THE IMPACT OF DIGITAL TRANSFORMATION ON PRODUCT DEVELOPMENT EVOLUTION

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ABSTRACT

The rapid advancement of digital technologies has revolutionized product development, transforming how companies conceive, design, and bring products to market. This paper examines the profound effects of Digital Transformation (DT) on product development methodologies, highlighting how the integration of technologies such as Big Data, Artificial Intelligence (AI), the Internet of Things (IoT), and Agile development has reshaped the innovation process. By reviewing key strategies such as the Stage-Gate model, Agile development, prototyping, and crowdsourcing, the study explores how businesses can leverage these tools to remain competitive in an increasingly dynamic global market. The analysis emphasizes the shift from traditional linear approaches to more flexible, customer-driven methodologies, allowing faster adaptation to market changes and consumer needs. The paper also discusses the challenges posed by digital transformation, including organizational structure shifts and data security concerns. Ultimately, this research provides insights into how companies can navigate the evolving digital landscape to enhance product innovation, improve customer satisfaction, and drive sustainable growth.

KEYWORDS: *innovation, digital transformation, product development, product innovation.*

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1. INTRODUCTION

In the fast-evolving landscape of global business, digital transformation has emerged as a pivotal force driving the modernization of product development processes. The advent of digital technologies has revolutionized how companies conceive, design, develop, and deliver products to the market, fundamentally altering the competitive dynamics across various industries. The shift from traditional product development methodologies, often characterized by linear, rigid processes, to more agile, flexible, and customer-centric approaches has been profound, enabling companies to respond more swiftly to market changes and consumer demands. The concept of Digital Transformation (DT) is not just about the adoption of new technologies but represents a comprehensive rethinking of how businesses operate, compete, and generate value. This transformation has been particularly significant in the realm of product development, where the integration of digital tools and methods such as Big Data, Artificial Intelligence (AI), Internet of Things (IoT), and Agile methodologies has redefined the boundaries of innovation. As noted by scholars like Cooper (2019) the application of these digital

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technologies in product development has not only improved efficiency but also fostered a culture of continuous innovation, allowing companies to maintain a competitive edge in an increasingly digitalized marketplace.

The literature on digital transformation in product development is extensive, with numerous studies highlighting its impact on various aspects of the process. For instance, the integration of Big Data analytics has enabled companies to make more informed decisions by analyzing vast amounts of data related to consumer preferences, market trends, and operational efficiencies (Johnson et al., 2017). Similarly, the adoption of Agile methodologies has facilitated more iterative and flexible approaches to product development, allowing for faster prototyping, testing, and refinement of products (Racheva et al., 2008). However, despite the extensive body of research, there is still much to explore regarding the long-term implications of digital transformation on product development, particularly in terms of how these changes affect organizational structure, culture, and customer relationships. As Vargo and Lusch (2004) suggest in their seminal work on Service-Dominant Logic, the shift towards a service-oriented approach in product development requires a fundamental rethinking of how value is created and delivered. This perspective is increasingly relevant as digital technologies enable more personalized and dynamic interactions with customers, further blurring the lines between products and services. In this context, this article aims to provide a comprehensive analysis of the impact of digital transformation on product development, drawing on a wide range of literature to identify key trends, challenges, and future directions. By examining the evolution of product development methodologies, from traditional Stage-Gate models to Agile and hybrid approaches, the article seeks to shed light on the critical role of digital technologies in shaping the future of product innovation. Moreover, it explores how companies can leverage these technologies to enhance their competitive advantage, improve customer satisfaction, and drive sustainable growth in an increasingly digitalized world.

2. LITERATURE REVIEW

2.1 The concept of product

In order to understand the concept of product we need to identify the key works that highlight the emergence of the product. One highly studied concept is the one that refers to service-dominant logic. Over time there have been numerous articles debating issues regarding the difference between goods and service (Fisk et al., 1993). Vargo and Lusch paper published in 2004 is considered to be a path-breaking in terms of the aspects related to service dominant logic. In the specialized literature, numerous authors have cited over the years this work which can be named a pillar of the development and research of service dominant logic. Numerous researchers including (Fisk et al., 1993; Vargo & Lusch, 2004) have tried to determine the necessity of the two concepts: goods marketing and services marketing. Different approaches have been considered. In 2006, the authors Lusch and Vargo (2006) deepened the topic that refers to services and goods and the demarcation that researchers want to impose between them and brought up the concept of "service dominant logic. The authors consider that it is important that we use the singular "service" in S-D logic, indicating a process of doing something for someone, rather than the plural "service", implying units of output as would be consistent with G-D logic. They also claim that the goods versus services debate is about the supposed differences between goods and services; S-D logic considers the relationship between the service and a good – that is, a good is an apparatus used in the provision of services. The concept of service has been defined in different ways by various authors. Warnaby and Medway (2015) and Grönroos (2006) defines it as ”an activity or series of activities of a more or less intangible nature that normally, but not necessarily, take place in the interaction between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems”. There are many approaches on how to interpret services. There are also authors such as Grönroos and Gummerus (2014) that bring another perspective upon service- „service logic”. Interaction and value creation together with customers is very important for service providers.

At the same time, the service provider can directly influence the fulfillment of clients' needs and does not only have the role of offering proposals and information (Grönroos, 2006). Some authors believe that services create value, while others argue that they come as a solution to consumer problems. Over time, services became indispensable for companies that produced goods. Traditional product concept has moved to service dominant logic that add value to the entire manufacturing process (Kowalkowski, 2010). The main find of the pioneers of the service dominant logic was that marketing has moved from a goods-dominant logic (characterized by the centrality of tangible results and discrete transactions between the firm and the customer) to a service-dominant (S-D) logic, where intangibility, exchange processes and relationships are central. The dominant logic of marketing was no longer based on tangible goods but on knowledge and skills that bring value to the costumers (Warnaby & Medway, 2015). Despite the existence of earlier publications on service marketing, the emergence of service-oriented concepts and models began in the 1970s (Grönroos, 2006). Since then, service marketing has developed independently from mainstream goods-based marketing. The research on service marketing and relationship marketing between 1977 and 2004 has developed many service-based concepts and models and has even discussed the potential for a service logic to impact mainstream marketing (Vargo & Lusch, 2004).

2.2 Product development

This chapter allows us to understand the term „product development" and how it influences the activity of a company and also the influence upon the community. The aspect that in the past years seemed like something innovative and intangible, today is indispensable and taken for granted. Product development is so wide-spread and it has become a strong competitive advantage therefore there is no longer any possibility for a company not to constantly innovate.

Everything we identify in everyday life is a product development and it was made to simplify our lives. According to the researcher product development (PD) has been an area of active research for decades therefore we cannot refer to it as if it were a modern area of concern. PD performance is based on three important keys: quality, cost and lead time. There is a pressure related to creating a competitive advantage on the market (Marzi et al., 2021). In such circumstances it is essential to always improve the innovative performance.

As the time passed the new products started to be presented as tangible gods or services that come from an orderly process, managed by people with developed experience in product innovation. The new products are made for the customer market and the business-to-business market (Robson et al., 2022). Also the management of the disciplines involved in the development of new products started to gain more importance and attention from the public (Trott, 2012). Gradually, the need for efficiency takes hold among those interested in the field of product development. Regarding the ways of defining the concept of product development we identify numerous authors that studied and defined it. Krishnan and Ulrich present the most comprehensive definition of product development as „ the transformation of a market opportunity and a set of assumptions about product technology into a product available for sale". This paper succeeds to bring the vast literature, concerning product development, together (Krishnan & Ulrich, 2001). Product development can also be defined as „a set of transformations of input elements into output elements" (Florén & Frishammar, 2012).

In 2014, Gmelin and Seuring bring back the initial vision from 1995 of Brown and Eisenhardt and argue that NPD seeks to transform market opportunities and a set of assumptions about product technology into a product available for sale. In 1994, Zirger and Hartley relate in their paper a model of new product development that was empirically tested using data from 130 manufacturing firms.

The model proposed in the article includes six stages of the product development process: idea generation, idea screening, concept development and testing, business analysis, product development, and commercialization. Therefore, it led to numerous discussions regarding the factors that affect each of these stages, and provides empirical evidence on the relationships between the stages (Gmelin & Seuring, 2014). The most critical factors affecting the success of new product development are the

quality of the idea, the ability to identify market needs, and the ability to manage the development process effectively. There is a strong positive relationship between the quality of the product and the effectiveness of the development process (Zirger & Hartley, 1994). The chronology of the product development evolution shows us that the next step regarding the scientific research is the product innovation. A structured approach to product innovation is necessary to ensure that products meet the needs of consumers and are successful in the marketplace. Consequently, we identified a five-stage model for the product innovation process: idea generation, screening, concept development and testing, business analysis, and product development (Cooper, 1990). This approach emphasizes the importance of customer input in each stage of the product innovation process, and suggests that companies should use a variety of techniques to gather customer input, such as surveys, focus groups, and ethnographic research. Also discusses the importance of a cross-functional team approach to product innovation, and the need for effective project management to ensure that the process runs smoothly (Cooper, 1990). New product development is defined as "the process of introducing a new product or service to the market that satisfies a perceived customer need and provides value to the firm". New product development involves managing the various disciplines that contribute to the creation of new products. Each of these disciplines has its own unique perspective based on their involvement in the development process. For example, production management focuses on how to manufacture the product efficiently (Trott, 2012). Krishnan and Ulrich (2001) paper attempts to bring together this vast literature and examines product development as a series of decisions, including concept development, supply chain design, product design, and production ramp-up/launch (Krishnan & Ulrich, 2001). Another perspective upon the subject is that new product development involves taking a market opportunity and a product technology assumption and transforming them into a product that is ready for sale. This requires quick development cycles and cross-functional integration (Brown & Eisenhardt, 1995; Krishnan & Ulrich, 2001).

New product development (NPD) typically involves a series of staged processes that guide decision-making across planning and execution activities (Robson et al., 2022). These processes are designed to manage project outcomes and have been extensively studied in management literature (Marzi et al., 2021). It is important to note that integrated knowledge from diverse sources is crucial for delivering new product advantages and is a prerequisite for successful NPD staged processes (Cooper, 2019). Developing new products has become a critical aspect for firms to remain competitive in various industries, such as software and cars (Brown & Eisenhardt, 1995). In order to gain an advantage over competitors, companies must quickly develop exciting products that appeal to consumers (Brown & Eisenhardt, 1995).

Despite this large and fragmented literature, a comprehensive understanding of product development has yet to be achieved. Therefore, the aim of this article is to enhance our understanding of product development.

2.3 Product development methodologies

The development of the product through digital innovation has led to the creation of new approaches that support technological development and create competitive advantages in product development.

Stage gate model

A stage-gate model is a project management process that is commonly used to manage new product development or other types of innovation projects. It is called a stage-gate model because it divides the project into stages (also called phases) and gates (also called checkpoints), which act as decision points for whether the project should continue to the next stage or be terminated (Cooper, 1990). Stage-gate model recognizes that innovation is a process that can be managed like any other process. It applies process-management methodologies to the innovation process, similar to how the production process is used to manufacture a physical product. The focus is on improving the quality of the output by removing variances in the process (Cooper, 2019). The innovation process is divided into a predetermined set of stages, each composed of a group of related and often parallel activities.

Quality control checkpoints, or gates, are placed between each stage. These gates specify a set of deliverables and quality criteria that the product must meet before it can move to the next stage (Cooper & Edgett, 2008). The stages are where the work is done, and the gates ensure that the quality of the product is sufficient. For example, the "Validation" stage might include mandatory or optional activities such as in-house prototype tests, field tests with customers, pilot or trial production, and test marketing. Overall, the stage-gate model is a structured approach to new product development that helps organizations bring innovative products and services to market successfully (Cooper, 1990). Also, the stage-gate model is a commonly used process for product development that breaks down the effort into a series of time-sequenced stages, with each stage separated by a management decision gate. Certain limitations are involved when discussing the stage gate model considering that the stage-gate process framework consists of work-flow and decision-flow paths that outline the necessary supporting systems and practices to ensure a smooth operation. Recent research has focused on hybrid methods that integrate features of both stage-gate and agile methods to create a single approach that is well-suited for the dynamic nature of the current market and applicable in a broader context. The aim is to combine the strengths of both methods to achieve a more effective product development process (Granato et al., 2022). The authors rely on the research done by Cooper who claims that hybrid methods are gaining popularity in the business world as a means of striking a balance between the highly structured, sequential phases of the stage-gate process and the extremely iterative and agile approach (Cooper, 1990).

Agile development - for software products

Agile development is an iterative approach to software development that emphasizes flexibility, collaboration, and customer satisfaction. The term "Agile" was introduced in 2001 by a group of software developers who created the Agile Manifesto, which outlines the principles and values of Agile development.

Flexible product development refers to the ability to make modifications to a product or the development process, even during the later stages of development, without causing significant disruptions. The more flexible the process is, the later changes can be made, and the less disruptive the change is, the more flexible it is considered (Trott, 2012). Changes can arise due to various factors such as customer needs, competitor response, and technological advancements (Trott, 2012).

Another important opinion on the field belongs to the author (Cooper, 2019).

He claims that agile software development is a set of methodologies that focus on iterative and incremental development through collaboration between self-organizing, cross-functional teams. The goal of Agile is to encourage adaptive planning and delivery, using a time-boxed iterative approach that responds quickly to changes (Cooper, 2019). Due to the importance placed on agility and speed-to-market, numerous programming companies are shifting towards agile methods (Reifer, 2002). Unlike conventional methods, these approaches prioritize the creation of early versions of functioning products, using mostly collaborative techniques such as pair programming, refactoring, and customer involvement as team members on site. These functioning products, rather than prototypes, are used by programmers to showcase features and functions to stakeholders involved in their use, marketing, and support. As Racheva et al. (2008) affirm, agile techniques, such as Extreme Programming (XP), SCRUM or CRYSTAL, promote a requirements engineering (RE) process throughout the software product development cycle in small and informal stages. Rather than engineering all requirements upfront, agile software practitioners allow requirements to emerge during the development process (Racheva et al., 2008). This approach is particularly beneficial for software producers dealing with uncertain requirements, experimenting with new development technology, and clients who want to explore how an evolving product can help achieve their business goals (Schön et al., 2015).

Voice of customer

According to the academic literature, customer satisfaction is believed to depend on the difference between a consumer's initial expectations and their perception of the purchase experience (Brown & Eisenhardt, 1995). When the experience exceeds the customer's expectations, it is considered a

positive confirmation, leading to a positive evaluation (Iacobucci et al., 1995). The inception of VOC research can be traced back to Parasuraman's work, where he highlighted that VOC data can be gathered through customer recognition and customer surveys (Aguwa et al., 2012).

Voice of Customer (VoC) encompasses various forms of customer communications, including conversational voice recordings, emails, text messages, chat transcripts, and agent notes. Contact centers serve as the primary source for collecting the majority of VoC data (Subramaniam et al., 2009). Various methods for capturing the voice of the customer (VOC) were explored, such as ethnography, focus groups, and lead user analysis. Among these methods, certain ones are widely employed, particularly customer visit teams, focus groups aimed at identifying customer issues, and the lead user approach (Cooper & Edgett, 2008). Leveraging Voice of Customer (VoC) can enhance business intelligence and transform contact centers, typically considered cost centers, into profit centers. In addition to extracting valuable insights from contact centers, it is also possible to exert influence on customers by utilizing those insights through contact centers (Subramaniam et al., 2009).

Prototype

The process of developing new products encompasses three main stages: conceiving a new concept, manufacturing, and testing prototypes. Prototyping plays a central role in the testing phase of the design throughout most of the development processes (Canuto da Silva & Kaminski, 2015).

A prototype represents an operational model of the application system, implementing certain aspects of the future system. (Budde et al., 1990) It provides a tangible basis for discussions among developers, users, and management, aiding in the identification of challenges, clarification of problems, and formulation of design decisions (Cooper & Edgett, 2008). When necessary, prototypes can be accompanied by written system specifications. Furthermore, each prototype serves as a foundation for subsequent prototypes or the eventual application system (Budde et al., 1990).

Crowdsourcing

Crowdsourcing refers to the practice of outsourcing a task or responsibility, typically performed by an employee or a specific team, to a diverse and often sizable group of individuals through an open call (Zahay et al., 2018). Crowdsourcing has been characterized by numerous distinct definitions and has been prone to various misconceptions. Despite garnering significant interest from both practitioners and scholars, it is noteworthy that top-tier journals have only recently begun publishing research specifically focused on crowdsourcing (Hossain & Kauranen, 2015).

The term "crowdsourcing" encompasses a broad range of activities that can take various forms (Howe, 2006). The flexibility of crowdsourcing enables it to be a highly effective and potent practice, but at the same time, it presents challenges in terms of defining and categorising it due to its adaptable nature (Estellés-Arolas & González-Ladrón-de-Guevara, 2012). Crowdsourcing is characterised as the practice of delegating tasks that were traditionally conducted within an organisation or assigned to external entities through business arrangements to a vast and diverse collective of potential participants (Hammon & Hippner, 2012). Also, the concept of crowdsourcing pertains to a contemporary business model that operates online and utilises the collective creativity and problem-solving capabilities of a widely distributed network of individuals. It involves issuing an open call for proposals to this network (Brabham, 2008). Jeff Howe provides a concise definition, stating that crowdsourcing refers to the practice where a company or institution transfers a task previously handled by employees to an unspecified and typically large group of individuals, leveraging the power of an open call (Howe, 2006).

Big data

In contemporary science and business, big data and its analysis occupy a central role. This vast volume of data originates from diverse sources such as online transactions, emails, videos, audios, images, click streams, logs, posts, search queries, health records, social networking interactions, scientific data, sensors, and mobile phones along with their applications (Sagiroglu & Sinanc, 2013). The presence of big data is revolutionizing the business landscape by functioning as a versatile capability that enables managers to align strategies and make informed decisions that are in sync with

market demands (Johnson et al., 2017). Big data holds the potential to unlock unprecedented levels of scientific breakthroughs and economic value. Big data encompasses a vast and intricate collection of data originating from various instruments throughout the entire process, spanning acquisition, storage, sharing, analysis, and visualization (Johnson et al., 2017).

2.4 The impact of technology

In the year 1963, Ross and Rodriguez (1963) introduced us to the concept of CAD, or Computer-Aided Design, which is software utilized for generating electronic files that can be employed in various manufacturing operations such as printing and machining. Its advent significantly enhanced designers' productivity and heightened design quality, amongst other benefits

Although there has been a remarkable evolution in terms of digital transformation, expertise is still needed necessary to identify the most appropriate machining processes based on the CAD model and source qualified manufacturing suppliers that are capable of implementing the identified processes (Peddireddy et al., 2020). The next step in the evolution of product development was the emergence of the concept Computer-Aided Manufacturing (CAM) software (Spanninga, 1979) which enabled manufacturers to use computers to control and automate the manufacturing process, reducing errors and increasing efficiency (Schweitzer et al., 2019). The evolution of product development continued with Product Lifecycle Management (PLM) system is a software solution that captures, manages, and shares product-related information, including data on various versions of a product throughout its lifecycle (Schweitzer et al., 2019). Organizations are utilizing digitalization to transform their products, procedures, and value chains while exploring new markets and also a larger audience (Lanzolla et al., 2020).

The changes in the global market and economy led to the development of more complex and intelligent products and also a major need for companies to differentiate themselves on a flexible and constantly changing market (Barrane et al., 2021). Therefore the concept of Digital Product Development appeared on the field and with it technologies like 3D printing, virtual reality, and the Internet of Things (IoT) (Albukhitan, 2020). The primary digitalization tool for manufacturing is Additive Manufacturing, also known as 3D Printing. This technology combines different materials and processes that share the ability to convert 3D data directly into physical objects (Albukhitan, 2020). The Internet of Things (IoT) typically refers to situations in which objects, sensors, and other everyday items that are not typically considered computers are enabled with network connectivity and computing capabilities (Rose et al., 2015). This allows these devices to exchange, generate, and consume data with minimal human intervention, thereby enabling a wide range of new applications and services (Li et al., 2015). The concept of Asset Performance Management (APM) is also identified as a widely used digitalization tool for manufacturing. APM comprises various tools that improve the availability of manufacturing equipment and plant performance to collect, consolidate, visualize, and analyze data in a systematic and easy manner (Santos et al., 2017). An opportunity appeared on the market was represented by agile development for software products.

According to Trott (2012) flexible product development refers to the ability to make modifications to a product or the development process, even during the later stages of development, without causing significant disruptions. Cooper (2019) advocate that the goal of Agile is to encourage adaptive planning and delivery, using a time-boxed iterative approach that responds quickly to changes. Reifer (2002) argue that it appears that the software industry is adopting a new approach to conducting business. Unlike conventional methods, these approaches prioritize the creation of early versions of functioning products, using mostly collaborative techniques such as pair programming, refactoring, and customer involvement (Racheva et al., 2008). After a long period of research and numerous systems that facilitated product development Industry 4.0 appears as a link between these systems that helps to integrate them (Albukhitan, 2020).

Industry 4.0 revolves around the development of intelligent factories, products, and services that are interconnected through the Internet of Things and services, also known as the industrial Internet and

also involves merging physical and digital technologies throughout the various stages of product development (Santos et al., 2017). Industry 4.0 encompasses a wide range of areas and technologies aimed at improving the efficiency, productivity, and quality of industrial processes. Some of the key technologies associated with Industry 4.0 include additive manufacturing technologies, such as 3D printing, as well as modelling and visualisation tools, which also involve the integration of systems, leveraging the Internet of Things and cloud services while ensuring cyber security (Kurasov, 2021). Artificial intelligence, big data analytics, energy-efficient technologies, and alternative energy solutions are also important components of Industry 4.0 (Santos et al., 2017). Overall, digital transformation has transformed product development from a slow, linear process to a fast, iterative, and highly collaborative one. Companies that embrace digital technologies are better equipped to stay competitive in a rapidly changing market (Barrane et al., 2021; Cooper, 2019; Schweitzer et al., 2019).

3. CONCLUSIONS

As we look towards the future, the impact of digital transformation on product development is set to deepen, with emerging technologies such as Artificial Intelligence (AI), Machine Learning (ML), and Blockchain poised to further disrupt traditional models of innovation. The integration of these technologies into product development processes offers unprecedented opportunities for companies to enhance their capabilities, streamline operations, and deliver more personalized and value-driven products to consumers. However, with these opportunities come significant challenges, particularly in terms of managing the complexity, data security, and ethical considerations associated with these technologies. One of the key takeaways from the literature on digital transformation is the critical importance of agility and flexibility in product development. As markets become increasingly volatile and consumer expectations continue to evolve, companies that can quickly adapt their product development strategies to respond to these changes will be better positioned to succeed. The adoption of Agile methodologies, which emphasize iterative development, cross-functional collaboration, and continuous feedback, has proven particularly effective in enabling companies to navigate the uncertainties of the digital age (Schön et al., 2015). Moreover, the shift towards a Service-Dominant Logic (S-D Logic) in product development, as articulated by Vargo and Lusch (2004), highlights the growing importance of viewing products not just as tangible goods but as platforms for delivering ongoing value through services. This perspective is increasingly relevant in a digitalized world, where products are often integrated with digital services that enhance their functionality, usability, and customer experience. As companies continue to explore the potential of digital technologies, the distinction between products and services is likely to become even more blurred, leading to the emergence of new business models and value propositions.

In conclusion, digital transformation represents both a significant challenge and an enormous opportunity for companies engaged in product development. The successful integration of digital technologies into product development processes requires not only technological investment but also a fundamental shift in organizational culture, mindset, and strategy. Companies that embrace this shift, investing in the right technologies, developing the necessary skills, and fostering a culture of innovation and collaboration, will be well-positioned to thrive in the digital era.

Future research should focus on exploring the intersection of digital transformation and emerging technologies in product development, particularly in terms of their implications for organizational structure, culture, and customer relationships. Additionally, there is a need for more empirical studies that examine the practical application of digital transformation strategies across different industries, providing insights into best practices and potential pitfalls. As the digital landscape continues to evolve, staying at the forefront of these developments will be crucial for companies seeking to maintain a competitive edge and drive sustainable growth in an increasingly complex and interconnected world.

REFERENCES

Aguwa, C. C., Monplaisir, L., & Ozgu, T. (2012). Voice of the customer: Customer satisfaction ratio-based analysis. *Expert Systems with Applications, 39*(11), 10112–10119. https://doi.org/10.1016/j.eswa.2012.02.071

Albukhitan, S. (2020). Developing digital transformation strategy for manufacturing. *Procedia Computer Science, 170*, 664–671. https://doi.org/10.1016/j.procs.2020.03.173

Barrane, F. Z., Ndubisi, N. O., Kamble, S., Karuranga, G. E., & Poulin, D. (2020). Building trust in multi-stakeholder collaborations for new product development in the digital transformation era. *Benchmarking an International Journal*, *28*(1), 205–228. https://doi.org/10.1108/bij-04-2020-0164

Brabham, D. C. (2008). Crowdsourcing as a model for problem solving: An introduction and cases. *Convergence: The International Journal of Research into New Media Technologies, 14*(1), 75–90. https://doi.org/10.1177/1354856507084420

Brown, S. L., & Eisenhardt, K. M. (1995). Product development: Past research, present findings, and future directions. *The Academy of Management Review, 20*(2), 343–378. https://doi.org/10.2307/258850

Budde, R., Kautz, K., Kuhlenkamp, K., & Züllighoven, H. (1990). What is prototyping? *Information Technology and People*, *6*(2/3), 89–95. https://doi.org/10.1108/eum0000000003546

Canuto da Silva, G., & Kaminski, P. C. (2015). Selection of virtual and physical prototypes in the product development process. *The International Journal of Advanced Manufacturing Technology*. https://doi.org/10.1007/s00170-015-7762-2

Cooper, R. G. (1990). Stage-gate systems: A new tool for managing new products. *Business Horizons, 33*(3), 44–54. https://doi.org/10.1016/0007-6813(90)90040-I

Cooper, R. G. (2019). The drivers of success in new-product development. *Industrial Marketing Management, 76*, 36–47. https://doi.org/10.1016/j.indmarman.2018.07.005

Cooper, R., & Edgett, S. (2008). Ideation for product innovation: What are the best methods? *PDMA Visions Magazine*, 242709879.

Estellés-Arolas, E., & González-Ladrón-de-Guevara, F. (2012). Towards an integrated crowdsourcing definition. *Journal of Information Science, 38*(2), 189–200. https://doi.org/10.1177/0165551512437638

Fisk, R. P., Brown, S. W., & Bitner, M. J. (1993). Tracking the evolution of the services marketing literature. *Journal of Retailing, 69*(1), 61–103. https://doi.org/10.1016/S0022-4359(05)80004-1

Florén, H., & Frishammar, J. (2012). From preliminary ideas to corroborated product definitions: Managing the front end of new product development. *California Management Review, 54*(4), 20–43. https://doi.org/10.1525/cmr.2012.54.4.20

Gmelin, H., & Seuring, S. (2014). Determinants of a sustainable new product development. *Journal of Cleaner Production, 69*, 1–9. https://doi.org/10.1016/j.jclepro.2014.01.053

Granato, G., Fischer, A. R. H., & van Trijp, H. C. M. (2022). Misalignments between users and designers as source of inspiration: A novel hybrid method for physical new product development. *Technovation, 111*, 102391. https://doi.org/10.1016/j.technovation.2021.102391

Grönroos, C. (2006). Adopting a service logic for marketing. *Marketing Theory, 6*(3), 317–333. https://doi.org/10.1177/1470593106066794

Grönroos, C., & Gummerus, J. (2014). The service revolution and its marketing implications: Service logic vs service-dominant logic. *Managing Service Quality, 24*(3), 206–229. https://doi.org/10.1108/MSQ-03-2014-0042

Hammon, L., & Hippner, H. (2012). Crowdsourcing. *Business & Information Systems Engineering, 4*(3), 163–166. https://doi.org/10.1007/s12599-012-0215-7

Hossain, M., & Kauranen, I. (2015). Crowdsourcing: A comprehensive literature review. *Strategic Outsourcing: An International Journal, 8*(1), 2–22. https://doi.org/10.1108/SO-12-2014-0029

Howe, J. (2006). The rise of crowdsourcing. *Wired magazine, 14*(6), 176-183.

Iacobucci, D., Ostrom, A., & Grayson, K. (1995). Distinguishing service quality and customer satisfaction: The voice of the consumer. *Journal of Consumer Psychology, 4*(3), 277–303. https://doi.org/10.1207/s15327663jcp0403_04

Johnson, J. S., Friend, S. B., & Lee, H. S. (2017). Big data facilitation, utilization, and monetization: Exploring the 3Vs in a new product development process: Big data volume, variety, and velocity. *Journal of Product Innovation Management, 34*(5), 640–658. https://doi.org/10.1111/jpim.12397

Kowalkowski, C. (2010). What does a service-dominant logic really mean for manufacturing firms? *CIRP Journal of Manufacturing Science and Technology, 3*(4), 285–292. https://doi.org/10.1016/j.cirpj.2011.01.003

Krishnan, V., & Ulrich, K. T. (2001). Product development decisions: A review of the literature. *Management Science, 47*(1), 1–21. https://doi.org/10.1287/mnsc.47.1.1.10668

Kurasov, D. A. (2021). Computer-aided manufacturing: Industry 4.0. *IOP Conference Series: Materials Science and Engineering, 1047*(1), 012153. https://doi.org/10.1088/1757-899X/1047/1/012153

Lanzolla, G., Lorenz, A., Miron-Spektor, E., Schilling, M., Solinas, G., & Tucci, C. L. (2020). Digital transformation: What is new if anything? Emerging patterns and management research. *Academy of Management Discoveries, 6*(3), 341-350. https://doi.org/10.5465/amd.2020.0144

Li, S., Xu, L. D., & Zhao, S. (2015). The internet of things: A survey. *Information Systems Frontiers, 17*(2), 243–259. https://doi.org/10.1007/s10796-014-9492-7

Lusch, R. F., & Vargo, S. L. (2006). Service-dominant logic: Reactions, reflections and refinements. *Marketing Theory, 6*(3), 281–288. https://doi.org/10.1177/1470593106066781

Marzi, G., Ciampi, F., Dalli, D., & Dabic, M. (2021). New product development during the last ten years: The ongoing debate and future avenues. *IEEE Transactions on Engineering Management, 68*(1), 330–344. https://doi.org/10.1109/TEM.2020.2997386

Peddireddy, D., Fu, X., Wang, H., Joung, B. G., Aggarwal, V., Sutherland, J. W., & Jun, M. B. (2020). Deep Learning Based Approach for Identifying Conventional Machining Processes from CAD Data. *Procedia Manufacturing, 48*, 915–925. https://doi.org/10.1016/j.promfg.2020.05.130

Racheva, Z., Daneva, M., & Buglione, L. (2008). Supporting the dynamic reprioritization of requirements in agile development of software products. In *2008 Second International Workshop on Software Product Management*, 49–58. Barcelona, Spain. https://doi.org/10.1109/IWSPM.2008.7

Reifer, D. J. (2002). How good are agile methods? *IEEE Software, 19*(4), 16–18. https://doi.org/10.1109/MS.2002.1020280

Robson, M. J., Chuang, F., Morgan, R. E., Bıçakcıoğlu- Peynirci, N., & Di Benedetto, C. A. (2022). New Product Development Process Execution, Integration Mechanisms, Capabilities and Outcomes: Evidence from Chinese High- Technology Ventures. *British Journal of Management, 34*(4), 2036–2056. https://doi.org/10.1111/1467-8551.12686

Rose, K., Eldridge, S., & Chapin, L. (2015). The internet of things: An overview. *The Internet Society (ISOC)*, Geneva, Switzerland.

Ross, D. T., & Rodriguez, J. E. (1964). Theoretical foundations for the Computer-Aided Design System. *SIMULATION*, *2*(3), R-20. https://doi.org/10.1177/003754976400200312

Sagiroglu, S., & Sinanc, D. (2013). Big data: A review. In *2013 International Conference on Collaboration Technologies and Systems (CTS)*, 42–47. San Diego, USA. https://doi.org/10.1109/CTS.2013.6567202

Santos, K. E., Loures, F., Piechnicki, F., & Canciglieri, O. (2017). Opportunities assessment of product development process in Industry 4.0. *Procedia Manufacturing*, *11*, 1358–1365. https://doi.org/10.1016/j.promfg.2017.07.265

Schön, E., Escalona, M. M., & Thomaschewski, J. (2015). Agile values and their implementation in practice. *International Journal of Interactive Multimedia and Artificial Intelligence*, *3*(5), 61. https://doi.org/10.9781/ijimai.2015.358

Schweitzer, F., Handrich, M., & Heidenreich, S. (2019). Digital transformation in the new product development process: The role of IT-enabled PLM systems for relational, structural, and NPD performance. *International Journal of Innovation Management*, *23*(07), 1950067. https://doi.org/10.1142/S1363919619500671

Spanninga, D. (1979). Common shipyard information system and data processing problems. *Paper presented at The Seventh Annual Proceedings of the REAPS Technical Symposium*, San Diego, California.

Subramaniam, L. V., Faruquie, T. A., Ikbal, S., Godbole, S., & Mohania, M. K. (2009). Business intelligence from voice of customer. In *2009 IEEE 25th International Conference on Data Engineering*, 1391–1402. Shanghai, China. https://doi.org/10.1109/ICDE.2009.41

Trott, P. (2012). *Innovation management and new product development* (5th ed.). Harlow, England: Financial Times/Prentice Hall.

Vargo, S. L., & Lusch, R. F. (2004). The four service marketing myths: Remnants of a goods-based, manufacturing model. *Journal of Service Research*, *6*(4), 324–335. https://doi.org/10.1177/1094670503262946

Warnaby, G., & Medway, D. (2014). Rethinking the Place Product from the Perspective of the Service-Dominant Logic of Marketing. In *Springer eBooks* (pp. 33–50). https://doi.org/10.1007/978-3-319-12424-7_3

Zahay, D., Hajli, N., & Sihi, D. (2018). Managerial perspectives on crowdsourcing in the new product development process. *Industrial Marketing Management*, *71*, 41–53. https://doi.org/10.1016/j.indmarman.2017.11.002

Zirger, B. J., & Hartley, J. L. (1994). A conceptual model of product development cycle time. *Journal of Engineering and Technology Management*, *11*(3–4), 229–251. https://doi.org/10.1016/0923-4748(94)90011-6