Smart City for Sustainable Urban Freight Logistics

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Abstract: Sustainability has become an important objective of city logistics management. Smart city, being a technology and data driven paradigm for a city's sustainable development, has entailed new research opportunities from different perspectives. It is foreseeable that smart city will keep evolving in the domain of city logistics, which plays a key role in this game changing evolution. Recent research in this field is characterized by interdisciplinary approaches and disruptive innovations. We review the state-of-the-art of this general area and conduct a bibliometric analysis. We conclude with a new conceptual framework of smart city for sustainable urban freight logistics and the relevant key perspectives.

Keywords: City logistics, Urban freight, Smart City, Framework, Sustainability, Disruptive technology, Data-driven solutions, Innovation, IoT, Digital Twin.

1. Introduction

Smart cities integrate both digital technology and data analytics to improve the quality and sustainability of life. New technologies, such as smartphones, IoT devices, sensor systems, are directly injected into the lives of residents. Instant information about transit, traffic, community news, health services, and safety alerts are analysed and utilized to facilitate better decision making by the city planner, industry practitioners, and individual residents. Among all the key ingredients of a successful smart city, transportation and supply of goods, public transportation services, and flow of traffic play key roles when the city layout, business applications, and infrastructures are designed.

When putting the focus on freight, *city logistics*, also called *urban freight logistics*, deals with the physical distribution of goods to the final destination at urban areas, with respect to a set of objectives such as effective services, cost-effectiveness, and sustainable development (Savelsbergh and Van Woensel, 2016). City logistics have been playing an increasingly important role both in economic and in social development (Taniguchi et al., 2001). More specifically, city logistics mainly deal with two major physical flows, i.e., forward or reverse flows (Bektaş et al., 2016). The former consists of Business-to-Business (the so-called B2B or B-to-B) flows from a supplier's site to a retailer' site, Business-to-Consumer (B2C) flows from a seller's site to a consumer's location, or Consumer-to-Consumer (C2C) flows between individual consumers. The latter mainly deals with waste and collection of recycled materials and returns of goods. Both forward and reverse flows must be effectively and efficiently managed, despite the complexity in the operational processes (Holguín-Veras et al., 2018).

The main objective of city logistics is to improve the effectiveness and efficiency for shippers, service providers, and customers. Since the last decade, sustainable development has become a contemporary and significant objective to city logistics stakeholders. Under the paradigm of sustainability, the goal is to reduce the negative externalities of logistic activities, while ensuring service coverage and improving quality of life of all inhabitants at the city level (Anderson et al., 2005). Typical negative externalities include those from transport activities such as CO_2 emissions, climate change, congestion, noise, accidents, and air pollution (as defined in the handbook (European Commission, 2019a)). It also includes other issues such as land use and working conditions for human labor. Balancing the economic, social, and environmental objectives, which are sometimes contradictory, remains critical for logistics service providers. Meanwhile, policy makers and municipalities become increasingly more concerned with the environmental and social impacts of city logistics. As a result, the conventional best practices for city logistics are often challenged in this new context.

The theoretical foundation and the best practices of city logistics have been primarily supported by the research areas of Operations Management (OM), Operations Research (OR), Supply Chain Management (SCM), and Industrial Engineering (IE). There is a rich existing literature that builds theories, investigates new mechanisms, and explores novel methods for optimizing the many problems in smart city logistics, including network design, process optimization, resource utilization, city service science, transportation, etc (e.g. see the recent review in Bektaş et al. (2019)). In recent years, emerging digital technologies and data driven approaches have entailed new research opportunities for disruptive innovations to the same end. As a result, there is an urgent demand for research from new perspectives that develop innovative solutions. Motivated by the need to fill the void of research in this fast-developing field, this Special Issue investigates how disruptive technologies and emerging operational approaches offer new research opportunities that could be fundamentally different from conventional practices. We are keen to explore the new perspectives to manage city logistics for improved efficiency and better sustainability, specifically in the realm of Smart City.

The rest of this paper is organized as follows. Section 2 presents the new challenges to sustainable city logistics. Section 3 presents our bibliometric analysis and a new conceptual framework of smart city for sustainable urban freight logistics. Section 4 highlights the main research ideas and the contributions of the papers that are included in this Special Issue. Section 5 concludes this paper and suggests topics for future research.

2. New challenges in sustainable city logistics

In this section, we discuss the new challenges related to sustainable city logistics. Our discussion is based on the recently published papers that provide in-depth analyses of the problem, for example, Taniguchi et al. (2016), Savelsbergh and Van Woensel (2016), Dablanc et al. (2017), and Holguín-Veras et al. (2018).

Megacities and urban planning. A report by the United Nations (2018) indicates that, globally, the number of megacities (i.e., having 10 million inhabitants at least) is projected to rise from 33 in 2018 to 43 in 2030, and 60% of people are expected to live in cities with at least half a million inhabitants. It is foreseeable that freight demand will increase and massify in such cities, that will make logistics activities more difficult to manage. The issue must be tackled at its roots such as urban planning and design. Taking parking space as an example, Dalla Chiara and Goodchild (2020) found that, in Seattle downtown, on average cruising for parking took 28% of the trip time for commercial vehicles, and around 1.1h per commercial vehicle tour. The problem is mainly related to the urban areas and infrastructures issue. Logistics in mega-cities should also be concerned about other land use-related issues, e.g., path for freight transportation, land for warehousing, handling, micro-hubs or reception lockers.

The population of on-demand delivery. As suggested in (Dablanc et al., 2017), on-demand (or instant) delivery services provide "*on-demand delivery within two hours – by either private individuals, independent contractors, or employees – by connecting consignors, couriers and consignees via a digital platform*". In a broader sense, the quoted time can be shorter or longer than two hours. Well-known examples include Amazon Prime Now, Deliveroo, Uber Eats, etc. Due to the wave of digital platforms, such services are rapidly growing across the world. However, how to efficiently and sustainably manage the service remains a critical challenge, especially the impact on traffic accidents, safety, and congestion. The main issue for on-demand services is that, on the one hand it is hard to forecast precisely the arrival time of orders, and on the other hand it is almost impossible to consolidate orders for economies of scale due to very short lead-times. Consequently, a delivery tour can have one or few orders (clients), and therefore becomes inefficient and unsustainable.

The war of speed and flexibility in an omnichannel environment. The role of city logistics is enhanced by the recent rapid growth of e-commerce sales and, especially, the new business environment of omnichannel retailing that stresses both online and offline channels (Giannikas and McFarlane, 2021; Janjevic and Winkenbach, 2020). To advance the competitiveness of services, retailers and logistics service providers have devoted significant efforts to deploy express fulfilment services, e.g., same-day or next day delivery, omni distribution channel. This results in new logistics challenges, such as fragmented and downsized shipments, higher delivery frequency, shorter delivery time, highly fluctuant and uncertain demands and returns. Such challenges are particularly impacting on parcel markets (Buldeo Rai et al., 2019). A notable example is the Single day e-commerce festival held on November 11, 2020 in China: *Alibaba* group hit the sales record of $75 billion in 24h against $38 billion in 2019, generating billions of parcels to deliver during the following weeks. On the one hand, this is a huge challenge to the flexibility and agility in product distribution and delivery. On the other hand, this will also challenge the capacity and cost-effectiveness of the reserve logistics systems, knowing that according to the previous years' trend, the return rate is up to 25-40% depending on the products (Chen et al., 2017). Collecting and recycling the packaging materials (e.g., cardboard boxes, plastic packaging) is another sustainable issue of importance (Escursell et al., 2021).

Strict regulations and new objectives. Due to the aforementioned negative externalities, regulations to freight transportation are becoming more and more strict in cities. For example, municipalities are now placing more restrictions on delivery hours (e.g., no off-hour delivery), vehicle accessibility (e.g., light commercial vehicles only), cleaner vehicles (e.g., cargo-bike), or logistics land use issues (Holguín-Veras et al., 2018). This is fully aligned with the new objectives in Europe, notably towards sustainable zero emissions urban freight and city logistics by 2050[1]. These regulations as well as the objectives, on the one hand well-protect the interests of all stakeholders (inhabitants, municipality, consumers, etc.); on the other hand, however, result in tough constraints to city logistics planners and operators. As a result, conventional practices in city logistics are still facing difficulties to balance economic profit and environmental or social protection.

Consumer attitudes towards sustainability. A lifestyle change towards more sustainable habits and behaviours can be observed in many countries around the world driven by the realisation of the impact current behaviour has on the environment and the future of our planet more generally. As a result, a new type of consumer, one that values sustainable produce, distribution and waste/re-use has emerged (Longo et al., 2019). Those consumers are more likely to prefer, or even demand, sustainable methods for their urban freight logistics needs, such as bike deliveries, compared to conventional ones (Gruchmann Tim et al., 2019). This is often coupled with a willingness to pay a premium for such sustainable services or a preference towards retailers who adopt more sustainable practices, thus creating a business need for sustainability. From a company's perspective, the final result is consumers with very different requirements and needs that retailers and logistics providers are required to serve alike.

In the next sections, we introduce the concept of Smart City, and discuss how it could help city logistics cope with the new challenges discussed above.

3. Sustainable city logistics in smart city: review & framework

Among the most breakthrough approaches for sustainable city logistics, more and more attention has been paid to Smart City (or Smart Cites as is interchangeably used in the

[1] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

literature). Different definitions can be found in the literature, one of which given by the European Commission (2019b) is as follows:

> *A smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. A smart city goes beyond the use of information and communication technologies (ICT) for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population.*

The definition is aligned with the Smart City Foundations suggested by IBM researchers (Harrison et al., 2010), which defines Smart City as "*connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city*". This definition emphases on three key foundational concepts: *Instrumented* referring to data sources from physical or digital world; *Interconnected* referring to integration, interconnection and communication of data among the various city services or companies; *Intelligent* referring to data processes for intelligent decision making.

The definitions cited above are broad enough such that all kinds of transportation services are covered, including mobility and freight at city level. They also place emphasis on digital transformation and ICT technologies for data collection and communication for decision making. Even though urban freight logistics activity is not explicitly specified in the definitions above, it is obviously an essential pillar for Smart City because of its importance and significance (Kumar et al., 2016; Russo et al., 2016). As a novel paradigm for city planning and management, Smart City should be considered as a game-changer that changes the mindset of the stakeholders related to city logistics. For the research community, the ICT-enabled smart transportation networks as well as the smart logistics infrastructures empowered by Smart City are opening up new research avenues for sustainable city logistics.

3.1 The related literature

The city logistics related literature has already paid wide attention to the Smart City paradigm. To better understand the trend and foci, a bibliometric analysis is conducted. It is worth noting that the analysis is for statistical purpose only, aiming at analysing the publication trends and the most occurred keywords. We encourage a future research which could be a taxonomy or systematic review based on the collected dataset.

We use the *Scopus* database for collecting publications, which is suggested in many review works, for example, see Dolgui et al. (2020) or Pirola et al. (2020). Four criteria are set to select the most relevant and pertinent publications:

(C1) Time period: considering smart city as a recent term, we did not set any specific time range in the queries. In other words, publications until 2020 (as of the date of this work) are taken into account.

(C2) Sources: to better cover all contributions, journal papers, conference papers, reviews, books, and book chapters are included. Nevertheless, technical reports, conference reviews or editorials are excluded.

(C3) Language: only papers written in English are considered.

(C4) Keywords: We firstly use the following keywords for queries in the publication database: “smart cit*” *AND “last mile” OR "freight transport*" OR "city logistics"*

OR "urban logistics" OR "urban freight" OR "urban distribution". The first term is to cover *smart city* or *smart cites* that are interchangeably used in the literature. The second terms are to cover the keywords related to city logistics. Note that we have also tried to include the keyword “supply chain” in the queries. A preliminary analysis indicated that the “supply chain” related papers investigate mainly how smart city will challenge supply chain management, without putting focus on city logistics. Therefore, we decided to not include it.

Based on (C1)-C(4), the Scopus string is displayed as follows: TITLE-ABS-KEY ("smart cit*" AND "last mile" OR "freight transport*" OR "city logistics" OR "urban logistics" OR "urban freight" OR "urban distribution") AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")).

The keywords are used to search the document’s title, abstract, and keywords list. Accordingly, 135 documents are identified from Scopus. However, due to the term “last mile” that is too wide (covering public transportation or community service), we noticed some documents that do not actually deal with freight flows. We therefore proceeded with a paper selection step. After reviewing the title and abstract of the 135 identified documents, 53 of them are removed, which focused on other topics rather than on freight transport, for example, smart grid or power supply, electric vehicle, ICT technologies, public transportation and mobility, and bike sharing.

Finally, 82 papers are selected for bibliometric analysis. The software *VOSviewer* is used to analyse and visualize the results of the bibliometric analysis on the selected publications, which is well recommended in the literature (Dolgui et al., 2020). For technical presentation of the software, we refer to the articles suggested by the developer (van Eck and Waltman, 2014, 2010). Note that the default settings of the software are applied in the analysis.

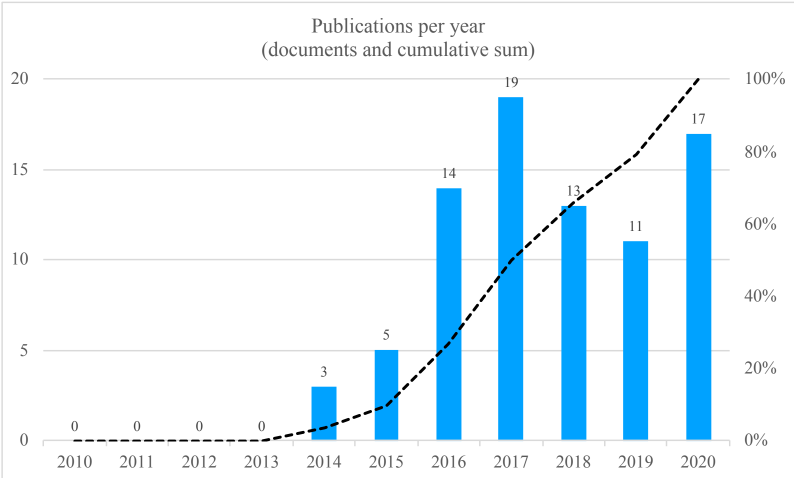

Figure 1. Number of documents per year among the identified publications (as of December 2020)

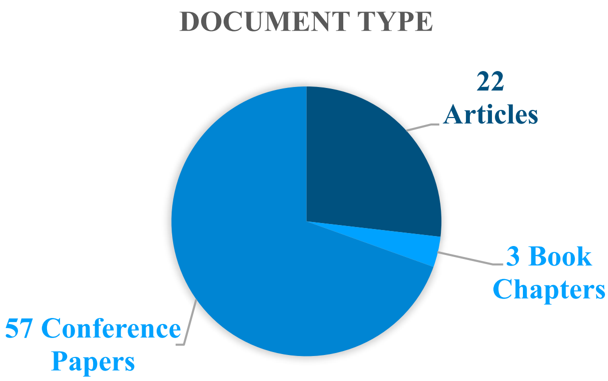

Figure 2. Document type among the identified publications

Figure 1 shows that, according to the selected dataset, the first papers dealing with city logistics from the angle of Smart City were published in 2014. Since that, the number of publications has increased significantly, despite a slight drop in 2018 and 2019. Figure 2 illustrates that about 70% of the papers were published in conference proceedings, while only about 27% were published in journals. More surprisingly, the 82 papers were published in 65 different outlets; and only 4 outlets have published at least 3 papers each. These outlets include Sustainability (journal), Transportation Research Procedia (TRP), Lecture Notes in Computer Science (LNCS), Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering (LNICST) (conference proceedings). The findings imply the interdisciplinary nature of the research problem.

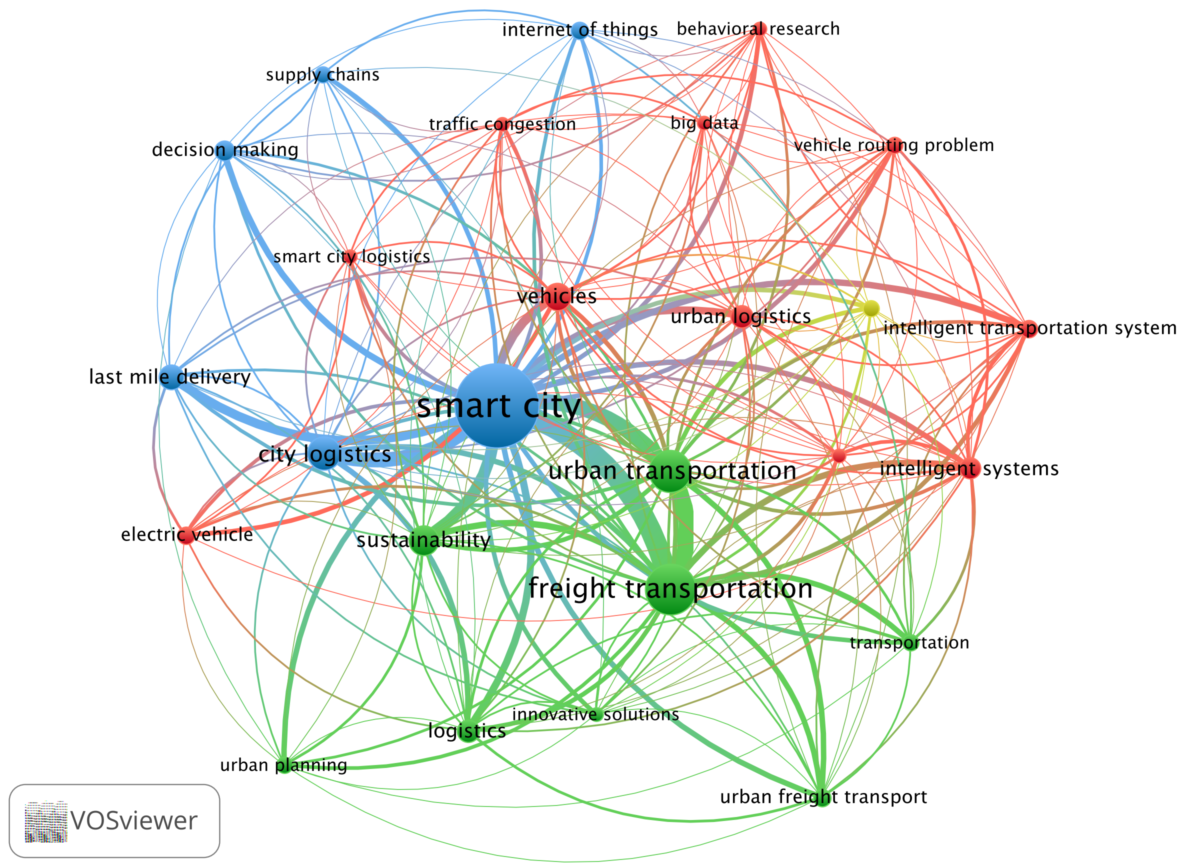

Figure 3. Most occurred keywords (at least 5 times) and the co-occurrence among the identified publications

According to the analysis of the most occurred keywords, 26 out of 830 keywords have occurred at least 5 times in the dataset. Their co-occurrence is displayed in Figure 3, in which we can see that smart city is strongly related to logistics, transportation, and sustainability. Further, we also used *VOSviewer* and its default clustering algorithm to categorize the top keywords. As shown Figure 3, three major clusters can be observed: *Red Cluster* that is concerned with data and intelligent transportation, *Blue Cluster* concerns city or last-mile logistics and supply chain, and *Green Cluster* concerns freight transportation and sustainability.

Several key findings from the bibliometric analysis should be highlighted. First, the research problem of Smart City for City Logistics is new to the literature, and mostly studied from interdisciplinary perspectives, including OM/OR, computer science, and data science. Second, knowing that sustainability was not used as keyword in the queries, the results imply that sustainability was massively investigated as key issue in the related literature. Third, the literature places exclusive focus on transportation activity and related infrastructures. No adequate attention has been paid to other logistics activities such as warehousing, material handling, and land use. Last, innovations on logistics services should merit more attention. Innovative business models and the related new technologies should be among the most important keywords, e.g., digital twin, artificial intelligence, smart product-service-system or servitization.

3.2 Framework of Smart City Logistics

Based on the findings from published papers in the smart city logistics literature, we propose a comprehensive framework that integrates the key elements and major perspectives, including the main processes, intelligence component, policy and regulation, social, economic, and environmental issues (Figure 4). Specifically, from this framework, we form the following angles for smart city logistics:

1) city as a service
2) intelligence in smart cities
3) sustainability perspective: social, economic, environmental

"City as a service": the core activities of smart city logistics include: urban infrastructure provision, traffic, public transportation, land usage, facility locations, waste management, inventory, transportation, and warehousing. These activities help practitioners to offer services and transfer goods to satisfy everyday demands from the habitants in the city. Energy, manufacturing, and other supplies may take place in the city or from another city or country. The end-of-life (EoL) products after consumption are usually fed back in the reverse supply chain for sustainable development of the society, economy and environment.

Prasetyo et al. (2020) discuss smart city architecture characteristics for service platform implementation in the digital service ecosystem. With the volume of data in smart city initiatives, there is a need to secure such data. To this end, Cason and Wierschem (2020) discuss securing information and communication systems of smart city through the transportation sector. They identify several trust issues and vulnerabilities in such systems and discuss security methods that are used to protect transportation and smart city communications. It should be noted that not all smart city data are similar in content, structure, and elicit the same response from citizens. For example, Ylipulli and Luusua (2020) discuss the case of Finland where sensor and infrastructure data (e.g., point of sale and public transport data) exist along with citizen life data "from cradle to grave" and the need to democratically treat such data. While the rest of the world is engaged in gathering massive IoT-generated data and other processes in those cities, Finnish cities already have such in-depth data that provide deep insight into everyday lives of their citizens. As such low-level data has existed in Finland for hundreds of years, new ways to use such data ethically presents huge challenges to policy makers and private citizens.

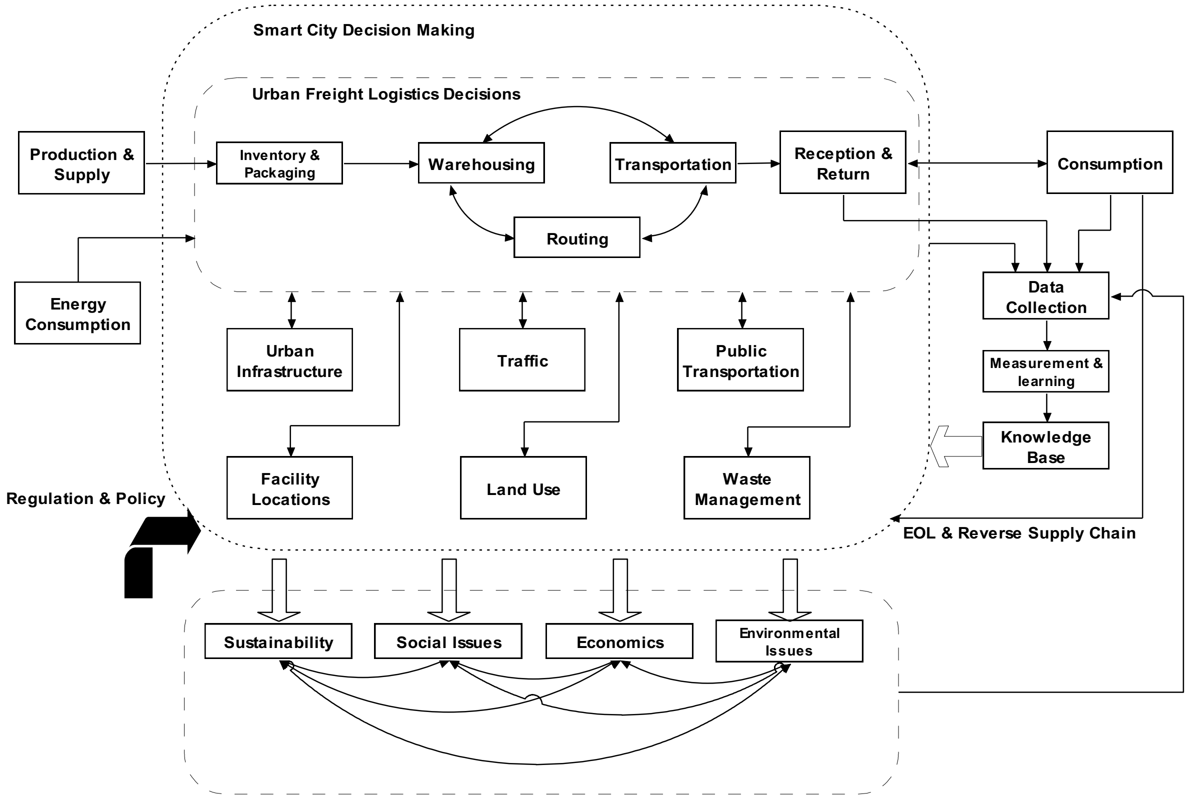

Figure 4. Framework of Smart City Logistics

"Intelligence in smart cities": a tremendous amount of data is created every day in smart cities. After the data are collected, measured, and analysed, knowledge is updated that will be further used to facilitate the decision making process at the city level. This process creates a self-adaptive learning intelligent system for the smart cities to continually improve the social, economic, and environmental issues for sustainable development. Specifically, knowledge obtained from data can be used to manage traffic, public facilities, land planning and usage, infrastructure planning, waste management, and many other services more efficiently. Thanks to emerging technologies such as IoT, blockchain, and more general Internet based applications and digital platforms, data can be collected in real-time from transactions, devices, facilities, building, roads, power plants, water supply units, physical goods, and even citizens.

Blockchain and Smart Contract among other emerging technologies are worth special mention. For example, Irannezhad (2020) recommends blockchain to alleviate inefficiencies caused by invisibility and disconnectivity in freight transportation due to delay, double-spending, disputes, and cancellations. Humayun et al. (2020) observe the resource constraints in IoT devices, which play a significant role in smart transportation, and propose a layered framework that integrates IoT and blockchain that is secure against several security attacks through real-time information sharing and better fault tolerance. As there is some resistance for blockchain adoption, Orji et al. (2020) identify the availability of blockchain tools, infrastructural facility, and government policy and support as significant factors that influence blockchain adoption in the freight logistics industry. As for customer satisfaction in urban logistics, Tian et al. (2020) use a blockchain-based evaluation approach to identify the factors as cost performance, information transparency, cargo-damage rate, and on-time delivery. While blockchain technology has generally been recommended for freight logistics, there are some issues with the use of blockchain for this purpose. For example, Perboli et al. (2020) propose and evaluate a Hyperledger Sawtooth-based framework in two smart logistics system settings and conclude that performance is compromised when concurrent transactions are submitted to multiple nodes. Regardless, based on the current state of blockchain technology and its applications, Koh et al. (2020) conclude that further theoretical studies are needed to comprehend what it takes for successful integration of blockchain technology in transportation and logistics. Other emerging technologies such as IoT also face related constraints in terms of technology, privacy, and security with respect to gathering, storing, and analysing data.

"Sustainability: social, economic, environmental perspective": sustainable social development, economic development, and environmental protection in smart cities create the capacity for biosphere and human civilization to co-exist. Also commonly defined as a socio-

ecological process characterized by the pursuit of a common ideal, sustainability is achieved through the balance of species and resources by maintaining the equilibrium of natural resources and consumption. Smart city technology allows city officials to interact directly with both community and city infrastructure and to monitor what is happening in the city and how the city is evolving. Real-time data are used to enhance performance, quality, optimize the interactivity of urban services, and to reduce resource consumption. A smart city may therefore be well prepared to respond to the more general challenges of sustainability than the traditional ones with a simple "transactional" relationship with the citizens.

Karaman et al. (2020) consider communication of sustainable supply chain practices such as materials usage, energy efficiency, recycling, and waste management metrics to customers and other stakeholders to develop environmentally friendly supply chains and to improve the competitive posture of companies. Choudhary et al. (2020) identify 36 potential sustainability risks associated with freight transportation systems and classify them into seven categories and develop a framework to manage these risks with different risk preferences. They also observe that most high priority sustainability risks in freight transportation systems are not financially driven but are behaviorally and socially induced. Tavasszy (2020) recognizes the rapid changes in freight transport logistics, impelled by information technology progress as well as consumer involvement, and related significance of understanding logistics innovations. He then reviews these innovations for model improvement on the modeled structural elements, functional relations among these elements, and the model's dynamic properties. Kumar and Anbanandam (2020) observe that compared to economic process, environmental and social sustainability-related processes are poorly managed in the freight transport industry. They then propose an index to evaluate sustainability performance.

4. About this Special Issue

This Special Issue aims to collate the breakthrough research addressing sustainable city logistics from the angle of smart city and the technology- and data driven solutions. Table 1 summarizes the papers included in this Special Issue and the research foci.

Title	Authors	Focus
A parcel network flow approach for joint delivery networks using parcel lockers	Pan, Shichang; Zhang, Lele; Thompson, Russell; Ghaderi, Hadi	Parcel delivery and lockers
Integrating autonomous delivery service into a passenger transportation system	Mourad, Abood; Puchinger, Jakob; Van Woensel, Tom	Autonomous vehicles
Operating policies in multi-warehouse drone delivery systems	Shen, Yaohan; Xu, Xianhao; Zou, Bipan; Wang, Hongwei	Drone in warehousing
Crowdsource-enabled integrated production and transportation scheduling for smart city logistics	Feng, Xin; Chu, Feng; Chu, Chengbin; Huang, Yufei	Crowdsourced delivery
A Resilience Assessment Framework for Urban Transportation Systems	Gao, Yue; Wang, Junwei	Transportation Resilience
Physical Internet-enabled customised furniture delivery in the metropolitan areas: digitalisation, optimisation and case study	Luo, Hao; Tian, Siyu; Kong, Xiang T.R.	IoT for large commodity delivery
Urban delivery of fresh products with total deterioration value	Chen, Jingyi; Fan, Ti-Jun; Fei, Pan	IoT for fresh product delivery
A blockchain-based evaluation approach for customer delivery satisfaction in sustainable urban logistics	Tian, Zonggui; Zhong, Ray Y.; Vatankhah Barenji, Ali; Wang, Yitong; Li, Zhi; Rong, Yiming	Blockchain for service rating

Table 1. The papers included in this Special Issue

Eight papers are included in this Special Issue. These papers can be categorized into three research problems:

1) Deployment of autonomous devices in city logistics and last-mile delivery. Three papers belong to this problem. Pan et al. (2020) suggest autonomous parcel lockers for joint delivery; Mourad et al. (2020) investigate the combination of autonomous vehicles and passenger transportation system; Shen et al. (2020) study the usage of drone for warehousing.
2) Alternative or multi-modal delivery channel. Two papers in the Special Issue are concerned with this research problem. Feng et al. (2020) suggest crowdsource-based logistics and delivery services; Gao and Wang (2020) investigates whether metro

system could be a more resilient solution of transportation for both freight and passenger flows.

3) Application of IoT/ICT technologies for freight delivery. Three papers focus on this problem. Luo et al. (2020) propose to combine Physical Internet-based scheme and IoT technologies in real-time delivery of large commodities like furniture; Chen et al. (2020) demonstrate how IoT technologies can help improve logistics efficiency while minimizing the total deterioration value of fresh products; Tian et al. (2020) propose the adoption of Blockchain technology to evaluate and improve delivery service.

The papers as well as the Special Issue provide significant contribution to the sustainable city logistics research, from research and application perspectives. In terms of methodology, all included papers are concerned with quantitative research. Most of them rely on optimization approaches and models aimed at improving the effectiveness and efficiency of IoT or autonomous devices for logistics services, except Tian et al. (2020) who study the problem from ICT perspective with special regard to Blockchain technology.

5. Conclusion

One of the main objectives of smart city logistics management presented in this paper is that of sustainable development by reducing the consumption of natural resources and improving the quality of service provision to the city citizens. Smart city, being a technology and data driven paradigm for a city's sustainable development, has entailed new research opportunities from different perspectives. It is foreseeable that smart city will keep evolving in the domain of city logistics, which plays a key role in this game changing evolution.

Recent research in this field is characterized by interdisciplinary approaches and disruptive innovations. This paper conducts a bibliometric review and provides a conceptual framework of smart city for sustainable urban freight logistics. The paper and the Special

Issue encourage further research on the problem, and here we point out some of the important research avenues towards sustainable smart city logistics:

- Stress on interdisciplinary research: operations, information systems, computer and data science, and industry specific fields (civil engineering, food and agriculture, transportation engineering, energy, etc.);
- New methodological contributions: novel analytical models, empirical evidences, qualitative research, design approaches;
- Use both holistic and reductionist approaches: top-down problems like multi-echelon network design, door-to-door integrated logistics services, reverse supply chain, land use, freight transportation and mobility combability, etc.; bottom-up solutions such as warehousing, micro-hubs, facility location, real-time vehicle routing problems, etc.
- Smart and autonomous systems development: vehicle-to-infrastructure or vehicle-to-vehicle communication, delivery droid, autonomous underground systems, self-organizing last-mile delivery (van Duin et al., 2020), blockchain and smart contract-enabled autonomous process management, etc.
- Digital sustainability (Osburg and Lohrmann, 2017) related to smart technologies and devices: energy consumption, life-cycle assessment, social-technology, impact on human behavior.

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