
	Very low	Low	Neutral	High	Very high
They will help reduce the service cost?	☐	☐	☐	☐	☐
They will help improve the service quality?	☐	☐	☐	☐	☐
They will help increase the service reliability?	☐	☐	☐	☐	☐

4. Willingness to use UCC services and impacts of governmental incentives

4.1. Willingness to use UCC services (Please specify your intention)

	Intention				
	Very low	Low	Neutral	High	Very high
I have interest in discussion (e.g., feasibility study)	☐	☐	☐	☐	☐
I intend to become the customer of UCC when it is implemented	☐	☐	☐	☐	☐

4.2. Impacts of governmental incentives (Please specify the importance of the following governmental incentives)

	Importance				
	Very low	Low	Neutral	High	Very high
Financial subsidy for the usage of UCC services	☐	☐	☐	☐	☐
Preferential policies for business expansion	☐	☐	☐	☐	☐

Thank you very much for completing the questionnaire!

Appendix 5: Actual situation of city logistics in Chengdu


-0505

Note: pictures were taken in September, 2013 in Chengdu.

Declaration of Honor

I hereby confirm on my honor that the doctoral thesis submitted herewith is my own work.

All resources and aids that are used in my thesis have been cited according to the rule for academic work and by means of footnotes or other precise indications of source.

The academic work has not been submitted to any other examination authority.

Hiermit melde ich mich bei meiner Ehre, zu bestätigen, dass die vorliegende Arbeit selbständig angefertigt habe.

Alle Resourcen und Hilfsmittel, die in meiner Dissertation verwendet werden, sind nach den Regeln für die wissenschaftliche Arbeit und durch Fußnoten oder andere präzise Herkunftsangaben zitiert worden.

Die wissenschaftliche Arbeit hat keiner anderen Prüfungsbehörde vorgelegt worden.

Darmstadt, Feb. 10th, 2014

Yanqiang Ma

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