

Article

Scaling Up Smart City Logistics Projects: The Case of the Smooth Project

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Abstract: A large number of smart city logistics projects fail to scale up, remaining a local experimental exercise. This lack of scalability is, in fact, commonly recognized as a major problem. This study aims to determine the key success factors related to the scalability of smart city logistics projects. The process of scaling up, which is articulated as expansion, roll-out, and replication, is defined as the ability of a system to improve its scale by aiming to meet the increasing volume demand. Specifically, this study investigates the scalability intended to be used as expansion and roll-out. A qualitative case study was conducted to fulfill the research purpose. The chosen case study is SMOOTH, a pilot project currently underway in the city of Gothenburg, Sweden, involving a diverse group of companies including Volvo Group and DHL. Semi-structured interviews were conducted with seven of the project's stakeholders. Through a thematic analysis, four categories and the respective success factors were identified. These were represented by a business model, as well as technical, stakeholder and regulatory factors. The paper concludes with observations and recommendations aimed at the pilot initiatives, adding new perspectives to the upscaling debate.

Keywords: smart logistics; smart city project; pilot project; scale up; key factors



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1. Introduction

Societies and cities are facing a growing number of challenges, including climate change, the rise of pollution levels, and urbanization [1]. These challenges impact and push cities to move toward an environmentally sustainable path. Much of this pressure is exercised on logistics transportation, which can be held partly responsible for traffic congestion, noise problems and poor urban environments.

Cities are consequently required to respond to these needs by introducing urban logistics initiatives aimed at implementing sustainable strategies for the urban environment [2]. These initiatives often take the form of smart city projects which begin as pilots and are then scaled up. Scalability, which is articulated in expansion, roll-out, and replication, refers to the ability of a system to improve its scale by aiming to meet the growing volumes demand [3,4]. Smart city projects, on the other hand, take advantage of ICT based on multi-stakeholder collaborations, designed to explore new logistic solutions in an experimental setting [5]. Indeed, innovative transport modes take advantage of a high degree of collective approaches, making it possible to achieve a high fill rate and reduced vehicle movements [6]. These projects are supported by the municipality and funded by subsidies [7]. The sources of funding include Europe's Horizon 2020 program, which provides EUR 18.5 billion in subsidies for green transport and clean energy, as well as from the European Regional Development Fund (E.R.D.F), which promotes sustainable urban development by offering a minimum of EUR 16 billion between 2014 and 2020. These programs will continue to run after 2020. For instance, the Europe Commission is now working on programs planned from 2020–2027, namely the Multi-Annual Financial Framework. Accordingly, the projects on sustainable developments will be funded to promote economic growth, sustainability, and social impact.

1.1. Problem Statement

The existence of funds which support and show an interest in the field allow the flourishing of smart city projects. Nevertheless, most of these projects fail to scale up, failing at the pilot stage (Winden and Buuse, 2017). This is a major problem, given that the greatest benefits derive from the scale up phase, which makes it possible to obtain cost-effective applications which can be accessed by a larger number of consumers. To avoid project failures, a suitable degree of scalability is required. The issue related to project upscaling is scantily addressed by the existing literature. Ref. [7] committed themselves to developing, through their papers, frameworks capable of identifying the factors which impact scaling. Nevertheless, none of the existing studies have provided an in-depth analysis of the smart city projects which operate in the logistics field.

1.2. Research Purpose and Research Question

The aim of this research is to study the scalability of smart city logistics projects and to fill the gap in the existing literature by identifying key factors for project scale up. This study will focus on scalability intended as expansion and roll-out. This is achieved by examining a smart city project practical case, represented by the SMOOTH project in the city of Gothenburg. The study aims to provide meaningful recommendations and guidelines for the management purposes of the pilot projects.

To achieve the objective of this study the following main research question is addressed:

*Which factors influence the scalability potential of the SMOOTH
Smart City Logistics pilot project?*

1.3. Disposition

As shown in Figure 1, this research paper is structured into six chapters. The theoretical framework includes a literature review of the academic research on smart city logistics and scalability. Next, the methodology is described, containing details of the research strategy, design, and method adopted for data collection and analysis. In Section 4, the empirical results from the interviews are presented. In Section 5, the results will be discussed and analyzed considering the research question of the study. Finally, in Section 6, the conclusion, an overview of the more relevant insights of the research is presented and suggestions for future research on the topic are highlighted.



Figure 1. Research structure overview.

1.4. Delimitations

The delimitations of the research are expressed in three main aspects. The first is related to the theoretical scope of this study, which is limited to factors related to expansion and roll-out. More specifically, the study focuses on city roll-out and/or geographic expansions. The key factors related to replication, on the contrary, are not part of the research because different variables need to be evaluated, and the elected case study does not produce the relevant findings on the topic. The second limitation concerns the fact that the results are specifically addressed to projects currently in the pilot phase. In fact, since scale up should be addressed from the pilot phase, the chosen case study is represented

by a research project. Finally, the third limitation concerns the geographical context; the results of the research are mainly applicable to the European socio-cultural context.

1.5. The SMOOTh Project

The elected case study is the SMOOTh project, a three-year research project, launched in 2019. The solution proposed by the project aims to consolidate freight transport in the context of smart city logistics through the introduction of a System of System (SoS). The project started as a result of the EU-funded Novelog project and was subsequently expanded as it became part of a state-funded project to which Volvo Group, Rise and IVL, and Nordstan all contributed.

The main problem at the root of the project, was that the 90% of the trucks were loaded at one third of their full capacity [6]. The SMOOTh project intended to reduce the amount of truck traffic within the city by approximately 40%, consequently reducing fossil fuel vehicles for goods transport in pedestrian areas by 75% (Malmek et al., 2019). This solution is being tested and demonstrated through a living lab through which the project idea is progressively implemented.

A turning point for the project was represented by the establishment of the Nordstan Cargo Bike Hub. Nordstan, being the largest business hub in Sweden, with 200 shops and 6000 office workplaces, offered a cargo capacity available along the 1.5 km long lower floor. The initiative caught the interest of Pling, Gothenburg's oldest box bike operator, first and, later, of DHL Express. The aim of the project was to put in place the conceived model, shown in Figure 2, according to which the goods follow a multimodal transportation: parcels being prepacked at the Urban Consolidation Center (UCC), out of the city center, will be driven out to the city hub in Nordstan in electric trucks. The parcels will be finally delivered by DHL, Pling and Best from the city hub by smaller zero-emission delivery vehicles, such as cargo bikes and smaller electric vehicles. As a result, the model will allow parcel consolidation by multiple transport providers to use trucks loaded at a high rate. The data will be at the center of the business model since, through a dynamic decision-making algorithm, a case-by-case logistic decision will be undertaken, thus determining whether the goods would benefit from a consolidation as opposed to end-to-end deliveries.

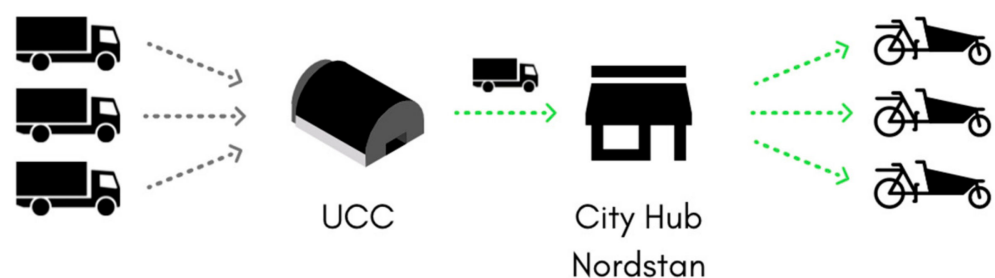


Figure 2. SMOOTh model.

The consortium consists of 11 members active within the transportation industry, including traffic administrators. As of now, Nordstan's Service Center has taken over the last mile delivery for the Swedish Post, "Postnord," resulting in the delivery of all goods to inhouse offices and shops after a short stop in Nordstan. However, the SMOOTh project is not yet functioning as envisioned by the stakeholders. Currently, the IT system is inexistent and the business model is still being defined.

SMOOTh vision implies the creation of a scalable SoS able to combine transport solutions, logistics and politics. Consequently, the SMOOTh project intends to act as a model that could inspire other cities around the world, aiming to also shape national policy, serving as the foundation for a new European Commission directive.

2. Literature Review

A review of the field being researched, corresponding to the smart city logistics projects is provided in the following chapter. This includes the definition of smart city logistics and the key stakeholders involved.

2.1. Smart City Logistics Definition

Smart city projects are emerging to address and solve the efficiency and environmental problems which are characterizing the logistics industry. A smart city can be defined as an ecosystem of stakeholders, which develops in the form of public–private partnerships (PPPs), engaged in a process aiming to address public issues through the use of Information and Communications Technologies (ICT) [5]. Smart cities create an active involvement of different players, including the citizens themselves, transforming them from mere observers to key contributors to innovation [8,9].

The smart city logistics solution applies the smart city approach to meet a city's logistical purpose. The optimization of logistics activities is therefore achieved by leveraging on the connectivity between different players. This optimization process aims to meet customer needs, minimizing monetary costs and associated externalities, which include climate change, air pollution, noise, vibration, congestion, and accidents [10].

The main elements of smart city logistics can be consequently summarized by the following trends:

- **Digitalization and Big Data Analytics:** Improved data sharing is fundamental to extract the maximum value from the available big data on transport, contributing to wider data sharing amongst the transport stakeholders, and leads to improved products and services [11]. An Intelligent Transport System (ITS), which represents an advanced system of the combination of technology, infrastructure, service and planning, and operation methods, supports real-time data collection related to track and trace [12,13]. The tools which are deployed for ITS includes sensors, actuators, controllers, GPS devices, mobile phones, cloud computing and IoT [13]. These tools enable ITS to offer secure and economic on-demand services. The resulting increase in vehicle productivity has positive effects in terms of CO₂ emissions [14].
- **Collaboration across stakeholders:** A change in paradigm, which is ongoing in the transportation sectors, also has an effect and enhances the importance of a collaboration of multiple and diverse stakeholders [5]. In this case, the aim for a successful collaboration is increasing the transparency and communication between players through the process of digitalization [11]. The managers' and workers' culture and training are key ingredients for success in a smart city project, which go beyond the simple infrastructure and assets. The main stakeholders and their relationships are detailed in the paragraph 2.1.2.
- **Flexible deliveries through multimodal transport:** Multimodal transport indicates the transportation of goods, performed under the terms of a single contract, which involves more than one mode of transport. Multimodal logistics allows more efficient and sustainable delivery and has therefore become an important logistical component worldwide. Its use is encouraged by government directives and shaped by the ITS [15]. In addition, the flexibility which characterizes a dynamic decision-making approach is fundamental to control real-time changes.
- **Urban Consolidation Center:** Urban Consolidation Centers (UCCs) or Urban Freight Centers are defined by Browne et al. (2005) as logistic facilities located in relative proximity to the geographic area that they serve. UCCs arose as a potential solution for reducing the pollution from last-mile freight transportation [16]. These centers collect packages from many logistics companies, consolidate them, and then proceed with delivery to the city customer [1]. Consequently, UCCs serves as a terminal for multimodal transport, as previously introduced. UCCs aim to counteract the disadvantages deriving from the lack of a holistic system which causes prolonged travel routes and a consequent cost increase, as well as negative impacts on the environment.

The deriving freight flow integration allows citizens to access goods, while supporting cities' sustainable developments [17]. Nevertheless, UCCs still represent a concept for multiple urban stakeholders [18,19]. In this regard, several authors identified the KSFs for a UCC-based scheme corresponding to: (1) concertation and political support, (2) supporting regulations, (3) governance and financing viability, (4) strategic location and (5) the organization of the last-mile transport.

- **Specialized fleets:** Electrified fleets and pedal-powered vehicles represent an additional key component able to decrease the carbon footprint of a society. These vehicles are particularly suitable for small parcels, as opposed to big parcels which may need a higher volume and traction power.

In conclusion, smart city logistics projects combine digital technologies able to integrate stakeholders, systems and a means of transport which interact with users, aiming to achieve a sustainable, safe, and accessible environment that meets citizens' mobility needs. The readers can refer to [20] for a comprehensive overview of the factors affecting smart cities and the various definitions which have emerged from the literature.

2.2. Stakeholders Involved

Urban transport, as mentioned, involves a collaboration between many stakeholders, driven by different aims and goals. The environment takes the name of multi-agent systems (MAS). These heterogenous conjunctions of autonomous decision-making agents must facilitate, communicate, and exchange knowledge to make the holistic collaboration work.

The stakeholders can be divided into four main categories: shippers, carriers, customers, and administrators [1]; each of which belongs to a different portion of the city's logistics, remaining closely linked to each other (Taniguchi et al., 2001).

The first category, defined by [1], is the shippers, which includes the manufacturers, wholesalers, and retailers. They can be either the owners or receivers of the goods. The shippers send goods to other companies or person, and they are often not located in the cities [21]. The study points out that the shippers' goal is to maximize the quality of the service offered, which depends on accessibility, delivery speed, and cost management [1]. In the event of the receipt of goods, limited time windows are established.

The second category, the carriers or Logistic Service Providers (LSPs), concerns the companies specialized in transporting freight and parcels within the city to the final customers. [1] indicate that the objective of the carriers includes cost minimization and the maximization of financial performance. A trade-off exists between the high level of service and the efficiency of freight vehicle loads. Their efficiency is influenced by boundaries sets by other stakeholders, such as administrators, who have the power to enforce increasing restrictions on the traffic system of an urban area, or the opening hours of stores.

The city resident category includes the people who live, shop, and undertake other activities in the city. Their interests can be compared to those of the authorities with regard to concerns about the environment and traffic reduction.

Finally, [1] classify city administrators as those players establishing the guidelines within the environment. Along with finding the balance between business satisfaction and public benefits, they have the power to enhance projects able to expand mobilities, which aim to enable more intelligent, sustainable, and accessible solutions [22]. A favorable environment for innovation can indeed make the difference in the development and success of smart city logistics projects [23].

2.3. Scale Up of Smart City Project

A literature review regarding the scale up of smart city projects is provided here. Initially the different typologies of upscaling are evidenced and analyzed. The paragraph then proceeds with an analysis of the key factors associated with the scale-up of smart city projects already highlighted in the existing literature.

2.3.1. Typologies of Scaling-Up

Scale up or scalability is defined by [4] as the ability of a system to improve its scale aiming to meet the growing volumes demand. The different upscaling typologies are defined by [24], which distinguish among expansion, replication, and spontaneous diffusion. Winden (2016) has subsequently elaborated on this aspect, by substituting the spontaneous diffusion typology with roll-out.

The scale up phase emerges as a major problem for smart city project initiatives, as previously illustrated. The projects, which tend to be designed to satisfy a particular demand in the city of interest, encounter a series of issues when attempting to broaden the impact of the initiative. Obstacles includes competing interests from existing stakeholders, non-supportive legislation or policy mechanisms, and a lack of resources in terms of personnel, expertise, processes, or findings [3].

Furthermore, different scholars underlined the fact that the pilot project design plays a fundamental role, being influential in determining the scale up success. Hartman and Linn (p.16, 2008) affirmed that: *“pilots should be designed in such a way that they could be scaled up, if successful, and so that key factors which will be necessary for a scaling up decision—with what dimensions, with which approach, along which paths, etc.—are already explored during the pilot phase.”*

According to the literature regarding upscaling, two main dimensions exists: scalability and replicability [25,26]. The first of the two, scalability, is further broken down in the expansion and roll-out by [3]. Therefore, in the next paragraphs, the three main categories of scale up, corresponding with roll-out, expansion and replication are considered.

2.3.2. Overview of the Scaling-Up Typologies

In general, upscaling can be described as a multi-layered process, which allows the coexistence of different dimensions [7]. The type of path toward upscaling depends on the nature of the intervention. The expansion is more likely to be an effective solution where hierarchical interventions are required, while replication is more suitable where non-hierarchical methods are required.

The three upscaling types are shown in Figure 3, which highlights their relationship and ranks them based on their level of context sensitivity. The replication represents the type with highest context sensitivity level, while the roll-out represents the type with the lowest context sensitivity level [1]. From a project perspective, the expansion and replication typologies are the most relevant types [7].

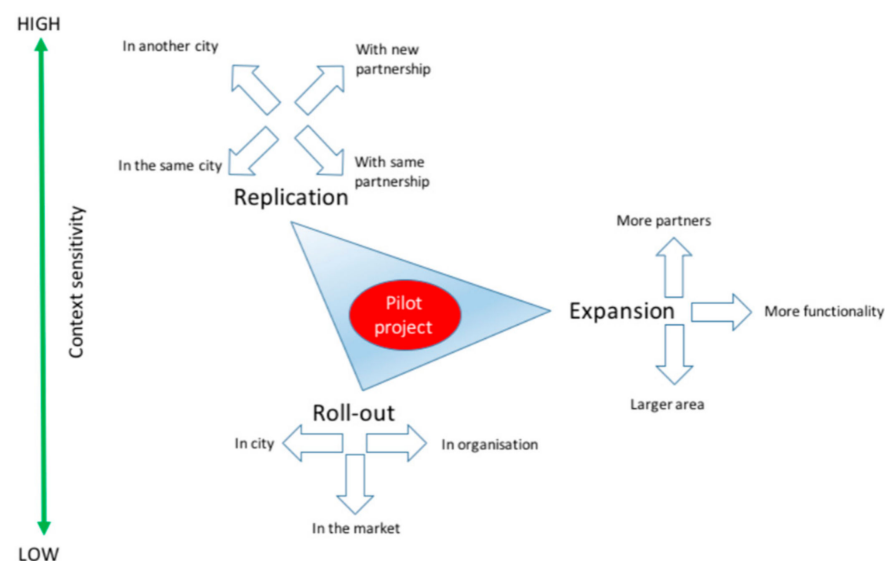


Figure 3. Types of upscaling. Reprinted from Ref. [3], Winden (2016, p. 8).

2.3.3. Scalability: Roll-Out

To establish the groundwork for the roll-out definition, it is considered pertinent to briefly provide a definition of spontaneous diffusion, as it was a scalability typology that substituted roll-out in the [24] framework. Ref. [24] defined spontaneous diffusion as indicating the spread of good practices, which occurred by means of its own initiative. Instead, Winden (2016) substituted spontaneous diffusion with the concept of roll-out, the development of which could not be considered as spontaneous. Roll-out scale up occurs when a smart city solution, successfully tested during the pilot phase, is made available to consumers or the B2B market (market roll-out). Alternatively, it can be applied to the entire organization (organizational roll-out) or city (city roll-out) [3]. Ref. [3] declares that the transition toward scale up can be achieved without performing major changes to the product or solution; therefore, it does not require any new partnerships or significant changes which impact the organization. Normally, control during this phase is exercised by the company that initiated the pilot study, which is responsible for defining a profitable business model that includes a funding strategy and a viable value proposition [3]. The funding requires more effort if the pilot is financially supported, primarily by grants. The major complications arising from this phase are related to the need for the organization to be ambidextrous. This means that exploration is necessary at this stage.

2.3.4. Scalability: Expansion

Expansion involves scaling up the pilot within the organization(s) that develops it [24]. This phenomenon occurs during a phase in which the pilot project is not closed or dissolved. Moreover, expansion is related to co-production which requires the close collaboration of different stakeholders. Ref. [3] identified three ways through which expansion can occur: the first refers to expansion in terms of geographic area (geographic expansion); secondly, this can happen through the recruitment of new partners (quantitative expansion); and, finally, through the addition of functionality (functional expansion). This form of upscaling applies to the co-production process that relies on the near alignment of several stakeholders. This typology is particularly valuable for the mobility project for which a collaborating partner create added value [3]. Different from roll-out, expansion is naturally more complex: transaction and coordination costs are high because there is no clear oversight regarding the mechanism and many autonomous organizations are involved.

2.3.5. Replication

The last and most complex typology of scale up concerns replication. This scale up dimension implies the reproduction of the model developed through the pilot project in a different context, such as a new city or part of a city. Cooley and Kohl (2005) argued that this occurred at the hands of an organization distinct from the one that originally developed the pilot project. Alternatively, [7] sustained that replication could also occur by the original pilot partnership; replication could occur as a proxy or exact replication of it. In general, replication can indistinctly be applied within all kind of smart city solutions being tested and developed during pilot projects [7]. Replication implies having to deal with a different environment, characterized by different regulations and partners. This represents the reasons why, most of the time, replication entails a non-exact replica of the original pilot. New partners must commit to readjusting the project based on the rules dictated by the new context [3].

2.4. Conditions for Scaling-Up

Few existing studies in the literature defined the frameworks needed to identify factors that could help determine the success of the transition from the pilot phase to the scale up. The main existing frameworks specifically tailored for smart projects are the ones provided by [7,26]. These frameworks are shortly introduced, accompanied by a comparison between the factors addressed within.

Ref. [26] highlighted the factors relevant to scalability and replicability separately, focusing on smart grid projects. The research results into the creation of three categories of factors: technical, economic, legislative, and stakeholder acceptance-related factors. A summary of the factors on the subject is provided in Table 1. In addition, the research provides a methodology suitable for assessing the factors and the scalability of the single project. This implies a prioritization of the factor's categories, according to which technical factors should be built upon the economic factors, which act as a prerequisite for stakeholder acceptance. Ultimately, all categories need to exist as a prerequisite for the potential scalability of the project [26].

Table 1. Scalability factors. Adapted from Ref. [26], May et al. (2015, p. 2).

Areas	Scalability Factors	Replicability Factors
Technical	Modularity Technology evolution Interface design Software tools integration Existing infrastructure	Standardization Interoperability Network configuration
Economic	Economy of scale Profitability	Macro-economic factors Market design Business model
Legislative and regulatory	Regulation	Regulation
Stakeholder	Consent	Acceptance

In light of this changing landscape, researchers are becoming increasingly interested in the scalability of smart city projects, and [7] elaborated on the model listed above by defining a framework consisting of six requirements for performing a successful scaling process. The elements are: (1) the prospect of reaching economies-of-scale; (2) the presence of knowledge transfer mechanisms and incentives; (3) the management of ambidexterity in exploration–exploitation activities; (4) the presence of enabling regulatory, legal, and policy frameworks; (5) the interoperability between systems, data, and standards; (6) the inclusion of standards to measure returns on an investment. Once the elements were properly defined, [7] categorized these factors according to the referenced upscaling types. Unlike the previous framework, all three categories (expansion, roll-out and replication) are mentioned here. However, it is important to highlight the fact that the only difference between the first two categories lies in data interoperability, which is not considered as a fundamental requirement for roll-out. On the other hand, replication, different from roll-out and expansion, needs an effective knowledge transmission mechanism, which is particularly crucial in case the replication is managed by different stakeholders than those who previously applied the solution in the original environment.

Now that an overview of the factors identified by the existing studies has been provided, a in depth description of the different drivers and their interrelation will follow. The key factors provided by the literature are categorized into technical, economic, organizational and stakeholder-related factors, redefined based on the subdivisions offered by the study of [26]. Table 2, at the end of the chapter, provides an overview of these factors.

2.4.1. Technical

The technical factors aim to evaluate if the solution offered by the project is inherently scalable and/or replicable.

Modularity is identified by [26] as a factor influencing the roll-out and expansion success. Modularity refers to the possibility of dividing the solution into interdependent functional units. This is defined by [26] as the basic precondition for scaling up, due to its flexibility. In addition, from a technical factor perspective, the collaboration between the different players creates consequences in terms of the data and system interoperability

requirements [7,26]. The factor is particularly relevant for smart city projects, being based on ICT and data that are part of the projects. In multi-stakeholder collaborations, the willingness of partners to engage in data sharing is of crucial relevance. This willingness is characterized by a positive relation with trust and mutual collaboration, which is key in inter-organizational collaboration [7]. The data and system interoperability creates consequences not only for privacy concerns but also for the requirements of interface design or the ability of the platform to handle data originated from each stakeholders' system. Interface design, for example, can become overly complex and redundant when the scale increases [26]. Consequently, suitable software tools, able to cope with an increase in size, should be exploited. Furthermore, according to [26] the existing infrastructure can represent a limitation depending on the maximum capacity that it offers.

In the specifics of replication, the use of published standards in terms of technical solutions represents a success factor. Nevertheless, many standards exist; therefore, the interoperability with a system which operates according to a different standard should be equally achieved [26].

Table 2. Factors influencing projects scale up.

Categories	Factors	Roll-out	Expansion	Replication	Source
Technical	Data Interoperability		☑	☑	May et al. (2015) & Winden and Busse (2017)
	Modularity	☑	☑		May et al. (2015)
	Existing infrastructure	☑	☑		May et al. (2015)
Economic	Economies of scale	☑	☑	☑	May et al. (2015) & Winden and Busse (2017)
	Profitability	☑	☑	☑	May et al. (2015)
	Standards to measure ROI	☑	☑	☑	Winden and Busse (2017)
Organizational	Knowledge transfer mechanisms and incentives			☑	Winden and Busse (2017)
	Effective management of ambidexterity	☑	☑	☑	Winden and Busse (2017)
Legislative and regulatory	Enabling regulatory, legal, and policy frameworks	☑	☑	☑	May et al. (2015) & Winden and Busse (2017)
	Acceptance	☑	☑	☑	May et al. (2015)

2.4.2. Economic

Economic factors are necessary to establish whether scaling up or replication is economically feasible from an investment and business model perspective (May et al., 2015).

Having a vision of potential economies of scale is critical for a successful scaling up and is an element contained in all of the frameworks previously mentioned [7,26]. The economies of scales are correlated with the economic viability of the solution on the intended scale [26]. Specifically, it is critical that this vision is already defined in the pilot phase, as the phase will serve as groundwork for potential upscaling; therefore, the scale up dimensions, and the planned approach should already be properly defined. Furthermore, detailed information on how a larger volume is positive correlated with lower unit costs and higher profits can act as valuable incentives for those who want to capture them. Ref. [7] defined the economies of scale as a driver for each single scaling up typology, particularly relevant in case of roll-out where a single firm could capture the benefits of scaling. On the contrary, [26] mentioned economies of scales as exclusively correlated to scalability, dismissing the factor in the case of replicability. Furthermore, according to [26], the project should be characterized by a positive profitability considered as an attractive financial opportunity. Regarding the search for funds, establishing the standards

to measure returns on investments (ROI) can have a positive impact on the willingness of funders to support a project [7].

From a replicability perspective, it is necessary to evaluate whether the solution is still profitable within a different environment by conducting an analysis of macro-economic factors [26]. Replication makes the project successful dependent on the new market design. Finally, [26] claimed that the modification of the original business model should be properly considered to allow the adaptability of the original idea to new context.

2.4.3. Organizational

The organizational category includes factors related to project management during the transition from pilot to the exploitation phase.

The pilot phase is mainly characterized by explorative activities focused on innovation, experimentation, and R&D. On the contrary, a large-scale production requires the exploitation of old certainties aimed at efficiency, implementation, and execution. Through ambidexterity, the organization must find the right balance between exploration and exploitation [7]. This balance can be reached through three main alternative paths: (1) temporal separation, (2) organizational separation, and (3) pure and contextual ambidexterity.

The knowledge transfer mechanism and contextualization are crucial elements for making upscaling happen [7]. This is particularly true when dealing with the replication type of scaling. A lack of trust between supply chain players acts as the main obstacle for data sharing [11]. The main challenge arises from enabling tacit knowledge transfer [27].

2.4.4. Legislative and Regulatory

This category includes factors which impact the degree to which the current legal environments are ready to adopt a scaled-up version of a project.

Incentives are fundamental to maximize the upscaling potential. These incentives can be mainly offered by policy makers. The latter, together with regulators, are included in the stakeholder category who, as such, have an influential role in facilitating the project expansion [26]. Incentives could positively affect stakeholder motivation by participating in smart city projects [7]. As already indicated, regulation can have an important influence on the outcome of the Smart City Pilot Project. Scaling-up is facilitated in a city with high ambitions related to CO₂ emissions reduction, increasing the use of renewables energies, etc. Nevertheless, [7] also evidenced the role of public procurement policies, whose regulation may act as a launching customer for a pilot project on one side, or as an obstacle on the other side. In some cases, projects fail to scale up due to isolation from real-world legislation and market forces.

Acceptance represents a further fundamental element of upscaling success. This affects regulators, stakeholders, and authorities. The fact that organizations which take part in a project may be characterized by heterogeneous ambitions and perspectives regarding upscaling reinforces the need for incentives, previously outlined [7]. It is important that the key stakeholders and policy makers accept the proposed solution in all the three types of upscaling categories [7].

3. Methodology

3.1. Research Strategy

The elected research strategy is an inductive approach as it focuses on discovering new patterns and themes based on the current phenomena, rather than analyzing a previously stated theory. The application of smart city logistics is not widely covered in the existing literature. The contributions to identifying key factors related to the scaling up of smart city logistics projects appear to be more significant than attempting to fit into the current analytical structure. These contributions can be obtained through an inductive research strategy, which is suitable for new research areas.

To address the research purpose and answer the research question, a qualitative approach is deemed suitable for this study. The rationale for adopting this research strategy

is that it primarily emphasizes words rather than numbers, which is necessary to gain in-depth, real-world knowledge by various stakeholders involved in smart logistics projects, collecting their opinions while identifying social connection and the network between them. In addition, because the academic analysis of the subject and market implementations is very limited, it is preferable to take a qualitative approach to better explain the scientific evidence, to derive conclusions from various angles, and to make the research relevant for the purpose of the study [28].

3.2. Research Design

A single case study is the selected method that will be applied to address the research question and to dictate the direction of this research and the choice made within it [29]. In essence, this implies that the empirical findings are produced by the thorough and intensive review of a single case [29]. The case study makes it possible to achieve the previously established goal of building theoretical ground for future research.

In order to choose the research design, the relationship between the design and the research method is considered. The fact that the case study research design is in line with the qualitative research strategy is considered of crucial importance. The case study allows for the in-depth exploration of a case of interest and a fundamental factor, when it is necessary to understand a novel field, as in the case of smart city logistics, to address the inductive approach purpose, obtaining a strong internal validity [29]. [29] suggest that a case study is an appropriate research design if the objective of the research is to understand how and why something occurs. This is in accordance with the elected research question which aims to identify the key factor which may maximize a project upscaling potential.

The research project on which the case study was developed is identified as being in collaboration with the Swedish consultancy company, First to Know. We sent to the company a research proposal in which the aim of the study and the main elements of the methodology were contained. First to know then carried out an identification of a company or a project that could fit the request within its own network. The choice was SMOOTh, an ongoing smart city logistics pilot project in the city of Gothenburg coordinated by Volvo Group. The decision to study a project, which is currently in the pilot stage was justified through the literature, which emphasized that key factors of the project should be investigated since the pilot stage. On the other hand, the decision to focus this research on Sweden, specifically on the city of Gothenburg, is because this city pays particular attention to environmental issues, and in fact hosts several transition projects toward a more sustainable mobility that improves connectivity while being environmentally friendly. Furthermore, Gothenburg is undergoing an exceptional redevelopment with construction work that will last for the next 20–30 years; making the city more connected and urbanized will also prompt the need for an adequate transportation system.

The project can be considered as a “broadly” *revelatory case study*, being conducted predominately through the implementation of an inductive approach through which the phenomenon of smart city logistics will be analyzed in-depth. Additionally, the novelty of both the SMOOTh project and of the phenomena, further strengthens the elected research design decision; indeed, according to [15] this approach is preferred when a lack of prior theorizing about the subject of study is carried out. With this in mind, this research design was evaluated as the most adequate in relation to the study purpose and qualitative research strategy, being mainly associated with application of a theory, rather than the testing of it [29].

3.3. Research Method

3.3.1. Secondary Data Collection

To provide a theoretical background to the study, a review of secondary data was performed as part of the literature review. The literature review is described by [29] as a helpful tool for developing the basis on which the researcher justifies the research question and selects the research design. The method through which the literature review

was conducted was a systematic literature review. Different from a narrative review, the systematic review had the purpose of identifying the literature gap and finding out what the research project could add to the existing knowledge about smart logistics [29]. Therefore, the systematic review was more focused on a wider-ranging scope than the narrative review, and thus was more suitable for this study. The main advantage deriving from this choice was linked to the fact that the biases of the review were minimized. This is because of the adoption of an approach which is characterized by an explicit procedure. This implied the definitions of the inclusion and exclusion criteria adopted when deciding which existing literature to consult. The elected criteria are reported in Table 3. The secondary data collection is the preliminary step for the development of a new theory, and thus needs to be performed at the beginning of the research process and eventually be iterated toward the end of the process.

Table 3. Inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
<p>Papers related to:</p> <ul style="list-style-type: none"> • Smart City Logistics definition • Scale up definition • Key factors of scale up related to Smart City Projects 	<p>Paper in which:</p> <ul style="list-style-type: none"> • KSFs are related to the smart city in general and not to the project's scale up phase • The focus is on stakeholder collaboration • Smart logistics is analyzed on a technical level

The search for the existing literature occurred through the utilization of some Key-works. The individuation of the latter was carried out following the research topic and objective. The main keywords were: “Smart Logistics”, “Smart City Project”, “Pilot Project”, “Scale Up”, “Key Factors”. Sources from which the articles and reports were collected included Google Scholar, the Gothenburg Online Library and Luiss Online Library.

3.3.2. Primary Data Collection

The data were collected through semi-structured interviews. This data analysis method appears consistent with the choices made so far regarding the methodology. The qualitative analysis focuses on words rather than numbers. Furthermore, in-depth information is necessary to fill the literature gap and perform the purpose of an elective, inductive approach.

This method was evaluated as the most suitable method for two main reasons. Firstly, the method made possible the gathering of detailed information from key informants together with obtaining a deeper understanding of the subject. Secondly, the method offered a structure for the interviewers provided by the interview guide, which in turn made it possible to cover all the relevant arguments for the research question, while assuring the free choice of the interviewee to reply. The interview guide, displayed in Appendix A, allowed the interview to be more consistent, creating the main structure to exert the data from. Additionally, the interview guide also increased the study replicability. Since the elected method was semi-structured interviews, the order of the questions altered depending on the previous answer. In this regard, the semi-structured interviews provided space for the interviewer to interpret and respond to the questions, while ensuring that the overall purpose of the interview was not lost.

In terms of identifying a sample which would be strategically relevant to the posed research question, a purposive sample was considered as appropriate. The criterion applied to select the sample was that of importance, which was based on the knowledge and expertise of the respondents. To meet this requirement, it was established that any respondents should cover their relevant role within the SMOOTh project and the company for which he/she was working. Furthermore, to facilitate the respondents' identification

process, a snowball approach was used. In Table 4, the specifics about the interviewees and interview dates are shown.

Table 4. Interviews Overview.

Respondents	Role and Company	Medium	Date	Length
<i>Ronja Roupé</i>	Business Designer, Volvo Group	Zoom	4/01/2021	45 min
<i>Magnus Zingmark</i>	Project Partner, Nordstan	Zoom	4/01/2021	41 min
<i>Johan Erlandsson</i>	Project Partner, Velove	Zoom	4/13/2021	46 min
<i>Sönke Behrends</i>	Researchers, SSPA	Zoom	4/15/2021	43 min
<i>Michael Browne</i>	Reference Group Member	Zoom	4/27/2021	45 min
<i>Magnus Jäderberg</i>	Project Partner, Trafikkontoret	Zoom	5/04/2021	55 min
<i>Christoffer Widegren</i>	Logistic Consultant, CW Logistic	Zoom	5/11/2021	30 min

Interviewees were contacted in advance via mail to schedule an interview date. The interviews were carried out during formal online meetings. Even if online meeting potentially limited the personal engagement which characterized face-to-face interviews, they were the preferred medium due to the current pandemic situation and geographical distance. At the beginning of each interview process we gave a brief introduction to the interviewees to better explain the research purpose and their main role within the research. During the interview process we took advantage of the interview guide. All interviews were recorded for transcript purposes. A full transcription presented significant advantages including the possibility of capturing every single detail that would be significant for the analysis, ensuring the minimization of bias [29]. The validation of the reported information was finally confirmed with the interviewees to further increase research validity.

3.3.3. Data Analysis

The data analysis followed a process of preparing the collected data that subsequently allowed for the development of a thematic analysis. This process was chosen since it facilitated the interpretation and breakdown of information gathered during the data collection process, leading to the qualitatively rigorous demonstration of a link between the codes toward an induction of a new concept. A thematic analysis indeed offered an opportunity to develop inductive research of a qualitative rigor. This was indeed one of the most common approaches adopted to perform a qualitative data analysis [29].

The first performed step included the coding process. The coding process was performed in Word, in which phrases or words in the transcripts referring to the same concepts were highlighted using different colors depending on the matter addressed. In the second step, a comparison process among the related codes was performed in order to identify the similarities and differences among the several “concepts” in the coding table. The third step consisted of the further condensation of concepts in broader topics, called “aggregate themes”, in the coding table. The themes were defined through the identification of similar concepts referring to one key specific factor, and thus paying attention to the degree of relevance with regard to the research question. Categories were developed by elaborating on the categories previously identified through the literature. There were four resulting aggregate themes: economic factors, technical factors, stakeholder-related factors and legislative factors. The resulting coding table is shown in Appendix B.

The methods claimed to be relatively flexible and easily applicable [29]. The process was subsequently performed during the interview phase. The results of the thematic analysis are shown through a coding table. The sources gathered from the interviews are noted in the Section 4 as “p.c.” for “personal communication”.

3.4. Research Quality

To assess the research quality, four main criteria are considered: credibility, transferability, dependability, and confirmability. These are the criteria specifically suitable for qualitative studies.

3.4.1. Credibility

Credibility assesses the trustworthiness of the research. Credibility was reached by being transparent of the scope of the interviews beforehand. At the beginning of each interview the research was communicated. Furthermore, the respondents were asked to validate the summary of the interview. Finally, the integrity was also established by sharing the final research with all of the interviewees.

3.4.2. Transferability

Ref. [29] describe transferability as the degree to which the results can be generalized. In this regard, the qualitative research is characterized by disadvantages in terms of the lack of objectivity compared to the quantitative strategy (Bryman and Bell, 2011). Furthermore, the other main problems regarding the thematic analysis are related to the data reduction and the loss of the context in which the data were generated, which in turn causes data fragmentation. These downsides were mitigated through the implementation of an iterative process. Similarly, the case study design concentrates on the uniqueness of the case and develops a deep understanding and complexity, undermining generalizability. To mitigate this, we provided a detailed description of the case study in Chapter 1, as well as a description of the environment of the city of Gothenburg in Chapter 3, enabling the reader to evaluate the possible complementarities of the specific environment of interest.

3.4.3. Dependability

Dependability defines trustworthiness and entails that all of the interview records, transcripts, and email conversations are kept during all of the research phases in an accessible manner (Bryman and Bell, 2011). During the drawing up phase, all of the information related to this research was preserved and is available upon request.

3.4.4. Confirmability

According to [29], confirmability assesses the extent to which the researcher is influenced by their own values in collecting data and reporting findings. Specifically, qualitative research may suffer from a high level of subjectivity related to the judgements of the researcher who interprets the interview data. This subjectivity was minimized by using the follow-up questions aimed at capturing the real meaning of the answers and by asking at the end of the interview if the interviewee felt it necessary to add any other information that had not emerged from the questions already asked.

4. Empirical Findings

4.1. Key Scalability Factors

In Figure 4, an overview of the scalability key factors identified through the empirical investigation is displayed. The main categories identified are represented by economic, stakeholder-related, technical, and legislative factors.

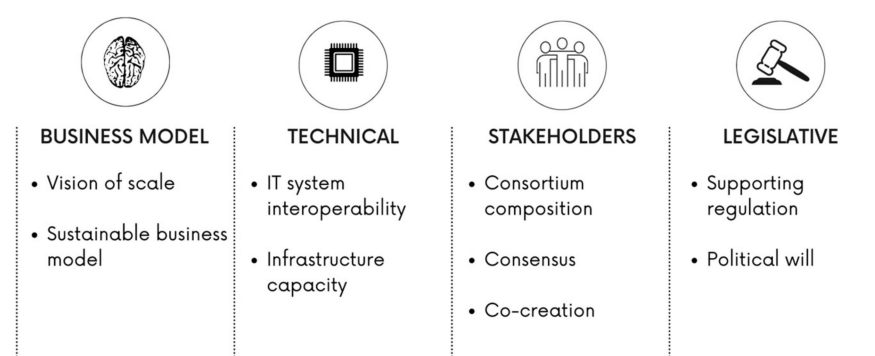


Figure 4. Key factors identified in the empirical investigation.

4.2. Economic-Related Factors

Economic factors determine whether the project is addressing its vision of scale and whether it is feasible in economic terms to pursue scaling up.

4.2.1. Vision of Scale

The interviewees highlighted that the SMOOTh project was driven by a strong underlying motivation. During interviews, the stakeholders mentioned a detailed future vision of the SMOOTh project, as well as the sub-goals which the project set out to reach. Specifically, the motivation behind the upscaling lay in the desire to produce significant effects deriving from the reduced traffic and level of pollution. The expansion from Nordstan to the Gothenburg inner city area is a key prerequisite for reducing the number of trucks entering the city of Gothenburg. The project clearly achieves its objective, expressing the will to reduce the amount of truck traffic within the inner city by 40% [15]. In the long-term the SMOOTh project intends to replicate the model in different cities all over the world, which is described as fundamental to improve the reduction in traffic and the level of pollution on a global scale. The pilot stage is above all intended to verify and test the underlying idea [15].

“We need a successful small-scale demonstration to show that it works: the systems’ tasks must be met (transports delivered on time and without extra damage), traffic must be reduced, a better way to the receiver must be provided, and transportation companies must be able to save money.” Sonke Behrends

Therefore, the definition of a clear vision is necessary to test that the designed model practically works, and that the underlying system is in place. In addition, the simulations and potential analysis of large-scale projects can act as a prerequisite for the consequent scale up. These practices can show to decision makers that the model works in practice and display the potential risks.

4.2.2. Economically Feasible Business Model

From all of the interviews it was observed that, during the pilot stage, the SMOOTh project was committed to define the most appropriate business model. It emerged that the business model should, above all, be economically feasible. To be more easily scalable, the emerging economic aspects should be characterized by their own revenue streams, which make them independent from the economic support received from the government. During the pilot stage the service is dispensed at small prices or for free, as in the actual case of SMOOTh project. However, to achieve profitability, the considerations about the ideal price of the service, which are established in the next step, should be undertaken as early as possible. An economically feasible business model should ensure, on the one hand, the possibility for the system to be profitable, and, on the other hand, be fair and cost-effective for external logistics service providers who want to access the service offered by SMOOTh. LSPs, navigating within a highly competitive environment characterized by high-end customer bargaining power, may show interest in the service by aiming to embrace

sustainability to increase their reputation within the market [15]. However, at the same time, the logistics sector represents a cost-sensitive business, which makes LSPs unwilling to pay high extra costs to access the sustainability service [15]. Consequently, the pricing should be defined in a way that balances this trade-off. Finally, to be economically feasible, the business model needs to be flexible and able to change and readapt to the external environment, as well as able to properly distribute the value created among stakeholders, as is discussed in paragraph 4.4.3. The difficulty related to economic sustainability stems from the fact that no financial reward is correlated with the creation of environmental benefits [15]. The efficient use of the capacity and operation of electric vehicles can generate increased costs, disincentivizing the increased economies of scale. On the other hand, the trucks intended for city distribution do not require large batteries, which are one of the main expenses. Furthermore, electric vehicles are expected to gain cost-effectiveness over time, reaching a breakeven point in the next future.

On the other hand, environmental sustainability can generate a further advantage. Sustainability reports and CSR, different from financial reports, help by putting an emphasis on the environmental performance of the project, quantifying its impact on sustainability issues.

4.3. Technical Factors

Technical-related factors include considerations regarding IT systems and the infrastructure capacity.

4.3.1. IT System Interoperability

In the SMOOTH project, data are described as crucial for scale up, especially regarding the inner-city expansion. UCC by itself is not sufficient to reach the predefined scale vision; therefore, the reorganization of the flow of packages via the use of data is necessary. To accomplish this goal more easily it is desirable for the project that every logistic stakeholder within the consortium shares data regarding the trucks' localization and load rate, partially opening their own systems. The information chain is broken down into sub-parts because of the intermodal transport that occurs from the UCC to the city hub and from there to the end customer. For this chain to be reconstructed, several IT platforms must be integrated into one single system. The data management system can generate advantages related to the increase in the collaboration levels:

"It is important to make the collaboration among different players easy and this can be achieved by exploiting an information system." Sönke Behrends

Although the logistics company, Velove, did not express true dissent for the data sharing, other interviewees from the management side stated that there may be many companies who are reluctant to share information; this stems from the fact that the companies' perception of gaining an advantage does not offset the potential disadvantages of competitive friction [15]. Therefore, the firm incentives for data sharing should be defined.

In addition to an incentive definition, the system created by the project must appear secure, meaning that it must be ensured that the data are not shared with organizations outside of the system. Once again, the concept of trust plays a role in this sense [15]. A functioning and reliable business, IT architecture should consequently be developed and tested during the pilot stage, being an essential tool to guarantee future scalability.

4.3.2. Existing Infrastructure

The infrastructure capacity is a further precondition necessary for scale up. It is therefore opportune for a smart city pilot project to adequately take into consideration how upscaling may affect the existing capacity; therefore, the appropriate considerations can be made about how to approach the expansion of the existing capacity. The capacity involved is not only related to trucks but, above all, related to the physical infrastructure through which the transport model is articulated. The SMOOTH model, as previously highlighted, exploits a city hub and a UCC. The upscaling perspective should therefore take into consideration the impact on both of the two infrastructural elements. Although practices

with more than one suburban hub exist in Europe, the establishments of an increasing number of hubs may undermine the traffic optimization. During the pilot requirements, the hubs are defined, and they can and should be studied through further research.

4.4. Stakeholder-Related Factors

The stakeholder-related factors include observations about the consortium composition, the establishment of a consensus-based environment, and remarks about the co-creation process.

4.4.1. Consortium Composition

Encouraging stakeholders to get involved in the project is a prerequisite for scale up; therefore, the incentives and mechanism for the involvement should be defined during the pilot project. The respondents were asked about the composition of an ideal consortium for the downtown scale up and this was described as featuring the participation of about three/four large transportation companies, and about two/three real estate companies, as well as administrators. Large logistics companies are needed because of the system they already have in place and because they can provide a significant volume and capacity for the project, which is essential for expansion [15]. Large logistics companies may be complemented by smaller companies that may be involved through business transactions and thus are not necessarily integral to the project. Real estate companies, on the other hand, should participate in the organization, as they cover a key role in terms of providing receivers, intended as offices and stores which are their tenants (particularly in the case of malls). The latter can be involved in two alternative ways: receivers can either pay money directly or, alternatively, a fee is paid by the real estate companies. Finally, administrators are a crucial actor within the scenario because they assume the role of neutral parties, not being directly connected to any organization. The neutral role is required due to the competition which normally exists between the companies operating in the same industry [30], such as the case with the logistics and real estate industries. Therefore, the consortium should be a good representation of the market, integrating the public and private sectors.

“SMOOTH project has an opportunity related to the involvement of some different actors which is definitely a plus.” Michael Browne

The degree of diversity in terms of the composition of the SMOOTH consortium is an advantage in counteracting the competitive forces which typically characterize the logistics industry. Furthermore, having a large company such as Volvo Group, which is active in the field of logistics, meant that leading the project was considered of great added value by the participants.

4.4.2. Consensus

To accomplish a long-lasting partnership, it is also necessary that the vision is shared and fully understood by the various stakeholders involved in the project since the early stages of the project. The establishment of this common idea of the projects may not be an immediate process. The related obstacles stem from the fact that a heterogeneous consortium involves different players, each of which belong to a different view of the world. This challenge was fully described by one respondent through the following metaphor:

“Initially, the team may be associated with a group of blindfolded people who are touching the same elephants while trying to describe it aloud. Someone is touching a foot, and someone is touching an ear, etc. . . . It is the same elephant, but the challenges come from the fact that no one sees the whole picture.” Ronja Roupé

This difficulty can be countered through the communication that is articulated through meetings and workshops. Being able to communicate the potential benefits to different actors is a necessary step to ensure successful upscaling. Moreover, since different actors capitalize on different benefits, the key is to formulate separate types of messages for each

category involved. Despite this, it emerged that the communication must be properly balanced to ensure that it is not perceived as ineffective and unnecessary by participants.

Once a consensus is established, it should be maintained during the evolution of the project, as the business model evolves over time especially during the pilot testing phase. The evolution behind the scale up of the SMOOTh project involves business model changes, which can be relatively frightening for the companies currently involved in the project. Initially, stakeholders recognize that everyone plays their part, but as the project evolves the business model will undergo significant changes and stakeholders may begin to question whether they will have a role in the future of the project, causing a resistance to change. Moreover, the latter is often not clearly visible, as companies will follow the project without maintaining a real desire for change. Understanding what can truly trigger this behavior change during the pilot project is critical for a successful scale up.

4.4.3. Co-Creation

An economically feasible business model was also linked to the concept of co-creation. In fact, to make a business model economically feasible over time, it was necessary to put in place a balanced process that allows actors to give and take, consequently allowing the system to create more value than any single company could create individually. The trust among stakeholders can establish the foundation for co-creation, as each organization must trust their peers to give away resources or knowledge earlier than the moment in which the resulting benefits are received. The basis for this trust was defined during an interview by the following statement:

“Trust requires understanding of the fact that we are all doing it together for the same reason and for a common goal.” Ronja Roupé

The organization's role is to facilitate collaborations and the co-creation process. Since an SoS included actors with extra costs, complemented by others who received large benefits, the system should consequently be designed to be able to redistribute income and system-wide benefits. In other words, to create an advantage for each of the stakeholders, the benefits for the player in the second category must be reduced and redistributed to players which recorded losses instead. By redistributing the value equally, the give-and-take process related to co-creation can take place. In this way, the business model would be able to create a benefit for each party involved, establishing the foundation for a lasting partnership.

4.5. Legislative and Regulatory Factors

Legislative and regulatory factors include the external environment with regard to regulatory and politics perspectives.

4.5.1. Supporting Regulation

Regulation exercises a marked influence toward smart city logistics projects. Traffic and mobility regulation is described as the “carrots and stick” approach. In the case of green projects, substantial advantages can originate from the introduction of a vehicle free zone which limits the possibility of driving within the city in predetermined time frames. Vehicle free zones can provide a new mobility solution for freight distribution, aiming at creating a win-win situation. These initiatives can incentivize the SMOOTh project development by condensing big truck traffic within the inner city (from UCC to the Nordstan City Hub) in a limited time window from 5.00 am to 10.00 am. During the reminder of the day, cargo bikes and smaller electric vehicles can circulate within pedestrian streets, causing no disturbances or risks to citizens. Therefore, a vehicle free zone would make the use of a UCC more profitable, representing an effective way to handle stricter regulations. In this sense regulation has the power to speed up the change toward a more environmentally sustainable freight transport, encouraging different players to change their businesses earlier than they would do under ordinary circumstances.

Despite this, complications may arise with regard to regulation and, consequently, the project cannot rely totally on it. Specifically, it is hard to know how regulation will evolve since the role of cities in freight traffic regulation is uncertain [15]. Furthermore, the freight industry is treated differently from the car industry and it is uncertain whether regulation is convenient for promoting electric vehicles. The SMOOTh project hopes to electrify smaller vehicles, which are driven within the inner city and larger vehicles, which connect the UCC to the City Hub, but the latter represents a larger challenge.

4.5.2. Political Will

Regulation and politics must be aligned in the same direction to make the establishment of a vehicle-free zone possible and to favor the future scalability of the SMOOTh project.

“Political will is a critical factor to make upscaling possible and to develop vehicle free zone.” Magnus Jäderberg

Sustainability issues exert additional pressure on politicians who wish to reach a certain air quality goal [31], together with reducing congestion, traffic noise and pollution levels. Transportation receives a lot of attention from public authorities, but often the focus is primarily on public transportation, rather than freight transportation. Politicians may be reluctant to approve a vehicle-free zone since this will impact not only freight, but also car and public transportation. To overcome this the project should communicate to politicians the main project mission, providing data regarding the successes obtained throughout the project during the pilot stage, presenting the project as interesting and desirable. Conducting the relevant studies during the pilot stage is crucial to show the potential of the project and to visualize potential risks. The difficulties arise from the fact that communication with politicians is very rigid and bureaucratic. The risk associated with political will is that, in most cases, this decision is influenced by the politician's own knowledge rather than practical reasons. However, sidewalk management urges policymakers to plan the effective management of this resource.

5. Discussion

5.1. Key Scalability Factors

To meet the research purpose and answer the research question, four main categories of factors are identified. These correspond with the business-model-related, technical, stakeholder-related, and legislative factors. All the factors are mutually necessary and should be developed during the pilot project to achieve a successful scale up. A strong connection between these factors exists, and an iterative process is required for their full development.

Before beginning to analyze each of these categories specifically, a general perspective on the SMOOTh project upscaling is introduced. As previously outlined, the project vision envisages expansion to the inner city, followed by the replication in other cities around the world in the long term. Even though project stakeholders revealed that they were able to visualize the key factors for project scale up within the Gothenburg inner city, the research revealed that the upscaling perspective was rarely openly discussed within the project, nor was the mechanism which promoted the scale up put in place.

All factors were mutually necessary for project upscaling, but a logical sequence could be defined based on the research results, as shown in Figure 4. Each layer determined a well-defined key factor, which was built upon the results obtained in the lower layer, and in turn contributed to the scale up of the project. The pilot project must first focus on the definition of the business model, on the basis of which the technical factors relating to the infrastructure used and the functioning of the IT system will be constructed. Once the infrastructure is in place and data interoperability is established, the focus of the project shifts to the stakeholders' engagement. This would allow a consensus-based environment and co-creation process to be established. In fact, to secure a consensus from political and regulatory stakeholders, the project should demonstrate that the business model and IT

system are in place and that the stakeholders are engaged. Consequently, the underlying potential in terms of traffic optimization and environmental sustainability can be revealed.

A strong binding exists among these factors, which is represented by the arrow in Figure 5, whose double arrowhead indicates the underlying iterative process. To obtain consistent results the process may be repeated several times by improving and solving previous errors to reach the final version of the project.

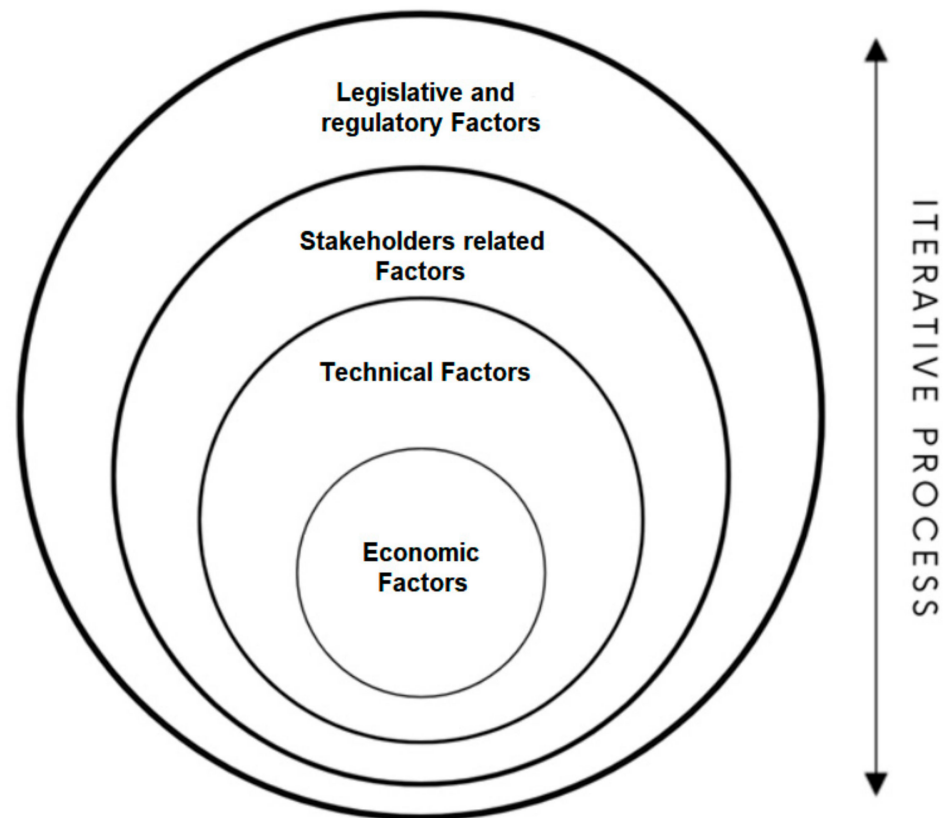


Figure 5. The relations among key scalability factors.

5.2. Business-Model-Related Factors

This category of factors refers to the extent to which the business model holds at a larger scale. The business model represents the driving force for scale up and is the number one priority. It drives the factors related to the stakeholders' acceptance and is capable of generating interest at the regulatory and policy level.

5.2.1. Vision of Scale

The establishment of a vision represents the first prerequisite for scale up. This includes the definition of a series of future stages which can collectively build a path toward scale up.

A correspondence between the theory and empirical findings exists and can be highlighted through the empirical studies of [24,25] which place an emphasis on the definition of a vision, describing it as the first step to be performed in the scale up process. The definition of a vision, in addition to representing a strategy to be pursued at the next stage, generates implications about the actions which should be implemented in the pilot stage itself to ensure future successes. As a result, defining a clear vision is often needed to verify that the planned model genuinely operates and that the underlying structure is in place. This concept can be interlinked with the one of trialability identified by [26], which is defined as an indicator of the scalability potential, referring to the extent to which the solution can be experimented with in a local context before its full implementation. This factor has a twofold advantage: on the one hand, it demonstrates the potential of the project

both in the internal and external context and, on the other hand, it identifies and pre-empts the risks which may increase during the scale up process.

5.2.2. Economically Feasible Business Model

The creation of an economically feasible business model represents the second key factor. Here, sustainability is interpreted in two different ways: from an economic perspective and from an environmental perspective.

The SMOOTh project has resulted in a particular focus on economical sustainability, aimed at not being bounded by temporary subsidies or grants, that could obstruct the path toward upscaling. The concept of economic sustainability, which emerged from interviews, can be directly correlated with the concept of profitability identified by [26] and indirectly connected with the factors of the economies of scale introduced by [7]. According to the first study, the project must be characterized by positive returns on a larger scale, and thus economically feasible when considered to be financially attractive in the long term [26]. At the same time, the goal deriving from the economies of scale can be considered as connected to this. The establishments of economies of scale deriving from project size growth can lower costs, producing significant impacts on future profitability [7]. However, the results from the research provide a new insight regarding economies of scale within smart city logistics projects. The establishment of economies of scale may be more challenging when dealing with environmental sustainability goals. The latter creates the need to achieve a high load rate and the use of electric vehicles, which contribute to increased costs when the number of deliveries increases.

Nevertheless, economic sustainability alone is not sufficient. The introduction of sustainability reports can increase the prominence of other KPI compared to those which are strictly connected with financial performance. Smart city logistics projects which favor a decrease in pollution may consequently benefit from the inclusion of non-financial performances which can support their growth. This agrees with the establishment of standards to measure ROI which are revealed by the existing literature [7].

Finally, a crucial prerequisite for the business model is flexibility [26]. This indeed must have the potential to be easily adaptable to the external environment, and thus successfully perform project scale up.

5.3. Technical Factors

Technical factors are necessary to evaluate whether the solution developed by the project is inherently scalable [26]. Technical factors, including infrastructure capacity and the IT system are built upon and based on the business model.

5.3.1. IT System Interoperability

The role of data within smart city logistics projects is remarkably emphasized both in the literature and through empirical findings. Smart city logistics projects need to invest heavily in digitization, the latter of must be more agile in the implementation of the multimodal transportation system. Ref. [7] underlined the fact that the multi-stakeholder scenario, such as the one which characterizes the logistics industry, increases the relevance of this factor. The IT system is the tool through which the vision of scale up and the underlying business model can be put in practice. Firstly, to successfully scale up it is necessary to collect data from different stakeholders which are processed within the IT system. To do so a trust must be established and an incentive to share data must be defined. Afterwards, since with the multimodal transport several logistic providers interact with each other, the system must achieve interoperability, and thus must be designed to be capable of handling data deriving from different sources. In this regard, it is expected that the system is capable of managing an increasing number of interactions in terms of data. Only through the establishment of data interoperability can the SoS be harmonized and stakeholder collaboration can take place.

5.3.2. Existing Infrastructure

Duly taking into consideration the infrastructure capacity is necessary. This is in line with [26], who demonstrated in their research the relevance of the existing infrastructure. The infrastructure capacity also sets a limit in terms of service potential, potentially acting as a barrier to future project expansion and restricting chances in success [32]. The infrastructures of the logistics industry can be translated in the UCC and city hubs, the latter of which corresponds with Nordstan in the specific case of the SMOOTh project. Therefore, during the pilot stage, the key infrastructures for the project should be determined, in this sense the involvement of a real estate company within the the SMOOTh consortium, which is recalled in the next section and is crucially important. In addition, over time it is considered appropriate to assess the capacity dictated by the existing infrastructure. This may have implications, especially in the long term. In this sense, by making this a consideration, smart city logistics pilot projects can visualize what expansion would imply in terms of infrastructure capacity, and eventually plan the actions needed to achieve it. Furthermore, establishing in a concrete way the infrastructure which has a capacity suitable for scale up provides more credibility to the project, allowing the actual pilot test to be carried out.

5.4. Stakeholders–Related Factors

These factors reflect the extent to which the current multi-stakeholder environment is ready to embrace the scale up version of the project [26]. Their support is crucial to explore the path toward scale up.

5.4.1. Consortium Composition

The consortium members are responsible for the success of the project and for this reason it is necessary to accurately consider the composition of the consortium.

During the pilot stage, the project should be capable of achieving the critical mass in terms of stakeholders taking part in the project. On the contrary, the fact that the project is not able to engage enough stakeholders may undermine its future success. Involving a minimum number of players is particularly relevant within the logistics industry, for which delivery capacity plays a role. Furthermore, a degree of diversity within the consortium composition should be ensured. Specifically, big logistic providers and real estate companies are fundamentally important, since they are able to provide the assets needed. On the other hand, the SMOOTh consortium also involves administrators, representing the neutral players that can help establish a balanced coexistence between different players, together with research institutes. The contribution of the latter is equally essential to support and promote the innovative processes development. It can be deduced that the ideal consortium should involve at least three out of four stakeholders' categories identified from a framework defined by [1]: shippers, who correspond with the real estate's tenants, and carriers, as the logistic service providers and city administrators. Nevertheless, overall, no real connection between the findings and literature emerged for this key factor. This may mainly derive from being a characteristic correlated with a specific industry. The logistics industry represents a landscape which hosts a heterogeneous group of players, each one essential to the other.

5.4.2. Co-Creation

The companies within the consortium must develop an awareness that they are contributing to a co-creation process that is enabled by the synergies which characterize a SoS.

Co-creation factors are associated with the process of mutual concessions and compromises which occur within multi-stakeholder projects. The groundwork of co-creation is represented by trust. The trust that the organization will receive a remuneration for the value created is particularly necessary for those organizations which face the highest costs. This trust and process of co-creation should be fueled by the system arising from

the partnership. One way to achieve this is represented by enabling a value exchange system. This mechanism would make the collection of system-wide benefits possible, and they could be distributed to those players who sustain the highest costs. This concept is supported by the statement of [33], which affirmed that *“the nature of the coordination process was in fact the key to establishing an atmosphere of trust and mutual collaboration and for the overall success of each multiparticipant project”*. On this basis, the project management body and city administrators should primarily lay the groundwork for this collaborative process by taking the sides of neutral figures who can handle and prevent potential trade-offs.

5.4.3. Consensus

Encouraging stakeholders to become involved in the project is not sufficient for long term success, and thus a consensus represents a further key factor for project upscaling. The business model will suffer changes over time; therefore, it is necessary to maintain stakeholders' interests toward reaching project goals and upscaling for the duration of the whole project to avoid the generation of internal contrasts. The first step to establish the groundwork for a consensus includes the clear communication of the project missions and the underlying model. A consensus can be traced back to the stakeholder acceptance factors revealed by [26]. Scholars affirm it is crucial that key stakeholders, as well as regulators, accept the proposed solution. Furthermore, the incentive addressed to those players who may lack the motivation toward scale up may be crucial to maximize the upscaling potential of the solution [7]. This consensus must be maintained over time, as revealed by [26] and the research results, since it is very likely that the original business model will not hold and will undergo changes. At this time, the resistance to change caused by concerns that there may be no space left for a consensus, may undermine the implementation of a consensus.

5.5. Legislative Factors

Legislative factors reflect the extent to which the regulatory and political environments express a consensus toward the smart logistics project scale up (May et al., 2015). Legislative factors lie in the outermost layer, as the project potential is already expressed to be communicated to institutions.

5.5.1. Supporting Regulation

The influence that regulation can exercise through city administration is evident. Regulation can intervene in two alternatives way: by proving incentives or by establishing restrictions [7]. The establishment of a vehicle-free zone within the inner city is included in the second category which, as previously highlighted, would contribute to the promotion of the SMOOTh project. The beneficial regulations also include the facilitation of electric vehicle traffic in the inner city. In this sense, regulation may be able to accelerate the transition toward a greener and smarter city logistic environment. Therefore, the measure of restriction can vary from case-by-case depending on the geography and cultural context of the city of interest [19]. The consensus from regulators is an essential element of proceeding with the scale up of the tested solution [26]. On the other hand, the regulations can act as obstacles to smart city project scale up when they shield the project from the real-word market forces and legislation, which it will inevitably be exposed to during the scale up phase [7]. Nevertheless, the SMOOTh project results were not excessively shielded from the regulations, which limited the scale up potential from the beginning.

5.5.2. Political Will

Politicians serve as representatives of city residents, as well as a regulatory body with a jurisdiction over traffic rules and freight distribution, or the owners of areas that may be used for the UCC [19]. Consequently, their involvement is essential for the project scale up. Since the initiative of the application of a smart logistics system is derived from private operators, the dialogue with politicians should focus on reporting, with data in

hand, the potential benefits of the large-scale implementation of the project. In line with this, [26] affirmed in their study that a detailed and accurate concertation process between the public administration and the stakeholder representatives represents a pre-requisite for the acceptability of the new system. Indeed, the visibility of results is a precondition for a constructive communication with politicians [26]. In this sense, [7] already demonstrated in their study that the city realm characterized by a high ambition toward goals, such as a reduction in CO₂ emissions, may favor the project development.

6. Conclusions

6.1. Answering the Research Question

This work is driven by the increasing emergence of smart city logistics pilot projects, in which various stakeholders collaborate, aiming to increase last-mile delivery efficiency, while decreasing the deriving negative environmental impacts. The low rate of project upscaling centers the attention toward the scale up phase, which can transform a local experimental exercise into a real-life industrial-scale implementation. This research contributes to the existing academic debate by identifying the key scalability factors for smart city logistics projects, focusing on the expansion and roll-out type of upscaling. To achieve the research purpose, this study investigated a three-year research project, named SMOOTH, launched in 2019 in the city of Gothenburg.

Having introduced the theoretical foundation for the study through a systematic literature review, a framework containing key factors resulted from the study. The framework was developed by combining empirical findings with the existing literature. Four main categories of factors were identified: economic, technical, and stakeholder-related factors, as well as legislative and regulatory factors. All the factors were mutually necessary and should be developed during the pilot project to achieve a successful scale up. A strong linkage between them existed, and an iterative process was required for their full development.

Our findings allowed us to identify some key ingredients which existed for each of the factor types, which could be used as drivers for future smart city projects with scaling up targets. First of all, the economic factors were strongly needed to support the development of a smart city project. Within this category, we discovered that a vision was one important factor to succeed in such projects, since all the stakeholders must pursue long-term objectives and commitments to engage in a continuous scaling up. These objectives could be reached only when a second important ingredient existed, that is, the economic feasibility of a smart city project through which the smart city activities could be reinforced over time and then focused on environmental sustainability and social inclusion.

Regarding the technical factors, which were the second most relevant type of factor, we discovered that the IT systems' interoperability helped firms and stakeholders to connect and share all the information regarding the city. Without clear and accessible information, the objectives of a smart city project could never be achieved. This also applied to elements, such as data privacy, security, and reliability. The information exchanged by firms and stakeholders must be used to integrate and optimize the infrastructure, which was the second technical ingredient we identified in our research. Consequently, smart cities must be technically sound in terms of soft technical factors (e.g., information), as well as in terms of hard technical factors (e.g., infrastructure). The great use of infrastructure was possible only when the information interoperability existed.

According to our findings, three ingredients emerge from a stakeholder's point of view. First of all, we find that stakeholders should be organized in consortiums, with the objectives of sharing opportunities and resources but also the risks and possible consequences of some actions. Second, the consensus that stakeholders can reach is a key ingredient in pursuing the projects effectively. The project objectives should then have a great interest and be beneficial to the stakeholders in general. Finally, all stakeholders should participate in the value creation process which should end up with higher outcomes

than the ones obtainable by one stakeholder alone. This would lead stakeholders to act jointly and harmoniously.

Our findings allowed us to identify the legislative and the regulatory key factors in the scale up of smart cities projects. Among the possible elements, we identified the support and the political will. These two factors were very much interconnected. The smart city projects should receive the support of the policy makers since they required considerable investments and had welfare targets as outcomes. Indeed, only the policy makers' willingness to pursue such projects could sponsor their realization and cause an acceleration of the development of smart cities projects.

6.2. Future Research

This research project could be a foundation for further research which wishes to contribute to the sparse literature on the upscaling of smart city logistics projects. Future research could reveal the potential limitations of this study.

As initially highlighted in the delimitation section, this research does not consider factors related to the replicability of a smart city logistics project. Therefore, future studies could fill this gap by focusing on replicability by analyzing a project that is in the process of carrying out this strategy or has already done so. This direction should consider the important trends of sustainability and digitalization more comprehensively.

The generalizability of the research is limited by the application of a case study methodology. This research focuses exclusively on the SMOOTh project, focusing on the Swedish and European context. However, Sweden, and in particular the city of Gothenburg, unlike other contexts, pays particular attention to environmental issues as it is engaged in a transition toward more mobility. Future research can therefore conduct studies in different contexts or cultures to increase the generalizability of the results. In this regard, a comparative study could be performed by analyzing different smart city logistics projects around the world. This would be useful to identify elements of commonality and divergence. Machine learning techniques could be used to support scaling up projects.

The results are affected by the choice to analyze a project currently in the pilot phase. This choice, although it has advantages, also has limitations resulting from the inability to consider the actual scale up phase. To better understand the implications of these results, further studies could address the study of the SMOOTh project in the future, or alternatively analyze the smart city projects which already perform upscaling. A longitudinal study would enrich and lend support to the present research.

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Appendix A. Interview Guide

Appendix A.1. Introduction

- Introducing the authors and the research purpose.
- Asking permission for recording and citing the interviewee name in the study.

Appendix A.2. Interview Questions

Stakeholder Overview	Could You Describe Your Work within the Organization?
	Which Is the Motivation That Led Your Organization to Join the SMOOTH Project?
Upscaling	Can you describe the SMOOTH project future vision and desired scale?
	Does your company have the interest toward project upscaling and the capacity needed?
	Which do you think would be the technical, organizational, economic and regulatory critical success factors for project scale up in the inner city?
	Which are the steps that make up the pathway to scale up?
	What do you think are the barriers to upscaling?
	According to you which is the best way to motivate and incentivize the company to stay committed and comply to the main goal of the project over time?
	What kind of incentives would facilitate data sharing within the system for the stakeholders?
Pilot phase	How does communication happen within the project?
	What is necessary to be tested during the pilot study to assure future scalability?
	What are the main difficulties that emerged during the evolution of the project and how would these lessons learned be relevant to the scale up phase?

Appendix A.3. Concluding Questions

- Is it okay if I send you the summary of the interview and maybe you validate it?
- Would you be interested in the final report and results?

Appendix B. Coding Table

Contribution to a Better City Environment (Less Traffic and Pollution)		
Creation of a system of systems Inspiration for other cities Reducing by 40% the amount of traffic	Vision of Scale	Business Model
Identify proper revenue stream Define the ideal price for the service Successful demonstration on pilot project scale Visualize potentials risks and barriers Preserve flexibility Go beyond economical KPI Sustainability reports	Sustainable Business Model	
Define the players that should be involved Define incentives to involve them Large logistic companies, real estate companies and administrators	Consortium Composition	
Vision needs to be accepted by various stakeholders Different interests among players Communicate the potential benefits to each stakeholder by elaborating different messages Maintain consensus over time	Consensus	Stakeholder
Establish a give-and-take process Trust is necessary Create synergies within the SoS Properly distribute value created among stakeholders Make it easy to collaborate	Co-creation	Technical
Necessity of data for expansion Define incentives to share data The system must appear as secure Different data sources must be accepted	IT System Interoperability	
Define the capacity needed Evaluate the increase in number of city and suburban hubs Dealing with publicly owned infrastructure may be challenging	Infrastructure Capacity	
Environmental policies can drive development Fossil-free cities or restriction of truck movements Vehicle-free zones Carrot and stick approach	Supportive Regulation	
Politicians may be reluctant to approve vehicle-free zone Showing data to politicians is necessary Bureaucracy may make communication more difficult	Political Will	

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