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Drivers of Digital Product Innovation in Firms: An Empirical Study of Technological, Organizational, and Environmental Factors

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Abstract**—**With digitalization increasingly changing the rules of competition, firms face the need to adapt and assimilate digital technologies in order to remain competitive. Firms can choose from various possibilities to integrate digital technologies including the option to embed digital technologies aiming to innovate products or to develop digital products. However, the question of which specific factors influence a firm's decision to pursue digital product innovation remains unanswered in research. By adopting the Technology-Organization-Environment (TOE)-framework we have designed a qualitative exploratory study including eleven German practitioners to investigate relevant contingency factors. Our results indicate that the most critical factors for a company's decision to pursue digital product innovation can be found in the technological and environmental dimensions, namely customers, competitive pressure, technological change, as well as digitalization fit.

Keywords**—**Digital innovation, digitalization, product innovation, TOE-framework.

I. Introduction

DIGITAL technologies are a driving force in today's economy, as they can enhance the competitiveness of a firm to increase its flexibility and market reach, as well as the efficiency and effectiveness of processes and products – while often lowering operating costs [1]. Under the term digital technologies, combinations of information systems, computing, communication and connectivity technologies can be subsumed [2], all of which fundamentally transform business activities.

Digital technologies have facilitated innovation that has led to disruptive changes in business activities of firms in former established industries, such as music and publishing [3]. Firms in both industries have only hesitantly accepted the rapid technological developments and initially reacted by ignoring the unavoidable fundamental changes [4]. These industries were the first to be affected because their products could easily be encoded into a digital format and thus become completely digitalized [5]. The music and publishing industries are prime examples in which negligence concerning the impact of digitalization on established business activities led to a financial crisis and decline of many firms in these industries. Bearing these developments in mind and despite all progress companies have made, they still must face the challenge to outline the possible consequences of digitalization alongside the increasing emergence of new digital technologies for their business and assimilate these technologies in order to improve their competitiveness [2]. One possibility firms are starting to pursue is to leverage digital technologies by embedding these in their product and service offerings [6] which leads to product innovation.

Digital technologies with their unique properties have become the "primary driver of business innovation" [7, p.331] and have thus opened up new possibilities for innovation [8]. Advances in digital technologies have created substantial opportunities for generating digital product innovation [9]. In this regard, a digital product innovation is either a new product which is embodied in digital technology or is enabled by it [7]. Examples of digital product innovation are new platforms, e.g. ERP-systems, new consumer products, e.g. smartphone apps, and existing products substantially enhanced by the addition of digital technologies, e.g. digitally connected machines [9]. In order to stay competitive product innovation is crucial for organizational success in times of ever shorter product life cycles [10]. However, despite the high awareness of the importance of assimilating digital technologies for a firm's value creation, performance and survival, scholars and practitioners alike struggle to understand how to optimally and effectively leverage digital technologies [3]. In this matter, [3] propose to integrate digital technologies into products which offer firms a strategic option to secure future business. Nonetheless, as firms can choose from various possibilities to integrate digital technologies [2], the question arises as to which specific factors influence a firm's decision to pursue digital product innovation. Prior research has been conducted to identify crucial factors for the adoption and implementation of new technologies by using the established TOE-framework [11, p. 33], [12]. Building upon the TOE-framework, our research goal is to investigate major factors that can be regarded as influential on the specific decision to digitalize products. In order to do so, we conducted in-depth field interviews with practitioners who are in the process of developing their digital business strategy. These interviews aim to identify crucial factors for this question.

The paper is organized as follows. First, we present a brief literature review on the TOE-framework with its corresponding technological, organizational and environmental factors influencing the adaption and implementation of new technologies. Second, we describe our

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methodological approach, provide information on the sample and present our results. Finally, we conclude our paper with implications for academia and for management, as well as mentioning some limitations.

II. Literature Review and Research Model

The TOE-framework [11, p.33] summarizes previous research on the adoption of innovative digital technology and aims to elaborate on crucial factors influencing users' adoption of new information technology. The TOE-framework is an organization-level theory and represents how a firm's context influences the adoption and implementation of innovation [13]. The framework contains three major components that affect the process of adopting innovative technologies, namely technology, organization and environment and these components present both opportunities and hindrances for innovation [11]. Although the framework has its primary goal in the elaboration of factors that lead to an adoption of new technologies within organizations, such as e-business usage, enterprise systems or communication technologies, e.g. [12], we infer that this conceptual framework can be transferred to the context of innovation projects in which firms instigate these innovations. Our approach is based on the fact that product innovation research also involves identifying contingency factors that promote the acceptance and usage of these innovations among customers, e.g. [14]. Hence, the developed approach offers a fruitful avenue to explore the transferability of the TOE-framework respecting firms' innovations.

The technology dimension of the framework includes both internal and external technologies available to the firm, such as equipment and processes. Technology is obviously a major influencing factor regarding the digitalization of products as new technologies facilitate innovation [15]. New technologies are driven by the technological change to which firms must constantly adapt their business activities and offerings [16]. The large improvements in digital technology itself within the last ten years, e.g. faster mobile connectivity and more digital services have unleashed new opportunities by digitalizing key functions and capabilities of conventional, physical products such as cars, phones, cameras, and even books [2]. Previous literature highlights the role of digital capabilities for new product success in a firm's ability to acquire and apply various technologies [17] as this is critical for product innovation [1].

Organizational factors will affect the firm's intention to adapt new technologies for product innovation [18, p.16] as these factors are a prerequisite for the ability to respond to digital innovations [19]. In the context of a firms' adoption and implementation of new technologies, literature in this field has observed that corporate strategy [15], organizational culture and organizational structure [15], financial resources [20] as well as top management support [15], are influential factors. The corporate strategy entails how a strategic vision influences innovation management and how a firm positions itself in relation to its competitors [15]. This vision outlines the future direction of an organization and its medium and long-term activities and objectives [21]. The strong influence of organizational culture has been widely elaborated upon as a major driver and key factor in the management of innovation and the creation of value, e.g. [15]. An appropriate organizational structure is necessary for the successful adoption and integration of technology [15]. Further, [15, p. 9] indicates that a complete separation of organizational culture and organizational structure is a challenge, "as both have developed parallel over the lifetime of the organization". The adoption of new digital technologies can be substantially hindered by a lack of financial resources [22]. Financially stable firms are more likely to adopt new technology than financially less stable firms, as a good financial situation allows a firm to take more risks [20]. Top management support refers to which extent the executives understand the function and characteristics of product innovation based on digital technologies [15]. With regard to this, the study of [23] found that top manager's support has a major effect on the adoption and implementation of information technology.

The environmental dimension represents the current operating environment of firms and has been identified as a major driver for innovation and organizational change [11], [24]. With the emergence of new technologies and the increasing digitalization, new entrants with innovative business models have endangered established business models and have changed the "rules of competition" [8, p. 494]. This leads to fundamentally changed environments in which firms operate. Previous studies concluded that competitive pressures enhance the adoption and implementation of new technologies [25] and that the resulting pressure increases the intensity of product innovation [26]. According to [27], the integration of digital technologies in a firm can be mobilized by the industry in which a firm operates as this influences the degree of digitalization in the particular industry. Although most studies in pertinent literature do not include customers in their research, we propose to do so as they represent a factor to be taken into account when investigating the development of innovation. In this matter, the increasing digitalization requires consideration of two additional aspects, namely changing customer expectations and the possibility of customer empowerment [28].

TABLE I
Factors Influencing Digitalization at Product Level (Multiple Indications Possible)

Technological factors	Organizational factors	Environmental factors
Technological resources [15]	Corporate strategy [15]	Competitive pressure [25]
Digital competencies [1]	Organizational culture [15]	Industry structure [27]
Technological change [16]	Organizational structure [15]	Customers [29]
	Financial resources [20]	
	Top management support [15]	

Due to the omnipresence of digital technologies and unlimited information access, customer expectations have changed. This leads to customers applying higher demands on the quality of information and product offerings of firms [29]. Further, customer empowerment reflects consumers' enhanced

ability to access, understand and share information [28] and this concept has been of growing interest in prior studies on product innovation, e.g. [30].

Based on the discussion above, the framework which will be evaluated in the exploratory study contains eleven variables and categorizes them in accordance with the dimensions of the underlying TOE-framework. Table I summarizes these factors.

III. Methodological Approach

In order to analyze the factors that influence the digitalization of products, we conducted in-depth field interviews with eleven German practitioners, all of whom are responsible for implementing their company's digitalization strategy. A crucial criterion to be chosen as an expert in our study was the prerequisite that the companies had recently faced, the strategic decision of whether and how to digitalize their business. The practitioners work in different industries, namely media, telecommunication, financial, automotive, pharmaceutical, online advertising, logistics, and insurance. With regard to size, the number of employees of the represented companies ranges from 51 to 300,000. The position the interviewed experts hold can be broken down as following: four of them are CEOs, three are heads of business development, and the remaining four experts work in a staff function assigned to digital transformation. By selecting a variety of different industries, we obtained a diversified sample enabling a grasp on a broad scope of factors influencing the digitalization of products. As digitization is relevant to both firms and industries we chose to analyze B2B, as well as B2C companies, to cover different facets of digitization influences. The participants were provided the interview guideline at least one week prior to the interview. All interviews took place in June and July 2015. The interviews lasted between twenty to forty-five minutes. For validation purposes we recorded and transcribed all interviews. The study focused primarily on the experts' evaluation concerning the question: Which of the factors derived from the literature review on the TOE-framework have a major influence on a firm's decision to pursue digital product innovation? Further, the practitioners were asked to name influential factors that had not been included in the interview guidelines. In order to analyze the data, two researchers independently sorted and analyzed the statements. Further, the answers were coded with the help of a qualitative data analysis tool (MAXQDA) to secure a thorough data analysis, as well as to analyze the interviews systematically. Following the structure of the TOE-framework the chosen codes were (1) technological, (2) organizational, (3) environmental, and (4) additional factors identified by the experts.

IV. Empirical Results

Our empirical results include insights into relevant factors for the digitalization of the TOE-framework dimensions namely, technological, organizational, and environmental factors influencing the digitalization of products. All experts agree that the adoption of digital technologies offers ample possibilities to enhance existing or to create completely new products. Based on our derived research model, the experts were asked to evaluate the factors within the dimensions environment, organization, and technology. An overview of the major factors is provided in Table II.

TABLE II
Factors Influencing Digitalization at Product Level (Multiple Indications Possible)

Factors influencing the digitalization of products	Characteristics	Counts
Environmental factors	Customers	8
	Competitive pressure	7
Technological factors	Technological change	5
Organizational factors	Financial resources	2
Additionally identified factor	Digitalization fit	4

The environment dimension reflects external forces involved in a firm's adoption of digital technologies. With eight experts stressing the important influence of customers for adopting new technologies and seven indications for competitive pressure, the results show that the environmental dimension is the most important among those given. In order to satisfy and retain their increasingly tech-savvy customers, firms need to consider how to innovate and enhance their product or service offered by integrating digital technologies in order to address these changing needs and to develop products correspondingly. Consequently, in order to adequately respond to customer needs, firms must improve their customer orientation and take advantage of the technology-based opportunities of customer empowerment. In line with other research regarding information technology adoption, e.g. [12], competitive pressure (seven indications) is a major factor influencing a firm's decision to digitalize products, as competition forces firms to constantly review and revise their service offerings and thus remain competitive. Some experts recognize the opportunity of digital technologies to enable firms to develop entirely new products that serve unmet customer needs in order to "*use this as a unique selling point over the competitors*" as quoted by one expert. It can be noted, that in all interviews the competitive pressure to assimilate digital technologies for product innovation does not originate from other established players, but rather from innovative digital start-ups like FinTechs or born-digitals like Google entering new domains.

The technology dimension represents technical issues of adopting digital technologies in order to create digital products. In this matter, technological change (five mentions) is the main driving force that influences the orientation towards digital products. Due to technological change firms must constantly rethink their product offerings in order to grasp opportunities arising through the implementation of new digital technologies. When considering the technological dimension, four experts added the factor, digitalization fit, which describes the feasibility of assimilating digital technologies into existing products or completely digitizing established products. According to one expert, for example,

banking is regarded to be "*perfectly suited for digitalization, because the product can be completely digitalized,*" and thus programmable, which facilitates simply adding new mobile services or further improving existing digital products regarding their efficiency, effectiveness, and convenience [29]. The experts stress this factor as the possibility and the degree of feasibility to digitize products or to innovate a digital product complementary to existing products, as a prerequisite to address the question of implementing technology-based product innovation. To date the factor, digitalization fit, has been neglected in digitalization literature and shall be regarded as a new factor in research.

According to our experts, organizational factors play a solely subordinated role. Only financial resources, as a possible hindrance, were named to be relevant when assessing important factors for digitalizing products. These firms name the unpredictability of financial returns as a reason for not pursuing digital product innovation.

When evaluating the obtained results, it can be derived that organizational factors can be neglected when the decision to adopt digital technologies in order to innovate products is made. Thus, rather than the TOE-framework, a framework consisting solely of technological and environmental factors sufficiently explains contingency factors that facilitate or hinder a firm's decision to pursue technology-based product innovation.

V. Conclusion and Implication

The goal of this paper was to investigate relevant factors that influence a firm's decision to pursue digital product innovation. In order to do so we developed a research approach based on the TOE-framework which contains factors influencing the adoption and implementation of new technologies derived from an extensive literature review with the context of product development. These factors were tested in a qualitative exploratory study with practitioners who are responsible for implementing their firm's digitalization strategy. Among the initially derived factors which originate from the technological and environmental dimensions, four can be regarded as the most influential. Customers, competitive pressure, technological change, and financial resources are major influencing factors for the decision to adopt digital technologies to innovate products. Further, with the factor, digitalization fit, we add a new contingency which may prove to be important in further research.

Drawing upon our empirical findings, we can derive some implications for academia and management. To scholars our work offers deeper insights into firms' strategic decisions to assimilate digital technologies. Our research shows that approaching an established framework under a new perspective can be evaluated as a fruitful avenue to strengthen and transfer the framework's application. For practitioners, this study identifies relevant factors that influence a firm's decision to use digital technologies in order to enhance their product portfolio. The results shed light on the issue of digitalization fit which means that managers must evaluate possibilities to integrate digital technologies into their products or to invent new digital products complementary to existing products.

Although this study provides valuable insights regarding factors influencing a firm's strategic decision to digitalize products, some limitations have to be mentioned. This study investigates only a limited number of organizations, and thus consequently, contains only a very small number of cases for each industry. Further, the factors which have been neglected in the introduced research approach could easily interrelate. The study design should be repeated with a larger sample and extended to different settings. Future research could extend to approach further facets of firms, for example, to analyze factors influencing the digitalization of processes and the adjustment of business models by using digital technologies.

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