

The progression of IoT business model types: implications for supply chain management

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Abstract

The current study investigates the progression of Internet of Things (IoT) business models and their implications for supply chain management (SCM). It reviews the existing literature to gain new insights, and through a systematic process identifies three distinct IoT business model types: connectivity, servitization, and data ecosystems. The study delineates how these models leverage IoT to form new business models and what SCM implications can be realized. The connectivity type focuses on data-driven monitoring and connection between devices, users, and firms; the servitization type shifts focus from product to service offerings to enhance the core offerings and operational flexibility, and the data ecosystem type addresses interconnectedness and collaborative innovation. The findings contribute to the theoretical views on the intersection of business models and SCM, particularly in the context of IoT. It also offers insights for businesses aiming to utilize IoT technologies to transform their business models and improve their SCM.

Keywords: IoT business model, supply chain management, data ecosystems, data-driven value creation, systematic review.

1. Introduction

The soaring volume of data and the availability of various technologies to process and extract value from it have increased the utility of this critical source for creating business value in an unprecedented way. With the advancement of IoT technologies and the increase in transmission bandwidth and speed, IoT devices are now capable of collecting, transmitting, and processing large amounts of data crucial for forecasting, decision-making, and maintaining competitiveness in the market (Suja Mary et al., 2024). As a result, the significance of data for businesses has shifted from mere collection and storage to sophisticated, large-scale data mining to drive innovation and business expansion (L. Wang et al.,

2023). With big data analytics becoming more integrated into organizational processes, firms that implement more advanced data-driven strategies tend to exhibit superior information quality (Wang et al., 2023). This has turned data into a key asset for many firms and, is considered to be the “new oil” (Rong, 2022).

The growing use of data as a key source impacts two critical aspects of the firm: the business model, and the management of the supply chains. Companies are utilizing data to develop data-driven business model innovations that enhance value in operations management, marketing, resource integration, and strategic planning (Wang et al., 2023). By leveraging data analytics, firms can anticipate customer demands and thus, adjust their business models, and prevent bullwhip effects in the supply chains. The use of data in business models can also enable more personalized and customer-centric services, allowing firms to shift from traditional product-based offerings to service-oriented solutions that respond dynamically to customer needs (Zambetti et al., 2023).

Research has already acknowledged the close linkages and relationships between a firm’s business model and its SCM (Li et al., 2022; Y. Wang et al., 2018). The changes in the business model, particularly through the integration of data, have substantial repercussions on the firm’s SCM. As business models evolve to become more data-driven, the supply chain must adapt to support new business activities. With more data-driven business models, the complexity of the supply chain often increases due to the need to incorporate data analytics and data-driven insights into supply chain operations. Data-driven business models also can lead to shifts from traditional product-centric to service-oriented offerings, which necessitates a more dynamic and agile supply chain that can handle varying customer requirements and rapid service delivery expectations. IoT business models are particularly important for SCM, as the appropriate utilization of IoT can lead to enhanced real-time tracking, inventory management, and supply chain optimization, as well as enabling delivery route optimization, downtime

reduction, and timely delivery of goods (Zrelli & Rejeb, 2024). Thus, the transformative impact of IoT business models on supply chain management – enhancing efficiency, visibility, and responsiveness – makes them crucial for the future development of the discipline.

Current literature provides limited knowledge of the data-driven business models and SCM implications, particularly in the context of IoT. Although works such as Cheng et al. (2001), Boyson et al. (2003), Wang et al. (2018), and Li et al. (2022), provide valuable insights into business models and SCM, there is a need for new theoretical perspectives on the data-driven business models and SCM implications. This need manifests itself, particularly in two key areas. First, the need to identify and delineate different types of business models, and second the SCM implications that each of these business model types can entail. Such a theoretical perspective not only enables a better understanding of the characteristics of these models but also fosters a more nuanced view of how SCM activities can be optimized for efficiency, responsiveness, and sustainability. The current study takes this limitation as an opportunity, and IoT as the enabler of data-driven business models and supply chains to address the following research questions: *a) what are the types of IoT business models with regards to data-driven value propositions, and b) what are the supply chain management implications of these business model types?*

This study conducts a systematic literature review (SLR) to address the posed questions, aiming to contribute to the body of knowledge and practitioners focusing on the intersection of IoT business models and supply chain management.

2. Theoretical background

2.1. Business models and supply chains

Despite the diversity in definitions and interpretations of the term, there is broad consensus that a business model represents the framework through which a firm proposes, creates, delivers, and captures value (Amit & Zott, 2001; Teece, 2010). A business model can also be viewed as an interconnected system of activities, where the constituent elements – particularly value creation and value capture – are synergistically integrated (Zott & Amit, 2010). On the other hand, SCM is defined as “the management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original

producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction” (Stock & Boyer, 2009, p. 706). Conceptualization of SCM, therefore, involves the realization of relationships with various firms, and managing purchases, production facilities, logistics, marketing, and related systems, emphasizing productive flows of information and physical items to meet customer requirements profitably which is a strategic focus for many businesses due to its impact on performance (Lai et al., 2006). Clearly, the two concepts have various linkages and overlaps. The value delivery component of a business model is intrinsically tied to the network of relationships and logistics. Effective SCM ensures that value delivery is executed by managing the logistics of transportation and distribution. The value creation is deeply connected to value addition, purchasing, and production functions that are core components of SCM. The value capture component in business models is closely associated with profitability, the flow of information, and finances where SCM plays a critical role. Effective SCM utilizes data and information systems to enhance decision-making and transactions.

2.2. Business models, supply chains and data ecosystems

The criticality of understanding the linkages between business models and the SCM becomes even more evident when it comes to the emerging notion of data ecosystems. This new notion represents a complex socio-technical network that enables collaboration between autonomous actors to explore data that provides an environment for creating, managing, and sustaining data-sharing initiatives (Oliveira et al., 2019). Data ecosystems are a new breed of decentralized ecosystems, in which various stakeholders, technologies, methods, and approaches are merged to co-create value, and ultimately, unlock the potential benefits of data. These ecosystems are increasingly emerging as economical solutions, particularly in B2B environments (Scheider, Lauf, Möller, et al., 2023), and can be built based on collaboration and interaction between various actors, including public and private organizations, development partners, and end users (Oliveira et al., 2019).

From a wider perspective, data ecosystems primarily depend on the economic value that is co-created among its actors through various activities such as data collection, data sharing, and service provision (Šestak & Copot, 2023). In these ecosystems, firms interact to jointly devise a cooperative value proposition that was not possible to devise individually (Neff et al., 2024). Building on the potential of data ecosystems, it is

crucial to recognize that while these ecosystems offer new opportunities for value creation, the actors involved must also adapt and innovate their business models to survive and thrive within these environments. Despite the advantages of data ecosystems (Orenga-Roglá & Chalmeta, 2018) participating in these complex networks requires a deep understanding of the adequate business models, as well as the SCM implications for firms to navigate the challenges and opportunities presented by such interconnected environments effectively.

2.3. IoT, data and ecosystems

IoT, a network of physical and virtual objects, devices, or things, capable of collecting and sharing surrounding data, is meant to be the future of the current Internet (Sembroiz et al., 2018). Fundamentally, IoT is an infrastructure for information that enables services by interconnecting both physical and virtual objects using existing and evolving interoperable information and communication technologies (Kiran, 2019). It can be seen as a system of interconnected computing devices, mechanical and digital machines, objects, and humans, that enable the transfer of data over a network (Kiran, 2019).

Data is continuously generated by the vast array of sensors embedded in things. The recent advancements in IoT devices have enabled firms and individuals to produce larger amounts of data that can be transformed into added value and enable new ways of monetization (Martín et al., 2023). Utilizing the data from IoT has facilitated a broad range of business models, ranging from products enhanced with limited IoT features to comprehensive service-based offerings, and further to IoT platforms and ecosystems where performance, or even the data itself, can be traded (Toorajipour et al., 2024). The availability of data and the technological and analytics tools have facilitated the emergence of ecosystems that operate on data. From the ecosystem perspective, data has evolved into a key source, serving as an instrument for governance and control, and a means for managing the firm's territory (Halpern et al., 2022). This necessitates studies that focus on the linkages between business models and SCM with regard to data and enabling technologies such as IoT.

3. Methodology

Current research has an exploratory perspective to study the types of IoT business models and the SCM implications. Therefore, it is concerned with two aspects simultaneously. First, the essence of the IoT business models in terms of value creation; and second how these business models impact the SCM of the firm. To address

these dimensions, we consulted the existing body of literature through an SLR, detailed in the following sections.

3.1. Systematic literature review

To conduct the SLR, the five stages of a systematic review suggested by Denyer and Tranfield (2009) were followed. The search for the papers started in early October 2023, with two updates in November 2023 and January 2024. The search string was designed to include as many relevant papers as possible to ensure a comprehensive review. The strings were ("IoT" AND "business model") OR ("internet of things" AND "business model") in the title, abstract, and keywords of the papers. The search started by exploring Web of Science which led to an initial pool of 458 papers. To include the most relevant papers with the highest quality, a limitation was added to the results: only journal articles, in English, in the business category. This led to 52 items for the next round. Finally, the papers without a clear focus on IoT business models were excluded which resulted in a final set of 35 papers. On Scopus, the same string and set of limitations were used, which led to a primary pool of 1714 articles. Furthermore, the results were limited only to papers that had "Internet of Things", "IoT" and "business model" in the keywords, to exclude irrelevant papers. At this stage, 122 articles including 20 duplicate items were left. The same inclusion criteria (as for Web of Science) for the remaining 102 papers led to a final set of 50 papers. In total 85 papers were selected for analysis and synthesis.

To analyze the collected text, and identify IoT business model types, we started by open coding (Seale, 2004). Coding was conducted in two phases. In the first phase, the aim was to identify the business model types. Thus, the emerging codes were synthesized into categories and themes based on the value creation components of the IoT business models. With this aim, the content of each paper was meticulously analyzed, which led to the identification of three business model types. For each type, the corresponding papers were also distinguished and categorized. Table 1 shows the three business model types as well as the corresponding papers. In the second phase, coding was conducted to identify the SCM implications for each business model type.

A similar coding technique was applied however with a more directed approach towards understanding how each business model type interacts with and impacts the supply chains. This involved coding for specific SCM aspects including logistics, operations, inventory management, flow of information and material, tracking, etc. which are directly influenced by

IoT applications. To ensure consistency and reliability in the coding process, each text segment was coded independently to allow for cross-validation of the identified codes and themes. Discrepancies were reviewed and checked to ensure that the findings accurately represented the data. The findings were documented in detailed descriptions that outlined the relationship between IoT business model types and their SCM implications.

Table 1, Business model types and the corresponding papers

	Web of science
Connectivity	(Abbate et al., 2019); (Foltean & Glovatchi, 2021); (Shoukry et al., 2021); (Yopan et al., 2022); (Haaker et al., 2021); (Paiola & Gebauer, 2020); (Zancul et al., 2016); (Passlick et al., 2021); (Barrar & Ruiz-Benitez, 2023); (Matthyssens, 2019); (Straker et al., 2021); (Ge et al., 2016); (Abbate et al., 2019); (Shoukry et al., 2021); (Yopan et al., 2022); (Ehret & Wirtz, 2017); (Kaur & Kaur, 2018); (Falkenreck et al., 2023); (Gebauer et al., 2020); (Ge et al., 2016)
Servitization	(Leminen et al., 2018); (Metallo et al., 2018); (Hanafizadeh et al., 2021); (Le et al., 2019); (Abbate et al., 2019); (Nguyen Dang Tuan et al., 2019); (Sturm et al., 2023); (Foltean & Glovatchi, 2021); (Shoukry et al., 2021); (Paiola et al., 2022); (Cranmer et al., 2022); (Haaker et al., 2021); (Paiola & Gebauer, 2020); (Paiola et al., 2021); (Hasselblatt et al., 2018); (Matthyssens, 2019); (Leminen et al., 2020); (Naik et al., 2020); (Straker et al., 2021); (Ge et al., 2016); (Veile et al., 2022); (Park et al., 2023);
Data ecosystem	(Leminen et al., 2018); (Metallo et al., 2018); (Hanafizadeh et al., 2021); (Abbate et al., 2019); (Nguyen Dang Tuan et al., 2019); (Cranmer et al., 2022); (Paiola et al., 2021); (Hasselblatt et al., 2018); (Matthyssens, 2019); (Ehret & Wirtz, 2017); (Leminen et al., 2020); (Gebauer et al., 2020); (Şimşek et al., 2022); (Leminen et al., 2018); (Paiola et al., 2022); (Cranmer et al., 2022); (Paiola & Gebauer, 2020); (Paiola et al., 2021); (Radenković et al., 2020); (Wan et al., 2014); (Warner & Wäger, 2019); (Şimşek et al., 2022);
	Scopus

Connectivity	(Lamendola & Genet, 2022); (Wielki, 2017); (Qiu et al., 2015); (Mattos & Novais Filho, 2023); (Njomane & Telukdarie, 2022); (Leiting et al., 2022); (Chauhan et al., 2022); (Weking et al., 2020); (Palmaccio et al., 2021); (Kraft et al., 2021); (Sood & Woodside, 2021); (Karttunen et al., 2021); (Kiel et al., 2017); (Z. Zhang et al., 2023); (Nalajala et al., 2023); (Wielki, 2017); (Mattos & Novais Filho, 2023); (Njomane & Telukdarie, 2022); (Mattera & Gava, 2022); (Angeles, 2019); (Lamendola & Genet, 2022); (Abdelghaffar & Abousteit, 2021); (Weking et al., 2020); (Almeida et al., 2020); (Saarikko et al., 2017); (Esmailpour Ghouchani et al., 2019)
Servitization	(Athanasopoulou et al., 2019); (Ulrich et al., 2023); (Lee, 2019); (Giovanardi et al., 2023); (Molling & Zanela Klein, 2022); (Ammirato et al., 2022); (Delgosha et al., 2022); (Marcon et al., 2022); (K.-L. Chen et al., 2023); (Rocha et al., 2022); (Hashem et al., 2016); (X. Zhang et al., 2022); (Lai et al., 2017); (Krotov, 2017); (Palmaccio et al., 2021); (Volberda et al., 2021); (Del Sarto et al., 2022); (Hakanen & Rajala, 2018); (Lokshina et al., 2018); (Alcayaga et al., 2019); (Hamidi & Jahanshahifard, 2018); (Liu et al., 2020); (Gao & Li, 2020); (Weking et al., 2020); (Saarikko et al., 2017); (Esmailpour Ghouchani et al., 2019); (Boehmer et al., 2020); (Almeida et al., 2020)
Data ecosystem	(Ancillai et al., 2023); (Garbuio & Gheno, 2023); (Saarikko et al., 2017); (Ulrich et al., 2023); (Delgosha et al., 2022); (Leiting et al., 2022); (Marcon et al., 2022); (Hamidi & Jahanshahifard, 2018); (Wielki, 2017); (Volberda et al., 2021); (Del Sarto et al., 2022); (Mahdad et al., 2022); (Leiting et al., 2022); (Niyawanont, 2022); (Leminen et al., 2017); (Wielki, 2017); (Del Sarto et al., 2022); (Abdelghaffar & Abousteit, 2021); (Kraft et al., 2021); (Y. Chen et al., 2021); (Almeida et al., 2020); (Hamidi & Jahanshahifard, 2018); (Hashem et al., 2016); (Laya et al., 2018);

4. Results

The analysis and synthesis of the data from the SLR led to the identification of three IoT business model types including connectivity, servitization, and data ecosystem. For each type, the value creation components are explained, followed by the SCM implications of each type. In what follows, a detailed description of the steps is provided.

4.1. Type I – Connectivity

The first IoT business model type is labeled as “connectivity”. IoT facilitates communication between devices as well as between devices and users creating a robust infrastructure that supports information networks. IoT enables value creation through communication between devices, allowing them to exchange data and coordinate actions autonomously. IoT provides the possibility for the connection between objects and users by offering real-time data, analytics, and alerts via software applications and digital interfaces. These devices constantly gather data that is immediately analyzed and presented to users. Additionally, IoT supports the automation of actions based on insights derived from the data. Value can also be created by leveraging IoT and significantly improving product functionality by using data from connected devices. This enables enhancements in performance, the introduction of new features, and the provision of personalized experiences and add-ons.

This business model type implies that it can **enhance monitoring and response** in supply chains. The connectivity between things, and between devices and humans enables continuous monitoring of the physical status and performance of devices across the supply chain. This capability allows for real-time adjustments and interventions, which can drastically reduce downtime and improve responsiveness to maintenance. The ability to predict and prevent disruptions before they occur not only maximizes efficiency but also ensures the consistency of supply chain operations. The connectivity of devices and the possibility of sharing data implies that firms can **improve inventory management**. IoT connectivity provides visibility into products and usage patterns. This data-driven approach can also support more accurate demand forecasting and inventory optimization. By aligning inventory with actual usage rates and anticipated orders, firms can reduce carrying costs and minimize instances of overstocking or stockouts, leading to more efficient SCM. Findings also imply that connectivity enables **smart logistics and distribution**. The integration of IoT within logistics operations improves enhanced tracking of goods and assets as they move across the supply chain. This connectivity allows for more precise tracking and routing of shipments, thus, reducing logistical costs.

4.2. Type II – Servitization

The next IoT business model type is labeled as “servitization”. Servitization refers to the shift from selling products to providing service-based solutions. This IoT business model type includes product-service

systems (PSS) – a business model that synergizes products and services into a cohesive offering tailored to meet specific customer needs. The development of smart PSSs shifts traditional product-oriented SCM from managing product flows to ensuring continuous service delivery. Enabled by IoT, smart PSS requires SCM to focus on service availability, predictive maintenance, and real-time product monitoring. This transformation demands a move from one-time product transactions to a service-dominant approach, integrating products and services within the supply chain. IoT plays a key role in making PSSs possible by embedding sensors, connectivity, and data analytics capabilities within products, effectively transforming them into smart, interconnected devices. These IoT-enhanced devices gather and transmit data and therefore, firms can extend beyond conventional product functionalities. In this business model type, the main idea is to turn everything into a service. Value is created through revitalizing the physical products and allowing customers to use products on a subscription basis rather than purchasing them outright. It increases flexibility and scalability which allows customers to adjust their usage according to their requirements and pay only for what they consume.

The first implication of this business model type is the **transition to a service-dominant logic** which requires supply chains to support continuous service delivery rather than one-time product distribution. This shift changes how inventory is managed, prioritizing parts and service readiness over finished goods. As firms adopt servitization, the supply chain must focus more on the availability of supporting services or providing spare parts and maintenance services to ensure uninterrupted value for customers. This requires rethinking inventory levels, storage locations, and logistics to reduce downtime for customers, directly impacting SCM strategies. The findings also imply that IoT for servitization can also **enhance demand forecasting**. IoT-enabled devices in a servitization model provide continuous data streams that can be utilized for predictive analytics in demand forecasting and improve the accuracy of supply chain planning. Also, the data collected from IoT devices allows firms to predict when services or parts will be required and contribute to just-in-time inventory practices and reducing overall costs. Finally, this business model type can **increase supply chain visibility**. Servitization requires enhanced visibility across the supply chain to monitor service performance and manage resources efficiently. As IoT technologies facilitate real-time monitoring and control of the supply chain, providing insights into the performance of products and the efficiency of services become easier and more accessible for the firms involved in the supply chain.

4.3. Type III – Data ecosystem

The third IoT business model type is labeled as “data ecosystem”. IoT consists of a network where physical objects are equipped with sensors, software, and other technological integrations that enable them to collect and share data across the Internet with other devices and systems. This interconnectedness allows these devices to operate seamlessly within a broader ecosystem that supports the flow of data, along with a range of applications and services. IoT is crucial in facilitating these ecosystems through the integration of diverse devices and sensors, which support real-time data exchange and collaborative operations. IoT-based data ecosystems lead to value creation by improving the functionality of core products and user experiences, IoT data ecosystems facilitate integrated solutions. They connect various devices and systems, offering cohesive solutions that tackle complex challenges more efficiently. Value is also created through interconnected offerings which are based on the collaborative development of products and services by multiple firms that result in a superior value for customers.

One of the most important implications of the data ecosystem business model type is **responsive supply chain operations**, which, within the context of IoT-enabled data ecosystems, refer to the capability of a supply chain to adapt and react to changes and challenges dynamically. The responsiveness is significantly enhanced by the real-time data and interconnectedness provided by IoT data ecosystems. IoT ecosystems improve communication flows between different stakeholders in the supply chain, such as suppliers, manufacturers, logistics providers, and retailers. By sharing real-time data across the ecosystem, each firm can adjust its operations based on the performance and status of other members. This integrated approach can allow other firms in the supply chain to respond more effectively to changes, whether it’s ramping up production in response to a spike in demand or adjusting delivery routes based on real-time traffic conditions. IoT-based ecosystems can also **improve supplier collaboration and integration**. Such ecosystems enable closer collaboration between a firm and its suppliers by providing an infrastructure for seamless data exchange and integration of operations. This in turn can lead to **dynamic supplier relationships** to ensure swift adaptability to changing requirements in core offerings. In this type, the relationship with suppliers shifts from transactional interactions to strategic partnerships, where suppliers are integrated into the delivery of final offerings. This often requires collaborative planning and shared systems for managing service lifecycles, thus changing how suppliers interact with and contribute to the company's value delivery.

Figure 1 illustrates the IoT business model types and SCM implications.

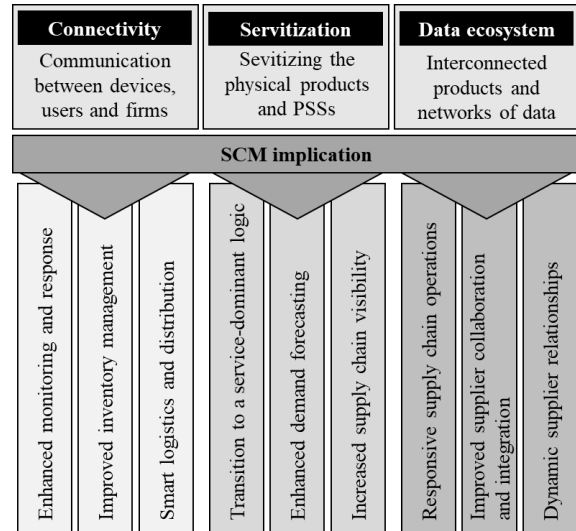


Figure 1, IoT business model types and SCM implications.

5. Discussion, and conclusions

The exploration of IoT-driven business models in this study is triggered by a transformative shift across industries, where the integration of IoT and data-driven initiatives is not merely enhancing supply chains but fundamentally redefining them. This study, primarily, posits that the linkages between firms’ business models and SCM are very strong, and changes in one can lead to disruptions in the other. Moreover, the growing importance of data and technologies such as IoT, can lead to various types of business models, and each of these business model types can have important implications for the firms’ SCM. To delve deeper into nuances of the business models, two research questions are posed and by systematically reviewing the extant body of literature, this study has identified three types of IoT business models.

The connectivity type focuses on enhancing the interactions by establishing networks that facilitate communication between devices, users, and firms. Connectivity can enhance monitoring and response in supply chains, improve inventory management, and it can enable smart logistics and distribution. The servitization type addresses the shifts from selling products to providing advanced service-based solutions. The implications of this model for SCM are the transition to a service-dominant logic which fundamentally impacts logistics and transportation, it can also enhance demand forecasting capabilities, and can also increase supply chain visibility. Data ecosystem is the third IoT business model type and

utilizes IoT technology as a network for data circulation and value creation. This model can lead to more responsive supply chain operations, improved supplier collaboration and integration, and dynamic supplier relationships.

This study contributes to the literature by providing a new insight that regards business models and SCM and adds to existing works such as Cheng et al. (2001), Boyson et al. (2003), Wang et al. (2018), and Li et al. (2022) by suggesting a typology of IoT business models and providing insights on the implications of these business model types for SCM. The identified IoT business models affect the information technology (IT) supporting SCM by enhancing real-time data capabilities and fostering greater integration and collaboration across the supply chain. The connectivity model improves IT systems by enabling real-time monitoring, better demand forecasting, and optimized logistics. The servitization model shifts SCM from product delivery to continuous service management, requiring robust IT infrastructure for predictive analytics and enhanced visibility. The data ecosystem model relies on integrated devices and real-time data sharing, enhancing supply chain responsiveness and supporting dynamic supplier relationships. While this study provides insights into the implications of IoT on business models for SCM, empirical data, particularly from experts in the field can significantly improve our understanding of the matter.

12. References

- Abbate, T., Cesaroni, F., Cinici, M. C., & Villari, M. (2019). Business models for developing smart cities. A fuzzy set qualitative comparative analysis of an IoT platform. *Technological Forecasting and Social Change*, 142, 183–193.
- Abdelghaffar, H., & Abousteit, M. (2021). Internet of Things (IoT) interoperability success criteria. *Int. Journal of Enterprise Information Systems*, 17(1), 85–105.
- Alcayaga, A., Wiener, M., & Hansen, E. G. (2019). Towards a framework of smart-circular systems: An integrative literature review. *Journal of Cleaner Production*, 221, 622–634.
- Almeida, T. D., Costa Avalone, M., & Fettermann, D. C. (2022). Buildings blocks for the development of an IoT business model. *Journal of Strategy and Management*, 13(1), 15–32.
- Amit, R., & Zott, C. (2001). Value creation in e-business. *Strategic Management Journal*, 22(6-7), 493–520.
- Ammirato, S., Felicetti, A. M., Linzalone, R., & Carlucci, D. (2022). Digital business models in cultural tourism. *Int. Journal of Entrepreneurial Behaviour and Research*, 28(8), 1940–1961. Scopus.
- Ancillai, C., Sabatini, A., Gatti, M., & Perna, A. (2023). Digital technology and business model innovation: A systematic literature review and future research agenda. *Technological Forecasting and Social Change*, 188, 122307.
- Angeles, R. (2019). Internet of things (IOT)-enabled product monitoring at Steadyserv: Interpretations from two frameworks. *Journal of Cases on Information Technology*, 21(4), 27–45.
- Athanasopoulou, A., de Reuver, M., Nikou, S., & Bouwman, H. (2019). What technology enabled services impact business models in the automotive industry? An exploratory study. *Futures*, 109, 73–83.
- Barrar, H., & Ruiz-Benitez, R. (2023). Exploratory study of the impact of the supply chain on integrated product-service systems design. *Business Process Management Journal*, 29(1), 262–284.
- Boehmer, J. H., Shukla, M., Kapletia, D., & Tiwari, M. K. (2020). The impact of the Internet of Things (IoT) on servitization: An exploration of changing supply relationships. *Production Planning and Control*, 31(2–3), 203–219. Scopus.
- Boyson, S., Corsi, T., & Verbraeck, A. (2003). The e-supply chain portal: A core business model. *Transportation Research Part E: Logistics and Transportation Review*, 39(2), 175–192.
- Casadesus-Masanell, R., & Ricart, J. E. (2010). From strategy to business models and onto tactics. *Long Range Planning*, 43(2–3), 195–215.
- Chauhan, C., Parida, V., & Dhir, A. (2022). Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises. *Technological Forecasting and Social Change*, 177, 121508.
- Chen, K.-L., Lassen, A., Li, C., & Møller, C. (2023). Exploring the value of IoT data as an enabler of the transformation towards servitization: An action design research approach. *European Journal of Information Systems*, 32(4), 735–761. Scopus.
- Chen, Y., Visnjic, I., Parida, V., & Zhang, Z. (2021). On the road to digital servitization – The (dis)continuous interplay between business model and digital technology. *Int. Journal of Operations and Production Management*, 41(5), 694–722. Scopus.
- Cheng, E. W. L., Li, H., Love, P. E. D., & Irani, Z. (2001). An e-business model to support supply chain activities in construction. *Logistics Information Management*, 14(1/2), 68–78.
- Cranmer, E. E., Papalexli, M., tom Dieck, M. C., & Bamford, D. (2022). Internet of Things: Aspiration, implementation and contribution. *Journal of Business Research*, 139, 69–80.
- Del Sarto, N., Cesaroni, F., Di Minin, A., & Piccaluga, A. (2022). One size does not fit all. Business models heterogeneity among Internet of Things architecture layers. *Technology Analysis and Strategic Management*, 34(7), 787–802. Scopus.
- Delgosha, M. S., Hajiheydari, N., & Talafidaryani, M. (2022). Discovering IoT implications in business and management: A computational thematic analysis. *Technovation*, 118, 102236.
- Denyer, D., & Tranfield, D. (2009). Producing a systematic review.

- Ehret, M., & Wirtz, J. (2017). Unlocking value from machines: Business models and the industrial internet of things. *Journal of Marketing Management*, 33(1–2), 111–130.
- Esmailpour Ghouhani, B., Jodaki, S., Joudaki, M., Balali, A., & Rajabion, L. (2019). A model for examining the role of the Internet of Things in the development of e-business. *VINE Journal of Information and Knowledge Management Systems*, 50(1), 20–33.
- Falkenreck, C., Leszczyński, G., & Zieliński, M. (2023). What drives the successful launch of IoT-related business models? *Journal of Business & Industrial Marketing*, 38(13), 180–194.
- Foltean, F. S., & Glovatchi, B. (2021). business model innovation for iot solutions: an exploratory study of strategic factors and expected outcomes. *amfiteatru economic*, 23(57), 392–411.
- Gao, P., & Li, J. (2020). Understanding sustainable business model: A framework and a case study of the bike-sharing industry. *Journal of Cleaner Production*, 267.
- Garbuio, M., & Gheno, G. (2023). An Algorithm for Designing Value Propositions in the IoT Space: Addressing the Challenges of Selecting the Initial Class in Reference Class Forecasting. *IEEE Transactions on Engineering Management*, 70(9), 3171–3182.
- Ge, B., Sun, Y., Chen, Y., & Gao, Y. (2016). Opportunity exploitation and resource exploitation: An integrative growth model for entrepreneurship. *Internet Research*, 26(2), 498–528.
- Gebauer, H., Fleisch, E., Lamprecht, C., & Wortmann, F. (2020). Growth paths for overcoming the digitalization paradox. *Business Horizons*, 63(3), 313–323.
- Giovanardi, M., Konstantinou, T., Pollo, R., & Klein, T. (2023). Internet of Things for building façade traceability: A theoretical framework to enable circular economy through life-cycle information flows. *Journal of Cleaner Production*, 382, 135261.
- Haaker, T., Ly, P. T. M., Nguyen-Thanh, N., & Nguyen, H. T. H. (2021). Business model innovation through the application of the Internet-of-Things: A comparative analysis. *Journal of Business Research*, 126, 126–136.
- Hakanen, E., & Rajala, R. (2018). Material intelligence as a driver for value creation in IoT-enabled business ecosystems. *Journal of Business and Industrial Marketing*, 33(6), 857–867. Scopus.
- Halpern, O., Jagoda, P., Kirkwood, J. W., & Weatherby, L. (2022). Surplus Data: An Introduction. *Critical Inquiry*, 48(2), 197–210.
- Hamidi, H., & Jahanshahifard, M. (2018). The role of the Internet of Things in the improvement and expansion of business. *Journal of Organizational and End User Computing*, 30(3), 24–44. Scopus.
- Hanafizadeh, P., Hatami, P., Analoui, M., & Albadvi, A. (2021). Business model innovation driven by the internet of things technology, in internet service providers' business context. *Information Systems and E-Business Management*, 19(4), 1175–1243.
- Hashem, I. A. T., Chang, V., Anuar, N. B., Adewole, K., Yaqoob, I., Gani, A., Ahmed, E., & Chiroma, H. (2016). The role of big data in smart city. *Int. Journal of Information Management*, 36(5), 748–758.
- Hasselblatt, M., Huikkola, T., Kohtamäki, M., & Nickell, D. (2018). Modeling manufacturer's capabilities for the Internet of Things. *Journal of Business & Industrial Marketing*, 33(6), 822–836.
- Karttunen, E., Pynnönen, M., Treves, L., & Hallikas, J. (2021). Capabilities for the internet of things enabled product-service system business models. *Technology Analysis and Strategic Management*. Scopus.
- Kaur, J., & Kaur, P. D. (2018). CE-GMS: A cloud IoT-enabled grocery management system. *Electronic Commerce Research and Applications*, 28, 63–72.
- Kiel, D., Arnold, C., & Voigt, K.-I. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies – A business level perspective. *Technovation*, 68, 4–19.
- Kiran, D. R. (2019). Chapter 35—Internet of Things. In D. R. Kiran (Ed.), *Production Planning and Control* (pp. 495–513). Butterworth-Heinemann.
- Kraft, P., Helm, R., & Dowling, M. (2021). New business models with Industrie 4.0 in the German Mittelstand. *Int. Journal of Technology, Policy and Management*.
- Krotov, V. (2017). The Internet of Things and new business opportunities. *Business Horizons*, 60(6), 831–841.
- Lai, C. T. A., Jackson, P. R., & Jiang, W. (2017). Shifting paradigm to service-dominant logic via Internet-of-Things with applications in the elevators industry. *Journal of Management Analytics*, 4(1), 35–54. Scopus.
- Lamendola, R., & Genet, C. (2022). Single- or multi-sided business models: How does time perception influence business model choice? *Int. Journal of Technology Management*, 89(1–2), 46–67. Scopus.
- Laya, A., Markendahl, J., & Lundberg, S. (2018). Network-centric business models for health, social care and wellbeing solutions in the internet of things. *Scandinavian Journal of Management*, 34(2), 103–116.
- Le, D. N., Le Tuan, L., & Dang Tuan, M. N. (2019). Smart-building management system: An Internet-of-Things (IoT) application business model in Vietnam. *Technological Forecasting and Social Change*, 141.
- Lee, I. (2019). The Internet of Things for enterprises: An ecosystem, architecture, and IoT service business model. *Internet of Things*, 7, 100078.
- Leiting, A.-K., De Cuyper, L., & Kauffmann, C. (2022). The Internet of Things and the case of Bosch: Changing business models while staying true to yourself. *Technovation*, 118, 102497.
- Leminen, S., Rajahonka, M., Wendelin, R., & Westerlund, M. (2020). Industrial internet of things business models in the machine-to-machine context. *Industrial Marketing Management*, 84, 298–311.
- Leminen, S., Rajahonka, M., & Westerlund, M. (2017). Actors in the emerging internet of things ecosystems. *Int. Journal of E-Services and Mobile Applications*, 9(1), 57–75.
- Leminen, S., Rajahonka, M., Westerlund, M., & Wendelin, R. (2018). The future of the Internet of Things: Toward heterarchical ecosystems and service business models. *Journal of Business & Industrial Marketing*, 33(6), 749–767.
- Li, G., Xue, J., Li, N., & Ivanov, D. (2022). Blockchain-supported business model design, supply chain resilience, and firm performance. *Transportation*

- Research Part E: Logistics and Transportation Review, 163, 102773.
- Liu, C., Feng, Y., Lin, D., Wu, L., & Guo, M. (2020). Iot based laundry services: An application of big data analytics, intelligent logistics management, and machine learning techniques. *Int. Journal of Production Research*, 58(17), 5113–5131. Scopus.
- Lokshina, I., Durkin, B., & Lanting, C. (2018). The IoT-and big data-driven data analysis services: KM, implications and business opportunities. *Int. Journal of Knowledge Management*, 14(4), 88–107. Scopus.
- Lai, K., Wong, C. W. Y., & Cheng, T. C. E. (2006). Institutional isomorphism and the adoption of information technology for supply chain management. *Computers in Industry*, 57(1), 93–98.
- Mahdad, M., Hasanov, M., Isakhanyan, G., & Dolfisma, W. (2022). A smart web of firms, farms and internet of things (IOT): Enabling collaboration-based business models in the agri-food industry. *British Food Journal*, 124(6), 1857–1874. Scopus.
- Marcon, É., Le Dain, M.-A., & Frank, A. G. (2022). Designing business models for Industry 4.0 technologies provision: Changes in business dimensions through digital transformation. *Technological Forecasting and Social Change*, 185, 122078.
- Martín, L., Sánchez, L., Lanza, J., & Sotres, P. (2023). Development and evaluation of Artificial Intelligence techniques for IoT data quality assessment and curation. *Internet of Things*, 22, 100779.
- Mattera, M., & Gava, L. (2022). Facing TBL with IoT: Creating value and positively impacting business processes. *Social Responsibility Journal*, 18(1), 178–201.
- Matthyssens, P. (2019). Reconceptualizing value innovation for Industry 4.0 and the Industrial Internet of Things. *Journal of Business & Ind. Marketing*, 34(6), 1203–1209.
- Mattos, C. A., & Novais Filho, M. J. (2023). Mechanisms to develop a business model through the Internet of things: A multiple case study in manufacturing companies. *technology analysis & strategic management*.
- Metallo, C., Agrifoglio, R., Schiavone, F., & Mueller, J. (2018). Understanding business model in the Internet of Things industry. *Technological Forecasting and Social Change*, 136, 298–306.
- Molling, G., & Zanela Klein, A. (2022). Value proposition of IoT-based products and services: A framework proposal. *Electronic Markets*, 32(2), 899–926.
- Naik, P., Schroeder, A., Kapoor, K. K., Ziaee Bigdeli, A., & Baines, T. (2020). Behind the scenes of digital servitization: Actualising IoT-enabled affordances. *Industrial Marketing Management*, 89, 232–244.
- Nalajala, P., Gudikandhula, K., Shailaja, K., Tigadi, A., Rao, S. M., & Vijayan, D. S. (2023). Adopting internet of things for manufacturing firms' business model development. *The Journal of High Technology Management Research*, 34(2), 100456.
- Neff, A., Weber, P., & Werth, D. (2024). Digital entrepreneurship in wholesale: Identification of implementation strategies for data spaces. *Int. Journal of Entrepreneurial Behavior & Research*, ahead-of-print (ahead-of-print
- Nguyen Dang Tuan, M., Nguyen Thanh, N., & Le Tuan, L. (2019). Applying a mindfulness-based reliability strategy to the Internet of Things in healthcare – A business model in the Vietnamese market. *Technological Forecasting and Social Change*, 140, 54–68.
- Niyawanont, N. (2022). Structural Equation Modelling of Digital Transformation Process of Thailand Agriculture & Food Industry. *Journal of Technology Management & Innovation*, 17(3), 40–51.
- Njomane, L., & Telukdarie, A. (2022). Impact of COVID-19 food supply chain: Comparing the use of IoT in three South African supermarkets. *Technology in Society*, 71, 102051.
- Orenga-Roglá, S., & Chalmeta, R. (2018). Framework for implementing a big data ecosystem in organizations. *Communications of the ACM*, 62(1), 58–65.
- Paiola, M., Agostini, L., Grandinetti, R., & Nosella, A. (2022). The process of business model innovation driven by IoT: Exploring the case of incumbent SMEs. *Industrial Marketing Management*, 103, 30–46.
- Paiola, M., & Gebauer, H. (2020). Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. *Industrial Marketing Management*, 89, 245–264.
- Paiola, M., Schiavone, F., Grandinetti, R., & Chen, J. (2021). Digital servitization and sustainability through networking: Some evidences from IoT-based business models. *Journal of Business Research*, 132, 507–516.
- Palmaccio, M., Dicuonzo, G., & Belyaeva, Z. S. (2021). The internet of things and corporate business models: A systematic literature review. *Journal of Business Research*, 131, 610–618.
- Park, Y. W., Hong, P., & Shin, G.-C. (2023). Rising and thriving in the post COVID-19 era: A case study of COSMAX, a leader of the Korean cosmetic industry. *Asia Pacific Business Review*, 29(4), 1105–1124.
- Passlick, J., Dreyer, S., Olivotti, D., Grützner, L., Eilers, D., & Breitner, M. H. (2021). Predictive maintenance as an internet of things enabled business model: A taxonomy. *Electronic Markets*, 31, 67–87.
- Qiu, X., Luo, H., Xu, G., Zhong, R., & Huang, G. Q. (2015). Physical assets and service sharing for IoT-enabled Supply Hub in Industrial Park (SHIP). *Int. Journal of Production Economics*, 159, 4–15.
- Radenković, M., Bogdanović, Z., Despotović-Zrakić, M., Labus, A., & Lazarević, S. (2020). Assessing consumer readiness for participation in IoT-based demand response business models. *Technological Forecasting and Social Change*, 150, 119715.
- Rocha, A. L. B., Cesila, C. H., Maciel, P. D., Jr., Correa, S. L., Rubio-Loyola, J., Rothenberg, C. E., & Verdi, F. L. (2022). CNS-AOM: Design, Implementation and Integration of an Architecture for Orchestration and Management of Cloud-Network Slices. *Journal of Network and Systems Management*, 30(2).
- Rong, K. (2022). Research agenda for the digital economy. *Journal of Digital Economy*, 1(1), 20–31.
- S. Oliveira, M. I., Barros Lima, G. de F., & Farias Lóscio, B. (2019). Investigations into data ecosystems: A systematic mapping study. *Knowledge and Information Systems*, 61, 589–630.

- Saarikko, T., Westergren, U. H., & Blomquist, T. (2017). The Internet of Things: Are you ready for what's coming? *Business Horizons*, 60(5), 667–676.
- Scheider, S., Lauf, F., Möller, F., & Otto, B. (2023). A Reference System Architecture with Data Sovereignty for Human-Centric Data Ecosystems. *Business & Information Systems Engineering*.
- Seale, C. (2004). *Social research methods: A reader*. Psychology Press.
- Sembroiz, D., Ricciardi, S., & Careglio, D. (2018). Chapter 10—A Novel Cloud-Based IoT Architecture for Smart Building Automation. In M. Ficco & F. Palmieri (Eds.), *Security and Resilience in Intelligent Data-Centric Systems and Communication Networks* (pp. 215–233). Academic Press.
- Šestak, M., & Copot, D. (2023). Towards Trusted Data Sharing and Exchange in Agro-Food Supply Chains: Design Principles for Agricultural Data Spaces. *Sustainability (Switzerland)*, 15(18). Scopus.
- Shoukry, A., Khader, J., & Gani, S. (2021). Improving business process and functionality using IoT based E3-value business model. *Electronic Markets*, 31(1), 17–26.
- Şimşek, T., Öner, M. A., Kunday, Ö., & Olcay, G. A. (2022). A journey towards a digital platform business model: A case study in a global tech-company. *Technological Forecasting and Social Change*, 175, 121372.
- Sood, S., & Woodside, A. G. (2021). Entrepreneurial orientation vignettes into open innovation of the internet of things: Advancing into the age of service dominant reasoning. *Int. Journal of Services Technology and Management*, 27(4–6), 324–336.
- Stock, J. R., & Boyer, S. L. (2009). Developing a consensus definition of supply chain management: A qualitative study. *Int. Journal of Physical Distribution & Logistics Management*, 39(8), 690–711.
- Straker, K., Mosely, G., & Wrigley, C. (2021). An Approach to Integrating Market Research with Customer Insights through the Development of IoT Products. *Journal of Int. Consumer Marketing*, 33(3), 239–255.
- Sturm, M., Weking, J., Böhm, M., Schrieck, M., & Krcmar, H. (2023). How two leading partners learn to tango: The case of IoT-based business model co-innovation between a retailer and an electronics supplier. *Electronic Markets*, 33(1), 34.
- Suja Mary, D., Jaya Singh Dhas, L., Deepa, A. R., Chaurasia, M. A., & Jaspin Jeba Sheela, C. (2024). Network intrusion detection: An optimized deep learning approach using big data analytics. *Expert Systems with Applications*, 251, 123919.
- Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43(2–3), 172–194.
- Toorajipour, R., Oghazi, P., & Palmié, M. (2024). Data ecosystem business models: Value propositions and value capture with Artificial Intelligence of Things. *Int. Journal of Information Management*, 78, 102804.
- Ulrich, A. M. D., Hollensen, S., & Eskerod, P. (2023). IoT platform stickiness and positioning in the value chain: Considerations for a sub-supplier. *Int. Journal of Value Chain Management*, 14(3), 309–324. Scopus.
- Veile, J. W., Schmidt, M.-C., & Voigt, K.-I. (2022). Toward a new era of cooperation: How industrial digital platforms transform business models in Industry 4.0. *Journal of Business Research*, 143, 387–405.
- Volberda, H. W., Khanagha, S., Baden-Fuller, C., Mihalache, O. R., & Birkinshaw, J. (2021). Strategizing in a digital world: Overcoming cognitive barriers, reconfiguring routines, and introducing new organizational forms. *Long Range Planning*, 54(5), 102110.
- Wan, J., Zou, C., Zhou, K., Lu, R., & Li, D. (2014). IoT sensing framework with inter-cloud computing capability in vehicular networking. *Electronic Commerce Research*, 14(3), 389–416.
- Wang, L., Boasson, V. W., Boasson, E., Liu, Y., & Chen, Y. (2023). Big Data-Driven Business Model Innovation (BMI) From the Perspective of Ambidexterity: Case Study of L. Vending Intelligence. *Journal of Global Information Management (JGIM)*, 31(1), 1–21.
- Wang, Y., Jia, F., Schoenherr, T., & Gong, Y. (2018). Supply Chain-Based Business Model Innovation: The Case of a Cross-Border E-Commerce Company. *Sustainability*, 10(12), Article 12.
- Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 52(3), 326–349.
- Weking, J., Stöcker, M., Kowalkiewicz, M., Böhm, M., & Krcmar, H. (2020). Leveraging industry 4.0 – A business model pattern framework. *Int. Journal of Production Economics*, 225, 107588.
- Wielki, J. (2017). The impact of the internet of things concept development on changes in the operations of modern enterprises. *Polish Journal of Management Studies*, 15(1), 262–275. Scopus.
- Yopan, M., Kasali, R., Balqiah, T. E., & Pasaribu, M. (2022). The Role of Digital Leadership, Customer Orientation and Business Model Innovation for IoT Companies. *Int. journal of business*, 27(2).
- Zambetti, M., Adrodegari, F., Pezzotta, G., Pinto, R., Rapaccini, M., & Barbieri, C. (2023). From data to value: Conceptualising data-driven product service system. *Production Planning & Control*, 34(2), 207–223.
- Zancul, E. de S., Takey, S. M., Barquet, A. P. B., Kuwabara, L. H., Cauchick Miguel, P. A., & Rozenfeld, H. (2016). Business process support for IoT based product-service systems (PSS). *business process management journal*, 22(2), 305–323.
- Zhang, X., Guo, X., Yue, W. T., & Yu, Y. (2022). Servitization for the Environment? The Impact of Data-Centric Product-Service Models. *Journal of Management Information Systems*, 39(4), 1146–1183. Scopus.
- Zhang, Z., Gu, Y., Jiang, L., Yu, W., & Dai, J. (2023). Internet of Things and Blockchain-Based Smart Contracts: Enabling Continuous Risk Monitoring and Assessment in Peer-to-Peer Lending. *Journal of Emerging Technologies in Accounting*, 20(2), 181–194.
- Zott, C., & Amit, R. (2010). Business model design: An activity system perspective. *Long Range Planning*, 43(2–3), 216–22.
- Zrelli, I., & Rejeb, A. (2024). A bibliometric analysis of IoT applications in logistics and supply chain management. *Heliyon*, 10(16), e36578.