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Connections between Big Data and Smart Cities from the Supply Chain Perspective: Understanding the Impact of Big Data

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Abstract: This study explores the impact of Big Data and smart city initiatives on supply chain management. The effects of smart cities and SCM integration on sustainable development are also examined. Big Data, smart cities, and supply chain characteristics have all received a significant amount of attention (supply network structure, governance mechanisms). Based on literature reviews, we created a comprehensive model for supply chains, Big Data, and smart cities. The study concluded that smart cities have various consequences for network architecture and governmental systems. Future research directions in supply chain management and smart cities are also addressed in this paper. A comprehensive model was developed that can be used to undertake empirical research on the implications of smart cities and Big Data on supply chain management and sustainable development in the future. Big Data, smart cities, and supply chains have more than merely causal interactions, and Big Data and smart cities will hugely impact sustainable development and SCM operations. Several studies have recently examined the use of information technology in supply chains, but few have specifically addressed smart cities and Big Data, according to literature analyses.

Keywords: supply chains; sustainability; smart cities; Big Data; sustainable development

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Citation: Abdalla, A.A.; Abdalla, Y.A.; Haddad, A.M.; Bhavani, G.; Zabalawi, E. Connections between Big Data and Smart Cities from the Supply Chain Perspective: Understanding the Impact of Big Data. *Sustainability* **2022**, *14*, 16161. https://doi.org/10.3390/su142316161

Academic Editors: Giada La Scalia and Mirco Peron

Received: 9 September 2022
Accepted: 28 November 2022
Published: 3 December 2022

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1. Introduction

Big Data and smart cities could revolutionize the art of supply chain management. Technology advancements can meet public expectations and address problems in the big information environment. Because they affect more people or stakeholders, big challenges are frequently characterized as such [1]. Most of the world's population lives in large cities, which are directly confronted by these serious issues but also have the resources to deal with them. By 2050, the prediction is that 70% of the world's population will reside in urban areas [2,3] due to an increase in urbanization. Hence, to facilitate the flow of people and products and lessen negative effects on the environment and standard of living, there is a higher demand for updated infrastructure and new infrastructure investments [4,5]. A growing number of communities are adopting the notion of "smart cities" to address this problem [6]. A wide range of interests, including those who produce knowledge-based consulting services that leverage "Big Data" collections, fostered the development of this term as a buzzword [7] "Smart cities" link previously unrelated activity with information and cutting-edge communications technology. A smart city handles public challenges through multi-stakeholders and municipally based ICTs [8,9]. These activities cover a variety of government efforts, for instance, improving transportation, fostering innovation, and conserving energy. These efforts aim to raise the standard of living in a city, making it more appealing to knowledge-based residents [8].

The theory behind smart cities is that recent technological advancements have significantly changed how cities operate and interact with their residents. Massive volumes of data are now being incorporated into governance and management initiatives by an increasing number of governments and businesses using it strategically to define and carry out operations, respond to public concerns, and provide a public benefit [10]. If cities pursue a smart city plan, they ought to be committed to understanding their data capabilities and matching them with people's needs [11].

Smart cities combine digital technology and data analytics to enhance the quality of life and sustainability; residents' lives are directly impacted by new technology such as cell phones, IoT devices, and sensor systems. Instantly available data on traffic, transit, local news, health services, and safety alerts are processed and used to help city planners, business professionals, and individuals make better decisions. The design of a city's layout, commercial applications, and infrastructures must consider the movement of people, the supply and transportation of goods, and the availability of public transportation [12].

Supply chain management has opportunities and challenges as smart cities and Big Data concepts become more widely adopted. For instance, "Congestion pricing" refers to using electronic toll systems to control potential traffic congestion, and charges of varied rates are used to balance the flow, minimizing congestion and travel time. Several industries have already begun to apply smart city innovations, but few academic studies have looked into the topic from a theoretical standpoint. Studies have been conducted on smart cities, but they have largely concentrated on urban studies without considering the supply chain perspective [13]. This research explores the connections between Big Data and smart cities from the supply chain perspective to close this knowledge gap.

2. The Integrative Framework

We put forward an integrative paradigm (see Figure 1) that brings together Big Data, smart city initiatives, and two aspects of supplier networks: design and governance mechanisms. Sections 3.1–3.3 cover the various components of the framework. In explaining the relationship between smart cities and Big Data, this paper offers background examples, while the description of organizational actions and performance introduces theoretical notions that aid in understanding how smart city initiatives may affect supply chain management.

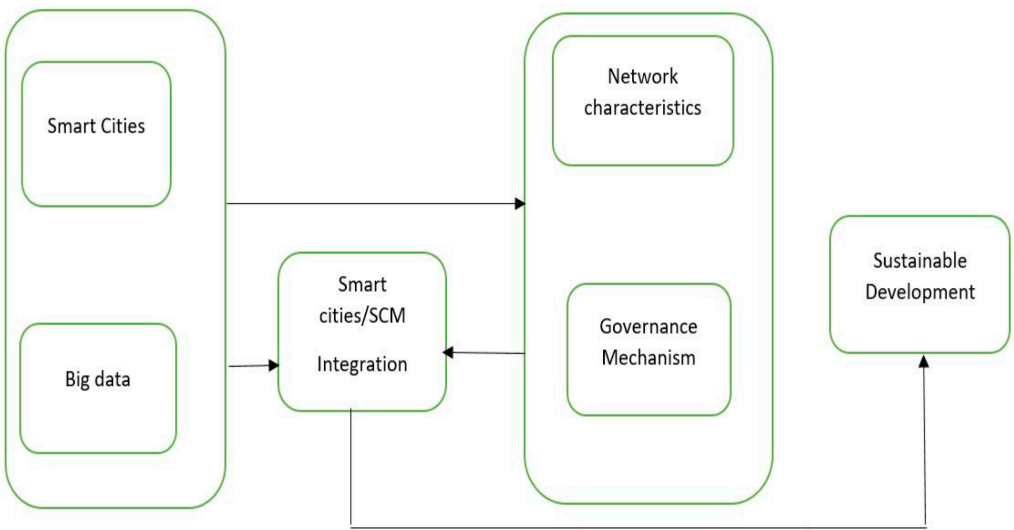

Figure 1. Integrated Framework of Smart Cities, Big Data, and SCM.

The main objective of this study is to investigate the interactions between supply networks and Big Data in smart cities. The proposed framework is suitable for this purpose, and this integrated framework is shown in Figure 1. A crucial component of this framework is the relationship between Big Data and smart cities, and this paper makes the case that companies should investigate how Big Data and smart cities may collaborate to maximize benefits. A second component is the supply network's characteristics. Density, centralization, and complexity was used to describe supply networks. Finally, the use of official and informal governance mechanisms was also considered [14]. The effects of smart cities and SCM integration on sustainable development are also examined.

3. The City Landscape (Left-Hand Side of the Framework)

3.1. Smart Cities

In addition to a telicity, information city, or digital city, a smart city is one of several urban models. The smart city concept is founded on intelligent cities. Intelligent cities are areas where communication technology and information (ICT) are integrated with real-world objects and urban environments [15]. Being an abstraction of all previous models has led to its increasing popularity [16]. The smart city inherits the IoT's fundamental operational principles because it is an IoT application [17]. Data management, application processing, and data output are crucial IoT-building elements for smart cities. A smart city is generally defined as one that uses ICT and related technologies to raise the standard of services offered to urban residents and the efficiency of routine municipal activities. Experts have defined the smart city while considering several factors and viewpoints. By definition, a smart city combines its ICT infrastructure with its social, commercial, and physical infrastructure to increase the city's intelligence [18].

Sustainable and inclusive qualities are included in smart cities, and there are many new Internet technology interfaces [19]. Despite acquiring popularity since the mid-1990s, the phrase took off in 2010 and 2011, as more cities started competing for sustainability and innovation [20].

However, no consensus definition of a smart city has yet been provided, and it has been challenging to identify a universally accepted description. However, definitions focus on typical traits and elements seen through the supply chain lens. Examples include improving the standards of living for a specific group of people—city residents—by using information technology hardware, software, networks, and the aforementioned data on various city regions and services. Various city elements, such as the environment, infrastructure, power, transportation, government, healthcare, and public safety, may also be included [21].

Smart cities offer numerous prospects for SCM. For instance, they might offer platforms for open data based on various sources, which is vital for supply chain mobility [22,23]. For instance, Intelligent traffic systems can make quick forecasts of traffic flow and travel speeds in certain areas to improve vehicle routing and transportation planning [24,25]. Another option is using automated transportation systems, such as city self-driving cars and long-haul truck automation. With these technologies, drivers can reduce gas costs, increase safety, and work more efficiently [26]. Through these systems, information on traffic and weather conditions and cars' precise locations and speeds can be shared, thereby optimizing the transportation process without requiring significant investments in physical infrastructure [27].

Smart city projects rely heavily on gathering and maintaining the proper data, evaluating patterns, and optimizing system performance [28]. This paper argues that connections exist between Big Data and smart cities. Businesses will be able to use Big Data with the help of smart cities because they will have the infrastructure to use it, plus governance structures to encourage multi-stakeholder collaboration and employees with the needed core competencies.

The modern smart city concept is closely linked to sustainability challenges, new technology, greater urbanization, and Big Data. However, the term "smart cities" can cover a wide variety of elements, including total city planning, energy-related solutions, or other specialized infrastructures (Figure 2). Local governments and communities, businesses, or a combination of both may take the initiative, integrating organizational and local-level activities [29].

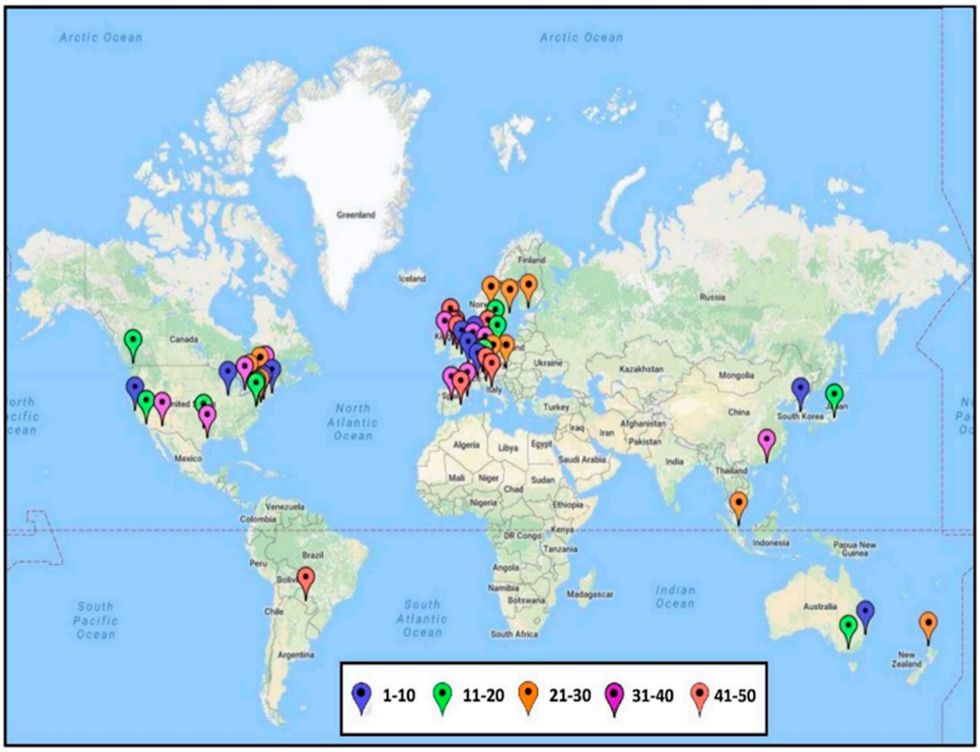

Figure 2. Dispersion of the top 50 smartest cities worldwide according to CIMI metric. https://citi.io/2020/07/16/the-top-50-smart-cities-in-the-world-2020.

3.2. Big Data

Big Data is referred to as "a holistic method to manage, process, and evaluate the five Vs (volume, velocity, variety, veracity, and value) in order to develop actionable insights for sustained value delivery, measuring performance, and establishing competitive advantages" [30]. Urbanization has also expanded quickly over the past 10 years, along with the enormous rise in the "velocity" and "volume" of municipal data. The high potential of Big Data has recently piqued the curiosity of businesses, academics, and the government. This data growth pace is quickly outpacing IT researchers' and practitioners' capacity to (1) create appropriate systems to manage the data properly and (2) analyze it to extract pertinent meaning for decision making. Therefore, it is essential to adopt frameworks and tools for the efficient management, organization, and analysis of such datasets.

The 5V model [31], shown in Figure 3 below, can describe Big Data. This model is an evolution of the 3V model that was originally described in [32]. The five Vs are listed as follows:

Volume (the era of size) means that the data scale grows bigger with the development and collection of massive amounts of data. The amount of data generated now is thought to be in the zettabyte range and is increasing by about 40% annually.

Velocity (the era of streaming data) means that to optimize the utilization of the business potential of Big Data, data gathering and analysis must be done quickly and promptly.

Variety (the era of unstructured data) refers to the different categories of data, which also include typical structured data as well as semi-structured and unstructured data such as audio, video, webpages, and text.

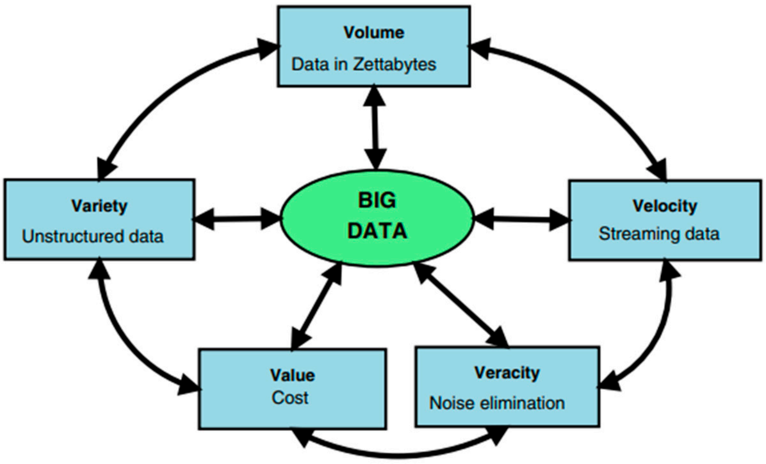

Figure 3. The 5V Model that currently defines Big Data.

Value (the era of the cost associated with data) indicates costs. While data are generated, gathered, and evaluated from various sources, data come at a price. Data may be a "commodity" that is exchanged for money with other parties. Understanding the price or value of the data can also help with budgetary planning by evaluating the cost of data storage.

Veracity (the era of data pollution that needs cleansing) means removing the noise from the data using techniques such as data pedigree and sanitization; it is necessary to verify its accuracy. This is to guarantee data quality so that judgments drawn from the data obtained are precise and efficient.

Big Data analytics refers to the process of attempting to make sense of this abstract and expanding quantity of data. Fundamentally, analytics applies sophisticated statistics to historical data to spot recurring behavior patterns that may, to some extent, be predicted. The "predictive" nature of Big Data analytics may provide supply chains a competitive edge. As a result, employing Big Data analytics can help organizations save money by reducing unplanned equipment downtimes, allowing them to reduce buffer inventories, and allowing partners to run a leaner supply chain while lowering supply risks. Supply chain partners must be informed of potential uncontrolled defects in order to enable quick mitigation efforts throughout the chain [33].

Massive amounts of unstructured data can be examined using Big Data analytics to find previously unidentified patterns, correlations, and other significant information [34,35]. In terms of scope, level of detail, and variety, this data differs from that often used in supply chain management [36]. For example, mobile phone firms can utilize location data to predict consumer displacements and micro-consumption patterns (so that calls can be routed efficiently) [37]. As a result, there is a significant possibility of profiting from this. Businesses can enhance their strategic performance (such as distribution network design), tactical performance (such as production planning), or operational (such as inventory management) performance (e.g., vehicle routing).

Big Data applications can be useful for all of the primary SCM functions. Instead of surveys and samples, Big Data can be used to develop distribution plans based on customer trends (for example, location-based data from mobile phones). In addition, on non-transactional Web sites, clickstream tracking in inventory management forecasting can reduce holding and back ordering costs by 3–5 percent [38].

In addition, embedded sensors in goods may be useful for SCM. New location-based services have been made possible thanks to real-time location data. Firms, for example, can utilize their knowledge of where and how people drive their cars to establish distribution and inventory locations. Moreover, companies might employ real-time or individualized trace data. They feel this brings opportunities and challenges, such as the chance to provide early warnings of potential supply chain issues and obstacles [39]. Large-scale real-time data flows from various sources, including smartphones, sensors, digital equipment, and a significant B2B data interchange, into logistics firms. Big Data gives supply chain management participants new competitive advantages such as improved visibility and the capacity to quickly adapt to demand variations [40].

Nonetheless, Big Data has significant disadvantages. It may be an oversimplification to assume that having more data means having "better" models of reality. For example, while Big Data is excellent at discovering correlations, it may fail to determine which connections are significant. Furthermore, even if the results appear statistically significant, too many irrelevant correlations with no causal connection might be found.

Big Data is better at studying highly common things than it is at detecting uncommon events [41]. It may miss a minor, less common pattern. Furthermore, the reality is far more difficult than a superficial examination could suggest. It is uncommon for found data sets to be interchangeable and, while Big Data is available to businesses, they are reluctant to share their information.

Additionally, even though computers can review and report on millions of records, they cannot understand the outcomes. They were designed to emphasize correlation rather than causality, which is the reason for this. Big Data does not address the most important challenge, which is figuring out how to properly improve a system and identify the cause of a problem [42]. Last but not least, as Big Data becomes more significant, a network of businesses, clients, and governmental agencies will emerge from the architecture, continually exchanging information and making informed decisions [43]

3.3. Integration of Supplier Network and Smart Cities

With smart cities, businesses could access Big Data infrastructure, governance systems encouraging multi-stakeholder collaboration, and IT networks for dissemination. All these factors point to the network becoming a more significant organizational unit [44]. On the other hand, congestion fees, low emission zones (where vehicles must adhere to low emission standards or pay the price), and car-free laws can all have a detrimental effect on the effectiveness of the city supply chain networks [45].The smart city will pressure businesses to create new urban distribution tactics, such as urban freight consolidation hubs, and/or look into alternate forms of mobility, such as electric scooters and micro bike lanes [46]. New work designs will likely emerge due to pressures for change and opportunity seeking. As a result of smart city initiatives, many assumptions must be made when exploring supplier network design in complexity, density, and centralization [47].

4. Analysis

This section discusses how smart cities impact such operational levels by combining initiatives for smart cities with supplier network design. The subsections are organized based on the right side of the integrative framework shown in Figure 1 and are supported by a variety of examples.

4.1. Integration of Big Data, Smart Cities and Network Density

Network density is calculated by dividing the total number of connections by the total number of connections in a network [44]. In contrast to the physical distances between supply chain participants, network density describes how relationships are structured inside a network. As a result, a dense network would have connections between every node. Big Data, network density, and smart cities all seem to reinforce each other.

Smart city and Big Data projects positively impact the development of network links. Logistics companies have several uses for Big Data, such as restoring the ties lost when retailers shifted to direct-to-consumer services [48]. The integration of a supply chain enhances network cooperation. Further, network effects are evident when the number of members in a network grows. Embeddedness, in particular, is the result of frequent communications; hence a high density of networks implies more interactions and augments network effects [49].

Network density describes how relationships are structured inside a network [50]. In actuality, the transportation picture will grow substantially more varied within 15–20 years. Instead of a single, most efficient transportation network, there will be several redundant ones in this scenario [51].

4.2. The Integration of Network Centralization, Smart Cities and Big Data

Centralization describes the extent to which decision-making authority is dispersed across the network. Network efficiency improves when centralization is high, but flexibility suffers [20]. Supply networks have traditionally been centered around leading enterprises with more power and resources. There are two basic forms of SCM flow: material and information flow, and each will be affected differently by smart cities. According to studies, cities are turning towards decentralized designs organized as “compact urban cells” regarding material movements [52].

The growth of “nanostores”, also known as micro-retailing, is another development linked to the decentralization of supply networks. Such stores would gain much from the enhanced network coordination and information flows made available by smart cities and Big Data. For instance, smart mobility initiatives can combine open databases with real-time data (such as traffic patterns and weather patterns) and increase urban logistics efficiency. It will increase productivity in “the last mile” delivery in micro-retailing, historically characterized by high unit prices [45]. Big Data and smart cities can support these tendencies [53].

Data flows show that Big Data deployment requires significant processing and storage capacity. As a result, it will present opportunities for companies to combine and evaluate the massive amounts of data flows; businesses can use Big Data to centralize decision making more effectively [54].

Sensors, RFID, and other identifiers employed to gather real-time data will also be used by businesses that have mastered Big Data to enhance corporate operations. Because of this, using Big Data in smart cities may result in a more centralized information flow. Therefore, excessive centralization might create new challenges. For instance, optimization based on the viewpoint of a single company may result in less optimal choices throughout the entire system. For instance, a retailer can place its urban consolidation hubs in less competitive areas to lower the cost of “last mile” distribution [55].

4.3. The Integration of Big Data, Smart Cities, and Network Complexity

Examining the concept of complex adaptive supply networks will help someone comprehend how smart cities and network complexity interact from a supply network perspective (CASN). The concept of smart cities can be explained as a network of components that form a complex, self-organizing system, similar to the CASN [56]. A system with many components and interactions often develops patterns, resulting in self-reinforcing feedback loops and predictable behavior [57]. However, completely interconnected systems tend to be unstable. In this situation, there may be numerous interactions between stakeholders with competing goals, making the network more complex. Inferring more structurally complicated distribution networks is the urban tendency toward micro-retailing, which features multi-tiered structures, numerous modes of mobility, and a wide variety of distribution locations. At the supply network level, this can require alternative organizational options, including vertical integration [58].

From an information-theoretical perspective, complexity is classified into two types: operational and structural. It is possible to quantify structural complexity by measuring how much information is needed to explain the state of the planned system. In addition, how much information is required to describe a deviation from a plan can be used to conceptualize operational complexity [59]. However, whereas Big Data and smart cities decrease operational complexity, their impact on structural complexity is the opposite.

To summarize, the complexity, density, and design of the supplier network will increase in the future as Big Data-capable companies replace corporate centralization in the network. The complexity and density may be advantageous for Big Data collecting and smart city programs in particular but difficult for the businesses involved.

4.4. Integration of Big Data, Smart Cities, and Governance Mechanisms

The term "governance" is frequently used to refer to the efficiency, effectiveness, and wise direction of government activity. The ability of the authorities to engage local stakeholders and corporate leaders and the amount of public participation should all be considered when addressing the problems that cities face because city residents are key to resolving all of these issues. Additionally, this dimension includes all activities intended to increase administration efficiency, such as creating new organizational and management models. For smart cities, Big Data, and supply networks to be connected, there must be a system of rules known as network governance [60].

From the literature on organization design, we specifically use formal [61] and informal governance methodologies [62]. Control systems must be in place for formal governance procedures because they allow organizations to specifically arrange their interactions [61]. These procedures are usually built on hierarchical controls and may include command structures, incentive systems, SOPs, and documented dispute-resolution processes [60,63].

While some supply relationships are clearly defined and strictly regulated (i.e., formal), others are vague and undefined (i.e., informal) [64]. Standards, contracts, codified procedures, and control systems are the foundation for formal governance structures [63]. Coupling and formalization are frequently linked. A supply network is tightly connected when items, processes, and performance requirements are clearly defined. Information sharing is challenging in relationships with lax coupling [64]. Big Data and smart cities are frequently linked to formal governing structures and paired interactions.

Additionally, the theoretical framework of innovation diffusion [65], and the information processing perspective can be used to better understand the relationship between smart cities, Big Data, and formal governance structures [66]. The information processing approach contends that a firm and its setting impact the adoption of IT, in contrast to the innovation diffusion approach's assertion that some aspects of the technology have an impact [67]. As a result, the adoption of Big Data and smart city initiatives is accelerated concurrently by the demand from businesses in the network and the availability of new technology.

Instead of being characterized by bureaucratic systems, informal governance procedures are characterized by connections. They entail transferring information, values, culture, and social rules [68]. There may be a need for informal mechanisms to lower the transaction costs associated with monitoring and coordination [69] They might incorporate moral principles and self-control [70]. Similarly, it is contend that connections among organizations act as social control mechanisms. They can serve as the primary form of governance when formal controls are complex, despite typically being viewed as a complementary governance mechanism [71].

Intangible factors, including values, culture, customs, and relationships, are the foundation for informal governance mechanisms [63]. A stable environment and mutual confidence between the parties are necessary for the implementation of informal mechanisms, as claimed by [72]. Long-term collaboration is just getting started as the framework for smart cities is still rapidly changing. Furthermore, almost two-thirds of European smart city projects are still in the development or pilot testing phases, according to a survey from the European Commission [9]. Therefore, it would appear that formal governance mechanisms are more significant in the context of smart cities than informal ones. However, cultural or social norms, which function as informal governance structures, may help to facilitate citizen input into a smart app.

4.5. Smart Cities, Big Data Integration with SCM and Sustainable Development

Social, economic, ecological, or environmental factors are typically considered when discussing sustainable development. Sustainability has been essentially defined as the necessity for social and economic transformation while lowering the demand for environmental protection. Consequently, sustainability consists of the economy, society, and the environment [73].

Digital technologies and data analytics are combined in "smart cities" to raise living standards and sustainability. For their cities to achieve the necessary level of sustainability and raise living standards, many governments are considering integrating Big Data applications that enable smart city components. Smart cities utilize a variety of technologies to enhance the efficiency of their people's access to water, energy, health, and transportation services, as well as education and energy. This entails lowering expenses and resource usage as well as communicating with their citizens more successfully and actively. Big Data analytics is one of the more recent technologies that has a great deal of potential to improve smart city services. Data collecting has produced enormous volumes of data that have accumulated due to the widespread adoption of digitization, which can be used in a variety of ways. Due to the widespread adoption of digitization, massive volumes of data have been collected and are now available for use in a wide range of advantageous application sectors. Success in many commercial and service areas, including the smart city domain, depends on the efficient analysis and use of Big Data [74].

Smartphones, IoT devices, and sensor systems are just a few examples of how new technology is quickly interwoven into daily life. To assist city planners, business professionals, and everyday people in making better decisions, real-time data on transit, traffic, local news, health services, and safety alerts are researched and used. The design of the city layout, commercial applications, and infrastructures must consider the movement of people, the supply and transportation of goods, and the availability of public transportation [75,76].

Smart cities enable the coexistence of the biosphere and human civilization through sustainable economic, social, and environmental growth. Sustainability is achieved by maintaining the equilibrium of natural resources and consumption, also frequently referred to as a socioecological process. Municipal officials may engage directly with the community and the city's infrastructure thanks to smart city technology, enabling them to keep track of what is occurring in the city and how it is changing. Urban services are made more effective, high-quality, and interactive while using fewer resources due to real-time data. Therefore, a smart city may be better equipped than traditional ones with a basic "transactional" interaction with the residents to address the broader concerns of sustainability [12].

To create environmentally friendly supply chains and boost a company's ability to compete, [77] suggest communicating metrics for waste management, recycling, and other sustainable supply chain activities to consumers and other stakeholders.

5. Conclusions

Using organizational theories, this study provides a comprehensive framework that considers the features of supply networks, smart city technologies, Big Data, governance processes and sustainable development. This was necessary because few studies directly address smart cities from a supply chain perspective. Many studies have examined how supply networks implement IT innovation [66,78,79].

In addition, the idea of smart cities alone has little potential to promote novel SCM setups. It can have a considerable impact on SCM, however, when paired with Big Data initiatives. In more detail, smart cities might give businesses the infrastructure they need to benefit from Big Data projects. Additionally, the research framework is intended to demonstrate potential impacts on specific SCM issues. This study's key theoretical finding is that a linear cause-and-effect framework cannot accurately depict the connections between supply networks, Big Data, and smart cities. Given this, we have created an integrative paradigm that may be used in future empirical studies on the impact of Big Data and smart cities on SCM.

5.1. Theortical Contribution

We proposed an integrative model that combines Big Data, smart city efforts, and the design and governance of supplier networks. This study's main objective is to better understand how supply networks and Big Data interact in smart cities. Despite a large body of work at the strategic level, Big Data-based decisions' operational implementation in detail is still missing. Additionally, prior research has concentrated on the challenges of sources and capture [80]. The factors of volume and velocity are not theoretically emphasized. By offering in-depth insight into how big data could be analyzed and operationally integrated inside the smart city, we extend the analytical breadth of our work. Making related decisions will be made more effectively as a result. Other research results emphasize how crucial it is to include Big Data into city logistic planning. They promote the development of new ideas involving Big Data and call for better integration between Big Data and SCM. The literature is thus being expanded to the area of Big Data and smart city logistics research. With the help of this study, we are understanding more about the connections between Big Data, smart cities, and SCM.

5.2. Managerial Contribution

The framework presented has a number of managerial implications. First, it implies that while smart cities can support improvement projects, they have limited capacity for enhancing supplier network processes on their own. The framework also asserts that despite their advantages, smart cities may nevertheless result in obstacles to efficient supplier network management. The framework aids in bringing to light challenges associated with supplier network design and governance processes, where organizations must comprehend Big Data challenges and recognize how the overall environment may alter when new actors join. Opportunities driven by supplier networks, as opposed to city initiatives, relate to processes that connect enterprises in new ways, but such processes would be impacted by competing interests as networks become more complicated. From an operations management (OM) perspective, the suggested integrative framework helps managers identify and address these difficulties.

This study expanded the knowledge of supply chain management (SCM) by presenting an integrative framework of supply networks in the context of smart cities and Big Data. By laying the foundation for further investigation into this topic and offering potential study paths to academics and practitioners interested in this issue, we significantly contribute to the body of (SCM) literature.

6. Future Research

The power dynamics of supply networks should be studied in relationship to Big Data and smart cities. By providing businesses with crucial data on consumption trends, Big Data and smart cities may substantially impact how power is distributed within supply networks. According to a McKinsey Global Institute report, Big Data will give a substantial potential for firms that engage in large information flows, carry out millions of transactions, or deal with many customers, large retailers in this scenario might utilize these data to more precisely classify customers and better match distribution tactics, boosting margins and streamlining operations [81]. Along with a means of buying and selling data, it will also give the transit provider a way to publish open data for usage by outside parties [51]. Looking into how this can affect power dynamics within supply networks would be an intriguing area for further research.

Author Contributions: Conceptualization, A.A.A.; methodology, A.A.A. and Y.A.A.; writing—original draft preparation, A.A.A.; writing—review and editing, A.A.A., Y.A.A., A.M.H., G.B. and E.Z.; visualization, A.A.A., Y.A.A., A.M.H., G.B. and E.Z.; supervision, A.A.A. and Y.A.A.; project administration, A.A.A.; funding acquisition, A.A.A., Y.A.A., A.M.H., G.B. and E.Z. All authors have read and agreed to the published version of the manuscript.

Funding: The APC was funded by all authors.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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