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# Literature review on industrial digital platforms: A business model perspective and suggestions for future research

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ABSTRACT

Rapid digitalization of industries has led to the proliferation of complex industrial digital platforms; however, few industrial platform leaders have successfully established sustainable business models around their offerings. The need for a concrete definition of industrial digital platforms and their business models further complicates our understanding of the issue. In this prospecting review, we critically analyze the existing literature on industrial digital platforms to identify key research themes and research gaps and propose a future research agenda for the industrial digital platform literature from a business model perspective. Drawing on insights from research on industrial platforms, digitalization, digital servitization, and business-to-business (B2B) relationships, our analysis focuses on three key themes in defining the boundaries of industrial digital platforms and the crucial aspects of value creation, value delivery, and value capture on such platforms: (a) co-creative value creation, (b) digitally integrated value delivery, and (c) mutual value capture. The findings of this study and a future research agenda framework provide a roadmap for advancing the understanding of business models for industrial digital platforms. This research aims to contribute to the emerging field of industrial digital platforms and guide future research endeavors in this domain, unlocking the full potential of these platforms for businesses and industries.

## 1. Introduction

Digitalization holds the potential to revolutionize industrial activity across firms and ecosystems, unlocking new sources of innovation, efficiency, growth, and sustainability (Björkdahl, 2020). This potential is still largely untapped, as most data and innovative applications still reside in industrial silos, but both academics and practitioners regard industrial digital platforms as being fundamental next steps in a full-fledged digital transformation journey (Jovanovic et al., 2021; Riemensperger and Falk, 2020; Zhou et al., 2022) for several reasons. First, these platforms break silos by allowing for the collection, analysis, and sharing of data from a variety of industrial assets and devices, ranging from tools and machines to vehicles or whole fleets and factories across industrial ecosystems (Jovanovic et al., 2021; Hein et al., 2019; Sjödin et al., 2022). This flow of integrated data across firm ecosystems holds the potential to catalyze innovation by allowing novel complementary actors (e.g., artificial intelligence [AI] startups) to create advanced industrial applications and services to address customers' operational pain points (Jovanovic et al., 2021). Second, industrial digital platforms offer the potential for rapid and broad commercialization of innovations through digital marketplaces, connecting users and developers and thus facilitating the distribution and use of complementary applications to a large market of industrial customers (Pauli et al., 2021). Therefore, in addition to facilitating efficient transactions, digital platforms have become vehicles of business model innovation by finding, creating, co-creating, and exploiting new value arising from industrial data beyond the boundaries of the firms with customers and complementors (Gomes et al., 2022; Miehé et al., 2023; Usman & Vanhaverbeke, 2017).

The platform structure also provides opportunities for firms to move from a traditional make-and-sell logic to the creation of continuous revenue by selling solutions and services in an ecosystem (Burström et al., 2021; Kamalaldin et al., 2020; Palmié et al., 2022; Parida et al.,

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2019). Thus, industrial digital platforms business models may play a vital role in facilitating innovation as well as more effective transactions so the next steps in the digitalization of industry can be taken (Cusumano et al., 2019; Parida et al., 2019; Pidun et al., 2022). However, despite the rising interest in and potential impact of operating such platforms, most industrial providers fail to realize value creation or capture opportunities (Pidun et al., 2020, 2022). In practice, the path to succeed with industrial digital platforms is far from clear, and most companies struggle to find appropriate business models to align the incentives of complementors and customers in evolving platform ecosystems (Hauke-Lopes et al., 2022). For example, the Industrial Internet of Things (IIoT) Predix platform developed by General Electric failed to attract customers due to proprietary closed standards (i.e., it lacked the involvement of complementary actors) and difficulty in system integration with customers.

Prior literature has identified primarily technological reasons for the failure of B2B industrial platforms, such as technological complexities, lack of platform openness, lack of standardization (Tessmann and Elbert, 2022), and low customer acceptance. However, while technology is undoubtedly a challenge, we argue that the key factor explaining failures may be platforms' weak business model configuration, the mechanism whereby an industrial platform creates, delivers, and captures value (Teece, 2010). Indeed, little is known about the appropriate configuration of industrial digital platform business models, and we see several gaps in knowledge and a need to consolidate insights.

Specifically, we argue for the need to further review insights into industrial platform business models. In fact, studies on business models for industrial platform firms are currently limited (Veile et al., 2022) and mostly address only one of many dimensions of the business model framework (Hein et al., 2019; Sun et al., 2022). Though several reviews have been carried out of the platform literature, such reviews either consider only digital platforms, without focusing on B2B platforms (McIntyre and Srinivasan, 2017; Sutherland & Jarrahi, 2018), or have a very narrow focus on a certain issue within B2B digital platforms, such as adoption (Shree et al., 2021). In addition, due to the importance of the topic research studies are scattered across multiple domains of management and technology (Shree et al., 2021), leading to there being multiple incompatible definitions of the concept. The discipline can now benefit from a comprehensive assessment of the existing literature to not only define industrial digital platforms but also to assess the current state of the field to advance a future research agenda. We also propose that the business model theoretical lens can serve as a unifying concept for the segmented literature on industrial digital platforms.

To this end, the purpose of this study is to conduct a prospecting review (Breslin and Gatrell, 2020) of the literature on industrial digital platforms through the theoretical lens of business models. Accordingly, we seek to conceptualize industrial digital platforms, consolidate key business model insights, and propose a future research agenda in this domain. The review finds that the business model lens provides a unique, unifying perspective on the literature on the industrial digital platform. Through a qualitative thematic analysis, the results highlight the key issues pertaining to value creation, value delivery, and value capture in industrial digital platforms through three key themes: (a) co-creative value creation, (b) digitally integrated value delivery, and (c) mutual value capture. The findings are synthesized into a framework for future research to guide research in the area. The framework argues for theory-driven and conceptually sound research on industrial digital platforms from a business model perspective.

## 2. Theoretical background

### 2.1. Understanding and defining industrial digital platforms

Research on digital platforms cuts across several domains, including technology management, business, and economics (Hein et al., 2020; McIntyre and Srinivasan, 2017). The word "platform" is used in different contexts; hence, there is considerable confusion about its meaning in the research (de Reuver et al., 2018). While platforms originate in the technical literature, digital platforms can, from the business perspective, be defined as interfaces that mediate transactions between actors, including sellers, buyers, complementors, and users (McIntyre and Srinivasan, 2017; Blackburn et al., 2022). However, while some studies define industrial platforms from a technical perspective, others adopt a purely business perspective, leading to multiple definitions of industrial digital platforms. This confusion has also led to the use and adoption of multiple terms, particularly for B2B industrial platforms, including industry platforms (Gawer and Cusumano, 2014; Tee and Gawer, 2009), technology platforms (Gawer, 2014), B2B intermediaries (Johnson and Johnson, 2005), and platform ecosystems (Jovanovic et al., 2021). Further, there is confusion over whether internal organizational platforms, such as product and internal platforms, which have few external connections like supply chain platforms, should be considered industrial digital platforms (Gawer, 2014; Gawer and Cusumano, 2014; Thomas et al., 2014). Some research attention has also been directed to how an organization can transform from internal to external platforms (Chen and Cui, 2022; Thomas et al., 2014). However, no unified definition has yet been formulated to define industrial platforms. Table 1 summarizes the most important definitions of digital platforms in the B2B context in the literature.

Though the multiplicity of definitions can be interpreted as a strength in the changing world of platform research, it is also a major weakness that prevents industrial platform researchers from agreeing on what it is that they are studying. As such, and as explained above, a variety of definitions exists. While some definitions apply an inward perspective and consider industrial platforms as shared resources and processes within a firm, for example, product platforms (Ceccagnoli and Jiang, 2013), others consider industrial platforms to be exclusively external matters. Others still recognize the importance of considering both the inward and outward view and offer multiple definitions based on the context of the study (Jovanovic et al., 2021).

We argue that the multiplicity of definitions can be reconciled by taking an evolutionary perspective on industrial digital B2B platforms and linking it to the concept of business models. The term "business model" implies the different ways in which an organization creates, delivers, and captures value when it provides customers with products and service offerings (Teece, 2010). Therefore, synthesizing definitions of digital platforms and integrating the business model dimension, we define an industrial digital platform as *a foundational technological architecture and data upon which a focal firm organizes a diverse set of interdependent actors, activities, and interfaces to create, deliver, and capture value*. Industrial digital platforms are thus of several types and forms, which is important to summarize (Thomas et al., 2014). To do so, the following subsection applies an evolutionary lens to delve deeper into the types of industrial digital platforms discussed in the literature and how they are linked from the business model lens we use in this review.

### 2.2. Exploring the types and evolution of industrial digital platforms

A digital industrial platform's strength lies in leveraging the data it generates to customize value creation, capture, and delivery (Gebauer et al., 2020). However, in earlier studies industrial digital platforms were primarily described as inter-organizational information systems that enable multiple buyers and sellers to connect to find and execute transactions electronically (Rohm et al., 2004; Shree et al., 2021). This early definition gave limited scope for using data in a well-integrated and strategic manner. But, as highlighted above, platforms are now vehicles of new value co-creation with complex business models (Şimşek et al., 2022). Given such diverse ways of organizing platforms and business models, we argue that two key parameters dictate the form of an industrial digital platform and, consequently, the business model it adopts: (a) the extent of data integration within the platform (Tian et al., 2021) and (b) the extent of ecosystem integration (Mostaghel et al.,

**Table 1**
Summarizing existing definitions of industrial digital platforms in literature.

| Study | Definition of industrial platform(s) | Comment |
|---|---|---|
| Tee and Gawer (2009) | "Industry platforms are technological building blocks that act as a foundation upon which an array of firms, organized in a set of interdependent firms […], develop a set of interrelated products, technologies, and services" (p. 2019) | Does not consider non-firms as possible actors on the platform. |
| Gawer (2014) | "Technological platforms can be usefully conceptualized as evolving organizations or meta-organizations that: (1) federate and coordinate constitutive agents who can innovate and compete; (2) create value by generating and harnessing economies of scope in supply or/and in demand; and (3) entail a modular technological architecture composed of a core and a periphery." (p. 1245) | Considers external platforms in detail. Considers both the transactional and value oriented view |
| Gawer and Cusumano (2014) | "We define external (industry) platforms as products, services, or technologies that […] provide the foundation upon which outside firms (organized as a 'business ecosystem') can develop their own complementary products, technologies, or services"<br><br>"we define internal (company or product) platforms as a set of assets organized in a common structure from which a company can efficiently develop and produce a stream of derivative products" (p. 418) | Distinguishes external and internal platforms, but does not attempt to derive a unified definition |
| Pauli et al. (2021) | "platforms that (i) collect and integrate data from a heterogeneous set of industrial assets and devices, (ii) provide this data and additional technological support to an ecosystem of third-party organizations who develop and enable complementary solutions that (iii) affect the operation of industrial assets and devices, and (iv) provide a marketplace to facilitate interactions between platform owner, third-parties and business customers." (p. 183) | Considers data as a central and does not emphasize the role of orchestration |
| Shree et al. (2021) | "These B2B digital platforms are internet-based aggregators of buyers and sellers. They serve as intermediaries and facilitate the transaction among the parties involved and enable the exchange of value alongside information" (p. 354) | Focus on transaction efficiency as the key value. Platform as an intermediary. |
| Jovanovic et al. (2021) | "a platform ecosystem can be viewed as an evolving meta-organizational form characterized by enabling platform architecture, supported by a set of platform governance mechanisms necessary to cooperate, coordinate and integrate a diverse set of organizations, actors, activities, and interfaces, resulting in an increased platform value for customers through customized platform services" (p. 2) | A well rounded definition, but not specific to digital platforms |
| Ceccagnoli et al. (2012) | "…platform as the components used in common across a product family whose functionality can be extended by applications and is subject to network effects." (p. 263) | Has an internal focus and discussed internal or organizational platforms |
| Thomas et al., 2014 | "For the organizational platform stream, the platform is a structure that stores an organization's resources and capabilities."<br><br>"For the product family stream, the platform enables a product family and supports effective development of product variants to address different market niches."<br><br>"For the market intermediary stream, the platform enables a marketplace (typically electronic), creating market efficiencies in two-sided markets. In this stream, the market platform provides the device for connecting supply and demand and establishes and exploits market power."<br><br>"For the platform ecosystem stream, the platform is a set of shared core technologies and technology standards underlying an organizational field that support value co-creation through specialization and complementary offerings." (p. 201) | Definitions are for platforms and not digital platforms as such. Considers multiple definitions and hints at how they are connected to each other. |

2022; Parida et al., 2019; Eloranta and Turunen, 2016). By the extent of data integration, we mean the extent to which different forms of industrial data are utilized within the platform and to what extent the latter forms the basis of value creation, delivery, and capture. On the other hand, the extent of ecosystem integration implies the extent to which capabilities and business models of different ecosystem partners are integrated into digital platforms. Based on these parameters, we divide the extant industrial platforms into four broad types: (a) industrial product efficiency platforms, (b) industrial transaction platforms, (c) product-service platforms, and (d) industrial digital platform ecosystems.

***Industrial product efficiency platforms*** are low in both data integration and ecosystem actor integration. These platforms are usually internal to the company, have very limited capabilities, and are used within the organization, and can be considered the digital analogues of an organizational platform (Thomas et al., 2014). These platforms are generally structured as internally connected systems that track machinery and can provide basic digital services, such as monitoring spare parts and maintenance intervals (Jovanovic et al., 2021). However, these internal platforms can also become bedrocks of platform evolution as a platform leader, whether by itself or with suppliers, can construct a set of related products and services by deploying the components of the platform in the future (Kapoor et al., 2022; Gawer & Cusumano, 2014). As such, the internal platform affords cost savings and the ability to

reuse resources and structures within the organization to offer better services to customers (Ceccagnoli et al., 2012). Having made the initial step forward, the platform leader can either choose to focus on data integration, by enhancing the common digital architecture, or ecosystem integration, by reaching out to more partners on the platform using the internal platform as a base (Jovanovic et al., 2022; Thomas et al., 2014; Turner and Chung, 2005). In doing so, the platform may take the form of a product service platform or an industrial transaction platform.

***The product service platform*** represents one possible extension of the product efficiency platform. The extent of data integration is higher in this type of platform, which often sees some extent of data utilization for value creation, delivery, and capture along with efforts made by the platform leader to reach out to its nearest partners in the value chain (Tian et al., 2021; Jovanonic et al., 2022). The key difference here is that the platform leader starts to actively display orchestration capability to integrate those immediate partners who hold the most value by making initial platform investments, developing platform capabilities, and optimizing these capabilities (Shen et al., 2023; Cenamor et al., 2017). The digital servitization literature provides much insight into how these platforms function and provide advanced digital services to customers by not only integrating internal offerings, but also allowing partners to advance their value propositions on the nascent, yet developing, platform architecture (Cenamor et al., 2017; Jovanovic et al., 2022; Kohtamäki et al., 2022). For instance, Wei et al. (2020) suggest that platform leaders should carefully select partners based on the resources and capabilities they bring to the platform and their ability to meet customer demands. However, the emerging common digital architecture provides more opportunities to deliver more complex values to customers and presents an interesting means for the digital platform leader to progress.

***The industrial transaction platform*** represents those platforms that act as intermediaries in transactions between B2B entities. The extent of data integration is often quite low, but due to the nature and number of buyers and sellers on the platform, the ecosystem actor integration is often quite high. Indeed, much of the literature on such platforms is concerned with reducing transaction costs between customer and supplier businesses and designing ways to efficiently match supply with demand to increase the number of transactions performed (Truong et al., 2012). That is, platform leaders capture value by charging commissions as an intermediary (Eid et al., 2006; Fang et al., 2015; Li et al., 2018; Miao et al., 2019; Truong et al., 2012). For that reason, we call these platforms industrial transaction platforms. This model is a translation of offline customer–supplier interaction, which creates value by reducing search and transaction costs but fails to create and capture the complementary values enabled by industrial data.

Although industrial transaction platforms can take different shapes and sizes depending on the platform leader and functions, the most frequently studied is an electronic marketplace (Albrecht et al., 2005; Johnson and Johnson, 2005; Kandampully, 2003; Kaplan and Sawhney, 2000; Ordanini and Pol, 2001; Yoon et al., 2021). Industrial transaction platforms primarily thrive by capturing a portion of the transaction cost savings and rely on solving the "chicken and egg" problem to create cross-side network effects (Miao et al., 2019; Yoon et al., 2021). That is, they try to increase the number of customers and suppliers on the platforms so that participation is valuable for both sides of the transaction. However, lack of trust and high costs, which cannot be recovered because of the smaller scale, have stopped industrial transaction platforms from proliferating to the same degree as B2C transaction platforms (Mourtzis et al., 2021). Much of the research interest lies in understanding how consumers can be brought onto the platform and kept there (Liu et al., 2020; Mourtzis et al., 2021; Yuan et al., 2021). To this end, studies have investigated several interesting variables, including repeat purchase intention (Yuan et al., 2021), customer orientation (Chakravarty et al., 2014; Liu et al., 2022), participant motivations to participate (Johnson and Johnson, 2005), incentive strategies to keep customers on the platform (Li et al., 2018), supplier anxiety and trust (Lien et al., 2017), and competition between suppliers on the platform (Li et al., 2015). That is, the focus is on partner integration rather than data integration. Enhancing data integration and recruiting the right complementors can help a platform grow further into an industrial platform ecosystem.

***Industrial digital platform ecosystems*** represent the ultimate culmination of data and actor integration. Though platforms might follow different paths to become platform ecosystems, the key feature of these platforms is the purpose-driven orchestration of partners and deeply entrenched use of data in value creation, delivery, and capture processes or business models (Gebauer et al., 2021). In particular, recent literature highlights that industrial platforms now enable new forms of data-driven value delivery that leverage the value of industrial data, making the traditional model of producing and selling goods less attractive (Jovanovic et al., 2021; Shree et al., 2021). Along with this change comes a variety of business model issues that were previously not considered in transaction-based industrial platforms, including balancing leverages, data sharing, managing architecture, and boundary control (Thomas et al., 2014; Jovanovic et al., 2021). Further, firms that lead such platforms, or platform leaders, are often not e-commerce firms, such as Amazon, that try to facilitate transactions; rather, they are large industrial firms trying to create ecosystems to deliver complex value propositions to their customer businesses (Parida et al., 2019). These platform leaders are trying to move away from the winner-takes-all logic of traditional transaction efficiency and B2C platforms to a win–win for all platform participants (Hein et al., 2019).

Moreover, architectural openness and the ability to incorporate many contributors renew the importance of the concepts of generativity and complementarity that were previously unseen on industrial platforms because fewer actors were involved (Wu et al., 2022), thus reinvigorating the discussion on new value creation and protecting value on platforms. Platforms as "ecosystems of firms" become vehicles for business models that focus less on manufacturing and selling and more on selling digitally enabled services or digital servitization (Gebauer et al., 2021; Kamalaldin et al., 2020; Ruiz-Alba et al., 2019; Zhang and Banerji, 2017; Sjödin et al., 2021) or product–service systems (Mourtzis et al., 2021). Thus, they also become the basis for complex value creation, delivery, and capture mechanisms and, consequently, complex digital business models that are not seen on the platforms discussed above (Jovanovic & Ritala, 2024; Sjödin et al., 2022). However, although all the platforms discussed above have their reasons for existence, there is no consensus in the literature on the stages through which they have evolved.

Therefore, it is now worth examining how these types of industrial platforms are linked and how they have evolved over the years. The earliest research on industrial digital platforms examined marketplaces (Eid et al., 2006; Kandampully, 2003). However, most of the current discussion addresses how platform leaders can chase something more than just internal or external transaction efficiency through product efficiency, product service, or industrial transaction platforms. The focus is on aligning business model components not only with the product platform, but also with the business models of partners (Kohtamäki et al., 2019). Industrial digital platforms are now dynamic forms of organizations whose evolution is guided by the platform leader (Parida et al., 2019; Jovanovic et al., 2021; Hein et al., 2019). Unlike B2C platforms, which are designed to attract the maximum number of complementors and customers, industrial platforms, particularly those designed to co-create value, are more complex and are often designed with business models that encourage collaboration and value co-creation with a defined set of customers and complementors. Therefore, platform leaders must find the balance between increasing data integration and ecosystem actor integration to scale and derive more value from the platform as they evolve in their role as the platform leader.

Most platforms start as industrial product efficiency platforms (Thomas et al., 2014). Jovanovic et al. (2022) describe an evolutionary

progression whereby digital servitization provides a bridge to connect industrial product efficiency platforms and the industrial platform ecosystem through industrial product–service platforms. This change requires a synergetic data and analytics utilization-driven coevolution of platform architecture, platform governance mechanism, and platform services (Jovanovic et al., 2022). However, co-evolution with platform services suggests that services and platform offerings are to be co-developed with actors on the platform (Fu et al., 2022), implying that the business model must also evolve if the platform leader and its partners are to continue extracting value from the evolving platform. On the other hand, the platform literature states that the ecosystem stage can also be reached from the industrial transaction stage if the platform leader orchestrates the right partners to provide adequate complementary values (Eloranta and Turunen, 2016). However, this development may also be driven by the inability to achieve a winner-takes-all situation in the B2B setting (Hein et al., 2019).

Although research on this evolutionary path is limited, a related study by Ritala and Jovanovic (2023, 2024) describes how evolution progresses beyond the ecosystem level by advancing a platform market guardian as its final stage. In this framework, the platform guardian mainly captures value by capturing arbitrage fees on transactions and banking on future opportunities, and thus it can be considered as analogous to an industrial transaction platform. However, in this situation, the platform leader may now be able to only capture value from arbitrage or accrue indirect benefits, and the role of the platform leader is to ensure data neutrality on the platform (Ritala & Jovanovic, 2023, 2024). It is unclear how the leader will find enough partners to reach this stage, as ample literature on industrial platforms indicates that achieving economies of scale in this manner is difficult due to the limited number of partners in the market (Hein et al., 2019; Shree et al., 2021). In the absence of studies offering contradictory results or theories, it isn't easy to ascertain whether this relationship will hold true for all platform evolution stories. A summary of the evolutionary states discussed above can be seen in Fig. 1.

Regardless of type of evolution, however, the more we explore how firms can evolve through the platform stages, the clearer it becomes that the right business model decisions by the platform leader are essential in deciding not only the platform offerings now, but also their evolution in the future (Shen et al., 2023). In the following sections we describe our review method and the findings related to business models for industrial digital platforms with a specific emphasis of business model configurations towards the most advanced forms of industrial platform ecosystem.

## 3. Review method

Industrial digital platforms have been discussed widely in different disciplines (Hein et al., 2020). Under these circumstances, a purely systematic literature review method may not be appropriate as review of all the articles in the domain on an equal footing may not be possible, and thus a semi-structured review may be more appropriate (Snyder, 2019). Semi-structured reviews are well suited for scoping the existing literature to identify prominent themes and topics that have evolved

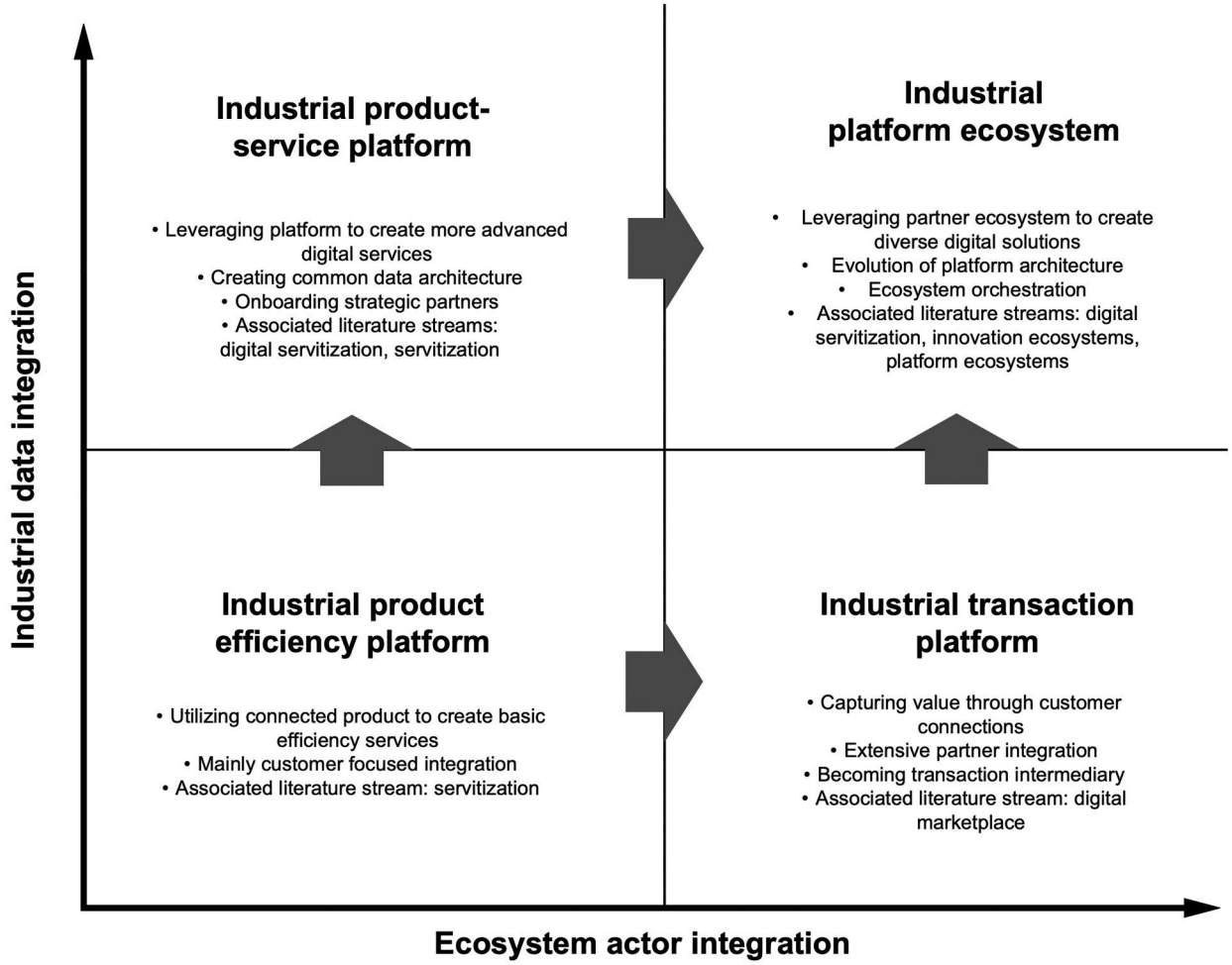


**Fig. 1.** Types of industrial digital platforms and their interrelationship.

(Wong et al., 2013). Since the current study aims to scrutinize and extend the body of knowledge on industrial digital platforms, we believe this method is well-suited to the task (Palmatier et al., 2018). Further, semi-structured reviews enable methods and analyses to be combined and a qualitative thematic content analysis method to be followed (Snyder, 2019). Specifically, we adopt those parts of the systematic review process associated with identifying and cataloging literature to make our search strategy more reliable and robust (Madanaguli et al., 2021; Mora Cortez et al., 2021).

A robust set of keywords is essential to ensure the search results in a comprehensive coverage of relevant literature. We accomplished this through a two-stage process. We started with the primary keywords of "industrial," "B2B," and "business to business" for industrial platforms and "digital platforms" for digital platforms. We ran these keywords in the Google Scholar database and analyzed the 100 most relevant search results as determined by the tool's algorithm. We read through the keywords of these studies and identified those that represented our topic. Further, we consulted other reviews on B2B, digital, and platform topics and collected their keywords. After reading through the keywords, we decided to split the topic into B2B-, digital-, and platform-related keywords. However, "industrial digital platform" is a new term whose scope extends to different areas. Therefore, we supplemented our search results with snowball searching and citation-chain searching, causing the search to spill over into the digital servitization domain, which has several interesting works on how servitization value is created on industrial digital platforms (for example, Gebauer et al., 2021; Cenamor et al., 2017).

Consequently, we added the keywords "servitization" and "digital servitization" to our search. We clubbed together similar keywords for each subtopic. The final string of keywords was (B2B keywords) AND (digital keywords) AND (platform keywords). We supplemented this search with a search on (servitization keywords) AND (platform keywords). The string ensured that only studies at the intersection of the three subtopics appeared in the search results.

To identify whether a study was relevant, we utilized qualifying criteria, as is the norm with literature reviews (Mora Cortez et al., 2021). Two authors evaluated each study on four key criteria: (a) Is the study set in a B2B or industrial setting, or does the paper's main topic involve B2B interactions and relationships on a digital platform?; (b) is the focus of the study on a firm or an interfirm level rather than an individual level of analysis?; (c) does the study address at least one business aspect of digital platforms, or is it published in an industrial marketing-focused journal?; and (4) does the study address some aspect of a business model? Each study was coded on a scale of 0 to 2, where 0 signified least relevant, and 2 signified most relevant. The scores from the question were added up to create a relevance score. If any of the authors ranked a study 5 (out of a possible 8), it was included for further analysis and review.

The list of keywords for each of the four concepts, industrial, digital, servitization, and platform, was combined through relevant Boolean operators to perform the search. The search was conducted in May 2022. Initially, the search yielded 1045 hits, of which 408 results were from Web of Science (WOS) and 637 from Scopus. However, we noticed that the two databases had a few duplicated entries. After eliminating these, we were left with 667 studies. We then proceeded to check for non-peer-reviewed or grey literature, such as book reports, web articles, and conference proceedings, and eliminated 112 studies. We examined the remaining 555 studies for relevance by reading titles and abstracts. In order to align closely with our inclusion criteria, we eliminated any study addressing only the technical aspect of B2B digital platforms without addressing the business aspect. Other studies not congruent with the topic were also eliminated. Topics in the eliminated studies include efficient matching algorithms and the technical design of platforms. The full texts of the 202 remaining studies were then examined for relevance based on the qualifying criteria mentioned earlier. After careful consideration of each study, we included 67 studies in the qualitative thematic analysis. The process, keywords, inclusion criteria, and overall structure of the study are presented in Fig. 2. Finally, we manually searched the literature based on citation chaining and snowballing and added eight studies, taking the total number to 75.

Each of the selected studies was examined for a topic of interest. One of the authors thoroughly read the selected research articles and coded relevant parts for issues related to the business models of industrial digital platforms, that is, factors influencing value creation, value delivery, and value capture on industrial platforms. The author paid particular attention to studies that highlighted changes in the business model factors of industrial digital platforms. The open codes were categorized into second-order themes, which were further classified into thematic areas. The author presented the codes and their categorization to the other authors, and each of the categories and their inclusion were discussed diligently, after which a vote was taken for relevance and inclusion. One of the researchers was nominated as the leader with a veto vote in the event of a tie. The results of the review are structured across the two sections. The analysis resulted in the data structure presented in Fig. 3 below. Section 4 presents the results of the thematic analysis, while Section 5 presents the research gaps and future research agenda to advance our understanding of industrial digital platforms from a business model lens.

## 4. Industrial platform business model insights

Our review of the literature allowed us to comprehensively map current insights into industrial platform business models and the need for future research. In the following sections we describe insights into industrial platform value creation (4.1), value delivery (4.2), and value capture (4.3) and present a summarizing framework and agenda for further research (4.4). Fig. 4 presents the key insights from our review relating to the business model elements and key mechanisms for industrial digital platform business models. The components are discussed in detail below.

### 4.1. Co-creative value creation and expansion

The value-creation dimension of the business model describes what is offered to the customer (i.e., products and services) (Teece, 2010). There are many different ways in which industrial digital platforms can leverage *co-creative value expansions* to create value for the customer through new, and often more advanced, digital service offerings. The platform architecture affords new opportunities for companies to move their existing offering to platforms and plan co-creation strategies to create new value on platforms (Abbate et al., 2019; Hein et al., 2019; Zhang et al., 2021). We identified three key themes of interest in industrial platform value creation: *(a) expanding platform offering portfolio, (b) co-creating customer value, and (c) combinatorial innovation.*

#### 4.1.1. Expanding platform offering portfolio

***Expanding platform offering portfolio*** is a key driver of value creation on industrial digital platforms. Indeed, the value-creating potential of platforms is often driven by the extent to which multiple complementary offerings from the focal platform providers and complementary actors are integrated (Veile et al., 2022; McIntyre and Srinivasan, 2017). A first step is often converting existing internal offerings to make them platform-compatible, and expanding the platform offering portfolio is a key aspect of value creation for platform leaders (Beverungen et al., 2021). By leveraging a common platform architecture and marketplace, manufacturers can streamline the integration of various services into a comprehensive portfolio of offerings, enhancing the overall user experience through the platform (Schreieck et al., 2017; Ritala & Jovanovic, 2024). Accordingly, the platform leader can also utilize the platform to integrate diverse internal offerings and fragmented capabilities across business units to create a shared service portfolio for customers (Cenamor et al., 2017). A good example of this process is Honeywell Forge, a

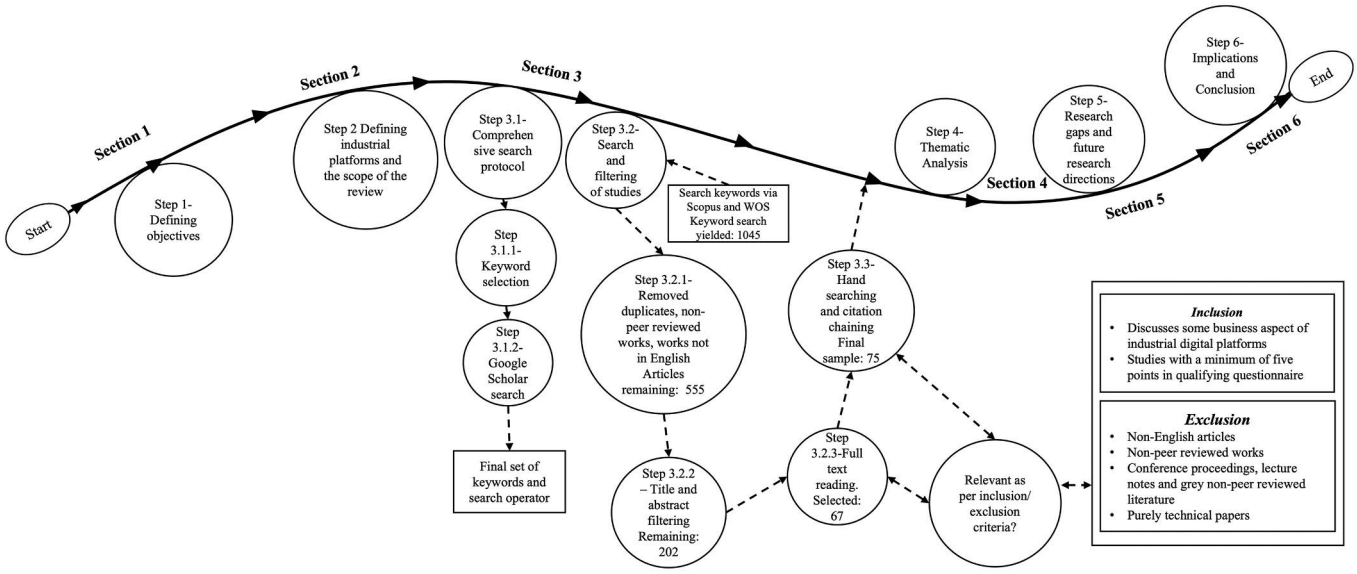


**Fig. 2.** Systematic literature review method used in the review.

platform that integrates capabilities and offerings from different Honeywell business units to provide more complete solutions to customers (Yusupbekov et al., 2021).

However, industrial platforms' key value creation potential is expanding beyond internal offerings to integrate complementary offerings from platform ecosystems (Jovanovic et al., 2022). Indeed, given the rapid digitalization of industry, no firm has the capabilities to keep up with customers' emerging requirements on its own (Kolagar et al., 2022; Sjödin et al., 2022). Thus, integrating complementary actors can fill in missing pieces in a portfolio of platform offerings and provide additional opportunities for value creation (Hein et al., 2019, 2020). Exploring the right synergies between customers, the platform leaders' fragmented capabilities, and the complementors' offering and bundling digital product–service offerings to create holistic and comprehensive solutions are essential to platform value creation and retention of customers (Veile et al., 2022).

#### 4.1.2. Co-creating customer value

***Co-creating customer value*** is an essential part of industrial digital platforms which is not present in B2C platforms (Hein et al., 2019; Beverungen et al., 2021). Since value propositions are often complex, value creation often follows an iterative step-by-step process whereby value is created in increments in consultation with customers on the platform (Rusthollkarhu et al., 2020). Thus, there are often high expectations that platform leaders will support customers' digital transformation journeys as well as their own (Parida et al., 2019). For manufacturers, this represents a shift from the traditional product-based make-and-sell logics to a more platform-oriented value creation logic of creating and delivering continuous value for the customer on the platform rather than delivering it at once through a product (Agarwal et al., 2022; Gebauer et al., 2021; Kamalaldin et al., 2020; Zhang and Banerji, 2017). Indeed, recurrently engaging with customers is central to the B2B value-creation process, as the changing nature of customer expectations can prompt them to leave the platform if their needs are not met (Flint et al., 2002).

Embracing the co-creation process requires a conscious focus on supporting customer digital transformation, which involves facilitating knowledge and resource sharing and empowering customers to innovate and adapt to the digital landscape (Struwe and Slepniov, 2023; Parida et al., 2021). The facilitation must also be trusted by the customer, and it is essential that the customer does not view the platform leader as opportunistic (Dalenogare et al., 2023); research shows that platform leaders can indeed be opportunistic and can preclude participants from value or, worse, restrict their access to their customers through envelopment (Eisenmann et al., 2011; Penttinen et al., 2018). Therefore, a culture of collaboration and trust should be fostered, enabling iterative development and continuous improvement over time (Tian et al., 2021; Sjödin et al., 2022). Data-driven value creation and innovation play a pivotal role in this process, allowing businesses to identify trends, uncover insights, and tailor their offerings to meet evolving customer needs (Hein et al., 2019). For example, consider the case of SAP Ariba, a digital B2B platform that connects buyers and suppliers across the entire procurement process. It helps with the customer digitalization journey by providing a comprehensive, end-to-end solution to manage procurement processes in a digital, streamlined, and efficient manner. This builds trust suppliers' trust in the platform leader.

#### 4.1.3. Nurturing combinatorial innovation

***Combinatorial innovation*** is at the core of industrial digital platforms' value creation potential. Platform architecture and the presence of varied actors give the platform leader a bird's-eye view of the offerings, an advantageous position that enables it to combine offerings from various business units as well as partners to create unique value propositions (Luz Martín-Peña et al., 2018). These "combinatorial innovations" involve the creation of new offerings by combining various elements from within the platform ecosystem. Indeed, combining complementary applications can spark generativity and higher-value solutions (Jovanovic et al., 2021; Wu et al., 2022). Thus, constantly providing new digital services by combining platform and complementary values is key to platform value creation.

Our review of the literature indicates that there are two key variants of these combinatory innovations, planned and unplanned. Planned or intended combinatorial innovations involve combining complementor value to generate scalable offerings that cater to a wide range of customers (Hein et al., 2019; Marcos-Cuevas et al., 2016). This ensures continued value to customers while simultaneously providing complementors with opportunities to roll out new value-creation potential (Gebauer et al., 2021; Kamalaldin et al., 2020). Since the customer base is already on the platform, complementors do not have to find a market for their innovation. On the other hand, unplanned combinatorial innovations are more serendipitous and result from the organic evolution of complementors, who independently create novel offerings for customers (Thomas & Tee, 2022; Pauli et al., 2021; Wu et al., 2022). Finally, emerging innovations arise from generative and serendipitous

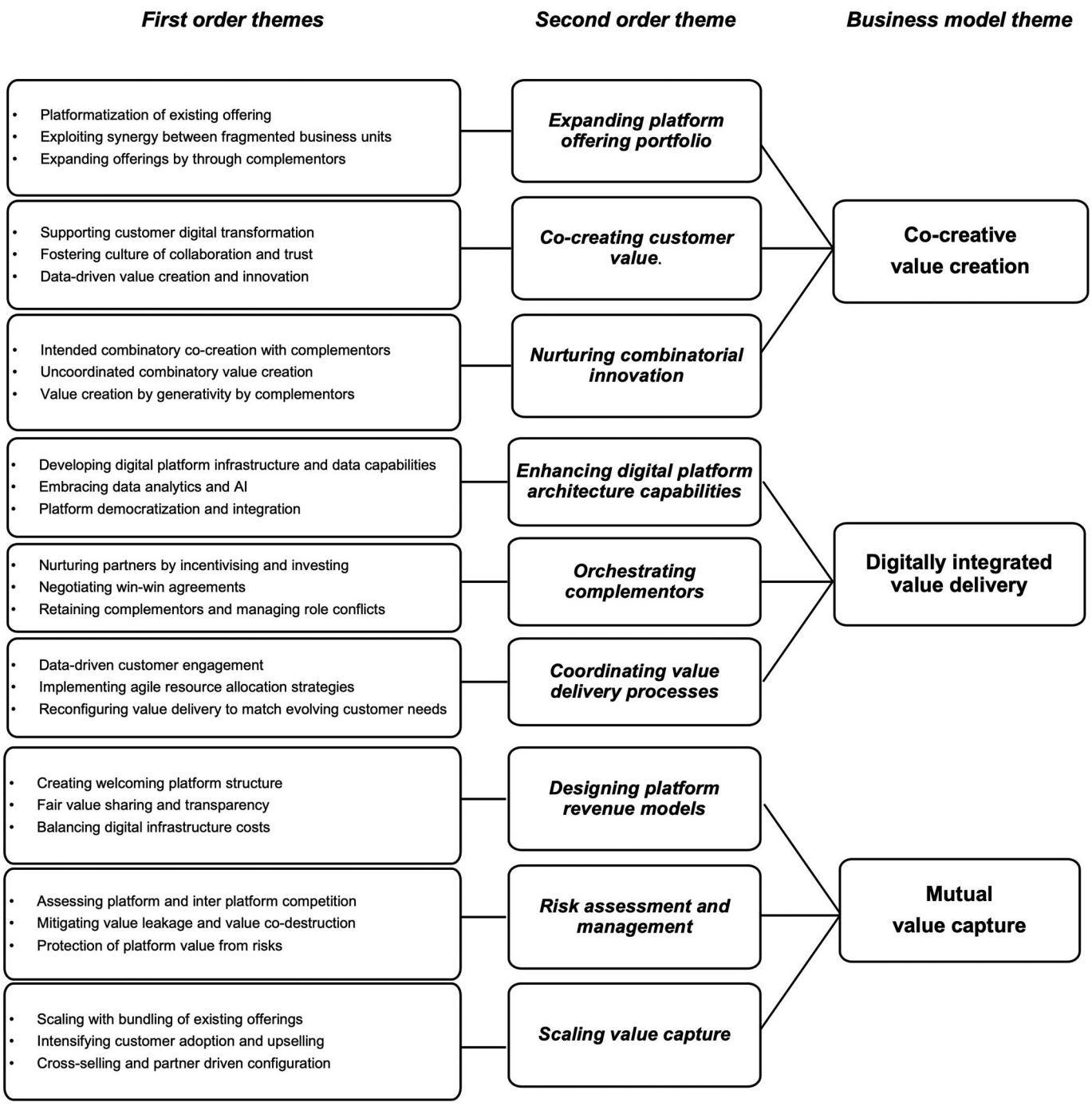


**Fig. 3.** Thematic representation of research on B2B digital platforms.

discoveries of new offerings that were not initially conceived (Thomas & Tee, 2022). This form of innovation enables platforms to target new customer segments and expand their market reach by channeling the spontaneous value into the platform's core offering.

### 4.2. *Digitally integrated value delivery*

Value delivery describes how capabilities, activities, and processes are employed to deliver the promised value to customers. Our review shows a significant change in leveraging *digitally integrated value delivery processes* towards the customer in industrial digital platform business models. These changes will occur both inside the company and within the business ecosystem that is external to the company. Indeed, platforms have a major impact on internal resources, capabilities, activities, and roles, and value creation is only one part of the puzzle for an industrial platform leader. Coordinating the value delivery process is crucial and has the ultimate goal of providing value to the customer (Hein et al., 2019). What is clear is that this process is more complex, interdependent, and inherently linked to the digital transformation of customers in B2B than in B2C. This engagement process with the customer is data-oriented, as insights gained from a well-architected digital infrastructure offer an understanding of the customer's needs and preferences (Riemensperger and Falk, 2020). Based on these data insights, the platform leader can determine the best way to engage with

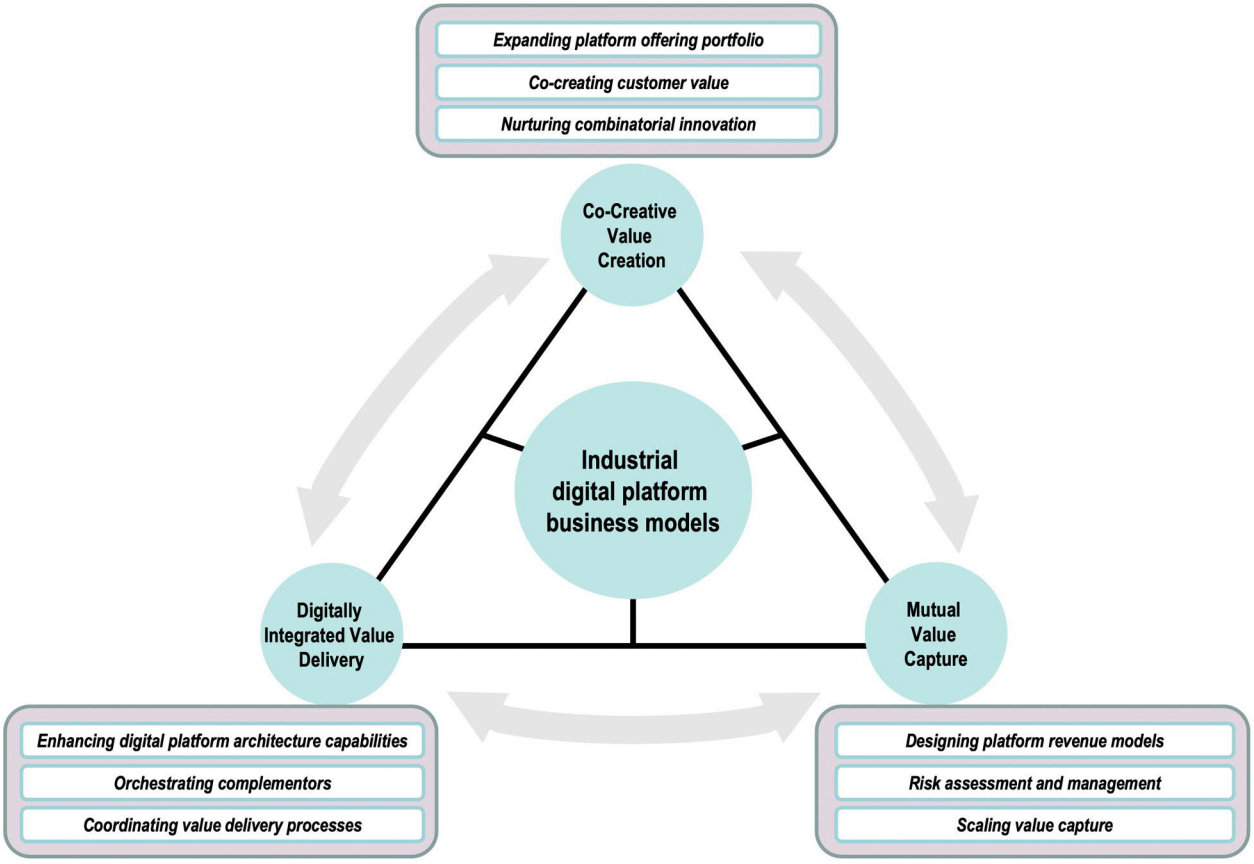


**Fig. 4.** Results of the thematic analysis of literature from a business model perspective.

customers, communicate the value proposition to them, and onboard them effectively. Consider the example of Siemens MindSphere IOT platform ecosystem. In this complex ecosystem, Siemens is the platform leader, ensuring seamless value delivery to all stakeholders. To do so, Siemens developed and maintains a robust digital infrastructure that connects all partners, facilitates real-time data sharing, and enables efficient decision-making. The platform, therefore works to *(a) enhance digital platform capabilities, (b) orchestrate complementors, and (c) coordinate between partners and customers to deliver value on the platform.*

#### 4.2.1. Enhancing digital platform architecture capabilities

***Enhancing digital platform architecture capabilities*** is the foundation on which value delivery on industrial digital platforms rests (Şimşek et al., 2022; Veile et al., 2022; Cenamor et al., 2019; Hein et al., 2019). Here, digital platform architecture capabilities refer to all the technical (e.g., ICT-based resources, data management capabilities) and non-technical (e.g., networking) capabilities associated with setting up and operating a digital platform (Cenamor et al., 2019; Mikalef and Pateli, 2017). The first key issue in developing these capabilities is the development of a common platform architecture where value can be delivered, as initial decisions can often have far-reaching consequences for value delivery. Data access is the primary value driver in this context, as connecting various data sources enables businesses to make informed decisions and drive innovation on the platform (Chirumalla et al., 2023; Rad et al., 2022; Hein et al., 2020; Sjödin et al., 2020a). Ensuring data quality through proper categorization and integration of diverse industrial data sets is critical for delivering accurate and reliable value. Furthermore, the platform leader must maintain the infrastructure over time to leverage more data and newer technologies (Jovanovic et al., 2021). However, our understanding of this evolutionary perspective could be more extensive.

A key value driver is incorporating data analytical capabilities and AI tools into industrial platforms (Jovanovic et al., 2021; Sjödin et al., 2021), which may increase market sentiments for innovation and collaboration (Fredström et al., 2022). One example of AI integration into digital platforms to deliver value is offered by Baker Hughes, a global oil and gas service company. Baker Hughes partnered with C3.ai to create a next-generation industrial AI platform called BHC3. BHC3 uses machine learning and predictive analytics to optimize oil and gas operations, reduce maintenance costs, and improve safety. By leveraging the capabilities of C3.ai's industrial AI platform, Baker Hughes is able to offer customers a more comprehensive and advanced solution on its platform that is data-driven.

However, using advanced technologies for value delivery implies that the platform technology and the capability to use it must be engrained in all the actors on the platform. Therefore, platform democratization is a vital aspect of developing platform architecture capabilities. Here, democratization implies making the platform and its feature easy to access and use for customers and partners to deliver value on the platform, primarily through the standardization of processes.

Creating standard boundary resources such as software development kits (SDKs), toolkits, and Application Program Interfaces (APIs) for system integration and interoperability is crucial in ensuring a unified approach to development and integration (Ghazawneh and Henfridsson, 2013; Hein et al., 2020). APIs and system integration play an essential role in streamlining communication between different software components both within the platform leader and with its customers and partners, thus enhancing overall architectural capabilities and offering a

more efficient delivery of value. This common architecture needs to be developed by the platform leader through lobbying for standards, co-development with customers, and gaining legitimacy through adoption (Parida et al., 2019). However, this is easier said than done: Customers and partners may resist standardization investments as they can lock these actors into a platform where they do not have access to data and could be misused by an opportunistic platform leader. Therefore, platform democratization must also include processes to build trust and a sense of joint ownership and must educate customers on the best practices for achieving standardization to help drive adoption and promote long-term growth and sustainability (Day et al., 2013; Kuttainen, 2005; Narang et al., 2019).

#### 4.2.2. Orchestrating complementors

***The orchestration of complementors*** is another key process for value delivery on industrial digital platforms to ensure seamless collaboration and growth (Parida et al., 2019). Indeed, platform leaders must carefully design and coordinate processes with complementors to deliver the value they create to customers while simultaneously delivering a win–win proposition to the complementor (Fu et al., 2022; Hein et al., 2019). In addition to investment in standardizing and democratizing the platform, the extant literature reveals two ways in which prospective complementors can be brought onto the platform and thus complementary value can be delivered to customers: nurturing and negotiating (Parida et al., 2019).

Nurturing complementors, such as small and medium enterprises (SMEs) and digital startups, is vital to this process. Nurturing implies investing in complementary networks and sharing core knowledge to persuade complementors to provide complementary values on the platform (Parida et al., 2019). Doing so opens opportunities for innovative startups with unique technology to enter the ecosystem and benefit from participation (Prashantham, 2021). For example, granting start-ups open access to a large-scale industrial customer base and its associated data is a key motivator for adoption (Sjödin et al., 2022). Indeed, promoting the onboarding of complementors by making the platform attractive to them is essential to create a thriving ecosystem (Wei et al., 2019; Hoshino and Matsumura, 2018). Providing incentives and support for digital transformation further encourages complementors to join the platform and contribute their expertise to enhance overall value delivery (Dalenogare et al., 2023; Sun and Zhang, 2021).

Whereas startups want to be nurtured, due to their resource poverty, the platform leader may need to be less aggressive with larger potential complementors and negotiate its leadership position over time by clearly establishing exchange rules, reducing conflicts, increasing trust, and carefully selecting new partners for an ecosystem (Parida et al., 2019). That is, the platform leader needs to develop a position on trust slowly and over time (Hoshino and Matsumura, 2018). This partnership needs to be developed with other original equipment manufacturers (OEMs) and incumbents to preempt the development of competing value delivery platforms. For instance, in 2016, BMW, Intel, and Mobileye announced a partnership to develop an open, scalable platform for autonomous driving. This collaboration aimed to create an industry standard that could be adopted by other automakers and technology providers, thus preempting the development of competing value delivery platforms. In such scenarios, establishing win–win agreements between platform stakeholders fosters a cooperative value delivery platform where each party can benefit from the partnership, thus competing and cooperating simultaneously (Jovanovic et al., 2021). This approach ensures the long-term success and sustainability of the industrial digital platform by fostering collaboration and creating a beneficial ecosystem. However, our understanding of designing such platform systems is limited and requires further attention. Addressing this knowledge gap will enable businesses to maximize the potential of these platforms, benefiting all stakeholders.

Furthermore, retaining complementors and managing role conflicts are vital to maintain a harmonious and productive platform environment. It is essential that the platform leader balances leading the platform with allowing complementors to contribute their unique skills and capabilities. By effectively managing these roles and addressing potential conflicts, platform leaders can ensure that complementors remain engaged and committed to the platform, ultimately contributing to the latter's success and value delivery. It is also essential that the platform leader constantly reconfigures the platform to keep innovation happening on it (Lütjen et al., 2019; Linde et al., 2021).

#### 4.2.3. Coordinating value delivery processes

***Coordinating value-delivery processes*** is essential for platform sustainability. In industrial digital platforms, data-driven customer engagement is pivotal in delivering value (Sjödin et al., 2022). For example, digital customer success teams harness rich data insights to tailor experiences and offerings to meet customer expectations effectively over time. Customer profiling and personalization enable personalized interactions and customized solutions, fostering stronger engagement. Indeed, capturing real-time customer feedback and incorporating it into iterative improvement processes ensures adaptability to changing customer requirements and enhances the overall value proposition (Cenamor et al., 2019). Leveraging platforms even further, predictive analytics techniques allow customer demands to be anticipated, enabling proactive decision making and timely delivery of value-added services (Garcia Martin et al., 2023; Lee et al., 2017).

Efficient value delivery is a core objective of industrial digital platforms (Şimşek et al., 2022). To optimize value delivery processes, several key considerations come into play. Platform owners may need to analyze and produce best practices for platform value delivery (Cenamor et al., 2017). A key consideration is standardizing service levels and implementing quality assurance mechanisms that build trust and credibility with customers (Dalenogare et al., 2023). Moreover, agile resource allocation strategies optimize the utilization of assets, personnel, and capabilities, resulting in improved value delivery and reduced operational inefficiencies (Gebauer et al., 2020; Eloranta and Turunen, 2016). In addition, processes for the streamlined integration of complementors and customers ensure smooth and efficient operations by integrating diverse platform offerings seamlessly into customer operations (Kapoor et al., 2022).

Adaptability and innovation are crucial for industrial digital platforms to stay relevant and competitive with target customers over time. Scalability and flexibility are important factors in accommodating evolving customer demands (Cenamor et al., 2019). Indeed, incorporating the potential of continuous technological advancements, such as AI, machine learning, and the Internet of Things (IoT), enhances operational efficiency and unlocks new avenues for value creation and delivery over time (Fu et al., 2022). Engaging the platform ecosystem in collaborative partnerships with the customer and co-innovation efforts fosters an environment of shared expertise and resources, promoting continuous improvement and innovation (Shen et al., 2023).

### 4.3. Mutual value capture

Value capture concerns the revenue model and its financial viability, with particular attention to potential revenue streams and the cost structure (Paiola & Gebauer, 2020). Capturing value from industrial digital platforms can accrue in various ways—for example, from decreased costs, higher revenues, or the capture of new revenue streams (Pauli et al., 2021). Given the emphasis on creating multi-sided industrial digital platforms, our review details the need to leverage mutual value capture for customer and complementors. It also clearly shows that limited attention has been paid to the value-capturing dimension of industrial digital platforms' business models, even though increasing value capture is a central component of the shift towards industrial digital platforms.

The earlier literature on digital platforms mainly addresses

transactional types and describes the key value captured by the platform as commission earned from acting as the transaction intermediary. Although transaction efficiency platforms can take different shapes and sizes depending on the platform leader and functions, the most frequently studied type is a digital marketplace (Albrecht et al., 2005; Johnson and Johnson, 2005; Kandampully, 2003; Kaplan and Sawhney, 2000; Ordanini and Pol, 2001; Yoon et al., 2021). However, a more complex structure, as discussed earlier, is a platform ecosystem that is set up to create complex value propositions. Platforms as ecosystems of firms become vehicles for business models that focus less on manufacturing and selling products and more on selling services or servitization (Gebauer et al., 2021; Kamalaldin et al., 2020; Ruiz-Alba et al., 2019; Zhang and Banerji, 2017) or product–service systems (Mourtzis et al., 2021) and depend on creating win–win relationships among members rather than the winner-takes-all logic. However, the complex structure also means that these platforms have to consider factors that do not concern transaction intermediaries. These factors manifest as increased complexity in *(a) designing platform revenue models, (b) risk assessment and management, and (c) scaling value capture.*

#### 4.3.1. Designing platform revenue models

***Designing appropriate platform revenue models*** is a critical challenge to capturing value from industrial digital platforms. B2B platforms must rely on something other than the winner-takes-all effect due to the smaller number of actors and must use real-world data-enabled operations (Riemensperger and Falk, 2020). Therefore, designing an appropriate revenue model for an industrial platform is crucial, as it can significantly impact the platform's success and profitability (Kim, 2016). The choice of revenue model should be tailored to the platform's structure, which can vary depending on whether it is open, semi-open, or closed, and on the stage of transition into the platform ecosystem (Letaifa, 2014).

For example, a digital startup that has recently launched a highly technical product may be incentivized to join an industrial platform to create network effects and increase its visibility, while a more standardized technology provider may require a commission to do so. Therefore, a platform leader must realize the different incentives and tailor the revenue model to optimize value sharing and capture (Gomes et al., 2022). To provide scalability, moreover, due to a limited supply of trusted ecosystem partners ecosystem leaders would need to build a system where they can increasingly create value that can be shared with partners. However, doing so would require the platform participants to have long-term trust in the platform leader.

Regardless of the type of actor, the platform leader needs to consider fair value sharing and a transparent way of distributing revenue. Prior literature on platforms notes that powerful platform leaders tend to abuse their power over ecosystem members (Gawer, 2021). This tendency is especially important in the case of industrial platforms, where heavy investments are made by industrial actors in the common platform and the data infrastructure they are developing (Parida et al., 2019). Clarifying the flow of revenue and the gains and costs for each actor is essential in designing an appropriate revenue model (Veile et al., 2022; Paiola & Gebauer, 2020). However, our understanding of what is considered "fair" and how revenue models can be designed to be fair in industrial digital platforms is currently limited.

At this juncture, it is also essential to consider the cost dimension of revenue capture. Industrial digital platforms represent a unique case within B2C platforms, and industrial providers need to consider the cost structure of designing and maintaining the digital infrastructure. Although we found no studies in our sample investigating the cost dimension effectively, we believe this argument is important because, as more actors are added, new requirements may arise, such as additional sensors and connectivity information and a requirement to develop new capabilities and processes (Jovanovic et al., 2021). Therefore, designing a platform revenue model requires consideration of the flow of revenue with multiple actors and the flow of cost. From the perspective of the platform leader, this may take the form of continued investment in technology and in customers to keep them updated and locked in to the platform. Therefore, revenue models designed at the time of onboarding need to consider future costs of this type so that the platform leader can continue to earn the leadership premium while simultaneously facilitating future win–win scenarios.

#### 4.3.2. Risk assessment and management

It is not enough for platform leaders to only create revenue models for value capture and fair value distribution: It is also important that they carry out ***risk assessment and management*** to protect platform value. The risks covered in the extant literature may be thought of as coming from three key sources, (a) complementors, (b) competition, and (c) time.

Complementors are considered one of the greatest strengths of the platform architecture and constitute the most important task of the platform leader (McIntyre and Srinivasan, 2017). B2C digital platforms have therefore been known to strategically work with architectural openness to create boundary technologies to attract as many complementors as possible. An excellent example of this model is Apple's app store, which allows independent app developers to develop apps for Apple products. However, similar mechanisms may not exist for industrial digital platforms for two main reasons. First, the number of complementors is limited, and the platform leader has to select carefully from a limited set of possible complementors (Pauli et al., 2021). Second, complementors are separate entities with varying degrees of autonomy on the platform and are coupled tightly or loosely to the platform, depending on their autonomy (Hein et al., 2020). Hence, complementors often have more say in platform development in the B2B context than in the B2C context (Vuolasto and Smolander, 2021). Prior literature notes that the wrong fit of a selected complementor to the ecosystem can destroy platform value (Hauke-Lopes et al., 2022). Laud et al. (2019) argue that resource integration on digital platforms needs to happen in trusted agreement with actors as attempts at unwilling, excessive, too little, deceptive, or coerced integration can lead to the misintegration of resources. However, very little is known about how these misalignments can be managed or the real extent of value destruction due to misalignments.

A second cause of platform value erosion is competition. Prior literature notes that B2B digital platforms have to deal with three types of competitors: incumbent non-platform firms, other platforms, and companies within the platform (Kretschmer et al., 2022). Different forces determine between-platform and within-platform competition. While between-platform competition depends on architectural control and the ability to provide more incentives to the same partners targeted by a competing platform, within-platform competition takes place with existing partners for the power to influence how profits are distributed within the ecosystem (Kretschmer et al., 2022). A platform leader has to constantly balance the two competitions to safeguard its own value-capturing potential in the ecosystem. However, more knowledge is needed about the strategies a platform leader can use to achieve this balance. This discussion leads us to the third factor: time.

We know that platform evolution takes a platform leader through different stages of value creation and value delivery. Prior research indicates that in the initial stages of transformation from supply chain platform to ecosystem, the platform leader should prioritize value creation over value capture to attract potential partners and complementors and create an environment of low competition for value (Letaifa, 2014). However, the decision must be made at some point in the evolution to focus on value capture over value creation, creating a highly competitive environment for platform value. As discussed above, if this is done incorrectly, it can lead to high within-platform competition, which drives value out of the platform leader into partners or, worse, drives partners to competitor platforms. Our current understanding of the literature does not adequately inform us when this transition must occur.

#### 4.3.3. Scaling value capture

***Scaling value capture*** simultaneously with created value as the platform expands is a key challenge in value capture. To scale a B2B digital platform, companies can use various strategies, such as bundling existing offerings (Hein et al., 2019), cost reduction, extending the number of products, and configuring more easily with partners (Sabidussi et al., 2018). As stated in the value creation dimension, one key way to offer new values and consequently to capture value is through intended combinatorial innovation. However, making combinatorial innovations can lead to disagreements between the leader and the firm over common ground on which to share value, as complementors may have a disproportional say in the value created (Hein et al., 2020; Kankaanhuhta et al., 2021).

Another dimension that is often ignored is the learning and reputation effect of recruiting new partners. For example, consider a platform like Kognifai, which helps with the digitalization of ships. It would have been technologically challenging to make the necessary investments to onboard the first ship, but as time passes it is easier to expand the offering to other ships. The argument here is that expanding from operating in one site to all the sites operated by the customer allows the platform leader to reap economies of scale and profit from the learning curve.

Another way platforms can extend the range of products offered is by upselling to existing customers or adding new products that complement existing ones. By doing so, the platform leader can attract and retain new customers, thus gaining benefits from economies of scope as selling a value to a customer is likely to cost incrementally less as it builds on the previous value sold.

Finally, it is worth noting that working with each customer creates substantial learning and improvement in technology and knowledge of the market. Hence, cross-selling solutions between customers can be an additional way of expanding and utilizing learning whereby the platform leader might propose the solution built for one customer to another customer in the same or different industry who might have the same need (Van der Borgh et al., 2023). For example, consider the AppExchange in Salesforce. If a customer purchases an app from the AppExchange that was developed for a specific industry or use case, Salesforce may suggest that same app to other customers who are in the same or a similar industry and have similar needs. By facilitating cross-selling solutions in this way, Salesforce is able to leverage its existing customer base to expand its reach and provide additional value to its customers. However, mechanisms such as this have not received adequate research attention.

## 5. Discussion: a future research agenda for industrial platform business models

A close inspection of the literature reveals that our understanding of how industrial digital platform business models work needs concentrated future attention. Now that we have a common understanding of the important factors to consider in value creation, value delivery, and value capture, forging a future agenda is not only possible, but a logical conclusion to the review. By assessing patterns in the value creation, delivery, and capture processes, we have arrived at a comprehensive research agenda and opened research questions that cover both the individual dimensions of the business model and the interdependency of the three components. Our suggestions for future research can be seen in Fig. 5, below. The framework emphasizes not only the individual dimension of the business model framework, but also the synergetic elements. Prior literature shows that a balance between the three dimensions and their synergy is essential in building a successful business model (Sjödin et al., 2020b; Gassmann et al., 2013). In this section, we present a theme-wise gap identification and further explain how the research questions in Fig. 5 were derived.

*Industrial platform value creation* has received some attention in literature. Studies adopting a servitization perspective of business models argue that firms need to focus on structuring their offerings on digital platforms and that these platforms can then serve as the core for combinatorial value creation with customers (Hein et al., 2019). However, the literature is largely silent on how to evaluate existing offerings for platformatization and how these co-creation processes would actively manifest in practice. For instance, the literature emphasizes that building trust to enhance ecosystem integration is essential for value co-creation on industrial platforms (Tian et al., 2021; Sjödin et al., 2020; Santos Delenogare et al., 2023), but how can a platform leader build this trust when they may be perceived as being opportunistic or dominating on the platform? The gap in our knowledge presents us from effectively understanding the intricacies of B2B relationships on industrial platforms and how selection of platformatization is more than just an internal decision for the platform leader.

Further, a platform affords an opportunity for generative or spontaneous innovation. Although such innovations cannot be planned in advance, platform leaders need to have processes in place to effectively channel them into their core offerings. Currently, although the B2C platform literature has recognized the potential of generativity, the industrial platform literature has largely remained silent. We therefore encourage research attention to aligning generative and spontaneous value to the core value of the platform leader.

Considering *value delivery on industrial platforms*, the extent literature highlights how industrial platform capabilities and technical capabilities are both essential to ensure value can be effectively delivered to customers (Şimşek et al., 2022; Veile et al., 2022; Hein et al., 2019). Some attention has been paid to certain specific capabilities, such as data management (Fu et al., 2022; Cenamor et al., 2019) and orchestration capabilities (La de Vasconcelos Gomes et al., 2022; Parida et al., 2019). However, our understanding of the other digital platform architectural capabilities required to effectively coordinate value delivery within industrial platforms is limited. For instance, all platform participants, including customers and complementors, must have the necessary capabilities to act on the platform. Although we know that ecosystem orchestration requires nurturing, negotiating, or standardization (Parida et al., 2019) by the ecosystem leader to achieve this, little is known about how a platform leader should actively work to make platform technology easy to use by all platform participants. We call this "platform democratization" in this review. In fact, the boundaries of platform democratization are unclear and require further attention. For instance, what are the processes to be followed to achieve platform democratization?

Further, considering that industrial digital platforms, and ecosystem platforms in particular, require a high degree of data integration, it is surprising that we are still largely uninformed on the implications of AI capabilities for such platforms (Jovanovic et al., 2022). Finally, we are unsure how changing technologies and relationship dynamics impact partner selection for platform value delivery. This information is important as partner turnover or selection of the wrong partner can lead to value destruction on the platform (Hauke-Lopes et al., 2022).

The extant literature highlights that value capture on industrial platforms is complex, and that multiple processes and actors are involved in it (Gebaur et al., 2020; Pauli et al., 2021; Kohtamäki et al., 2022). Several studies have considered how innovative value revenue models can be structured to maximize the value captured on platforms (Şimşek et al., 2022), for instance, subscription-based and pay per use-based models (Veile et al., 2022). However, the opposite end of value, that is, cost, has received less attention. In particular, it is important to consider how the platform leader can "share cost" not only effectively, but also fairly, so that it may maximize its outcome for itself while simultaneously not overburdening partners who may not be able to handle the cost, for example, startups and small firms. This is important, as fair mutual value capture between partners is essential to discourage within-platform and between-platform competition, leading to value erosion (Kretschmer et al., 2022). However, the literature on strategies for reducing competition for value within the platform is just emerging

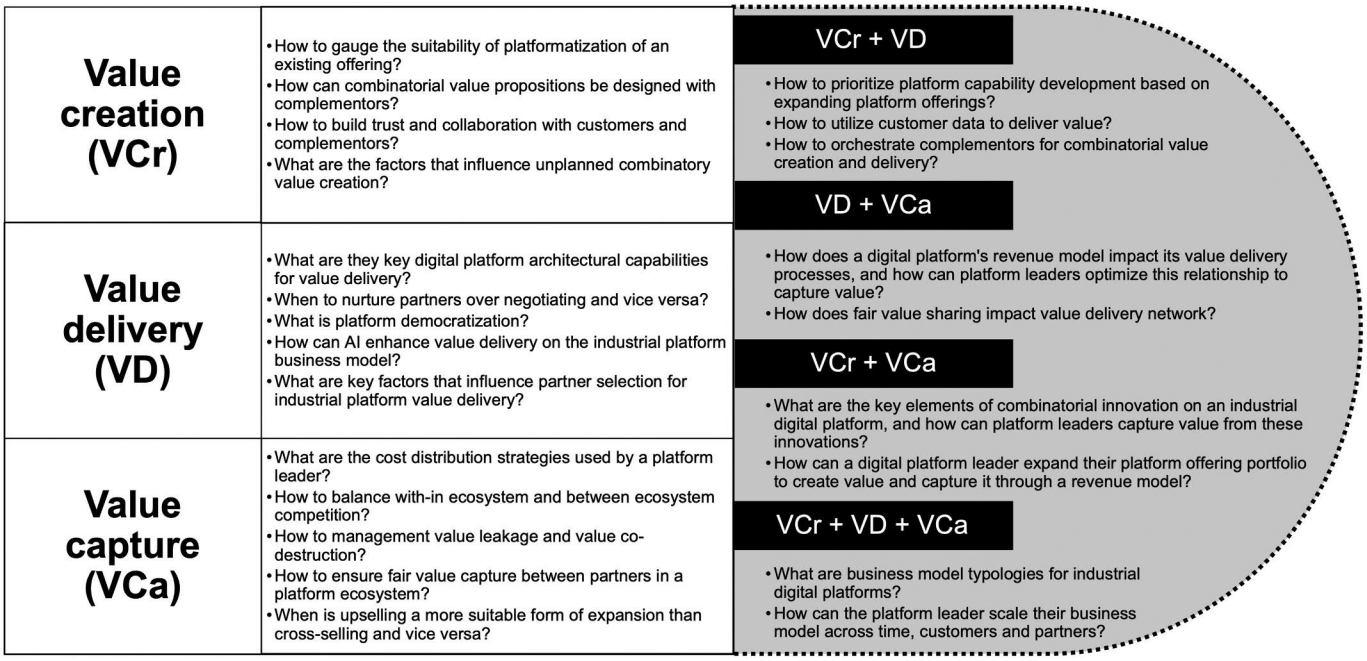


**Fig. 5.** Future research agenda for industrial digital platform research.

and requires further attention from industrial platform researchers. One final issue in value capture concerns scaling. Current studies on this issue are limited and focus on either suggesting a cross-selling strategy (Van der Borgh et al., 2023) or an upselling strategy. However, it is unclear which strategy works best in which circumstances, that is, when a cross-selling strategy is better for scaling than an upselling one.

Finally, it is paramount to understand that the value creation, value capture, and value delivery dimensions of the business model framework are interconnected, and a successful business not only manages the dimensions effectively, but also manages the alignment between components effectively (Teece, 2010). Ineffective coupling and misalignment of components can lead to the failure of an organization (Ritter & Lettl, 2018). However, the extant literature has mostly looked at platform business models in silos of value creation, delivery, and capture without considering the alignment perspective. To highlight the alignment perspective, the fourth component of our framework advances future research questions to examine synergetic effects between the business model components. We examine possibilities of future research in the intersection of value creation and capture, value creation and delivery, value delivery and capture, and, ultimately, alignment between all three components. As such, all these connections are new to the industrial digital platform literature, and a deeper examination is required to explicate the alignment perspective. These are only initial suggestions, and we see several opportunities for extending this line of reasoning.

## 6. Implication and limitations

### 6.1. Theoretical implications

This prospecting review on business models for industrial digital platforms has several theoretical implications for the field of industrial platforms, digitalization, and B2B relationships. Unlike prior reviews in the context of the industrial platform (Shree et al., 2021; Hein et al., 2019), which adopt a narrative style of reporting the extant literature and suggesting future research, the current review is deliberately positioned from a business model perspective to highlight the importance of the business model lens in the industrial platform discussion. This deliberate position has resulted in four key theoretical implications.

First, we advance the business model lens as the unifying perspective to synthesize a single definition of industrial business platforms from the myriad offered in the literature (Jovanovice et al., 2022; Gawer, 2014; Shree et al., 2021; Tee and Gawer, 2009). The lack of a common definition meant that digital business model scholars could not agree on what exactly they mean when they say "digital platforms," leading to several different interpretations and properties being proposed. We address this issue by synthesizing a definition of an industrial digital platform in the review, namely, "*a foundational technological architecture and data upon which a focal firm organizes a diverse set of interdependent actors, activities, and interfaces to create, deliver, and capture value.*" The synthesized definition draws on all extant definitions, which are either internal- or external-focused, and reiterates the emerging importance of industrial data. It also provides for a common understanding of industrial digital platforms on which future research can be built.

Second, this review provides a comprehensive analysis of the literature on industrial digital platforms that helps to fill the gap in the understanding of the business models of these platforms. We illuminate unique characteristics and key differences in the business model logics between B2B and B2C digital platforms. For example, industrial B2B platforms require a stronger emphasis on orchestrating and coordinating supply and demand side actors than B2C platforms to realize value delivery from platform offerings regardless of the nature of the industrial platform (Hein et al., 2019). Particularly, the types and evolution phases mentioned in Fig. 2 adds to the discussion on industrial digital platform evolution by introducing data integration and ecosystem integration as driving factors (Jovanovic et al., 2022, Ritala and Jovanovic, 2024). We highlight how industrial digital platforms tend to be organically evolving systems with vibrant business models that are guided by the platform leader trying to create a win-win for all the actors involved, whereas B2C platforms primarily rely on the winner-takes-all logic and are engaged in a race to obtain as many customers, suppliers, and complementors as quickly as possible. Therefore, alignment between

business model components both within the platform leader and with partners is the most important issue for platform leaders to focus on. This brings us to Fig. 3, which summarizes out thematic analysis from a business model perspective.

Third, we observe that most studies focus on value creation (Anderson et al., 2022; Ranta et al., 2020) and value delivery aspects of the digital platform business model. Attention to value capture has primarily been seen in regard to revenue models (Veile et al., 2022), and it was surprising that platform value erosion and protection have not received adequate attention (Kretschmer et al., 2022). This is an important gap in our knowledge that needs further attention. As more and more industrial firms seek to offer platformatized products and services, it is inevitable that inter-platform and within-platform competition will increase, worsening the value erosion problem. Further, we see that aspects relating to business model alignment are largely underplayed in the literature, although the interplay between different elements of the business model (e.g., value creation value delivery) is critical to understanding industrial platform success. Indeed, the alignment of different business model components both within the firm and with partners is what makes a business model powerful and resilient (Teece, 2010; Sjödin et al., 2020; Kohtamäki et al., 2019).

Additionally, the limited success of platform leaders in establishing sustainable business models around their offerings suggests the need for more empirical research to understand the underlying factors and mechanisms that contribute to successful business models in this context. Specifically, we contribute to the discussion by suggesting future research on areas that cut across the business model dimensions, as we believe this lens is essential to understand how value can be created, delivered, and captured efficiently in a platform structure, as prior research indicates that misalignment of components can lead to inefficient value capture or value leakage (Reim et al., 2022).

Finally, a major contribution of this review is proposing a future research agenda framework that provides a roadmap for advancing the understanding of business models for industrial digital platforms. The framework outlines key research directions, such as exploring new theoretical perspectives, investigating emerging technologies, and considering social and environmental sustainability, which can guide future research endeavors and contribute to the advancement of the field. We specifically point towards the need to consider the value creation, value delivery, and value capture dimensions of the industrial digital platform as synergetic components.

### 6.2. Managerial implications

The findings of this study on business models for industrial digital platforms have several managerial implications for practitioners in the industry. The insights from this study can guide managers and leaders in developing and implementing effective strategies for leveraging digital platforms in their businesses. We highlight three key contributions in particular.

First, the identification of key aspects of value creation, value delivery, and value capture on industrial digital platforms can help managers better understand the dynamics of industrial digital platforms and design their business models accordingly. Here, it is important to acknowledge that business logics for B2C platforms are radically different in the B2B context. Thus, while B2C platforms provide inspiration for the potential of platforms, the business models and nature of a digital platform are starkly different. The findings of this study point to important learnings for managers. For example, understanding how value is created on industrial digital platforms can help managers identify opportunities to innovate and differentiate their offerings to meet the needs of industrial customers. Understanding how value is delivered can help managers optimize their operations and manage complementor and customer interactions on the platform. Understanding how value is captured can help managers design pricing and monetization strategies that align with the unique characteristics of digital platforms in the industrial setting.

Second, our study highlights important areas where managers can focus their efforts to address challenges and gaps in the commercialization of industrial digital platforms. For example, managers are encouraged to invest in research and development to explore new technological capabilities that can enhance value delivery and, ultimately, the value proposition of their digital platforms. Managers should also seek to increasingly collaborate with ecosystems of complementors and other stakeholders to jointly align the business models and governance structures of industrial digital platforms. Indeed, the relationships with supply-side and demand-side actors is key for industrial digital platforms and may include vital insights to inform their strategic decision making and business planning. We also point towards an emerging need to understand how to protect value on an industrial platform as more and more platform leaders move towards creating their own industrial platform ecosystems.

Third, we encourage managers to stay updated with the latest advancements and trends in the field of industrial digital platforms. By keeping abreast of emerging business models and considering the implications of new technologies, managerial practices can be informed and adapted to stay competitive in the rapidly evolving digital landscape. Following the academic literature and future research agenda framework proposed in this study can serve as a guide for forecasting the future configurations of industrial digital platforms.

This study offers significant managerial implications by providing insights into the key aspects of business models for industrial digital platforms, identifying research gaps, and proposing a future research agenda. Managers can use these insights to inform their strategic decision making, optimize their operations, and unlock the full potential of digital platforms for their businesses and industries.

### 6.3. Limitations and outlook

While this prospecting review provides valuable insights into the business models of industrial digital platforms, there are certain limitations that should be acknowledged. First, the rapidly evolving nature of technology and digitalization means that the landscape of industrial digital platforms and the associated stream of literature are constantly changing, which may impact the relevance and applicability of the findings over time. Therefore, future research should continue to monitor and adapt to the emerging literature on industrial digital platforms.

Second, the analysis in this review is primarily based on the existing literature, which may have its own limitations, such as potential publication bias and limitations in the scope and depth of coverage. Future research could employ other research methods, such as case studies or empirical studies, to further validate and expand on the findings of this review. The research agenda presented provides a number of fruitful avenues to expand knowledge on the nature and configurations of industrial digital platform business models.

Third, the focus of this review is primarily on business model aspects relating to value creation, value delivery, and value capture of industrial digital platforms and may underplay other important dynamics. Other important aspects, such as governance, ecosystem dynamics, and regulatory issues, may also play a significant role in shaping the business models of these platforms and warrant further investigation. For example, succeeding with industrial digital platforms may require more targeted efforts in market shaping (Nenonen et al., 2019; Flaig et al., 2021) of institutions, market relationships, or geographical advantage.

Finally, this study provides a roadmap for future research on business models for industrial digital platforms, but other relevant research directions may emerge as the field continues to evolve. Future research could explore new theoretical perspectives, investigate emerging technologies and their impact on industrial digital platforms, and consider the implications of social and environmental sustainability in the context of these platforms. For example, the potential of industrial

digital platforms to catalyze the circular economy seems promising (Blackburn et al., 2022).

## Data availability

Data will be made available on request.

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