Technology Innovation Management Review

Insights

Welcome to the 11/12 issue of the Technology Innovation Management Review. We invite your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

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Overview

The Technology Innovation Management Review (TIM Review) provides insights about the issues and emerging trends relevant to launching and growing technology businesses. The TIM Review focuses on the theories, strategies, and tools that help small and large technology companies succeed.

Our readers are looking for practical ideas they can apply within their own organizations. The TIM Review brings together diverse viewpoints —from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others — to bridge the gap between theory and practice. In particular, we focus on the topics of technology and global entrepreneurship in small and large companies.

We welcome input from readers into upcoming themes. Please visit timreview.ca to suggest themes and nominate authors and guest editors.

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About TIM

The TIM Review has international contributors and readers, and it is published in association with the Technology Innovation Management program (TIM; timprogram.ca), an international graduate program at Carleton University in Ottawa, Canada.

Editorial: Insights
Mika Westerlund and Gregory Sandstrom

Welcome to the 11/12 issue of the Technology Innovation Management Review. This issue consists of a mixture of themes structured under our usual "Insights" title.

The issue starts with **Petra Kugler** and **Thomas Plank's** article, *"Coping with the Double-Edged Sword of Data Sharing in Ecosystems"*. In an investigation of the changing rules of business due to the emergence of digital technology and artificial intelligence, they introduce a data sharing strategy framework based on a literature review of texts about data analytics. The framework aims to help companies decide the kinds of data to share in a digital ecosystem, as well as what should be kept private to help companies maintain their comparative advantage. The paper explores the rules and regulations required for dealing with various types of operative, strategic and monetizable data. The intended audience includes both practitioners and scientists, who may benefit from the data framework to mitigate the risks of losing competitive advantage in digital ecosystems, or to improve usage of theoretical concepts related to data such as capabilities and resources.

The second paper by **Virender Kumar, Amrendra Pandey,** and **Rahul Singh** involves practitioner perspectives in asking, *"Can Artificial Intelligence be a Critical Success Factor of Construction Projects?"* To answer the title's research question, the authors conducted semi-structured interviews and analyzed the response content. The interviewees include experienced project managers from the global community with expertise in project management working on large construction projects. Results of the research include a distinction highlighted by senior project managers in perceiving artificial intelligence (AI) as different from information technology and advanced project management software. Some of the drawbacks of AI were identified as its lack of soft skills, having interpretive intelligence unlike human beings, and weak human relationship capabilities to address the ways people manage projects.

In the third paper, **Mika Westerlund, Ishdeep Singh, Mervi Rajahonka,** and **Seppo Leminen** explore *"Technology Project Summaries as a Predictor of Crowdfunding Success"*. This paper looks at the recent emergence of crowdfunding as a way for technology

entrepreneurs to raise funds for projects, products, and business ideas. Through an analysis of Kickstarter fundraising campaigns, the authors seek to predict what distinguishes projects that reach their fundraising goals from those that fail to do so. With the help of topic modelling on a data set of over 21,000 Kickstarter technology projects, they investigate if short-text project summaries may provide insights to help predict fundraising success or failure on crowdfunding platforms. Their results show that the displayed summaries of technology projects that successfully raise funds from backers use more trendy topics, offer wording that clearly reflects their novelty, and focus on solving a social problem.

The next paper by **Inka Lappalainen** and **Maija Federley** is titled *"The Role of Digital Platforms in Resident-Centric Housing Concepts"*. The authors investigate the designs, as well as value creation and capture of platform ecosystems in housing markets using service-dominant logic. They focus on four holistic pilot housing ecosystems in Finland that are designed to combine the physical environment of residents with a digital platform. The novelty of this study builds on a holistic understanding of value co-creation in housing, enabled by digital platforms at the ecosystem level. The paper concludes that digital platforms can enable new value creation opportunities in resident-centric housing concepts through a novel "housing as a service" platform approach. The audience is intended as both practitioners and researchers who are exploring opportunities of platform economies.

In the fifth paper, **Shweta Shirolkar** and **Kanchan Patil** present *"Antecedents, Decisions, and Outcomes of a Sharing Economy"*, following a systematic literature review. Their analysis covers research and papers published between 2008 and 2020, involving both developed and emerging countries. The literature review includes 93 articles gathered with an aim to understand emerging consumer behavior that involves collaborative consumption aided by technological innovation. The authors show that the impacts of sharing economies (SEs) on incumbents have increased competition between traditional market players due to the emergence of new platforms with sharing-oriented business model innovation. The research findings indicate that various value

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categories, including social value, hedonic value, economic value, environmental value, and entrepreneurial opportunity serve as major antecedents to participate in SEs.

For future issues, we invite general submissions of articles on technology entrepreneurship, innovation management, and other topics relevant to launching and scaling technology companies, and for solving practical business problems in emerging domains such as artificial intelligence and blockchain applications in business. Potential contributors could also consult the TIM Review topic model (https://topicmodeling.timreview.ca/#/model) to examine the dominant publication themes so far, which might help with ideas for valuable future contributions. Please contact us with potential article ideas and submissions, or proposals for special issues.

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Mika Westerlund
Editor-in-Chief, TIM Review &
Gregory Sandstrom
Managing Editor, TIM Review

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Coping with the Double-Edged Sword of Data Sharing in Ecosystems

Petra Kugler and Thomas Plank

"I never guess. It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."

Sir Arthur Conan Doyle,
Author of Sherlock Holmes Stories

Researchers and practitioners agree upon the huge potential of Big Data Analytics (BDA) for firms' competitive advantage. Capitalizing on Big Data (BD) often requires sharing firms' data with their stakeholders in an ecosystem. Sharing data, however, is a double-edged sword, because firms might also risk losing their competitive advantage by doing so. This conceptual paper uses extant literature on data analytics to introduce a comprehensive data sharing strategy framework that helps firms decide which data can be shared in an ecosystem, which should be kept secret, or if additional rules and regulations are required for sharing the data. The framework combines two distinct categorizations of data, and it relates the data categories to firms' strategic competitive advantage by employing the Resource-Based View (RBV). Firstly, the framework is grounded in the stages of the data analytics process and secondly, it distinguishes between operative, strategic and monetizable data, a new categorization introduced by this paper. Depending on the categories of data a company intends to share, the framework recommends five distinct data sharing strategies that help mitigating the risk of losing their competitive advantage.

Introduction

Digital technology and artificial intelligence are fundamentally changing the rules of business competition in markets from an external perspective, as well as the processes of value creation from an internal perspective (Brynjolfsson & McAffee, 2014; Iansiti & Lakhani, 2020). Especially "big data" and "big data analytics" (BDA) create new possibilities for strengthening companies' efficiency and productivity (Aaser et al., 2020; New Vantage Partners, 2020), or for fostering innovativeness and growth options (Aaser et al., 2020; Mariani & Fosso Wamba, 2020; New Vantage Partners, 2020) by enabling new products, processes, business models, or services (Lim et al., 2018; Auh et al., 2021). Big data is seen as a promising resource that has a positive effect on business or societal value (Aaser et al., 2020), competitive advantage, and company performance (Fosso Wamba et al., 2017; Auh et al., 2021). While the amount of data that is available for firms explodes (Davenport & Bean, 2018), many organizations are still struggling to compete regarding data (Akter et al., 2016; Vidgen, 2017; Urbinati et al., 2019). A recent New Vantage Partners study reported that there has been little to no success for companies over the past years to become data-driven (New Vantage Partners, 2020), and the majority of firms (61%) to date have been unable to turn insights from data into a competitive advantage (Jiang et al., 2021). The gap between leaders and laggards in adopting BDA is growing within and between industries (Diaz et al., 2018; Jiang et al., 2021).

The literature identifies a variety of reasons that hinder firms from turning data into value. Firstly, networking and data sharing are prerequisites for value generating

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data applications in business ecosystems (Cui et al., 2020). However, sharing data is a double-edged sword because, on the one hand, the data's value increases by sharing it (Lim et al., 2018; Thuermer, 2019) or by gathering and curating the data on sharing platforms (Parra-Moyano et al., 2021). On the other hand, organizations risk losing their source of value and competitive advantage to stakeholders because they run the risk of dependency or exploitation, especially in the longer run. Consequently, these firms are trapped in a data sharing dilemma (Kraemer et al., 2019). It can be concluded that to capitalize on data sharing, firms must first understand the mechanisms of data sharing that include, first, which data they can freely share with their (external) stakeholders, second, which data they need to protect, and, third, what tools and agreements help protect the data without compromising the value that is generated by sharing the data (IMDA & PDPC, 2019).

Secondly, the specific characteristics of data as a resource prove to be a hurdle for turning data into value, because raw data alone are insufficient for the generation of value from it (Gupta & George, 2016; Bumblauskas et al., 2017). Data are an intangible good (IMDA & PDPC, 2019) that is non-exclusive in use (Parra-Moyano et al., 2020). Anyone, or any firm that has access to the data can use it, which makes raw data inadequate for generating a competitive advantage (Parra-Moyano et al., 2020). For capitalizing on data, firms must clean the data, integrate, aggregate, and analyze it in a data analytics process (Jagadish et al., 2014). By doing so (raw) data must first be turned into actionable knowledge (Argyris, 1995), a process that requires both interpretation and integration by humans (Bumblauskas et al., 2017).

Based on an extant review of the literature on data analytics, this conceptual contribution aims at discussing how firms can constructively craft strategies for dealing with the double-edged sword of sharing data in a digital ecosystem. The paper introduces a comprehensive data sharing strategy framework that helps in deciding which company data can be easily shared with a firm's stakeholders without losing possible competitive advantages that can be generated from the data. The framework combines two distinct categorizations of data and relates the data categories to a company's competitive advantage by employing a resource-based view (RBV). Firstly, the framework is grounded in the various stages of the data analytics process (Jagadish et al., 2014). Secondly, it distinguishes

between operative, strategic and monetizable data, a new categorization introduced by this paper. Based on the categories of data a company intends to share, the paper recommends five distinct strategies for sharing data that mitigates the risks of losing a company's advantage.

The second section of the paper presents a summary of the ongoing discussion on big data in the management literature. In the third section, the paper reviews how data and data categories are linked to resources, capabilities, and competitive advantage from a RBV perspective. Also, the contribution introduces a data categorization that is based on the data's strategic value, operative, strategic and monetizable. In section four the paper introduces a data sharing strategy framework, that combines these data categories with the stages in the BDA process and it recommends five distinct strategies for sharing data in an ecosystem. Finally, a discussion on how firms can cope with the double-edged sword of sharing data concludes the contribution.

Big Data and Big Data Analytics

Characteristics of Big Data and Big Data Analytics
The term "big data" refers to large datasets from diverse sources that can be harvested (Urbinati et al., 2019) by using advanced techniques and for supporting various decisions (Chen et al., 2012). Big data analytics (BDA) is characterized as "a holistic approach to manage, process and analyze 5 Vs (i.e., volume, variety, velocity, veracity, and value) in order to create actionable insights for sustained value delivery, measuring performance and establishing competitive advantages" (Fosso Wamba et al., 2015). For turning raw data into value, BDA needs to cover a distinct number of steps within a data analytics process that comprises data acquisition, information extraction and cleaning, data integration, modelling and analysis, interpretation, and deployment (Jagadish et al., 2014).

Big data is characterized by features that distinguish it from other kinds of data (Parra-Moyano et al., 2020). Big data is heterogeneous, often unstructured, or semi-structured, agnostic, haphazard, and trans-semiotic (it is stored in text, image, sound), while other data (in a standard strategy process), in contrast, is homogeneous, structured, purposeful, theory-driven, and mono-semiotic (Constantiou & Kallinikos, 2015). Therefore, "Big Data is different data" (Constantiou & Kallinikos,

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2015), since it has a different, more difficult quality compared to other kinds of ("traditional") data. For working with and generating value from the data, a firm requires a complex mix of big data analytics capabilities (Gupta & George, 2016; Akter et al., 2017; Mikalef et al., 2020), meaning, "the ability of a firm to effectively deploy technology and talent to capture, store, and analyze data toward the generation of insight" (Mikalef et al, 2020).

Application of Big Data Analytics Practices in Firms
Despite the huge potential inherent to big data, firms claim that they still find it difficult turning BDA into new businesses or into value (Vidgen et al., 2017; New Vantage Partners, 2020). The potential inherent to the technology to a large extent seemingly cannot be exhausted and many firms cannot generate the competitive advantage or the increase in performance they had expected when using big data and BDA (Hagiu & Wright, 2020).

In fact, turning BDA into value seems to take more than just technology (Storm & Borgman, 2020). Factors inside the company especially must first be aligned to deal with big data, such as having a data-driven organizational culture (Gupta & George, 2016; Upadhyay & Kumar, 2020), a decision-making culture (McAffee & Brynjolfsson, 2012; Vidgen et al., 2017), a data-dominant logic (Kugler, 2020), and technical and managerial skills or roles (Gupta & George, 2016; Davenport & Bean, 2018). Many established processes, objectives, tools, and paradigms do not allow thinking and working with data beyond the established well-known structures (Kugler, 2020). This is especially true when a firm intends to use big data for innovation or strategizing purposes (Constantiou & Kallinikos, 2015).

To achieve the required shift organizations must develop distinct big data analytics capabilities (BDAC, more below), a multi-dimensional construct that covers management capability, technological capability, and talent capability (Akter et al., 2016). Hagiu and Wright (2020) conclude that firms lack data-driven business models and likewise that practitioners generally lack guidance for dealing with data analytics, a key component for addressing differences between experts and laggards (Vidgen et al., 2017).

Data Sharing in Ecosystems
As data is often created "when two or more instances of use interact" (Parra-Moyano et al., 2020) generating

value from data often requires sharing the data in an ecosystem, rather than in a company's isolated activities (IMDA & PDPC, 2019). "Data sharing" refers to "the sharing of otherwise closed data within or between organizations" (Thuermer et al., 2019). Other options for getting access to data, such as open data (Thuermer et al., 2019) or trading data on the market are difficult or of limited use because data's characteristics tend to hinder these transactions, and firms consequently tend not to share their data (Parra-Moyano et al., 2020).

In data sharing ecosystems, partner organizations "agree to share data and insights under locally applicable regulations to create new value for all participants" (Jiang et al., 2021). All kinds of organizations can benefit from sharing data, including data holders, innovators, intermediaries, and society as a whole (Thuermer et al., 2019). Data sharing ecosystems go beyond traditional value chains, industries, or data domains and have the potential for generating superior company performance because sharing data improves customer satisfaction (15% annually in the last 2-3 years), productivity and efficiency (14%), and helps reduce costs (11%, Jiang et al., 2020), while shared data enable data-driven innovation (Stalla-Bourdillon et al., 2020).

The Double-Edged Sword of Sharing Data
However, data sharing ecosystems are still in an infant stage (IMDA & PDPC, 2019) and their full potential remains untapped (Jiang et al., 2021), because sharing data is a double-edged sword for the companies involved. On the one hand, the data's value increases by sharing it (Lim et al., 2018; Jiang et al., 2021), while, on the other hand, organizations risk losing their source of value by granting their partners access to their data. They also run the risk of dependency or exploitation, especially in the longer run (Kraemer et al., 2019).

These firms are trapped in a data sharing dilemma (Kraemer et al., 2019) or, more generally speaking, in a social dilemma caused by data sharing (Linek et al., 2019). Social dilemmas are characterized when selfish, non-cooperative behavior is deemed more beneficial to individual parties involved. Yet if all parties involved behave in a non-cooperative way, they all would receive less payoff than if everyone cooperated (Linek et al., 2019). This risk runs especially high for small or young organizations that are sharing data with large platforms (Kraemer et al., 2019). The data sharing firms face a trade-off between positive short-term effects of sharing

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and challenging long-term strategic effects (Kraemer et al., 2019). Companies intending to get involved in these ecosystems still require guidance to help them cope with the challenges of sharing data, such as understanding the mechanisms of sharing data, ensuring compliance to regulations, and establishing mutual trust (IMDA & PDPC, 2019).

Big Data Categories from a Resource-Based View

Big Data Categories
The management literature on big data discusses a broad variety of data categories such as characterizing data as a resource or capability (Gupta & George, 2016; Bumblauskas et al., 2017; Mariani & Fosso Wamba, 2020), steps in the data analytics process (Jagadish et al., 2014), structured, semi-structured, and unstructured data (Praveen & Chandra, 2017), and the data related dimensions of volume, variety, velocity, and value (Akter et al., 2016; Fosso Wamba et al., 2017). The large number of data taxonomies available indicates that there is no one-size fits all solution to categorizing data, but rather depends on the context organizations need to define their own data categories (IMDA & PDPC, 2019). Also, none of these taxonomies alone is enough to determine the data's value or how it contributes to a competitive advantage. Similarly, Bumblauskas et al. (2017) stated, "the size, scope and scale of data are difficult to limit in defining Big Data, the definition of Big Data must revolve around the analysis of the data rather than the actual size of the data or spreadsheet (i.e. large data sets or databases)". Given these categories, it remains unclear if the data should be limited to focal organization, or if data sharing in an ecosystem is an option. Against this background, the current paper introduces a data taxonomy according to "how strategic the data is to the organization" (IMDA & PDPC, 2019), by the data's potential for generating a competitive advantage, and how it distinguishes between operative, strategic, and monetizable data.

In what follows, the paper introduces a comprehensive framework that builds upon two categorizations of data. First, it is grounded in stages of the BDA process and whether the data can be classified as resources or capabilities. Second, it is based on the data's strategic value regarding whether it is operative, strategic, and monetizable. Both data categories are linked to the data's potential for generating competitive business advantage. Depending on the data available, the paper presents five distinct strategies for data sharing.

Big Data and Big Data Analytics as Resources and Capabilities
In line with Gupta and George (2016), this paper argues that the resource-based view (RBV) links an organization's resources and capabilities (independent variables) with organizational competitive advantage and performance (dependent variables) (Amit & Schoemaker, 1993). Resources characterize "stocks of available factors that are owned or controlled by the firm" (Amit & Schoemaker, 1993). Organizational capabilities aim at connecting and exploiting organizational resources, meaning "the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result" (Helfat & Peteraf, 2003). What resources an organization has and how it combines and uses these resources with its capabilities, directly influences a firm's performance. Yet only those resources and capabilities have the potential to create sustainable advantage that are valuable, rare, difficult to imitate, and without substitutes (Barney, 1991).

Gupta and George (2016) classified (raw) data and their merging as a tangible resource because they are non-exclusive in use and available to many firms in the market (Parra-Moyano et al., 2020). Following Bumblauskas et al. (2017), raw data alone are of no value or only of little value to a certain company, given that they must first be transferred into actionable knowledge (Davenport & Prusack, 1998) that enables people to act or to decide: "[Raw] data is a set of discrete, objective facts about events … [but] data by itself has little relevance or purpose" (Davenport & Prusack, 1998). Raw data, therefore, does not suit Barney's (1991) four criteria, and it can hardly be a source of competitive advantage alone (Gupta & George, 2016).

Big data analytics capability (BDAC), in contrast, is more complex than raw data and marks a company's ability "to effectively deploy technology and talent to capture, store, and analyze data, toward the generation of insight" (Mikalef et al., 2020). While BDAC adds meaning to raw data, it has the potential to turn data into what Davenport and Prusack (1998) term "information and knowledge", however, this step can only be accomplished by human beings (Gupta & George, 2016), that is, not just by technical means. BDAC, therefore, is firm-specific, and has the potential to be valuable, rare, difficult to imitate, and without substitutes, as Barney (1991) suggests.

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Table 1. Characteristics of Big Data and Big Data Analytics.

Unit of analysis	Characterization (Davenport & Prusack, 1998)	Step in Big Data Analytics (BDA) process (Jagadish et al., 2014)
Data (tangible / resource)	Data is a set of discrete, objective facts about events.	Data acquisition
Information	Information is data to which meaning has been added, such as by means of contextualizing, categorizing, calculating, correcting, or condensing the data*.	Information extraction & cleaning Data integration Modelling
Knowledge (intangible / capability)	Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers.	Analysis Interpretation Deployment

Big Data Analytics Process
For turning raw data into knowledge and into value, raw data must go through a multi-step analytics process that covers data acquisition, information extraction and cleaning, data integration, modelling and analysis, interpretation, and deployment (Jagadish et al., 2014). Although these steps can partly be automated, the complex steps of data analysis, interpretation, and deployment especially depend upon human beings to extract or add meaning to the data (Jagadish et al., 2014; Bumblauskas et al., 2017). The software-generated results must be understood, questioned, or summarized as working hypotheses, all of which requires human cognition (Constantiou & Kallinikos, 2015).

It can be concluded that the biggest potential for companies that wish to turn data into competitive advantage lies in the more advanced steps of the data analytics process (Jagadish et al., 2014) that require BDAC. Meanwhile, less potential resides in the initial steps of the process grounded in informational resources and raw data. For a summary, see Table 1.

*Contextualized: we know for what purpose the data was gathered; categorized: we know the units of analysis or key components of the data; calculated: the data may have been analysed mathematically or statistically; corrected: errors have been removed from the data; condensed: the data may have been summarized in a more concise form (Davenport & Prusack, 1998).

Taking a RBV has been widely used to approach and explain causal relationships between big data, BDA, and competitive advantage (Akter et al., 2016; Gupta & George, 2016; Fosso Wamba et al., 2017; Mikalef et al., 2020). While the RBV is an established approach from an empirical scientific point of view, we conclude that it largely remains on an abstract or theoretical level, and typically lacks a comprehensive approach that helps get an overview of the available data's potential to generate competitive advantage.

Operative, Strategic and Monetizable Data
This paper introduces another categorization of data that is based on the data's strategic value. It distinguishes between operative, strategic, and monetizable data because these categories give information on how an organization uses or intends to use a certain data set in the shorter or longer run. While *operative data* are necessary to run daily business, *strategic data* can be used for innovation activities, while *monetizable data* are of little use for the focal company itself, but are rather of great use for external stakeholders.

Operative data are used to run current business. Data is used for efficiency increases, such as for controlling or (predictive) maintenance purposes, and for digital twins. These improvements can lead to short-term cost advantages in competition, while the advantages gained from the data might erode over time. Competitors can

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Table 2. Examples of operative, strategic, monetizable data

operative data	strategic data	monetizable data
(predictive) maintenance	customer insight	raw data
data supply chain	consumer trends	aggregated data
controlling	product, process, service innovation	data insights
digital twin (product, manufacturing)	business model innovation	
monitoring	management innovation	
product, process, service improvements		
efficiency increase	new business opportunities	additional yield

also use similar data in a similar way. Therefore, data itself cannot provide the potential for generating a competitive advantage (Kraemer et al., 2019). It is rather likely that using data creates a new standard in competition that is already or will later be used by many players in global markets.

Strategic data are used for generating new business opportunities, including innovative products services, processes, or business models, that might, for instance, build upon available consumer data. Strategic data has the potential to enable new possibilities for a firm's future success. New business opportunities link prior knowledge and solutions to unknown insights, and are more complex than operative solutions. Strategic data have the potential to serve as the origin of gaining competitive advantages.

Monetizable data are data than can be sold to stakeholders, such as, for instance, data that was generated as a by-product of other activities, and that is of no or of little use for the company. Such data can be used for generating additional yield for an organization. Similar to operational data, monetizable data are rather unlikely to serve as the origin of a competitive advantage (for examples see also Table 2).

Data Sharing Strategy Framework

Data Sharing Strategies
In the following section, we correlate the data categories operative, strategic, and monetizable with steps in the BDA process (Jagadish et al., 2014). As was demonstrated above, the highest value for a company resides in the more complex final stages in this process that require profound data analytics capabilities (data

analysis, interpretation, and deployment; Bumblauskas et al., 2017). These activities are necessarily linked to the interpretations and experiences which people add to making sense of the data (Bumblauskas et al., 2017), which is difficult to imitate or substitute. Largely unprocessed raw data are particularly valuable only if no other company has comparable data available. Therefore, raw data alone are of little or no strategic value to organizations. However, there is no guarantee, but rather only a probability that some kind of competitive advantage can be generated from the data.

From the proceeding discussion, it can be concluded that, depending on the type of data available, different strategies are available for how to deal with the data. Correlating the steps in the big data analytics process with the potential uses and strategic value of the data leads to five different strategies, depending on how well they are suited to generate a competitive advantage. These strategies will be outlined below, along with a brief illustration of each (see Figure 3). Strategies (1) and (2) are extreme cases in which data should or should not be shared openly at all with a company's stakeholders:

Strategy (1) deals with big data that classifies as strategic and that has been analyzed or interpreted. It therefore represents (actionable) knowledge that can be of great value to a company. The analysis and/or interpretation of the data strongly depends on the company's BDAC. These types of data have a high probability of leading to a competitive advantage. Companies should clarify the possible gains and risks of sharing these data. The safest way to cope with the potential risk is not sharing it at all.

However, if potential gains can outweigh the potential risks, then a company should use clear mechanisms to

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Table 3. Data sharing strategy framework

mitigate the risks. A brief example illustrates the strategy:

Most major car manufacturers (for example, BMW, Audi, Ford) equip their new vehicle models with sensors that enable them to provide telematics data (raw data) that is collected in the company's data center. The telematics-enabled vehicles generate a wide range of data, including condition data (for example, mileage), usage data (for example, heavy acceleration), or event data (for example, power interruption, service call). If selected data is aggregated and analyzed, it can be the starting point for the vehicle manufacturer's new services, products, or business models. This is the case, for example, if a company wants to offer its customers a predictive service model that can use the combination of data to predict when a vehicle repair is very likely to be necessary. The aggregated and analyzed data then has strategic value for the company and is not shared.

Strategy (2) combines monetizable data that is of no or little use for a company at the initial stage(s) in the big data analytics process. The data makes no use or only to a very small degree uses a firm's BDAC. Therefore, the probability that the data could lead to a competitive advantage is low. However, selling the data can lead to generating additional yield from the data (once or repeatedly), or to receiving some extra information for the data.

In this case the car manufacturer collects telematics data (raw data) that provides information about the use of the cars' shock absorbers. This data has already been collected for several years. Additionally, data is also collected that allows drawing conclusions about the condition of the roads cars are driving on, especially with respect to potholes, which place particularly high stress on shock absorbers. The car manufacturer has no use for the road condition data. However, that data may be of interest to a city, municipality, or country for the purpose of infrastructure maintenance, otherwise the government would have to pay the price of collecting this data by itself. The car manufacturer can sell the raw data to the city or country or share it for a fee. Alternatively, the vehicle manufacturer can provide the data free of charge to the government, but get back an aggregated view (more valuable data) from the government that is created from data provided by all manufacturers in return.

Strategy (3) deals with operative raw data or information that is helpful for efficiently running a daily business. Similar data is available or can be generated without the need for concise analytics capabilities by many companies. Therefore, the probability for generating a competitive advantage is rather low. However, because

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this type of data is easily available, its use can rapidly lead to a competitive (or industry) standard. This data is then more of a prerequisite to compete within an industry or between ecosystems.

The car manufacturer collects data on vehicle use, which provides information on the wear and tear of the vehicle's parts (for example, tires, battery, etc.), which the car manufacturer does not produce itself, but which it obtains from suppliers. This data can be interesting for suppliers (customers) because it helps to use these wearable parts more efficiently, for example if wearing of the tires depends more on climate or the driving behaviour of the driver. This data can be shared with suppliers as raw data, while the vehicle manufacturer employs additional means for risk mitigation.

Strategy (4) either consists of strategic raw data and information that can generate new business opportunities, or of operative data that has already been turned into actionable knowledge, and therefore reflects a potential source of competitive advantage. Firms should decide case-by-case if potential gains that can be achieved through sharing outweigh the risks of not doing so, like strategy 3.

The car manufacturer collects raw data on the driving behaviour of vehicle owners and on vehicle use, which provides information on the accident behaviour (probability of an accident) of drivers, and optionally the vehicle manufacturer aggregates and analyzes the data. These data form the basis for new business models for insurance companies that depend on driving behaviour and frequency of use reports. Such data would otherwise have to be collected separately by the insurance company. The data can be shared with or sold to the insurance company (as long as the drivers give their informed consent according to the regional legal standards).

Strategy (5) refers to monetizable data that has been transferred into knowledge by means of combining data analytics practices and capabilities. While these data are of no or little value to focal firms, the possibility still exists for generating competitive advantage given that the analyses can be valuable, rare, and difficult to imitate or substitute (Barney, 1991). Sharing or selling the data, therefore can be an option, but, again, the company should consider the appropriate risk mitigating activities.

Strategy 5 is like strategy 2, albeit with data that have already been aggregated, analyzed, and processed, instead of using raw data. These data can serve as the basis for a new business model.

It can be concluded that the highest value for firms resides in strategic data of all kinds, and especially in those data that have already been turned into actionable knowledge by means of analytics in combination with BDA capabilities. But also, operative or monetizable data that has been analyzed has a similar potential for value creation, and it should be protected or subject to the mitigation of potential risks.

Literature on Mitigating the Risks of Data sharing

The data analytics framework presented in this paper gives an overview of strategies for sharing data in a digital ecosystem, but it gives minimal information on concrete activities about how firms can mitigate potential risks that may arise. The scientific literature only starts to discuss a variety of measures that companies can take to mitigate risks, yet without classifying these activities and on a rather broad, unspecific level.

Some authors suggest using data trusts (Protection Information Management, 2018; Stalla-Bourdillon et al., 2021), making data sharing agreements (IMDA & PDPC, 2019) or contracts (Thuermer et al., 2019) when confronted with the risk of sharing data. While no prescribed format currently exists for such agreements, these companies and other sharing organizations should agree upon key issues, such as data confidentiality, the allocation of liability for contract breeches (IMDA & PDPC, 2019), restrictions to permitted data usage, and clarifications about who owns any intellectual property outcome of the shared data (Thuermer et al., 2019). In any case, trust between the sharing partners seems to play a crucial role for mitigating the risks of data sharing in digital ecosystems, and it can be strengthened by following the principles of fairness and ethics, transparency, security, and data integrity (IMDA & PDPC, 2019).

Kraemer et al. (2019) by referring to partnerships with large online platforms, suggested seeking data sharing partners from complementary markets or strengthening differentiation between competitors through sharing partnerships. Other literature refers to technical issues

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for mitigating the risks of sharing data, such as applying algorithms to data only where the data originally is stored so that raw data never leaves its repository, applying open algorithms so that experts can judge an algorithm's safety, or keeping data always protected in an encrypted state (Parra-Mayano et al., 2020). However, the discussion of how to cope with shared data is only in its beginning stages, and further research is required to better understand the appropriateness of the suggested patterns of risk mitigation in sharing partnerships, as well as the processes to do so.

Discussion and Conclusions

This paper aimed at, first, presenting a data sharing strategy framework that relates different types of data to decisions whether an organization should share their data in a digital ecosystem or not. Secondly, the paper introduced a comprehensive classification of big data that links data to competitive advantage, and distinguishes between operative, strategic, and monetizable data that correlates with steps in the BDA process. The paper adds value to both the scientific community and to companies that wish to share data in their ecosystems.

Practitioners can profit from the data framework by getting an overview of various data categories, and of the different strategies for sharing data while mitigating the risks of losing their competitive advantage. To *scientists*, the framework conceptually links the new topic of data sharing to well-established theoretical concepts such as capabilities and resources. However, data sharing in ecosystems is still a new topic that is only starting to be discussed in the scientific literature, and companies are still in search of answers to many questions about sharing their business data. Therefore, some issues can be identified that remain open to future studies. First, as the paper was developed conceptually, the findings of this contribution should be further verified by using empirical evidence.

Second, the paper assumes that data can clearly be classified by their strategic relevance and using a data analytics process. However, for companies these classifications might not always be clear, because on the one hand, firms might lack some pieces of information that would help them to classify their data as operative, strategic, or monetizable. Whenever firms get access to new pieces of information or to additional new data that can be combined with prior findings, the data's strategic

value can be subject to changes. On the other hand, what value a set of data has, differs between firms and between the context in which the data is used. New partnerships in a digital ecosystem or new possibilities to which the data can be applied, therefore, have the potential to also change how the data can be used and, finally, classified. Firms cannot always clearly determine what they will work on in the future. This is also a reason why numerous firms are collecting huge amounts of unstructured data, although they do not yet have a concrete purpose for using the data.

Thirdly, future research could refer more in detail to activities that firms can take to mitigate the risks of sharing data. The lack of a detailed overview persists of concrete measures and of a discussion of which activities are suited best for which data sharing situations. Not all options are open to all firms, due to constraints, such as customers that clearly define what their suppliers are allowed to do with the data (and often they are not allowed to do anything with the data at all). Although many of these measures that mitigate the risks of sharing data seem to be obvious at first sight, their application in a concrete situation of data sharing leaves many questions open. Such as, for instance, how can we clearly determine the value of data for a certain company? How can we estimate all possible risks and benefits of sharing data? How can we overcome internal or external hurdles for sharing data? What could a data sharing contract between digital ecosystem partners look like that constructively deals with the intangible and changing nature and value of big data?

Finally, and closely related to the proceeding issue, it also became clear to us, that for firms it might be not enough anymore to consider strategy and competitive advantages on the level of a single firm only. The more firms start to become part of broader ecosystems, the more it will be necessary to also take into account the perspective of the entire system, also when it comes to competitive advantages. The challenge will be to balance advantages on the firm level with those on the ecosystem level, while being aware of the potential contradictions or trade-offs that may arise in such situations. Companies should also reflect on the purposeful and comprehensive tools and approaches available for how to deal with possible contradicting goals on the firm and ecosystem levels, especially when sharing their data.

The Gartner Group (Goasduff, 2021) suggests, for

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instance, a "must share data unless" policy. Firms, then, are supposed to share their data unless there is a valid reason why this should not be the case. Open data, consequently, would become a new standard instead of proprietary data and information, which is today's standard. Open source software projects already demonstrate how such a change in the overall data regime can function. These projects refer to "copyleft" instead of "copyright" (Stallman, 2007). This implies, however, that firms must also change their mindsets and organizational cultures when sharing their data.

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Can Artificial Intelligence be a Critical Success Factor of Construction Projects?: Project practitioners' perspectives

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" Although the original vision for artificial intelligence was the simulation of (implicitly human) intelligence, research has gradually shifted to autonomous systems that compete with people. "

Susan L. Epstein (2015)

The construction sector has not been altogether successful in adopting automated systems. Related research on artificial intelligence has mainly been confined to the development of software models for a specific subset of construction work. This study aims to identify whether artificial intelligence is a potential critical success factor for construction project success. Data were collected through semi-structured interviews and analyzed using content analysis. The interviewees were selected on the basis of convenience and included highly experienced project managers from the global community with expertise in project management working on large construction projects. Our research shows that senior project managers perceive artificial intelligence as different from information technology and advanced project management software. Major drawbacks of artificial intelligence were found to be (i) lack of soft skills, (ii) lack of intelligence to interpret things in various ways like human beings, and (iii) lack of human relationship capabilities, including the ways people manage projects. The interviewees believe that artificial intelligence is still years away from becoming self-aware. This study improves the understanding of artificial intelligence as a success factor for construction projects and provides future directions for research in this field.

Introduction

Artificial Intelligence (AI) can be defined as constructing computer programs that (i) are capable of exhibiting intelligence, (ii) exhibit intelligence by using processes used by humans for the same tasks, and (iii) are capable of complementing or supplementing human intelligence (Simon, 1995). As Epstein said (2015), "Although the original vision for artificial intelligence was the simulation of (implicitly human) intelligence, research has gradually shifted to autonomous systems that compete with people". Artificial neural networks, machine learning, genetic algorithms, fuzzy logic, and statistical analysis form the basis of most applications under the label of "AI".

The role of AI and how it is transforming companies are not well studied (Kulkov, 2021). Despite its great potential for solving problems, there are still issues involved in its practical uses (Borges et al., 2021). Overpraised and highly criticized, AI died at least four times in five decades because of wild claims made by people and research about AI. Instead, we focus here on the best machine intelligence one can construct without regard to what people can do (Epstein, 2015), given that advances in AI research have mainly been in isolated silos (Loureiro et al., 2021).

Over the past few decades, the use of AI in diverse applications has increased substantially across different sectors and industries (Borges et al., 2021). Global spending on AI was expected to reach around US$ 98 billion in 2023 (Collins et al., 2021). Nevertheless, AI adoption in the construction industry has been moving at a slow pace (Akinosho et al., 2020), with research on AI in this sector mainly confined to developing software models for a specific subset of construction works. For this they have been using knowledge-based expert

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systems that have failed to gain wide acceptance on account of their inherent deficiencies.

Sinesilassie et al. (2019) stated that, "A construction project is considered as successful when it is completed in time, without cost overruns, and within the specified quality parameters". So-called "success factors" are interconnected performance factors that contribute to project success, as determined by the project management system that provides the tools to coordinate the technologies and people needed to complete a project to maximise chances of project success (Olugboyega et al., 2020). They form the basis for organizations to achieve success on projects (Nguyen et. al., 2020).

Though extensive research has explored the role of AI in software projects, the role of artificial intelligence as a critical success factor for construction projects has not been explored in project management literature. This omission spurs the current work that aims to identify whether AI is becoming a potential critical success factor for construction project success, that is, used in construction projects to increase project performance and efficiency. Thus, in this paper we address the following research question: *Can AI help complete construction projects within budget, on-schedule, and according to specifications thereby increasing the chances of project success?*

The construction industry lags behind many other industries in implementing AI solutions and remains severely under-digitized. AI may help in developing collaborative business models that can alter the current business environment, thereby improving performance and efficiency in the construction industry across the value chain from production of building materials to design, planning, execution, and maintenance (Akinosho et al., 2020). The huge benefits that can be obtained from applying AI in construction projects, therefore, necessitates understanding its role as a success factor for construction project success.

Very few studies have taken a practitioner's viewpoint that could provide valuable insights to construction project professionals in their daily activities (Townsend & Gershon, 2020). This study explores the perceptions of senior project practitioners about AI's role as a success factor in construction projects. To the best of our knowledge this is the first study in project management literature that identifies this gap and attempts to fill it.

The rest of the paper is structured as follows: The next section provides a literature review. Following that, the research approach and results constitute the next two sections. The next two sections then contain discussion and conclusions, including limitations of the research and directions for future research.

Literature Review

Artificial Intelligence
The roots of AI can be traced back to the seminal work of Vannevar Bush who proposed a system called memex, a machine proposed to be an enlarged intimate supplement to a person's memory (Bush, 2021), and Alan Turing (1950) who gave the idea of thinking machines that can imitate human beings. The term "artificial intelligence" was first used by John McCarthy in his Dartmouth Summer Research Project proposal in 1955 (McCarthy et al., 2006; Epstein, 2015). Early systems like ELIZA and General Problem Solver were developed in the 1960s based on the assumption that human intelligence can be formalized (Haenlein & Kaplan, 2019). Since then, we have come a long way from simple machine learning with collecting and processing of data to the present-day use of AI as a multidisciplinary field with intelligent thinking machines performing complex functions and procedures without human involvement. However, many believe that AI has failed to meet its high expectations (Muthukrishnan et al., 2020). Artificial neural networks, machine learning, genetic algorithms, fuzzy logic/sets, and statistical analysis form the basis of most applications under the label of AI, whereas topics like robotics technology, modular construction, energy, 3D printing, life cycle cost, and LCA have not been sufficiently researched (Darko, et al., 2020).

Pan and Zhang (2021) performed a scientometric and qualitative analysis on the current state of AI adoption in the context of construction, engineering, and management (CEM) inside the architecture, engineering, and construction (AEC) industry, and reviewed 4,473 journal articles published from 1997 to 2020. They found that various AI techniques have led to more reliable, time-saving, and cost-effective processes in CEM, under great uncertainty and intensive data that reveals the potential value of AI in supporting and improving CEM. Shukla et al. (2019) performed a bibliometric analysis of publications in the journal *Engineering Applications of Artificial Intelligence* (EAAI) using data from Web of Science (WoS) for the period 1988–2018. Darko et al. (2020) made a comprehensive

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scientometric study that analyzed 41,287 relevant publications for the period from 1974 to 2019, which assessed the state-of-the-art of research on AI in the AEC industry. A common thread linking these three most recent and comprehensive reviews are the concepts of "expert system," "fuzzy logic," "machine learning," and "optimization"/ "algorithm" as broad engineering applications of AI.

In the construction industry, research on AI has mainly been confined to developing software models for a specific subset of construction works using knowledge based expert systems (Ayhan & Tokdemir, 2019). Some of the researchers view AI techniques as suitable for solving complex real-world construction problems under uncertain environments (Tiruneh et al., 2020), while others view AI based systems/models as incapable of addressing real-world problems (Darko et al., 2020). Raisch and Krakowski (2021) argued for a substantial change in the way AI research in general is currently conducted to provide practice with sound advice.

Critical success factors
Critical success factors are levers that can address project success (Costantino et al., 2015) and directly increase the likelihood of attaining success (Maghsoodi & Khalilzadeh, 2017). Understanding the impact of critical success factors on project performance is considered a means of improving their efficiency and effectiveness (Sinesilassie et al., 2019). Daniel first discussed the concept of "success factors" in the 1960s (Leidecker & Bruno, 1984). Rockart, based on Daniel's conceptualization, has introduced a critical success factors (CSFs) approach and de ned CSFs as, "those few key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his or her goals" (Rockart, 1982).

Several works in the construction context have recognized factors that support completing construction projects successfully, especially the factors that have a greater effect on project success than others (Altarawneh & Samadi, 2019). Cheng et al., (2021) considered "technology" as one factor influencing productivity at construction sites. Kang et al. (2013) evidenced that use of IT in construction manifests itself through improvement in work processes that can lead to increased project performance. Many researchers have proposed AI systems to support time-cost-quality trade-off analyses in project management and performance (Elfaki et al., 2014; Costantino et al., 2015). Pan and

Zhang (2021) believed that AI can substantially benefit in automation, risk mitigation, and optimization, thereby making construction projects run more smoothly and efficiently. Klashanov (2016) opined that in construction, actively applying ICT helps in selecting economically feasible methods of management based on reliably grounded AI methods. Webber et al. (2019) suggested that AI tools can empower team leaders in doing team analysis and identifying improvement areas. Dam et al. (2019) claimed that AI technologies help in increasing success in agile (software) projects. Various lists of critical success factors for construction project success have been documented by numerous previous studies. However, *AI is not included as a CSF in any of the previous studies reviewed* (see Appendix A, Table I).

Methods

According to Cresswell (2013) qualitative approach is "appropriate to use to study a research problem when the problem needs to be explored; when a complex, detailed understanding is needed". This methodology is characterized by generating understanding, rather than testing (Corbin & Strauss, 2008). It "emphasizes words rather than quantification in the collection and analysis of data" (Bryman, 2012). This methodology is often adapted to understand a phenomenon about which little is known. Interviews, as a qualitative approach instrument, can be used for exploring new phenomena and for capturing individual understandings of meanings and processes (Given, 2008).

Interviews
Interviews are seen as a research strategy or technique for theory generation or theoretical framework generation. Qualitative interviews have the potential to generate insights and concepts and expand our understanding (Knight & Ruddock, 2008). Semi-structured interviews are employed to "learn the respondent's viewpoint regarding situations relevant to the broader research problem" (Blumberg et al., 2008 cited in Davis, 2017), provide rich data collection, allow for clarifications and expansion upon questions and answers during the interview (Davis, 2017). We chose to conduct semi-structured interviews to allow for identifying additional themes during discussions and to provide an opportunity for elaboration by interviewees. Various authors have recommended a different number of interviews to arrive at saturation in qualitative studies. Creswell (1998) recommended between five and twenty-five interviews, while Kuzel (1992) recommended six to

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Table 1. Respondent's profile, geography, and projects handled

S. No.	Item	Respondent 1 (PD)	Respondent 2 (PM)	Respondent 3 (PD)
1	**Qualification**	Master's in science	Degree in Engineering	Masters in Geology
2	**Total experience**	15 years	15 years	33 years
3	**Present project**			
3.1	Project type	Airport	Nuclear	Road, Building
3.2	Project location	Saudi Arabia	France	Algeria
3.3	Role in project	Project Director	Project Manager	Project Director
3.4	Project cost (tentative)	Project 1-Nine Billion US dollar (construction cost) Project 2 – 100-200 Million US dollar (construction cost)	35 billion euro (construction cost)	Project 1-110 million euro (consulting fee) Project 2-40 million euro (consulting fee) Project 3-8 million euro (consulting fee)
3.5	Present progress	Construction stage	Construction stage	Project 1-Closure stage Project 2-Ongoing project 3-Closure stage

S. No.	Item	Respondent 4 (PD)	Respondent 5 (PM)	Respondent 6 (OM)
1	**Qualification**	Graduate Engineer, MBA	Master's in engineering	High School
2	**Total experience**	23 years	11 Years	15 years
3	**Present project**			
3.1	Project type	Mining	Light rail	Road (O&M)
3.2	Project location	Africa	France	UK
3.3	Role in project	Project Director	Project Manager	O&M Manager
3.4	Project cost (tentative)	Two billion Euro (construction cost)	80 million euro (construction cost)	300-million-pound consulting fee for a 30-year O&M contract
3.5	Present progress	Recently completed	Construction stage	Operation and maintenance

S. No.	Item	Respondent 7 (DP)	Respondent 8 (PM)	Respondent 9 (PM)
1	**Qualification**	Master's in research, master's in engineering	Engineering, Business Administration	Graduate Engineer
2	**Total Experience**	15 years	14 Years	25 years
3	**Present project**			
3.1	Project Type	Road	Green Network	Road
3.2	Project location	French island	France	India
3.3	Role in project	Deputy Project Director	Project Manager	Project Manager
3.4	Project cost (tentative)	Five billion euro – construction cost	60 million euro (construction cost)	Five+ billion INR (construction cost)
3.5	Present progress	Construction stage	Construction stage	Recently completed

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Table 2. Themes and sub-themes

Theme	Sub-Themes
Theme 1 Artificial Intelligence (AI)	(1a) Project professionals' perceptions of AI
	(1b) AI vs. information technology
	(1c) AI vs. advanced project management software
Theme 2 AI and Construction project success	(2a) AI's perceived help to achieve greater project success
	(2b) AI's present use in construction projects
	(2c) AI's perceived timeline to become reality on construction projects
	(2d) AI's perceived impact on construction projects in the future.
Theme 3 AI vs. Project manager	(3a) AI perceived help to project managers
	(3b) Decision power/dominance

eight interviews (cited in Guest et al., 2006). Galvin (2015) found 8 to 17 interviews as the most common range, while Hennink et al. (2016) found that code saturation was reached after nine interviews.

The interviewees were selected on a convenience basis and included highly experienced project practitioners from the global community with expertise in project management, who have work experience on large construction projects and are engaging with state-of-the-art technology and AI integrated project management software like BIM, ERP etc. (Eber, 2020; Aktürk, 2021; Goundar et al., 2021). We conducted a total of nine face-to-face interviews between March 2019 and June 2019. Eight of the interviews took place in France and were video recorded, while one interview took place in India and was audio recorded. All nine interviews were then manually transcribed. Data were coded manually and analyzed using content analysis.

Data analysis related issues
Davis (2017) suggested replacing the terms "validity" with "truth value" and "reliability" with "consistency/confirmability" in qualitative studies, since the former are often presented as quantitative measures. We discussed the interview questions with two academic and two industry experts who reviewed and refined them with suggestions. We then developed an interview protocol and finalized it in consultation with the two academic experts. The professionals we interviewed represented seven geographic regions and were handling projects in eight different sectors. Table 1 summarizes the interviewee profiles, including geography, and projects handled.

Interview Results

Respondent profiles
All respondents except one had professional engineering qualifications and were working as a project manager or project director, handling large construction projects with varied teams. Their experience ranged from 10 to 33 years; specifically in project management, the average was 17.9 years. The construction cost of projects handled ranged from 60 million Euro to 35 billion Euro.

Themes and sub-themes
The interviews were manually coded to highlight the trends and differences in the respective interviewee's responses. After the initial coding, similar codes were collated and analysed, then themes were developed. These themes were analyzed to reveal respondents' perceptions about AI and its role as a success factor in construction projects. Table 2 shows the three main themes and related sub-themes identified during the process.

Theme 1: Artificial Intelligence

Project professionals' perception of AI
The key theme explored during the interviews was perceptions about AI by senior projects managers. We found varied and diverse perceptions of AI among the project professionals with some viewing it as an "intelligent system," some as a "processing tool," and others as a "prediction and data analysis" tool that

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outputs meaningful results from big data. Some respondents perceived AI as an intelligent system capable of analysing and making decisions like humans, while others disagree with that. Some respondents saw it as a processing tool or system that can help with specific activities to answer basic questions when asked in certain ways. Still others perceived it as a tool used for predicting and analysing big data and predicting situations, that it is "intelligent" with limited capabilities (See Appendix A, Table II).

AI vs. information technology

Two opposite views were found regarding AI as information technology (IT) with a majority of the respondents perceiving AI as different from IT, while a minority of others perceive AI and IT as the same thing, with only a difference of "level". Seven interviewees believed that AI differs from IT. They believe that AI uses IT as input, learns and improves by itself, can reason, interpret, make decisions, and reach conclusions. One unique respondent viewed AI and IT as the same thing, saying that both go hand-in-hand. He believed there is a level difference between AI and IT, meaning that AI is at a higher in level than IT, however, he accepted that AI cannot think for itself, since it is not self-aware.

AI vs. advanced project management software

Two opposite views were found about AI as an advanced project management software. Most respondents perceived AI being superior to advanced project management software, while minority others see AI and IT as the same. Seven interviewees saw AI as superior to advanced project management software like ERP, Civil-3D, or SAP, in that software can only simulate based on input data and cannot propose, whereas AI can propose different scenarios and offer a best option. One respondent viewed AI and IT as software programs.

Theme 2: Artificial Intelligence and construction project success

AI's perceived help to achieve greater project success

The opinions received about AI's perceived help to achieve greater project success were divided, overlapped, and varied from help in design, analysis, data processing, and with technical aspects only, and of no help in actual construction work. Five respondents opined that AI could help in designing, analysing, and predicting future suitability projections of a facility being constructed, thereby re-aligning investment strategies and phasing. Four respondents viewed it as a tool for

data processing, quick designs, risk evaluation or quantification, visualization, and planning. Five respondents viewed it as primarily helpful in planning and technical aspects by way of cutting down the time required. One respondent opined that AI will in fact increase efforts through extra time required to feed data to the system and review outputs. However, most respondents did not see AI as suitable during actual construction works and remained skeptical about AI being much help in construction: "…maybe, but I am not convinced."; "In a theoretical way it could work"; "It can or maybe it's like it can…"; "…maybe it, but in the sense…" (see Appendix A, Table III).

AI's present use in construction projects

None of the respondents said they were using any sort of AI technology in their present construction projects. One respondent believed that though direct AI was not being used for their construction projects, sometimes software and tools based on AI were used for traffic analysis. He refused, however, to consider project management software (such as ERP, SAP, and Civil 3D) as an example of AI.

AI's perceived timeline to become reality on construction projects in future

All respondents expressed certainty that AI is going to become a reality in construction projects in the future, though opinions regarding capabilities and timeframes for its emergence varied among them. Most of the respondents were of the view that AI may become a reality on construction projects within the next 7-20 years. One respondent believed that the problem with AI would not be technological, but rather the need to convince project managers to adopt it. One respondent viewed BIM software use as an intermediate stage to AI. One respondent remained skeptical about AI's capabilities, suggesting that AI can learn only within the parameters of programming, and that would mean somebody focusing on AI instead of on a project, at least until AI becomes "self-aware", which was considered as a point to worry about.

AI's perceived impact on future construction projects

Responses from respondents were mixed with most foreseeing a very limited role for AI in future construction projects and that it would be limited to the design, feasibility studies, and structured pre-construction phases. They perceived little benefit during the construction phase where humans are always facing surprises and must adapt to unknown situations, find

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solutions quickly, and in the right way. Most respondents were unsure or doubtful about the potential advantages of using AI in the construction phase: "I am not sure how"; "it can happen, it may happen"; "maybe I am wrong, but I think, no". Respondents were worried about losing employment to AI, as well as control over application of AI in construction projects.

Three respondents saw its use in the preconstruction design phase only, with not much use in the construction phase, as they doubted the ability of AI to develop soft skills and manage human relations. One respondent was apprehensive about AI having sufficient flexibility and agility to adopt a solution quickly and in a right way. Two respondents believed that eventually, like in other fields, AI will eventually find its place in complex construction projects and may help project managers dealing with multiple parameters by proposing quicker solutions. One respondent, in contrast, did not perceive any benefit from AI in future construction projects unless programs can think and make decisions on their own as a human would. This respondent was of the view that AI would be forced to make decisions that would have already been known to a person, and made a strong pitch for human analytical skills to assess situations and arrive at conclusions that AI would not be able to: "So, if you went to look at a structure that was damaged and as a … human you would look at it and would make a judgement on what type of repair [it needs], what was damaged, [and] so on and so forth. And AI could never do that".

Theme 3: Artificial Intelligence vs. project manager

AI as perceived help for project managers
The respondents were quite unanimous in their perception about AI currently being of very limited help to project managers during actual construction work. They perceived AI as a support assistant to the project manager for effective decision making. They viewed AI as being more useful during initial designs and simulations for optimizing resources and effective decision making. AI was perceived help in providing quick, well-formatted information and managing some regular tasks with first-hand checking. They opined that AI may be useful for processing data and proposing the most accurate option for one's project, thereby aiding the project manager's decision-making capacity. They did not perceive AI as a tool for the construction phase, in contrast to thinking of AI as "fully autonomous construction of useful real-world structures" in the

future, as predicted by researchers like Melenbrink et al. (2020). The construction project manager was seen as having the final say in validation and decision-making.

The major AI drawbacks identified by the respondents were the lack of soft skills (which humans possess), lack of intelligence to interpret things in various ways like human beings, and human relationship capabilities: "[B]ut the solution is never white or black; sometimes its white, sometimes its black, but often it's a compromise between you [and] the client", when it comes to managing projects.

Who will have decision-making power or dominance?
The respondents believed that project managers will continue to have the final decision power in the foreseeable future. However, the opinion on dominance was not held by one respondent who believed that AI would dominate and project managers "will just need to follow" the AI's recommendations. One respondent believed that until or unless AI can "argue back", there would not be any problem, but saw a big problem in the prospect of AI becoming self-aware in the future. All respondents except one agreed that final decision-making power should lie with the project manager, with the caveat that "as a project manager, you may take a decision which may not appear logical but for some political issue, economical issue, etc. you may choose in a different way" (see Appendix A, Table IV).

The interviews highlighted important perceptions about the roles and capabilities of AI in the minds of practitioner and emphasized the need to explore AI as a success factor for construction projects. The issues identified in the interviews were compared to those in the reviewed studies. The findings are summarized in the Discussion and Conclusions sections.

Discussion

The perceptions of construction project professionals reflect a contrast to the published literature about the current day success stories of AI-automated construction processes being used on construction projects. Table 3 shows the perceptual mapping of the identified themes and sub-themes within the published literature.

Artificial Intelligence
Perceptions from respondents who regarded AI as a processing tool or system contrasted with what has been

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Table 3. Perceptual mapping of AI in construction project

Theme	Sub-themes	Scientific Contribution
Theme 1 Artificial Intelligence	(1a) Perception of AI	Haefner et al., 2021; Haenlein & Kaplan, 2019
	(1b) AI as information technology	Pan & Zhang, 2021
	(1c) AI as advanced project management software	Aktürk, 2021; Goundar et al., 2021; Sacks et al., 2020
Theme 2 AI and construction project success	(2a) AI's perceived help to achieve greater project success	Pan & Zhang, 2021
	(2b) AI's present use on construction projects	Pan & Zhang, 2021
	(2c) AI's perceived timeline to become reality on construction projects	Haenlein & Kaplan, 2019;
	(2d) AI's perceived impact on construction projects in the future	Tiruneh et al., 2020
Theme 3 AI vs. project manager	(3a) AI's perceived help for project managers	Haefner et al., 2020
	(3b) Who has decision-making power and dominance?	Haefner et al., 2020

reported in previous studies about the success stories of AI. Respondent views of AI as an intelligent system somewhat aligned with the researchers' views of AI being a science of inventing intelligent machines and computer systems (Kumar et al., 2019; Darko, et al., 2020); a system capable of correctly interpreting and learning from external data (Kolbjørnsrud et al., 2017; Haenlein & Kaplan, 2019). However, practitioner respondents did not perceive AI as capable of accessing field situations during the construction progress or of making decisions like project managers. This stands in contrast to previous studies by researchers like Hamet and Tremblay (2017), Haefner et al. (2021), and Pan and Zhang (2021). The respondent perceptions of AI as being superior to project management software was in contrast to the published literature that claims AI as an integrated part of PMS software like ERP and others (Aktürk, 2021; Goundar et al., 2021).

AI and construction project success
The findings from the interviews differ regarding the suitability of AI during the construction project execution phase. The present state of use of AI, the timeline for AI to become a realty on construction projects, and the perception of a limited and only supportive role of AI in future construction project contrasted with the published literature. The published literature that have predicted since the 1950s that AI would reach intelligence behaviour *indistinguishable from humans* within a "few years"

(Haenlein & Kaplan, 2019; Şerban & Todericiu, 2020; Borges et al., 2021) were not reflected in the current study. Pan and Zhang (2021) opined that various AI approaches can achieve three major functions that are beneficial to CEM in terms of automation, risk mitigation, high efficiency, digitalization, and computer vision, including (i) Modeling and pattern detection, (ii) Prediction, and (iii) Optimization. However, respondents' opinions also contrasted with this.

The perception about AI being helpful in design and analysis, data processing, planning and risk evaluation was in line with previous studies (Ayhan & Tokdemir, 2019; Zheng et al., 2020; Pan & Zhang, 2021). As was the concern about AI potentially becoming "self-aware" in the future, along with fear of losing jobs (Epstein, 2015; Kaplan & Haenlein, 2019; Kumar et al., 2019; Borges et al., 2021; Loureiro et al., 2021). The concerns regarding ethical, legal, and philosophical challenges associated with AI have been raised in many previous studies (Haenlein & Kaplan, 2019; Asatiani, et al., 2021; Du & Xie, 2021), including by the noted scientist Stephen Hawking, who stated: "Success in creating effective AI, could be the biggest event in the history of our civilization. Or the worst. We just don't know" (cited in Girasa, 2020).

It thus appears that several apprehensions need to be removed from the minds of project professionals if the benefits of AI are to be reaped. Concerns about AI's

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flexibility and agility to adopt solutions quickly and in the right way were in line with Sacks et al. (2020). They found that basic BIM functions took 25 years to reach the market, none of the robotic machines made for construction achieved the revolutionary change they were thought to, and automation in construction has proved to be a frustratingly difficult goal when it comes to implementation.

Artificial intelligence vs. project manager
The finding that AI lacks soft skills and human intelligence to interpret things in different ways was in line with Epstein (2015) and Sinz et al. (2019). They found that the "skills" of artificially intelligent computers are even below that of a one-year-old child when it comes to perception and mobility. The belief that project managers will have final decision-making power was also in line with the opinion of Haefner et al. (2021) that the "judgement of managers may be difficult to replace". Respondents' opinions about AI being of limited help to professionals during construction projects aligns with the findings of Sacks et al. (2020) about automated project performance monitor and control systems encountering technical and conceptual barriers to provide real-time feedback to project managers. Likewise, the non-reliability of information provided thereby requires manual review and intervention that often invalidate the benefits of automation.

Conclusions

In this paper we addressed the following research question: *Can AI help complete construction projects within budget, on-schedule, and according to specifications thereby increasing the chances of project success?* In attempting to understand the inherent ambiguity, complexities, and dynamics of most large construction projects that bring in scheduling disruptions, cost overruns, and compromised conditions, this paper has observed the need for state of art technologies to protect construction projects from negative impacts. While we attempted to identify whether AI is a potential candidate as a critical success factor for construction project success, this paper's findings suggest that the perceptions of project practitioners about AI's suitability in field construction works differ from published studies. Likewise, the role of AI as a critical success factor in construction projects is yet to be fully explored.

Interview data that we collected show that construction practitioners' views are different from research findings regarding AI capabilities and uses. Project managers are aware about the advantages and capabilities of AI, perceiving AI as a tool or system that can predict and analyse, learn and make decisions at its own, or even potentially become self-aware, in contrast with information technology and advanced project management software. They perceive that AI is still in a very primitive stage and has a very restricted role during the execution phase of construction projects, which is primarily limited to design calculations and as support for project managers in completing basic repetitive tasks. The major drawbacks of AI cited by our interview respondents were its lack of soft skills, human-like intelligence to interpret things in various ways, human relationship capabilities, and the way human beings manage projects. Findings from these interviews highlighted the need to connect future research with the role of AI as a critical success factor for construction projects to exploit the full potential and advantages of AI in the construction industry. AI has already started affecting the entire value chain system of companies and is transforming industries in a fundamental manner. For project practitioners, this research provides a real-world example of senior project manager experiences. Given the good potential for AI uses on construction projects, we believe that project practitioners may increasingly opt to use AI more and more in executing their routine work to increase project performance and efficiency, thereby increasing the chances of project success.

Further, though prior literature has discussed CSFs in great detail, this study has tried to build a space for itself in the discourse. It provided insights for further research on AI as a CSF for scholars in project management, thereby complementing the existing body of work around the benefits of AI that contributes to success through extending CSFs.

Limitations and directions for future research
The major limitations of this study include the small sample size. This necessitates investigating the views of other stakeholders directly involved on the construction projects as well. We propose more in-depth interviews and surveys should be conducted with a wider audience in the construction industry to ensure comparable results. This would increase the credibility of this study and to allow for confirmation of whether this study's findings are similar across a larger sample of stakeholders.

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Appendix A

Table 1. Critical Success Factors identified in previous studies

CSF Dimensions	Scale item	Scientific Contribution
Human factors	Project manager's competency / Project team competency	Sanvido et al., 1992; Belassi & Tukel, 1996; Chua et al.1999; Chan et al., 2004; Nguyen et al., 2004; Fortune & White, 2006; Iyer & Jha, 2006; Yu et al., 2006; Toor & Ogunlana, 2009; Kog & Loh, 2012; Tabish & Jha, 2012; Gudienė et al., 2013a; Hwang & Lim, 2013; Davis, 2014; Ihuah et al., 2014; Rolstades et al., 2014; Taherdoost & Keshvarzsaleh, 2016; Maghsoodi & Khalilzadeh, 2017; Misic & Radujkovic 2017; Tsiga et al., 2017; Asgari et al., 2018; Ghanbaripour et. al., 2018; Mavi & Standing, 2018; Sinesilassie et. al., 2018; Altarawneh & Samadi, 2019; Negash et al., 2020
	Project manager's leadership	Fortune & White, 2006; Hyväri, 2006; Muller & Turner, 2007; Kaulio, 2008; Qureshi et al., 2009; Muller & Turner, 2010; Kandelousi et al., 2011; Walker & Walker, 2011; Ahadzie et al., 2014; Cserháti & Szabó, 2014; Ihuah et al., 2014; Medina & Medina, 2014; Lloyd et al., 2015; Andersen, 2016; Ghanbaripour et. al., 2018; Altarawneh & Samadi, 2019; Ahmed et al., 2020
	Project participants commitments in meeting the project goal	Sanvido et al., 1992; Belassi & Tukel, 1996; Chan et al., 2001; Nguyen et al., 2004; Iyer & Jha, 2006; Yu et al.,2006; Jha & Iyer, 2007; Tabish & Jha, 2012; Hwang & Lim, 2013; Cserháti & Szabó, 2014; Ghanbaripour et. al., 2018; Altarawneh & Samadi, 2019; Jitpaiboon et. al., 2019
	Trouble shooting	Pinto & Slevin, 1987; Toor & Ogunlana, 2009; Gudienė et al., 2013; Ihuah et al., 2014; Altarawneh & Samadi, 2019
	Good coordination between project participants	Belassi & Tukel, 1996; Chan et al., 2004; Jha & Iyer, 2007; Tabish & Jha, 2012; Gudienė et al., 2013; Cserháti & Szabó, 2014; Ihuah et al., 2014; Asgari et. al., 2018; Ghanbaripour et. al., 2018; Sinesilassie et. al., 2018; Altarawneh & Samadi, 2019; Negash et al., 2020
	Top management support	Nguyen et al., 1992; Belassi & Tukel, 1996; Iyer & Jha, 2006; Kumar & Iyer, 2007; Tabish & Jha, 2012; Cserháti & Szabó, 2014; Gudienė et al., 2014; Ihuah et al., 2014; Asgari et. al., 2018; Ghanbaripour et. al., 2018; Sinesilassie et. al., 2018; Altarawneh & Samadi, 2019; Jitpaiboon et. al., 2019; Negash et al., 2020
	Decision making effectiveness	Fortune & White, 2006; Iyer & Jha, 2007; Thi & Swierczek, 2010; Gudienė et al., 2014; Altarawneh & Samadi, 2019; Jitpaiboon et. al., 2019
Procurement factors	Comprehensive contract documentation	Sanvido et al., 1992; Chua et al., 1999; Nguyen et al., 2004; Toor & Ogunlana, 2009; Alzahrani & Emsley 2013; Cserháti & Szabó, 2014; Maghsoodi & Khalilzadeh, 2017; Ghanbaripour et. al., 2018; Altarawneh & Samadi, 2019
	Competitive procurement process	Chan et al., 2004; Li et al.; 2005; Cheung et al., 2012; Altarawneh & Samadi, 2019; Negash et al., 2020
	Transparency in procurement process	Chan et al., 2004; Li et al., 2005; Gudienė et al., 2013a; 2013b; Altarawneh & Samadi, 2019; Negash et al., 2020

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Table 1. Critical Success Factors identified in previous studies (cont'd)

	Appropriate risk allocation and risk sharing	Li et al., 2005; Kog & Loh, 2012; Gudienė et al., 2013b; Hwang & Lim, 2013; Ihuah et al., 2014; Maghsoodi & Khalilzadeh, 2017; Altarawneh & Samadi, 2019
	Accurate and reliable estimates of project costs	Maghsoodi & Khalilzadeh, 2017
	Awarding bids to the right designer/contractor	Nguyen et al., 2004; Toor & Ogunlana, 2008; Maghsoodi & Khalilzadeh, 2017; Sinesilassie et. al., 2018
Project management factors	Development of a good project plan	Chan et al., 2004; Toor & Ogunlana, 2009; Gudienė et al., 2013a; Ihuah et al., 2014; Maghsoodi & Khalilzadeh, 2017; Altarawneh & Samadi, 2019
	Adequate use of communication among project participant	Sanvido et al., 1992; Nguyen et al., 2004; Yu et al., 2006; Jha & Iyer, 2007; Toor & Ogunlana, 2008; Tabish & Jha, 2012; Cserháti & Szabo, 2014; Ghanbaripour et. al., 2018; Sinesilassie et. al., 2018; Altarawneh & Samadi, 2019
	Clarity of project goal to the project team	Ashley et al., 1987; Pinto & Slevin, 1987; Chan et al., 2004; Yu et al., 2006; Toor & Ogunlana, 2008; Cserháti & Szabó, 2014; Ghanbaripour et. al., 2018; Altarawneh & Samadi, 2019; Jitpaiboon et. al., 2019
	Effective project monitoring and control system	Ashley et al., 1987; Pinto & Slevin, 1987; Chan et al., 2004; Iyer & Jha, 2006; Jha & Iyer, 2007; Toor & Ogunlana, 2008; Tabish & Jha, 2011; Hwang & Lim, 2013; Gudienė et al., 2013a; Cserháti & Szabó, 2014; Ihuah et al., 2014; Maghsoodi & Khalilzadeh, 2017; Ghanbaripour et. al., 2018; Sinesilassie et. al., 2018; Altarawneh & Samadi, 2019
	Project team -motivation	Chua et al., 1999; Hwang & Lim, 2012; Inayat et al., 2012; Kog & Loh, 2012; Gudienė et al., 2013b; Hwang & Lim, 2013; Altarawneh & Samadi, 2019
	Effective partnering among project participants	Tabish & Jha, 2011; Sinesilassie et. al., 2018; Negash et al., 2020
	Awareness of and compliance with rules and regulations	Tabish & Jha, 2011
	Flexibility	Shahu et al., 2012; Ghanbaripour et. al., 2018
	Clear objectives and scope	Chan et al., 2001; Nguyen et al., 2004; Yu et al., 2006; Toor & Ogunlana, 2008; Elwakil et al., 2009; Inayat et al., 2012; Kog & Loh, 2012; Hwang & Lim, 2013; Asgari et. al., 2018; Sinesilassie et. al., 2018
	Continuing involvement of stakeholders in the project	Nguyen et al., 2004; Maghsoodi & Khalilzadeh, 2017; Ghanbaripour et. al., 2018; Jitpaiboon et. al., 2019; Negash et al., 2020
	Planning	Inayat et al., 2012; Kog & Loh, 2012; Hwang & Lim, 2013; Ghanbaripour et. al., 2018; Negash et al., 2020
	Supervision level	Ghanbaripour et. al., 2018; Negash et al., 2020

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Table 1. Critical Success Factors identified in previous studies (cont'd)

	Project management practices / methodologies / methods / tools	Jugdev et al., 2013; Joslin & Muller, 2015; Mitra Pedersen, 2016; Radek Doskocil, 2016; Haron et. al., 2017; Ghanbaripour et. al., 2018; Jitpaiboon et. al., 2019
	Client responsiveness	Ghanbaripour et. al., 2018
Project characteristics factors	Project size /	Belassi & Tukel, 1996; Chan et al., 2004; Hyväri, 2006; Ademiluyi, 2010; Inayatet al., 2012; Kog & Loh, 2012; Alzahrani & Emsley, 2013; Gudienė et al., 2013a; Maghsoodi & Khalilzadeh, 2017; Ghanbaripour et. al., 2018; Altarawneh & Samadi, 2019; Negash et al., 2020
	/ Value of a project	
	/ Complexity and uniqueness of project activities	
	/ The type of project (new, existing, maintenance)	
	/ The urgency of project outcome	
	/ Density of a project	
Project environmental factors	Physical environment	Park, 2009; Tabish & Jha, 2012; Gudienė et al., 2013b; Gunduz & Yahya, 2018; Altarawneh & Samadi, 2019
	Natural climates	Chan et al., 2004; Tabish & Jha, 2012; Amade et al., 2015; Gunduz & Yahya, 2018; Altarawneh & Samadi, 2019
	Economic and financial problems like price, local currency value	Pourrostam & Ismail, 2012; Alzara et al., 2016; Durdyev et al., 2017; Maghsoodi & Khalilzadeh, 2017; Ghanbaripour et. al., 2018; Altarawneh & Samadi, 2019; Negash et al., 2020
	Bureaucratic interference	Nguyen et al., 2004; Phua,2004; Altarawneh & Samadi, 2019
	Unexpected geological condition, unexpected prices raise for labor, unexpected prices raise for material	Chan et al., 2004; Tabish & Jha, 2012; Gunduz & Yahya, 2018; Altarawneh & Samadi, 2019
	Late delivery of materials and equipment	Doloi et al., 2011; Akogbe et al., 2013; Aziz & Abdel-Hakam, 2016; Altarawneh & Samadi, 2019
	Shortage of labor	Ugwu & Kumaraswamy, 2007; Ogwueleka, 2011; Alzahrani & Emsley, 2013; Altarawneh & Samadi, 2019
Factors related to project funding	Adequate funding throughout the project	Nguyen et al., 2004; Inayat et al., 2012; Kog & Loh, 2012; Hwang & Lim, 2013; Maghsoodi & Khalilzadeh, 2017; Asgari et. al., 2018; Ghanbaripour et. al., 2018; Negash et al., 2020
	Availability of resources	Nguyen et al., 2004; Maghsoodi & Khalilzadeh, 2017; Sinesilassie et. al., 2018; Negash et al., 2020
Project contract	Proper emphasis on past experience	Sanvido et al., 1992; Nguyen et al., 2004; Alzahrani & Emsley, 2013; Ghanbaripour et. al., 2018
Cultural and socio-demographic factors	National culture, Demographic profile of the respondents	Park, 2009; Al-Tmeemy, Abdul-Rahman, & Harun, 2011; Tripathi & Jha, 2017; Martens et al., 2018; Vijayabanu et al., 2020
Other factors	Organization structure	Belassi & Tukel, 1996

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Table 1. Critical Success Factors identified in previous studies

	Qualified and experienced project management	Maghsoodi & Khalilzadeh, 2017
	Ongoing consultation with the project employer	Maghsoodi & Khalilzadeh, 2017
	Regulations and political or economic and social issues	Maghsoodi & Khalilzadeh, 2017; Negash et al., 2020
	Pre-project planning and clarity in scope	Tabish & Jha, 2011; Sinesilassie et. al., 2018; Jitpaiboon et. al., 2019
	Up to date technology utilization / Advanced technologies / Use of IT tools	Chan et al., 2004; Nguyen et al., 2004; Toor & Ogunlana, 2008; Elwakil et al., 2009; Negash et al., 2020
	Owner's competence	Iyer & Jha, 2006; Asgari et. al., 2018
	Favourable working conditions	Iyer & Jha, 2006; Ghanbaripour et. al., 2018; Negash et al., 2020
	Contractor's company characteristics, technical and professional ability / competence & experience	Alzahrani & Emsley, 2013; Asgari et. al., 2018; Ghanbaripour et. al., 2018; Negash et al., 2020
	Decision making effectiveness	Fortune & White, 2006; Iyer & Jha, 2007; Thi & Swierczek, 2010; Gudienė et al., 2014; Altarawneh & Samadi, 2019; Jitpaiboon et. al., 2019
	Design expertise	Chan et al., 2001; Ghanbaripour et. al., 2018; Negash et al., 2020
	Education and training	Negash et al., 2020
	Formal dispute resolution process	Toor & Ogunlana, 2008; Inayat et al., 2012; Kog & Loh, 2012
	Legal environment / Legal expertise	Ghanbaripour et. al., 2018; Negash et al., 2020
	Material and equipments	Negash et al., 2020
	Mutual trust among project stakeholders	Ghanbaripour et. al., 2018
	No major changes in the scope of work during construction	Sinesilassie et. al., 2018
	Project cultural fit	Ghanbaripour et. al., 2018
	Regular quality control and quality assurance systems	Ghanbaripour et. al., 2018; Sinesilassie et. al., 2018
	Skilled workers	Ghanbaripour et. al., 2018; Negash et al., 2020

Note: Based on the scale by Altarawneh and Samadi, 2019 along with the authors' compliation.

Technology Project Summaries as a Predictor of Crowdfunding Success

Mika Westerlund, Ishdeep Singh, Mervi Rajahonka & Seppo Leminen

" It's fine to celebrate success, but it is more important to heed the lessons of failure. "

Bill Gates
Co-founder of Microsoft

Crowdfunding has emerged in recent years as an important alternative means for technology entrepreneurs to raise funds for their products and business ideas. While the success rate of crowdfunding projects is somewhat low, scholarly understanding of what distinguishes projects that reach their fundraising goals from those that fail remains incomplete. Further, studies on crowdfunding success often examine a number of variables that make predicting success a challenge for entrepreneurs willing to use crowdfunding. This study uses topic modelling on a data set of over 21,000 technology projects from Kickstarter to investigate if short-text project summaries can reveal predictors of fundraising success on crowdfunding platforms. The results indicate that compared to those that fail in fundraising, project summaries of successfully funded technology projects put forward more trendy topics, use wording that reflects novelty, and focus on solving a social problem. Our results contribute to theory and practice by suggesting the importance of summarizing project content for crowdfunding success.

Introduction

Crowdfunding has become an important channel for innovators, entrepreneurs, and incumbents to raise funds for developing new technology products and business ideas (Yuan et al., 2016; Kraus et al., 2016; Dushnitsky et al., 2016; Brem et al., 2019; Popescul et al., 2020; Rrustemi & Tuchschmid, 2020; Sahaym et al., 2021). Crowdfunding has been defined as "the efforts by entrepreneurial individuals and groups —cultural, social, and for-profit —to fund their ventures by drawing on relatively small contributions from a relatively large number of individuals using the internet, without standard financial intermediaries" (Hörisch, 2015; Simons et al., 2019). Unlike traditional funding and investment options, crowdfunding is an alternative digital multisided marketplace that stays open to everyone (Kraus et al., 2016; Hoegen et al., 2018; Isabelle et al., 2019; Koch & Siering, 2019). It thereby aims to collect small amounts of money from many non-professional investors, rather than large amounts of money from a few professional investors (Simon et al., 2019).

The benefits of crowdfunding include online platforms that allow for efficient matching of fund-seekers and funders, aggregating small donations into large pools of capital, lowering geographic barriers to fundraising, funding projects that may otherwise be outside of traditional funding methods, and democratizing research and exploration in underexplored fields (Pomeroy et al., 2019; Popescul et al., 2020; Felipe et al., 2022). Crowdfunding platforms provide fund-seekers and funders with means for investment transactions to take place that create value (that is, via legal groundwork, pre-selection screening, and processing financial transactions), as well as allowing for the testing of new products, estimating demands, and running new marketing campaigns (Cordova et al., 2015; Lukkarinen et al., 2016; Borst et al., 2018; Wehnert et al., 2019; Popescul et al., 2020).

According to Koch and Siering (2019), a successful funding of crowdfunding campaigns can be important for founders, investors, platform operators, and other interest groups. However, success in raising capital through crowdfunding that involves non-professional

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investors and happens online may not be easy and the determinants of investment decisions on crowdfunding platforms may be different than in traditional investing environments (Lukkarinen et al., 2016; Hoegen et al., 2018; Song et al., 2019; Popescul et al., 2020; Cappa et al., 2021). Rosetto and Regner (2018) found that most successful crowdfunding projects are not succeeding for 75 percent of their funding period. Further, Liang et al. (2019) noted that the success rate of projects that reach their crowdfunding goal is low (for example, 33 percent on Kickstarter), implying a need for research on what affects funders' intentions to sponsor or not sponsor a project.

Borst et al. (2018) argued that, for example, the online nature of crowdfunding may amplify a "bystander effect", which suggests that potential funders may withhold funding because they assume that others will provide funding. While research to understand and predict crowdfunding success has accelerated in recent years (for example, Majumdar & Bose, 2018; Song et al., 2019; Felipe et al., 2022), it has often focused on highly specific industrial domains, such as green energy (Hörisch, 2015; Kubo et al., 2021), restaurants (Lelo de Larrea et al., 2019), medical solutions (Ba et al., 2021), video games (Song et al., 2019), or space exploration (Pomeroy et al., 2019). Alternatively, research has also addressed multiple domains and numerous variables at once (for example, Parhankangas & Rernko, 2017; Zhou et al., 2018; Song et al., 2019; Ryoba et al., 2021).

More accurate prediction models may be provided by widening up a large number of variables into the research investigations, such as including project and funding level (Liang et al., 2019), the entrepreneur's gender (Johnson et al., 2018; Geiger & Moore, 2022), education (Allison et al., 2017), number of social network ties (Lukkarinen et al., 2016; Borst et al., 2018; Hoegen et al., 2018), number of comments and blog entries, and presence of a video appeal (see Kraus et al., 2016; Wang et al. 2018; Geiger & Moore, 2022; Kubo et al., 2021; Ryoba et al., 2021). However, applying such complex models into practice can be difficult. Fundraising has also been suggested as dependant upon how funding requests are placed (Majumdar & Bose, 2018), implying that crowdfunding decisions could depend on the content and persuasiveness of short-text descriptions that summarize a fund-seeking project's main idea (Parhankangas & Renko, 2017; Majumdar & Bose, 2018; Koch & Siering, 2019; Yeh et al., 2019). This possible avenue of exploration gives raise to our research question for this paper: can we identify what matters for

funders deciding whether or not to sponsor fund-seekers by investigating fund-seeking project summaries and using that information to predict project crowdfunding success?

Automated content analysis of texts can help to identify key topics in textual data (Yuan et al., 2016; Costello & Lee, 2022). One particular method of content analysis called "topic modelling" has emerged to explore hidden topics in text documents, which provides a means of analyzing large unclassified texts (Alghamdi & Amfalqi, 2015; Jeong et al., 2019). It creates clusters of words based on co-occurrences and similarity of meanings and distinguishes between uses of words with multiple meanings (Alghamdi & Amfalqi, 2015). Prior studies have applied topic modelling on crowdfunding project descriptions in specific technology domains such as green energy (Yuan et al., 2016) and software (Lee & Sohn, 2019), and suggested that results from topic modelling should be linked with project funding success (Jiang et al., 2020). Hence, in our research we used topic modelling, namely the Latent Dirichlet Allocation (LDA) method (Blei et al., 2003) applied to a data set of over 21,000 short-text summaries of diverse technology projects from Kickstarter. This was done to identify and compare topics in project summaries of successfully funded versus unsuccessfully funded fund-seeking projects. In this way, we aimed to contribute to the literature with various insights on what matters for fundraising success in crowdfunding.

Literature Review

Crowdfunding success

Crowdfunding opens an alternative financing channel for entrepreneurs to raise funds online for innovative projects (Xu et al., 2016). In crowdfunding, a high number of individuals, each contributing relatively small amounts of capital, can collectively aggregate funds for the purpose of financing potentially large projects (Hörisch, 2015). Crowdfunding is facilitated by online platforms where people can register a project and try to raise funds from a crowd of platform users (Brem et al., 2019; Song et al., 2019). Projects on crowdfunding platforms are often called "campaigns" (Popescul et al., 2020). A project "creator" (also known as "initiator", "founder" or "fundraiser") sets an appeal to potential funders (also known as "investors", "backers" or "lenders") in the crowd of users through a dedicated crowdfunding platform for capital. This takes place in the form of loans, donations, equity purchases, or pre-ordering a product (Kraus et al., 2016; Koch & Siering,

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2019; Pomeroy et al., 2019). Online platforms such as Kickstarter or Indiegogo serve as intermediaries that charge fees to creator fundraisers, while funders are not required to pay fees to the platform (Kraus et al., 2016; Zhang et al., 2022). Crowdfunding platforms not only allow creators to raise money, but also enable them to gain public attention, connect with others, run marketing campaigns, test and validate new products and services, and obtain feedback from a platform crowd (Cordova et al., 2015; Bi et al., 2017; Wehnert et al., 2019).

Crowdfunding can be applied to raise money for various purposes, based on the specific type of platform; for example, organizing an event, realizing an art project, accomplishing a social initiative, creating a product, or launching a start-up (Petitjean, 2018; Brem et al., 2019). Crowdfunding platforms offer several different models of crowdfunding: 1) donation-based crowdfunding, where funders do not receive any reward but donate for the pleasure that they get from supporting an initiative, 2) passive investment crowdfunding (also known as the "reward-based model") where funders receive a monetary or non-monetary reward for their support, ranging from honorary recognition to receiving the final product or service for free or at a discounted price, or even profit sharing, 3) the lending-based model, where investors provide small loans and can earn a contractually-agreed interest payment, and 4) active investment crowdfunding (also known as the "equity-based model"), where funders, similar to traditional investors, receive shares or similar rights in return for their financial contribution (Hörisch, 2015; Kraus et al., 2016; Yeh et al., 2019; Ralcheva & Roosenbloom, 2021; Felipe et al., 2022). According to several scholars (Cordova et al., 2015; Xie et al., 2019; Ralcheva & Roosenbloom, 2021; Cappa et al., 2021), reward-based platforms such as Kickstarter have been the most popular due to their widespread usage by entrepreneurs for raising funds for startup businesses or pre-selling products and services. However, platforms that have started using the equity-based model are rapidly growing in importance. Further, Petitjean (2018) argued that reward-based and equity-based crowdfunding campaigns are driven by similar success factors.

Previous research has investigated crowdfunding success from multiple perspectives. Xu et al. (2016) argued that crowdfunding consists of two major phases: 1) raising capital, and 2) project implementation. Thus, crowdfunding success or failure addresses two key dimensions: whether the crowdfunding project reaches its capital raising goal, and whether the entrepreneur implements the project successfully (Xu et al., 2016). Scholars such as Xu et al. (2016) and Pomeroy et al. (2019) have focused on understanding the antecedents and consequences of success in the second dimension, that is, project implementation. Xu et al. (2016) investigated the role of project implementation performance (delivery timeliness and product quality), project novelty, sponsor participation, entrepreneur activeness, and sponsor demographics. Of note, sponsor participation was found to be highly important for successful crowdfunding as it helps entrepreneurs improve their projects (Xu et al., 2016). Further, Mollick (2014) found that the geographical proximity of founders to their project's supporters tends to result in more successful projects. Stanko and Henard (2017) noticed that the amount of funding raised does not significantly impact implementation performance, while the number of backers does. Finally, Pomeroy et al. (2019) found that crowdfunding implementation can lead to democratizing exploration in emerging and under-researched fields.

That said, most research on crowdfunding success has aimed at identifying the antecedents of successfully raising capital, rather than on project implementation. Hence, similar to Yan et al. (2016), Sahaym et al. (2021) and Zhang et al. (2022), "crowdfunding success" in our study refers to the fundraising success of a project, addressing specifically whether or not the project's initial funding goal is met. Naturally, the higher a project's funding goal is, the less likely it will be reached (Koch & Siering, 2019). Nonetheless, prediction models that aim to understand crowdfunding success from the fundraising perspective typically include a large number of various antecedents, ranging from the creator's age and gender (Johnson et al., 2018; Ba et al., 2021), education (Allison et al., 2017), and social capital (Ba et al., 2021; Zhang et al., 2022), to web presence and social network ties (Hoegen et al., 2018), replies, updates, comments and blog entry counts on the project (Kraus et al., 2016; Wang et al., 2018; Yeh et al., 2019), word count of the project's introduction, video count (Bi et al., 2017), and project type and funding level (Liang et al., 2019). Cordova et al. (2015) investigated the roles of funding goal, project duration, and daily amount of money contributions in predicting fundraising success. They found that backers tend to evaluate project potential in terms of a project's anticipated economic value, in addition to the presence of a guaranteed tangible output. Likewise important were the degree to which the functional benefits of the project outcome serve a functional need of the individual funder

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(Cordova et al., 2015), as well as the project's general trustworthiness (Liang et al., 2019; Song et al., 2019; Yeh et al., 2019).

Nonetheless, it may not be quantity, but rather quality that matters most for crowdfunding success. In other words, important factors include what is said and how (that is, the tone) the project is being introduced (Chen et al., 2013; Costello & Lee, 2022; Geiger & Moore, 2022). For example, the presence of various persuasive appeals, such as videos (Wheat et al., 2013) and various rational and emotional appeals, use of images, length of project title and description (Koch & Siering, 2019; Yeh et al., 2019), as well as references to authenticity in a funding request increase the likelihood of a project's funding success (Majumdar & Bose, 2018). Davis et al. (2017) found that the affective reactions of funders toward a new product pitch, particularly in terms of how the funders perceive entrepreneurial passion in the crowdfunding pitch, be that written or spoken in a video, are strongly associated with crowdfunding success. Further, the linguistic style and persuasiveness of entrepreneurial communication and the project description have been identified as being essential for fundraising performance (Parhankangas & Renko, 2017). In particular, the content of the project description, via either a short summary of the project or a longer elaboration, has surfaced as a potential indicator of a project's funding success (Majumdar & Bose, 2018; Zhou et al., 2018; Yeh et al., 2019; Costello & Lee, 2022). Zhang and colleagues (2022) found that longer descriptions about campaigns can improve crowdfunding performance. However, while many crowdfunding platforms, such as Kickstarter, only provide short-text project summaries, limited to tens of characters (Koch & Siering, 2019), a question remains: can content analysis of short-text project summaries help to predict crowdfunding success?

Topic modelling
The accumulation of user-generated content (UGC), including a wealth of information about people's tastes, opinions, thoughts, and actions is raising an increasing interest from entrepreneurs (Gallinucci et al., 2015). Topic modelling offers a means to extract meaningful information from documents through attempts to identify models, trends, patterns, or rules in unstructured textual data (He et al., 2017). Topic modelling is based on the idea that every document in a text corpus addresses various topics that are not necessarily known a priori (Bittermann et al., 2018). Thus, it helps to uncover hidden shared topics in multiple text documents. This is because text documents are composed of words, and a topic mentioned in multiple documents can be expressed in a combination of correlated words (Jeong et al., 2019). As a result, topic modelling can discover underlying patterns called "topics" that unite the documents in the corpus (Alghamdi & Amfalqi, 2015).

Among the alternative topic modelling algorithms, Latent Drichlet Allocation (LDA) has become the most widely used (Guen & Juyoung, 2018). It is considered to offer the highest performance value when dealing with a large-scale of documents and interpreting topics (Jeong et al.,2019). LDA is a generative probabilistic model (Blei et al., 2003) that enables determining the probability of a text document that belongs to each topic and which thereafter groups overlapping topics in documents. It also helps to identify which topics are capturing more attention (Calheiros et al., 2017). According to Huang et al. (2018), the benefits of LDA include that, 1) it can process a massive collection of documents that would be too costly to code manually, 2) it provides a reliable and replicable classification of topics, and 3) it does not require researchers to pre-specify rules or keywords for the underlying taxonomy of categories. Lee and Sohn (2019) applied LDA to investigate the crowdfunding of software projects and suggested that the results from topic modelling should be linked with projects' funding success. Jiang et al. (2020) did not interpret their topics but found that the topics in project descriptions were statistically associated with crowdfunding success. We thus focussed on the Kickstarter platform, analyzing a large data set of projects across various technology subcategories, with the aim of identifying and interpreting key topics in the corpus, associating these topics with crowdfunding success and failure, and explaining the potential associations.

Methodology

Our empirical research draws on a topic modelling analysis of short-text project summaries that were extracted from Kickstarter in 2018. Kickstarter is a reward-based crowdfunding platform that enables entrepreneurs to garner funds in support of a specific purpose, which often centers on the development or distribution of a new, unfinished, or unproven product (Davis et al., 2017; Liang et al., 2019). Our initial data comprised of almost 23,000 project summaries with information on their funding success, covering a total of 15 technology subcategories. Xu et al. (2016) argued that the success of crowdfunding can be measured by

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whether the crowdfunding project reaches its capital raising goal or whether the entrepreneur implements the project successfully. Similar to Cordova et al. (2015), we studied the crowdfunding success of technology projects, and refer to success or failure in simple terms of overfunding and underfunding. While an overfunded project successfully reaches or exceeds the initial funding goal, an underfunded project fails to reach the goal, and is thus deemed "unsuccessful" in terms of fundraising. This is in line with Kickstarter that uses the All-or-Nothing model as compared to the Keep-it-All model, in which a project's owner can keep the raised funds even if their project failed to reach its crowdfunding goal (Koch & Siering, 2019; Kubo et al., 2021).

First, we split the data into three groups, namely: successful, unsuccessful, and cancelled projects. Given that we did not know the reasons for cancellations, we could not treat cancelled projects as unsuccessful because the fundraising cancellations took place before the project funding deadline. Thus, similar to Ryoba et al. (2021), we removed cancelled projects from the data, leaving a final data set of over 21,000 summaries with which to compare successful (~7,300) and unsuccessful (~13,900) technology projects. Of note, the ratio of approximately 34 percent successful versus 66 percent unsuccessful technology projects in our data extracted from Kickstarter is nearly equivalent to that of Cordova et al. (2015), whose data of technology projects extracted from the Indiegogo and Eppela platforms included 30 percent successful projects. Further, Liang et al. (2019) reported a 33 percent success rate on Kickstarter, while

Costello and Lee (2022) extracted a 37 percent success rate on Kickstarter.

Second, to understand the distributional properties of the data as suggested by Schmiedel et al. (2019), we calculated the total length of the text corpus, which was approximately 399,000 words. Further, we calculated the average length of a project summary, which was 19 words in both successful and unsuccessful project groups. This eliminated the possibility that crowdfunding success would be associated with the length of a project's summary. Of note, Koch and Siering (2019) pointed out that Kickstarter provides a rather fixed framework for filling out project information fields, including a strict short-text limitation for project summaries. Thus, we anticipated that project owners tend to put a lot of effort to maximize the informational value of their project description field.

Third, we applied the topic modelling widget of the Orange 3.18 software package to identify a set of topics in two separate corpora (successful and unsuccessful projects). Orange is an open-source data visualization, machine learning, and data mining toolkit (Wikipedia, 2019) that offers the option of applying the LDA algorithm for text analyses. LDA requires researchers to choose the number of topics to be generated (Maier et al., 2018). Given the purpose of providing managerially useful information, we followed the notion of Westerlund et al. (2018) and chose a relatively small number of topics based on trial, avoiding overlaps, and ensuring the interpretability of topics. We ran the analyses systematically from 5 to 15 topics and

Table 1. Topics and their keywords regarding successful projects

Topic	Keywords
Platform	community, free, platform, phone, app, digital, real, technology, project, video
Advanced	first, world, new, online, music, make, wearable, space, get, people
Mobility	design, social, allows, service, book, unique, charging, comfort, anywhere, training
Stress management	help, time, find, sleep, future, take, information, glasses, activity, smartphone
Learning	learning, mobile, students, built, support, home, access, work, needs, school
Smart	smart, better, without, users, power, play, perfect, tool, smartwatch, program
Ambient	learn, bluetooth, audio, control, battery, simple, businesses, performance, local, join

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concluded that 7 topics provided the best solution in both groups. We also drilled into the text documents to understand each topic using the "concordance" option, which allowed us to spot keywords and their use contexts. That is, we read the high-probability words in topics and their respective use in sentences, to provide a short and intuitive label for each topic (Huang et al., 2018). Finally, we compared topics and their keywords between the two groups (successful and unsuccessful projects) to understand the differences in topics and keywords that might explain the behaviour of funders.

Results

Successful technology projects
Our topic modelling analysis on successfully funded projects revealed several interesting and trendy topics (in 2018). We assigned the topics with descriptive labels based on keywords and their occurrences in the documents. The topics, which reflect uniform patterns across various types of technology, included: 1) Platform, 2) Advanced, 3) Mobility, 4) Stress management, 5) Learning, 6) Smart, and 7) Ambient. In the following, we will elaborate on these topics. Table 1 lists the topics and their keywords derived from the successful projects data set.

The first topic in the data set is 1) Platform, which refers to digital platforms and the related communities around those platforms, addressing how platforms provide digital content such as video, apps, and tools, as well as relevant data and services, and how they bring various stakeholders or sides together. The second topic is 2) Advanced, which refers to advancements in various interesting and newsworthy areas, such as music production, wearable technology, wireless technology, open source, experience creation, and final frontiers such as space exploration. This topic includes many kinds of novel technologies.

The third topic, 3) Mobility, refers to technologies that enable comfort anywhere by providing accessibility to services, media, and content "anywhere, anytime, anyone". Such technologies may include, for example, smartphone apps that enable access to social networking services or photo libraries, mobile solutions such as portable speakers, social activities, emails, and various types of information portals. The fourth topic, 4) Stress management refers to technologies that help users to relax, for example, by providing them with relaxing time, improving their sleep, monitoring their activity, or offering amusing and enjoyable virtual reality

content.

The fifth topic, 5) Learning, refers to various technologies aimed to support students and learning in general, in the context of schools, home and work, by providing remote access to solutions and research databases that help with learning. The sixth topic, 6) Smart, refers to smart devices, such as smartwatches, and how intelligent technology can augment traditional products and services, such as musical instruments or home and car keys to become smart products and services that provide more value to users.

The seventh topic, 7) Ambient, refers to embedded technologies, for example, technologies within technologies such as Bluetooth, sensors, inbuilt security, voice control, or novel audio or battery technologies that improve the performance, usability, and personal controllability of products and services.

In sum, topics and their keywords in the successful projects group include references to novelty and innovativeness (for example, world's first, new, unique, innovative, better, revolutionize), needs of communities rather than only individuals (for example, training, learning, service, platform), and a focus on socially relevant problems (for example, social, needs, information, sleep, time, access, future). Overall, the focus seems to be on providing value to communities and solving bigger and more complex problems.

Unsuccessful technology projects
The analysis of technology projects that failed to reach their initial funding goal revealed seven topics labelled as follows: 1) Power, 2) Connected, 3) Handy, 4) Usability, 5) Personal, 6) Mobility, and 7) Easy. Table 2 lists these seven topics and their keywords.

The first topic in the data set of unsuccessful crowdfunding projects is 1) Power, which includes a variety of aspects related to power management, especially in the small device context. These include, for example, charging of devices using the USB plug, power solutions, monitoring power, power-related safety, and the lack of need for charging. The second topic, 2) Connected, refers to being able to connect with social and digital networks, either through cables or wirelessly, with various support tools.

The third topic, 3) Handy, describes technologies and products that are aimed to be available and handy when needed, for example, items and gadgets for hobby,

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Table 2. Topics and their keywords regarding unsuccessful projects

Topic	Keywords
Power	new, usb, without, charging, ever, power, safety, see, solution, media
Connected	social, portable, tool, provides, makes, energy, network, fast, umbrella, cables
Handy	air, real, golf, let, cold, stick, long, style, protects, website
Usability	control, used, button, phones, ultimate, enabled, wallet, easily, bottle, left
Personal	app, phone, light, new, led, keep, stand, small, hand, best
Mobility	device, first, world, people, home, smartphone, car, free, mobile, technology
Easy	time, help, use, designed, life, make, way, easy, water, need

school, or home such as reachable sticks and tools, various time management applications, alert and messaging solutions, liquids that help to do something better than the current options, various items and clothes that provide protection from cold, and so forth. The fourth topic, 4) Usability, refers to features that aid and enable the use of various products or services in an easier manner, for example, a coffee maker equipped with only one button that allows operation through easy control.

The fifth topic, 5) Personal, refers to various types of personal products and services, such as small devices or phone applications that allow users to adjust and customize products and services to their personal liking and needs, which are convenient and lightweight to carry, and provide personal protection or other utility, for example, small but luminous led lights and other items that can be always available. The sixth topic, 6) Mobility describes mobile technologies such as smartphones and other mobile devices, hands-free gadgets, and so forth. Interestingly, the topic is like the Mobility topic identified in successful projects, the main difference being that unsuccessful projects use less novel and more product-oriented terms and argumentation compared with successful projects.

Finally, the seventh topic is 7) Easy, which refers to solutions designed to make an individual's everyday life simple, easy, and convenient. Such solutions include technologies that help a person find something that is lost, save time, money, and effort, for example, with solar and cleaning technologies. The solutions make it simple for people to use specific products and services (for example, remote operability), are fun, and resonate with personal interests and values of users, for example,

cameras and green technologies.

In unsuccessful crowdfunding projects, the topic of Mobility was considered similar to that in successfully funded projects, although the keywords were different and reflected less novelty. The keywords connected to other topics also seemed to address incremental advancements, such as usability improvements (for example, easily, control, enabled, easy, aid), a focus on personal gadgets and aiding tools (for example, tool, device, led, bottle) for easier daily life, and a focus on product features (for example, button, long, stick, portable, design) rather than its value. Overall, the focus tends to be on helping individuals and suggesting that small technological devices can enable more conveniences in their lives.

Discussion and Conclusion

This study used topic modelling on a data set of over 21,000 project summaries from Kickstarter to examine whether short-text project summaries can be used for identifying what appeals to funders or puts them off when assessing technology projects on crowdfunding platforms. According to our results, the topics differ in project summaries of projects that succeed in raising funds versus those that fail to meet their funding goals. Whereas project descriptions of successful technology projects focus on novelty, innovativeness, and big problems shared by larger communities, those of unsuccessful projects focus on providing minor improvements that mainly help individuals to make their daily lives more convenient.

Contributions to theory and practice
The findings provide implications to theory and practice.

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First, our results contribute to the extant body of literature on crowdfunding project success by suggesting that although studies on crowdfunding success tend to examine many variables at once to create better prediction models (see for example, Zhou et al., 2018; Yeh et al., 2019; Jiang et al., 2020; Ryoba et al., 2021; Sahaym et al., 2021), a simple content analysis of project summaries may be sufficient to estimate success or failure. Specifically, our results show that a content analysis of short-text project summaries can be used for assessing funding success likelihood on crowdfunding platforms. In other words, the project summary alone can be enough to predict whether a project is likely to reach or fail the funding goal.

Further, topic modelling seems to be a good tool for automated content analysis because it can handle large unstructured texts and does not require pre-set rules. However, results from a topic model analysis need to be enriched to proceed from mere clustering of related words into providing managerially meaningful topics. These topics and their keywords can then be converted into concrete results and suggestions that can inform decision-makers. Hence, our results contribute to the literature by addressing the notions by Lee and Sohn (2019) and Jiang et al. (2020) who call for more research that links topic modelling with crowdfunding success. Our study provides entrepreneurs, managers, and innovators with an example of how data mining and content analysis can help them find means to better promote their projects and improve the chances of meeting funding goals.

Second, our results confirm the notion by Yuan et al. (2016) who argued that researchers should look at topical features behind topics. That was apparent to us with Mobility, which surfaced as a topic in both successful and unsuccessful projects, differing between them only in terms of keywords. However, Mobility in unsuccessful projects used clearly less novel and more product-oriented terminology compared to successful projects. The potential of a project may thus be assessed at two levels, namely whether the topic falls under an ongoing technology trend and what the topic's features are, that is, keywords used in the project's fund-seeking summary. Overall, while successfully funded projects represent more trendy topics, they also use terminology that reflects novelty and focus on solving a social problem. While previous research has argued that non-profit projects that emphasize social problems are more likely to succeed in crowdfunding (Mollick, 2014; Hörisch, 2015; Xu et al., 2016), our results suggest that even for profit-oriented projects, focussing on social problems may be crucial.

Third, our findings are interesting in light of previous research, which found that, in general, online funding success is associated with the language describing a project's targeted focus on social problems, while the role of innovativeness has been less addressed (Parhankangas & Renko, 2017). Song et al. (2019) suggested that topic novelty could play a role in the online funding of non-profit campaigns. Based on our results, novelty plays an especially relevant role in for-profit campaigns. Our findings are in line with previous research, according to which online fundraisers can benefit more from the use of exclusive language if the messages are framed with possible gains for donating (Yilmaz & Blackburn, 2022). Therefore, our results suggest that technology entrepreneurs using crowdfunding should pay attention to wording and concepts in their project summary and emphasize novel project outcomes along with the problem's broader social character. This can be done even after launching a campaign, as Crosetto and Regner (2018) argued that crowdfunding projects can be boosted to eventual success at virtually any point of time.

Limitations and future research
As a limitation of this study, the data set was extracted from a single crowdfunding platform (Kickstarter), covering only a specific period in 2018 and focusing on diverse technology projects as selection criteria. However, Dushnitsky and Fitza (2018) argued that factors associated with success on a given platform may not replicate to other platforms. Lacan and Desmet (2017) noted that funders' attitudes and trust toward a crowdfunding platform itself may affect their funding willingness, thus underscoring the generalizability challenge and calling for further explorations of the results of similar projects across multiple crowdfunding platforms. Future research should therefore cross-validate the results using comparable data from another platform or several platforms.

Future research should also investigate the relationship between topics and their success or failure using a more fine-grained investigation. We only categorized the technology projects studied as "successful" or "unsuccessful", but future research should consider how much a project exceeds or falls short of its initial funding goal and investigate whether topics correlate with the degree of overfunding or underfunding. Finally, future research could examine the words used in project

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summaries from the perspective of marketing communication and technology adoption models as suggested by Djimesah et al. (2022). They argue that crowdfunding success and failure may differ in terms of usability, ease of use, and other dimensions of the technology and user acceptance models as presented in the project descriptions.

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The Role of Digital Platforms in Resident-Centric Housing Concepts

Inka Lappalainen and Maija Federley

" So we have to be idealists, in a way — because then we wind up as the true, the real realists. "

Viktor Frankl (1905-1997)

Platform-enabled services targeted to make everyday life easier have become increasingly available in recent decades, which in some cases challenge traditional ways of owning and working. However, comprehensive data-driven value creation opportunities, which are seamlessly connected to various needs in the everyday life of citizens or residents, are still largely untapped and unstudied. This article investigates value creation opportunities for holistic housing concepts with related ecosystems designed to combine the physical environment of residents along with a digital platform. The novelty of this study builds on a holistic understanding of value co-creation in housing, enabled by digital platforms at the ecosystem level. The empirical study focuses on a qualitative multi-case study of four holistic and resident-centric service concepts, which all include digital platforms. The main findings are concluded as follows: First, digital platforms enable various value creation opportunities in resident-centric housing concepts and related ecosystems. Second, exploring strategic choices regarding competitiveness, innovation, and growth revealed that digital platforms played various roles such as informative, supportive, integrative, or even embedded in novel housing as a service platform concepts, which call for totally new orchestration and business models across traditional industrial and ecosystem boundaries. Third, in light of the basic mechanisms for ensuring competitiveness and growth in data and a platform economy, we identify two main alternative strategic approaches. The findings serve both practitioners and researchers exploring opportunities of a platform economy, with a particular benefit for those in largely unstudied housing markets.

Introduction

Megatrends such as aging, urbanization, sustainability, digitalization, and communality are reflected in the diverse needs and expectations of housing. In addition, servitization and changing consumer habits constitute significant drivers of change in housing-related industries (Siltaloppi, 2015). Our homes and living environments have also become a part of our self-realization. In their daily lives, people look for new ways to acquire and co-produce the services they need, for instance enabled by a sharing economy and related platforms (Acquier et al., 2019). Meanwhile, housing residents are understood as playing active roles in value

co-creation, while companies adopt networked and data-driven value creation logic (Lusch & Nambisan, 2015; Siltaloppi, 2015; Vargo & Lusch, 2016). These trends enable opportunities to challenge established value creation logic and industrial boundaries between construction and residential service businesses, by means of more demand-driven and agile service models enabled by digital platforms.

This also creates a huge challenge across industries, in both B2C and B2B markets. In construction and residential contexts, profound transformation in value creation and capture logic is required to align with servitization: First, a shift from transactional business

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models towards service- and customer-orientated business models (Siltaloppi, 2015; Xu et al., 2019; Mikkola et al., 2020); and second, a shift towards more networked and data-driven business models that build on the platform economy (Leminen et al., 2018; Maxwell, 2018; Woodhead et al., 2018; Xu et al., 2019; Lappalainen & Federley, 2020). The ongoing changes primarily relate to the expansion and diversification of the construction and real estate services industries, as new innovative service models and actors emerge alongside traditional actors and roles to challenge established operating and thinking patterns. The construction phase is crucial from the life cycle building perspective and related data-driven value creation opportunities. Yet, there remains a kind of ecosystem gap in terms of different actors, governance, and shared logic between construction and other life cycle phases of buildings, such as use, operation, maintenance and renovation (Xu et al., 2019; Mikkola et al., 2020). Further, research has still concentrated on firm-level service innovations, but not as much on the impact of changing business models on the operation and composition of business ecosystems (Petrulaitiene et al., 2017; Leminen et al., 2018; Lappalainen & Federley, 2020).

While data-driven value creation opportunities for a platform economy in residential housing contexts are largely untapped and unstudied, the purpose of this article is to examine *what kind of value creation opportunities digital platforms enable in housing concepts and related ecosystems.* This study adopts a service-dominant logic approach to the housing context (Vargo & Lusch, 2016). It offers a holistic view on housing, comprised of promoting multi-sided value creation and optimal integration of resources between actors. The study focuses on *comprehensive housing concepts that combine physical, social, and digital solutions provided by a local service ecosystem.* Digital solutions and platforms are developed to make service exchange and shared resources easily available for residents, but also to support further development and new value co-creation opportunities, for example, through network effects.

The paper adopts a networked and systemic perspective in particular to narrow the research gap highlighted in recent studies (Fehrer et al., 2018; Leminen et al., 2018). We define platform ecosystems theoretically according to "design" and "co-evolutionary" perspectives. We elaborate a conceptual platform design framework based on the literature

(Parker et al., 2016; Täuscher & Laudien, 2018; Tura et al., 2018; Sorri et al., 2019; Hein et al., 2020; Isckia et al. 2020) and apply it for analyzing empirical findings from a multi-case study of holistic housing concepts. In the next section, we present the theoretical background, followed by the methodology and case descriptions of the empirical study. The article continues with a summary of the main findings and ends with a discussion and conclusion, including implications, limitations, and suggestions for further research.

Theoretical Background

Housing as a service platform - framed by the service innovation concept of S-D logic
Driven by service-dominant (S-D) logic, "service innovation" can be defined as complex network- and information-centric value co-creation by resource re-bundling in novel ways among beneficiaries (Lusch & Nambisan, 2015). S-D logic and taking a broader view of service innovation have inspired scholars across disciplines to also examine more specific mechanisms of data-driven service innovation that have been enabled by advanced technologies (Lehrer et al., 2018; Kugler, 2020). However, in the housing context, the S-D logic approach to studying innovative service concepts still seems rather unknown, and with a particular lack of empirical research (Siltaloppi, 2015; Lappalainen & Federley, 2020).

Lusch and Nambisan (2015) suggested a tripartite service innovation framework, comprised of service platforms, value co-creation processes, and service ecosystems, which provide a relevant basis for this study. First, residents are understood to play an active role in value co-creation, when housing is seen as a mutual everyday activity and the value of housing is seen as multifaceted, experiential, and context dependent (Lusch & Nambisan, 2015; Vargo & Lusch, 2016). Companies enable and support residential activities. Thereby, the value proposition focuses on interactions among the residents, as well as between residents and companies. In residents' (as customers') experience, the value proposition may be fulfilled or unattained. At the same time, value creation in housing expands from the physical environment of individual homes to the key activities of a resident's everyday life in the neighborhood, such as daily chores, mobility, and activities related to work, studies, and free time. Second, the built environment with everyday services and activities enabled through it are merged into one holistic service concept, where digital solutions make it easy to

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order, pay, and use the available facilities and services. This *service platform*, as defined by Lusch and Nambisan (2015), thus encompasses both tangible and intangible resources, and promoting mutual interaction between residents and with service providers. Hence, it facilitates the optimal integration of resources between actors (ibid.). Third, in comparison to the traditional real estate-focused model, networks of housing construction actors along with actors related to the actual residential phase of housing can expand into a *local service ecosystem*. The term "service ecosystem" has been defined as a complex, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation (Vargo & Lusch, 2016; Jacobides et al., 2018).

In their ecosystem literature review, Aarikka-Stenroos and Ritala (2017) identified two typical characteristics: co-evolution and broadening or blurring structural and sectoral boundaries. This is in accordance with our notion of housing construction and residential service industries, which have "evolved" separately — the construction industry being very established and dominated by large companies with traditional value chains, while residential service businesses are still in an emergent stage, particularly in Finland, where our empirical case study was located. However, digital platforms with IoT solutions that combine life cycle data from built environments, residential data, and public data from various service sectors enable novel value creation opportunities for both established actors and new entrants (Ikävalko et al., 2018; Leminen et al., 2018; cf. Xu et al., 2019; Mikkola et al., 2020). Nevertheless, there have been few studies on the specific perspective of innovating new, data-driven residential services that require the implementation of ecosystem-wide and even ecosystem-crossing collaborative actions.

Value co-creation in emergent business ecosystems enabled by digital platforms
In the rapidly growing data economy, the "platform ecosystem" concept has been widely adopted among researchers and practitioners. Platform ecosystems are created around technological platforms, typically owned or governed by platform leaders that connect multiple sides of markets, such as users, advertisers, developers, and content providers, to facilitate value co-creation (Gawer & Cusumano, 2014; Aarikka-Stenroos & Ritala, 2017; Hein et al., 2020). As this definition has been reflected upon, typically the

research debate around platform ecosystems has focused on new eco-systemic value creation logic enabled by these digital platforms, instead of examining *complex transformation* across entire value chains and networks, along with a combination of conventional linear business logic with platform-based business models.

Platform ecosystems challenge traditional business logic, rules, and relationships between product and service owners, vendors, and users, and how they are generated in emerging ecosystems. Moreover, the roles of actors in platform ecosystems change or become more diverse, while new players become critical, such as developers, called "complementors". This creates profound challenges to *platform design* and *co-evolution*, since a platform and its rules need to be designed in a way that enables fast growth by taking the advantage of a platform business and developing a sustainable and scalable combination of simultaneously different value creation logics and fair competition within an ecosystem (Ikävalko et al., 2018; Tura et al., 2018).

Tura and co-authors (2018) developed a conceptual platform design framework that highlights the four most crucial design choices to build the base for a sustainable platform business: platform architecture, value creation logic, governance, and platform competition. In the following, these are briefly defined, and linked with recent research in the platform ecosystem field from both design (Täuscher & Laudien, 2018; Sorri et al., 2019; Hein et al. 2020) and co-evolutionary perspectives (Isckia et al., 2020).

Platform architecture focuses on the actors, market, and fundamental structure of platforms. Necessary considerations include determining the main purpose, core interaction, and relevant market structures with key actors (users, providers, developers, managers, and owners) needed for value co-creation and capture by beneficiaries. The core interaction is defined as an exchange of value that attracts users to use the platform, and moreover that enables expansion beyond the original core interaction over time for competitiveness and growth (Parker et al., 2016). The openness of platform architecture refers to both technical and collaborative or contractual mechanisms that enable access and participation modes of key actor groups in value creation and innovation (see Governance) (Parker et al., 2016; Tura et al., 2018; Sorri et al., 2019; Hein et al., 2020). The level of openness seems to change along the

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platform development process, even though earlier architectural and strategic design choices play an important role in the platform ecosystem life cycle (Isckia et al., 2020).

The second element of *value creation logic* involves identifying actor roles for value to be created, and also how to achieve beneficiary commitments. Furthermore, it should be designed according to how network effects work and how they affect platform use. According to Parker and co-authors (2016), "network effects refer to the impact that number of users of a platform has on value created for each user". These can be same-sided or cross-sided, as well as negative and positive. While enhancing scalability and defensibility, positive network effects serve as a fundamental source of value creation and competitiveness in platform businesses (Gawer & Cusumano, 2014; Parker et al., 2016; Hein et al., 2020). To capture value, a platform revenue model needs to be carefully developed for optimal and dynamic pricing (incl. other incentives) to serve various actors. Different mechanisms (for example, subsidies vs. monetization techniques) may be needed to boost the fast growth of actors and network effects in the beginning to gain critical mass, and then to enhance commitment and new value co-creation opportunities (Parker et al., 2016; Täuscher & Laudien, 2018).

Design choices on leadership, ownership, and related management practices for a platform affect *governance* effectiveness, and thus the longevity of the platform. Here, platform rules, with respect to, for example, (data) access, content creation, sharing, and trading constitute the main mechanisms defined as collaborative/contractual boundary resources (Sorri et al., 2019). Hein and co-authors (2020) referred to the following three alternative archetypes of ownership to balance control rights against the autonomy of ecosystem actors: a central platform owner, a consortium of partners, and a decentralized peer-to-peer network (Parker et al., 2016; De Reuver et al., 2018). Ownership status affects the development dynamics of an ecosystem in terms of how governance mechanisms, such as input and output control and decision rights, can be exploited (Tiwana, 2014; Hein et al., 2020). In addition to typical owner-based management models, alternatives such as licensing a platform or using open source solutions can be applied (for example, Parker & van Alstyne, 2009; Parker et al., 2016). Each (organizational) actor needs to make a strategic decision and negotiate its role in the emerging ecosystem, either as an owner or in alternative roles, for example, as a financer, coordinator, producer, facilitator, or developer (Valkokari et al., 2017; Hein et al., 2020). In practice, the roles materialize in various ways and with different combinations during a platform ecosystem's life cycle.

Finally, the element of *platform competition* includes design considerations about the launch, competitiveness, renewal, and scalability of a platform. Competitiveness in a platform launch and diffusion are built by attracting, reaching, and maintaining critical mass (to tackle the chicken-egg-problem) and against incumbents or other new players (Parker et al., 2016; Tura et al., 2018). Here, two platform strategies are typical: first, focusing on increasing the number of users and interactions to reach economies of scale (depth), and second, investing in economies of scope (breadth) by bringing in new partners with services to the platform (Isckia et al., 2020). Scaling strategies are also essential platform growth mechanisms, and thus, design choices, such as platform openness, revenue models, and governance (technical and collaborative boundary resources) influence growth (Ibid). All of these main elements are strongly interlinked and thus have to be renewed in a systemic way to ensure innovation possibilities for different sides of a market. When a platform ecosystem's complexity increases, more openness is necessary, along with calling for different governance mechanisms to balance value co-creation and value capture. Likewise, both competition and collaboration are needed within a co-evolving platform ecosystems against competitors (Letaifa, 2014; Cennamo & Santaló, 2019; Hein et al., 2020; Isckia et al., 2020).

Methodology

We chose the empirically qualitative multi-case study approach of Eisenhardt (1989) as particularly relevant for exploring dynamic and emerging phenomena and creating renewed conceptual frameworks. By applying purposeful sampling, we selected four pioneering residential service concepts as cases for the study. All four concepts have been developed and implemented in Finland. "Pioneering" was defined to refer to holistic resident-centric service solutions that promote sustainable and continuous renewal by utilizing scalability and personalization enabled by a platform economy. The selected cases aim to extend value co-creation beyond the capabilities provided by the physical built environment and transactions of tangible value objects. Further, diversity in terms of customer

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segments and differentiated value proposition with holistic service concept were sought. One selection criterion was that the concept is designed to merge both the physical environment of residents and a digital platform. This criterion excludes many separate digital services and platforms, developed for housing services, home-deliveries, and resource sharing. The requirement interrelates with the role of an "ecosystem orchestrator" that connects residents and service providers with their *housing as a service platform concept*. The "pioneering" criterion also resulted in a set of block-level cases that have been recently built and were still under construction during this empirical study. In two of the four cases, the residents had only lived in the building for a few months on average at the time of the data collection and had little experience of the holistic residential service concepts with joint facilities, services and digital platforms. To gain balanced data on all the selected cases for analysis, we did not gather data on residents' experiences. This was a conscious methodological decision, which constitutes an essential limitation of this study on resident-centric service offerings and leaves it as a subject for further research.

Case descriptions and research question
Table 1 presents basic information about the four empirical cases, and then we briefly describe selected housing as a service platform concepts in the following paragraphs.

In Case A the value proposition of their housing as a service platform concept emphasizes the well-being of residents, ease of everyday living, and opportunities to spend time with other residents. Shared spaces for the community within the block, services for people in various phases of life, and nice surroundings are seen as essential elements to support the overall well-being of residents of all ages. Examples of shared spaces in the block are a gym, a reading room, a sauna, a guest room, a playroom, and a study. There are also shared cars and bicycles, tools, and other equipment available for residents. Good opportunities are available for outdoor activities in the immediate surroundings. A coordinated service offering includes cleaning, meal deliveries, massage, and maintenance services. A service advisor is available for residents regarding daily issues and organizing activities, if needed. The costs of the advisor and maintaining the shared resources are covered by a fixed monthly fee for each apartment. Additional services operate on a paid per usage basis. Residents make reservations for shared spaces and order services through a digital service portal, which also serves as an information channel. The housing as a service platform concept was developed and is operated by a company that creates new solutions for housing and well-being. The company is part of a private company focusing on health and wellness services. As a part of the housing concept, the company preselects service providers and makes contracts with them. The company has a clear permanent role in the housing concept, and its aim is to

Table 1. Background facts from empirical cases

Categories	CASE A	CASE B	CASE C	CASE D
Location & "type"	Northern Finland, close to center of large city, good public transport connections	Capital area in Finland, city center, high-rise building directly connected to a shopping center and public transport station	Capital area in Finland, city center, good traffic connections and close to services	Capital region in Finland, next to a small-town center, approx. 40 min drive from center of Helsinki, relatively close to the airport
Number of apartment buildings ready in 2020 / total planned	4 / A block of 10 apartment buildings with wellness services	1 / A block of 7 high-rise apartment buildings	1 / 1+2 apartment buildings built by partners	1 / A block of 9 wooden apartment buildings
Number of apartments	221	282	113 (+ 149 built by partners in the same block)	18
First residents moved in	2017	2019	2017	2020

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scale up the concept.

A central idea of the housing as a service platform concept in Case B is to promote effortless everyday life in an urban environment. Building automation and services are designed to make it possible for residents to have more time for pleasant activities during the day, instead of time spent, for example, waiting for elevators and deliveries, collecting groceries, doing laundry, or traveling to other places for free-time activities. An extensive service offering from the shopping center in the same complex is easily accessible, and many local businesses provide deliveries directly to the apartments. The service offering is coordinated by the construction company, which is also the developer of the entire housing as a service platform concept. There are a variety of shared spaces available for residents, such as three available saunas, a gym, terrace, kitchen, and a lounge suitable for teleworking. Shared cars and bicycles are also available for residents. A service coordinator at the lobby advises residents, offers reception services, and assists residents with their errands. Shared spaces can be booked, services ordered, and information related to an apartment, or to the building provided through a web-based service platform. The residents pay a fixed monthly fee to the operator, while an extra fee is charged per use of services, including private bookings of shared spaces.

In Case C an underlying aim of their housing as a service platform concept is to promote equality, social equity, and responsibility. In their rental housing production, the company emphasizes communality and support services. The goal is to create a multi-generational communal living environment that provides affordable housing for all kinds of people. Shared spaces and resources include, for example, a living room, kitchen, laundry room, music room, woodworking workshop, gym, a computer, tools, and a car. The basic cost of residential services, including internet connection and shared spaces, are part of the rent, while an extra fee is charged for some usages, such as the shared car. Especially during the first years, when a housing coordinator was present at the block every working day, communal events were organized for residents, and residents were supported in organizing activities. The housing coordinator also advises residents in housing-related issues, as needed. The company that developed this holistic housing concept also operates it and manages the related digital platform.

In their housing as a service platform concept, Case D aims to provide ecological and high-quality living in homes that are more than merely the space of an individual apartment. The building with timber cladding is equipped with geothermal heating and solar panels. The apartments are equipped with air-conditioning and digital access control. All buildings in the neighborhood are newly built and situated close to a sports park, within a green environment. The residents have access to shared spaces, such as a teleworking space, greenhouse, spa and sauna, and shared resources, such as an electric car and bicycles. In contrast to the other cases we researched, the housing concept of Case D does not include a service advisor. Reserving shared spaces can be made through a digital portal, along with other services directly through individual service providers' solutions. This holistic housing concept was developed by a construction company. They had initially negotiated with the service providers, but a model for future operation is still under development. Usage of shared spaces is included in the maintenance charge, while other services are paid per usage.

All four empirical cases represent pilot projects for the builders, which are contributing to the development of their housing as a service platform concept. The builders also took the role of main operator along the life cycle of the housing blocks and related service/platform ecosystem orchestration. However, the ecosystem model seems to be still in an emergent phase, particularly in the newest Case D. As seen from the case descriptions, even if the housing concepts have different value propositions and target markets, they all share the same idea of housing as a platform, which integrates *similar physical, social, and digital elements for resident-centric service activities.* Our interest is to further examine the role of digital platforms in these holistic residential service concepts and related alternative data-driven business opportunities. The research question we focus on is the following: *What kind of value creation opportunities do digital platforms enable in housing concepts and related ecosystems?*

Data Collection and Analysis

The main research methods for this study included a systematic analysis of public case-specific data, in addition to eight in-depth interviews of case representatives from 2017-2020 (see Table 2). Interviewees performed various roles in the different cases, such as facility manager, service and concept developer, managing director, and shareholder.

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Table 2. Methodological steps

Step	Method	Input	Output
1	Collection of public data related to the case studies and background information	Research literature, web sites, public media	Selected cases for the study, preliminary analysis, and knowledge gaps
2	Qualitative semi-structured interviews	Eight case study interviews	Characteristics of each case, roles, and operating models
3	Analysis and final synthesis	Data from the previous steps (transcripts, notes, summaries); Platform design principles and frameworks (Parker et al., 2016; Tura et al., 2018; Täuscher & Laudien, 2018; Sorri et al., 2019; Ischia et al. 2020).	Findings on the role of digital platforms in housing concepts with conclusions Supplemented comparative platform design framework

Interviews topics covered future living, emerging demand and market structures in residential services, the development and future plans of customer-centric housing concepts, and related opportunities and challenges to utilizing data and platform economy in their business. The interviews took approximately 1-1.5 hours and were documented in research notes, and most of them were also recorded for subsequent analysis.

The research followed an iterative process of empirical and theoretical exploration, covering the main steps described in Table 2. Following Eisenhardt (1989), theoretical background and research questions provided a tentative conceptual framing, which we gradually elaborated further in the iterative interplay with empirical data analysis and previous conceptual frames. However, the literature and research questions should not be allowed to limit interpretations in qualitative content analysis of selecting, coding, and categorizing the data and further elaborating conceptualization. (Sekaran & Bougie, 2016. Accordingly, the first platform business frameworks of Täuscher and Laudien (2018) and Sorri et al. (2019) were applied to classify the main characteristics of selected platform-based holistic service concepts based on public data sources. Second, as the main knowledge gaps were identified, interviews were conducted and analyzed based on the main themes and the tentative conceptual frame for the platform design characteristics. Third, the qualitative single and

cross-case analysis that we conducted called for further conceptual elaboration based on new theoretical sources. As a result, we selected the conceptual framework for platform design developed by Tura and co-authors (2018) and adjusted it for this study derived from insights from the recent literature (Parker et al., 2016; Täuscher & Laudien, 2018; Sorri et al., 2019; Ischia et al., 2020). In the synthesis phase, we specified the final empirical results and supplemented the comparative platform design framework. We were also able to test our interpretations and conclusions with the interviewees in terms of content validity (Kvale, 1996).

Findings

In all four cases, the pilot phase for data- and platform-based service solutions is under way. The basis for more advanced solutions is being developed in cooperation with the selected IT partner, service partners or network, and residents. Digital solutions and, more broadly, a digital platform economy have been recognized as enabling more resident-centric and cost-effective services based on mutual interaction. Likewise, various data collected from the residential block(s) and residents, can be enriched and re-utilized by considering data privacy and security issues.

As seen in Table 3, the cases differ in the main choices of digital platform design, and thus also in the roles that the digital platform plays in the holistic housing

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Table 3. Summary of the main findings on platform characteristics.

	CASE A	CASE B	CASE C	CASE D
Market structure	Multi-sided	Multi-sided	Two-sided	Two-sided
Key actors (sides) **- Users (U)** **- Providers (P)** **- Developers (D) (compliments)** **- Orchestrator (O)**	Residents Group companies, service partners The developer partner Operator as Owner & Manager	Residents Three-layered service partner network The developer partner (incl. service providers) Operator as Owner & Manager	Residents Single, scalable/ tailored partnerships The developer partner Operator as Owner & Manager	Residents Single, tailored service partnerships The developer partner Builder as Owner & Manager (so far)
Core interaction **- Service exchange (U-P)** **- Booking shared resources (O-U)** **- Informing (O/P-U)** **- Socializing/common activities (U-U)** **- Smart living support**	X X X X	X X X X - other platform X	 X X	 X X X - other platform
Platform (ecosystem) openness	Closed	Networked	Closed	Open
Main mechanisms to support network effects	Partner selection criteria, pricing models, resident feedback, recommendations	Partner selection criteria, pricing models, resident feedback, recommendations	Resident feedback	Not yet
Revenue model **- User -> Orchestrator** **- User -> Provider** **- Provider -> Orchestrator**	Monthly fee, Pay per use Pay per use E.g., share of sales, marketing fee	Monthly fee, Pay per use Pay per use E.g. share of sales, marketing fee	Included in rent Pay per use Rent or service fee	Subventions (from orchestrator to users) Pay per use
Ownership **Management**	Operator as platform owner, license model Centralized	Operator as platform owner, license model Centralized	Operator as platform owner Centralized	Builder as platform owner (so far) Centralized (so far)
Platform competitiveness	**Embedded:** Digital platform is built in Housing as a platform concept and business model.	**Integrative:** MVP-driven digital platform integrates smart building solutions and daily services.	**Supportive:** Digital platform is developed to improve/ supplement service experience.	**Informative, easily substitutable:** Simple digital portal to inform about service offering.
Innovation and renewal	**Systematic** innovation process, future focus on **analytics and AI** "learning platform" (closed, controlled)	**MVP** and "experiential" co-development with partner network (limited, networked)	**Incremental** development, future focus on **automatization** and service extension (closed, controlled)	The role of digital platforms in the service concept is **under exploration**. (cf. case B)
Platform growth -> scalability (identified strategic choices)	**Concept/Block-level scalability** Housing as a platform service and business model enabled by data from blocks	**Modular scalability** Chosen service bundles enable limited data-based business	**Limited scalability** so far with limited resources and other strategic focus	**Not yet a strategic choice**
Role of the entire service concept in the corporate strategy of the orchestrator	Core strategy (focus)	Living lab for new business	Core strategy with sustainability focus	Living lab for new business

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concept and related value proposition. Currently, at its narrowest, a digital platform provides two-sided communication and a resource booking channel in cases C and D, while at its broadest, it serves for multi-sided value creation and capture through a combination of several core interaction layers in cases A and B. In the latter cases, mechanisms for network effects have been designed to improve the service experience.

In all four cases that we studied, the platform revenue models are still in an emergent phase, particularly between the orchestrator and service providers as part of business model development, which is consistent with earlier platform business model studies (Täuscher & Laudien, 2018). However, cases differ on the level of platform openness in technical and collaborative boundary resources and related governance models (see Sorri et al., 2019). In the closed models adopted in cases A and C, access rights, data ownership, and use decisions are clearly defined and centralized by the main orchestrator, who is also the owner of the platform (see Hein et al., 2020). In the networked model, to which case B applies, residential service and digital platform capabilities are co-developed, while investments and risks are shared with carefully selected partners and the orchestrator. This enables agile solutions (for example, with APIs), while also calling for more sophisticated agreements between parties. Closed models seem to be typical entry strategies (Isckia et al., 2020), whereas case D chose the opposite approach in their digital portal, aiming to encourage bottom-up ownership of the operation model with digital platform by residents and local service providers.

However, as indicated in Table 3, critical design choices still must be made in case D if new value creation opportunities from the platform economy are the aim. Indeed, differences in design decisions, such as core interactions, mechanisms for network effects, platform openness, and governance models, are driven from differences in strategic choices regarding competitiveness, renewal, and growth. Platform competitiveness in this context reflects differences in the role or value that digital platforms currently play in holistic housing as a service platform concept now and for the future.

As Table 3 shows, cases vary substantially in their original strategic approaches, from so-called embedded in case A to informative and easily

replaceable in case D. In addition, different innovation strategies have been adopted in the four cases, which also influence competitiveness, growth opportunities, and scalability. For example, in case A, data-based KPIs already guide agile and continuous service development as a result of a systematic innovation process, while future focus will be on opportunities for analytics and AI. In this way, it seems that the scalability of data-driven housing as a service platform concept and platform-based business model are becoming enabled. Case B adopted the so-called minimum viable product strategy combined with experimental co-development among network partners and residents. Instead of searching for scalability on the entire housing as a service platform concept level, modular scalability was seen as more relevant, even though the chosen service bundles might enable limited data- and platform-based business growth opportunities. Case C followed an incremental development approach, with a future focus on automatization and service extension. So far, Case C's digital platform enables limited scalability in terms of depth and breadth (cf. Isckia et al., 2020). Nevertheless, if there will be opportunities for investment, future potential might be captured by enhancing integration in housing as a service platform concept.

Finally, for context-specific reasons, a new category was added in the conceptual frame of Tura and co-authors (2018) to define the role of the entire housing concept (including digital platforms) in the corporate strategy of the orchestrator. As seen from Table 3, cases vary from the core business focus to the living lab approach to new business opportunities, which also rationalizes the differences among cases in design decisions regarding digital platforms and related value co-creation opportunities in the future. All cases represent innovative project developments in housing, which take into account also the orchestrator role in the overall life cycle of the housing block and related service platform ecosystem (at least temporarily in case D). However, in case A, the orchestrator was an entrant in the housing market with a holistic housing concept, while in the other cases, the orchestrators were established players in their construction market segments. Case B represents a big builder company searching for new business opportunities, whereas case C and D are smaller players with limited resources. Case C focuses strongly on sustainability as a social enterprise and case D on living lab strategy for innovative housing concepts.

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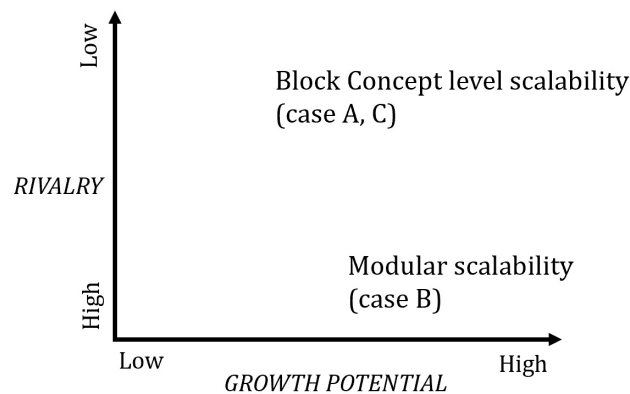
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Figure 1. Two main alternative growth approaches with empirical case illustrations

Conclusions and Discussions

The objective of the study was to examine, what kind of value creation opportunities digital platforms enable in holistic housing concepts and their related ecosystems. The theoretical structure was built by linking service-dominant logic with platform design and co-evolutionary approaches at an ecosystem level. In addition, recent research regarding urban living trends in residential housing contexts was presented to demonstrate related research gaps. We applied a qualitative multi-case study to reach our objective and narrow the identified research gaps. The study has several scientific and practical contributions, which are discussed and concluded as follows.

Scientific Contributions
While data-driven value creation opportunities of a platform economy in residential contexts are largely untapped and understudied, our empirical research showed that *digital platforms enable various kinds of value creation opportunities in resident-centric housing concepts and related ecosystems.* The empirical evidence indicated that the case studies shared the same innovative tripartite concept of housing as a service platform, with their unique value propositions and customer segments (Lusch & Nambisan, 2015). The specific analysis we conducted on the main digital platform design choices, based on the supplemented framework of Tura and co-authors (2018), revealed differences throughout the main, strongly interlinked elements, such as platform structure, value creation, governance, and competition. Aligning with the extant literature, our findings also indicate certain dependencies between design choices, enabling data, and platform-based value creation opportunities, and

a particular need for systemic design with a developmental approach (Tura et al., 2018; Isckia et al., 2020). For the time being, the widespread uses and opportunities that a platform economy offer are significantly limited due to the scarce number of residents as potential users, especially in the newly built block sites A, B, and D (see Hein et al., 2020). The attractiveness of a multi-sided marketplace with dynamic network mechanisms, revenue models, and an overall governance model, enable a digital service exchange, resource sharing, and other smooth, smart, and sustainable living activities as integral parts of housing as a service platform. However, competitiveness and scalability in terms of depth and breadth will only be realized when: 1) there are enough resident users, 2) the platform is open to various service providers and application developers, and 3) new housing blocks are built in new locations (Parker et al., 2016; Hein et al., 2020; Isckia et al., 2020).

The study also brings new empirical understanding on alternative approaches to utilizing data with a platform economy for housing concepts. Our exploration of various strategic choices regarding competitiveness, innovation, and growth revealed that digital platforms can provide informative, supportive, integrative, or even embedded structures in novel housing as service platform concepts. However, to be competitive requires totally new orchestration and business models across traditional industrial and ecosystem boundaries, which is in line with previous studies (Ikävalko et al., 2018; Lappalainen & Federley, 2020). Not only new business opportunities arise, but also huge challenges can be faced when combining conventional linear business logic with platform-based business models, which are rather unstudied,

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particularly in residential contexts. The case studies we researched were all in still the pilot phase, which means critical design decisions were being made to guide future opportunities. However, earlier literature supports findings of continuous platform development with strategic and operative changes (Letaifa, 2014; Tura et al., 2018; Isckia et al., 2020). The findings of the pilot sites suggest that orchestrators have adopted various strategic approaches to growth and scalability.

Thus, in light of basic mechanisms that ensure competitiveness and growth in data and a platform economy by scaling strategies focussed on depth and breadth (Isckia et al., 2020), the study proposes two main alternative strategic approaches: the block concept level of scalability and modular scalability. These are illustrated in Figure 1. Case D was excluded due to ongoing strategic elaboration in the early pilot phase, showed in the Findings Section.

With the *block concept level approach*, it may be easier to build competitiveness against rivalries as a new entrant that has great growth potential boosted by mega trends. On the other hand, significant investments are called for in the long term (economically, technically, organizationally, institutionally) across traditional industrial and ecosystem boundaries. In addition, the results of our research suggest that the block-like housing concept is always modified locally (Lappalainen & Federley, 2020). The same considerations were made by Aquier and co-authors (2019), when they defined a "shared-infrastructure business model" as part of sharing economy business model configurations. They also highlighted new business opportunities for established companies and new entrants in contributing to and orchestrating local ecosystems. Further, their (re)positioning may "be shaped by local authorities to promote policies in line with their local economic, environmental, and social strategies" (Acquier et al., 2019). Moreover, in their IoT platform business model study, Leminen and co-authors (2018) presented relevant future scenarios even though IoT solutions have not yet played a dominant role in the holistic housing concepts studied. They illustrated the so-called platform business model in a smart city context, where platform leaders "act as a resource integrator offering context-sensitive, multipurpose services for customers together with their partners in a closed ecosystem" (Leminen et al., 2018).

The *modular growth approach* might instead be more

agile and scalable in various housing contexts, as well as in international markets. Despite having attractive growth potential, the condition of rivalry is growing already and we assume it will become more significant with the smart living trend. From a resident's perspective, housing services as a platform ecosystem are still very fragmented, while services that enable daily life benefits are being developed separately. As the empirical cases above illustrated, we found that interesting data-based service solutions can emerge by combining data and actors from, 1) the life cycle of the built environment, and 2) the daily lives of residents, and that this happens across traditional industry boundaries. However, this would require a shift from closed to more open data sharing and value creation logic (Isckia et al., 2020), which is also aligned with the so-called horizontal market business model defined by Leminen and co-authors (2018). Accordingly, it "opens up a customer- and service-oriented view and a range of service businesses that are based on … everyday life by connecting people, devices and things in the extended home environment with a context-sensitive and seamless user experience" (Leminen et al., 2018.

Finally, we demonstrated that the supplemented platform design framework of Tura and co-authors (2018) with four main elements and complementary sub-categories seems to provide a relevant analysis base also in housing contexts. Instead of their case study, the comparative multi-case study in this article required a more structured analysis, which also revealed strategic choices behind design choices.

Practical Contributions
The study brings a needed empirical understanding of data-driven value creation opportunities, enabled by digital platforms for companies operating in various phases of residential housing development together with expanding the market of smart and sustainable living. This multi-case study illustrates various innovative holistic housing concepts as pioneering examples of housing as a service platform and related ecosystem with diverse value creation opportunities and strategic approaches. By demonstrating the ongoing industrial transformation logic towards servitization and a platform economy, with their related challenges and opportunities, the study also challenges both established players and new entrants to rethink their future opportunities and threats beyond current established industries, to involve in the emerging smart and sustainable living market. The ecosystem approach serves all organizational

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ecosystem actors, particularly construction companies and property developers that are interested in taking the role as orchestrators and operators along the life cycle of residential or hybrid blocks as service platforms and ecosystems.

In showing empirical examples of various strategic approaches and providing evaluative frameworks (Table 3 and Figure 1), this study provides managerial support to analyze and compare critical platform design choices and elements when searching for new business opportunities. The study demonstrates how crucial strategic design decisions take place to establish a platform-based service ecosystem, and thus how critical it is to invest in systemic design and development from the very beginning. In addition, the study provides valuable empirical knowledge and pioneering examples for municipal urban planners and developers that play critical roles as enablers for piloting new innovative concepts and creating conditions for ecosystem actors to contribute to local vitality, sustainability, and well-being (Aquier et al., 2019; Lappalainen & Federley, 2020).

Limitations and Need for Further Research
The qualitative empirical multi-case study provided a rich basis to gain deeper understanding on data- and platform-based value creation opportunities in a fairly unstudied residential service context. The main limitation of the study is that it covers only four cases, all in Finland. Furthermore, even if the focus was on resident-centric concepts, interviews of the residents could not be conducted, since in two cases the residents had moved in quite recently. In addition, because the empirical cases were in the co-evolving pilot phase, many critical design decisions are forming, driven by the yet emerging domestic and international markets.

The empirical and theoretical findings are only tentative, with three main paths for further research. First, new empirical cases (also from other geographical locations) with deeper examination are needed regarding the main interconnected digital platform design elements, such as platform architecture, value creation logic, governance, and platform competition in housing contexts. This will both help increase knowledge and support companies as orchestrators in ongoing transformation to build capabilities at the ecosystem level for a platform economy. The perspectives, value expectations, and experiences of housing residents, along with new

development ideas are necessary aspects that play a key role in value co-creation. These are captured in use and relate to future competitiveness and growth opportunities (see Lusch & Nambisan, 2015; Isckia et al., 2020). Moreover, taking a multi-actor perspective that also includes other ecosystem actors, such as service providers, content creators and application developers, as well as municipal urban planners, investors, builders and housing developers, is needed to enhance the ecosystem approach in terms of research, as well as urban development and business renewal.

Second, by adopting an expanded multi-actor approach, current cases may be able to contribute to interesting opportunities for a critical longitudinal study of the sustainability, scalability, and co-evolution of these housing as a service platform concepts, within their surrounding broader and dynamic service ecosystems. This would serve both practitioners and researchers in empirically exploring and conceptually re-structuring ecosystemic platform business model co-evolution and growth strategies in construction and housing markets (see Leminen et al., 2018).

Third, the supplemented conceptual platform design frame for comparative case studies seems to deepen the understanding of special industrial characteristics involving complex and dynamic value creation logic. Therefore, this housing market, and broadly smart and sustainable future living market has huge growth potential globally and is therefore interesting for further research. Particular interest should be focused on complex ongoing transformation where traditional linear, and slow asset-based business logic have to be combined with non-linear, agile and demand-driven business opportunities in a platform economy. The developed research design approach may also generally serve further studies in ecosystemic transformation towards platform economy across industries.

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Antecedents, Decisions, and Outcomes of a Sharing Economy: A Systematic Literature Review

Shweta Shirolkar and Kanchan Patil

" Don't walk in front of me, I may not follow. Don't walk behind me, I may not lead. Walk beside me and be my friend. "

Albert Camus

This article provides a comprehensive framework-based review of literature on "Sharing Economy" (SE) using an ADO (antecedents, decisions, and outcomes) framework. Based on extensive coverage of studies published over a period of 12 years between 2008 and 2020, we reviewed extant research on this phenomenon from both more developed and emerging countries. Using PRISMA methodology inclusion and exclusion criteria, we selected 93 articles for the review. The motivation to undertake this research was to understand emerging consumer behavior that intends to collaborate for consumption with the help of technological innovation. We identified major theoretical frameworks developed for investigating SEs and collaborative consumption behavior. The findings of the paper reveal possible antecedents, decisions, and outcomes of SEs. Many areas in the SE domain remain underexplored, despite recent significant advancements, and for this the paper provides directions for future research.

Introduction

Over the last decade, both the notion of a "sharing economy" (SE) and collaborative consumption have changed the way consumers are exhibiting consumption behavior through digital spaces. "Sharing" can be seen an ancient practice, while a SE as a consumption practice with the help of technological innovation is recent Belk (2014). Sharing Economies (SEs) as a research phenomenon themselves become prominent after 2008 with a majority of publications (from developed and emerging markets) spanning across the industry after 2013.

SEs are an economic phenomenon aiming to ensure access to underutilized assets and resources by different individuals through a digital platform. Through a digital platform, matchmaking is enabled between users and providers of the resources. Pallesen and Aakjaer (2020) investigated a SE as a path to welfare innovation where a

digital platform is established to support citizens with lung cancer, demonstrating the use of a SE by the public sector to extend its goals. Ruben et al. (2020) examined trust, transparency, and security in SEs. Access to information is considered as one of the important digital cues to ensure trust. The study posits the role of government to facilitate information access as a way to enhance trust.

SEs have many synonyms and the SE phenomenon overlaps with various concepts like "collaborative consumption", "collaborative economy", "access economy", "platform-based economy", and "community-based economy". Hamari et al. (2016) linked SEs to collaborative consumption and defined them as a "peer to peer" based activity of obtaining, giving, or sharing the access of goods and services coordinated through community-based online services. Digital platforms are starting to provide block chain technology-based opportunities for SEs. The literature

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available on SE has much complexity, inconsistency, challenges, and conceptual overlapping Acquier et al (2017).

A balanced explanation of the concept was given in the form of sharing exchange continuum by Belk (2007), as well as Gupta et al. (2019). Belk (2007) writes, that a "Sharing Exchange continuum was developed for the purpose of mapping any SE practices to determine how much non ownership forms of consumption consists of sharing related attributes" Belk(2007). For implementing a sharing exchange continuum, if any practice is categorized as a SE practice then a sharing score is calculated based on sharing vs. exchange related characteristics. SE practices, based on a calculated sharing score, are then placed on the continuum to understand whether a practice under consideration is closer to pure exchange, pure sharing, or balancing the two contrasting typologies (Habibi et al. (2017).

An SE is applied when there are unused or underutilized resources with an individual intending to share the same with others for their utilization and usage. The idea is basically to ensure community building, ownership to access, and contribution towards sustainable goals. Major beneficiaries would be the service providers who contribute the resources and assets, users who avail the services, assets, and digital platforms that facilitate matchmaking between service providers and users.

Though "sharing economy" is considered as a contested concept (Acquier et al. (2017). it is essential to review the literature available to dig deeper into the phenomenon (Gruszka, 2017). A previous research paper by Cheng (2016) reviewed 66 articles related to SE, out of which 10 specifically related to tourism and hospitality between 2010-2015. Altinay and Taheri (2019) reviewed the specific literature on SE related to tourism and hospitality to explain emerging theories and themes related to SE. Hossain (2020) conducted a comprehensive literature review on SEs, which presented a thematic analysis of selected papers between 2016-2018. In our study, we attempted to select the articles as recent as possible with a wider range of years, that is, from (2014-2020) as most publications associated with SE were published after 2013.

Our study selected 93 articles for a literature review to address the knowledge gap by contributing antecedents, decisions, and outcomes (ADO) of SEs. "Antecedents" are defined as the key motives of SE participants, "decisions" are key decisions and characteristics of SEs, and "outcomes" are key outcomes and impacts of SEs. This review also studies various theoretical lenses used to understand the SE phenomenon. While previous review studies conducted on SE have concentrated more on SE in tourism and hospitality, our study does not concentrate on one specific sector. Rather, we proposed the given framework based on relevant literature picked across the sectors from developed and emerging economies addressing the contextual gap.

In this article, we review empirical as well as theoretical studies published between the years 2008 to 2020 to understand both SEs and collaborative consumption, through the main characteristics of such phenomena in terms of antecedents, decisions, and motivations. This period was selected because the term "sharing economy" was first coined by Lawrence Lessig in 2008. The research questions addressed by this study investigate antecedents of SE as the key motives and enablers for SE, to examine the decisions that the key characteristics of a SE to participate, process, and explore the outcomes of SEs as a practice. This research focuses on proposing an antecedents, decisions, and outcome framework.

Hence, the article proceeds as follows: Section two presents the study's methodology. Section three presents a review of collected material in terms of various theoretical lenses used to study SEs. This section also presents a simple but comprehensive framework with antecedents, decisions, and outcomes to examine SEs. We then briefly describe the possible motives, outcomes, and characteristics of SEs. Subsequently, in section four we outline the proposed framework, future research directions, and provide a brief conclusion.

Review Methodology for SLR

The article follows the "systematic literature review" (SLR) method found in review articles by Paul and Benito (2018). We searched using Web of Science to identify empirical and theoretical articles published on SEs from 2014 to 2020.

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Table 1. Inclusion and Exclusion criteria for "Sharing Economy" article selection

Criteria for Inclusion	Criteria for exclusion
1. Articles can contain empirical findings or theoretical /conceptual findings	Non-English Papers
2. Articles must contain information related to SE, collaborative consumption associated theories, themes, variables, drivers, outcomes	Grey literature including blogs, newspaper articles, proceedings
3. Articles can be in the context of a developing economy or developed economy.	Conference proceedings
4. Articles must be a peer-reviewed papers published in journals from the Business and Management category.	

The initial articles search was based on keywords selected to promote emerging results and to answer the research questions. The Boolean operators were restricted to "AND" and "OR". The descriptors for the initial search query were "SE" "OR" "collaborative consumption" "OR" "access economy" "OR" "gig economy", "SE" "AND" "antecedents" "OR" "motivators", "SE" "AND" "decisions", "SE" "AND" "outcomes". The results of these searches were filtered through inclusion and exclusion criteria to arrive at an actual number of articles to be included in the final review as shown in Table 1.

Selection results
The selected results are presented in two forms. The first search presented the total number of documents identified after the initial search. The second search using the refinement criteria presented the antecedents, decisions, and outcomes of SE. The initial search query identified 1858 total studies. The keywords used to identify the initial documents were "sharing economy", "collaborative consumption", "gig economy", and "access-based economy".

The second search was performed specifically for understanding antecedents, decisions, and outcomes of the phenomenon. The literature was searched by combining "SE" with the keyword antecedents, motivators, decisions, and outcome, using 'AND', 'OR' as Boolean operators. The search results revealed a total of 270 studies, which were reviewed again for

relevance via abstract scanning, out of which 62 studies were finalized to be included in the review.

Apart from this database search, 31 additional studies were also reviewed from Science Direct and Emerald Insights, which were found to be relevant and therefore incorporated into the final review, making a total of 93 studies as depicted graphically in Fig. 1.

Review of collected material to identify Antecedents, Decisions, and Outcomes

Theoretical Underpinnings
The extant literature on SE research posits various theoretical underpinnings that scholars have applied in the context of SE. Some of the prominently known frameworks used by scholars in the context of SE are shown in Table 2.

Antecedents to Shared Economies
Antecedents to SEs are presented considering SEs as three-sided markets comprised of consumers, service providers, and platform providers.

Zuh et al. (2017) developed a value adoption model for a ridesharing mobile application, which posits that "functional value, emotional value, and social value" are the important antecedents of overall value derived from a SE ride sharing app. Hwang and Griffiths (2017) investigated the perceptions and attitudes of millennia's towards collaborative consumption services and found

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Figure 1. Flow chart of the literature review
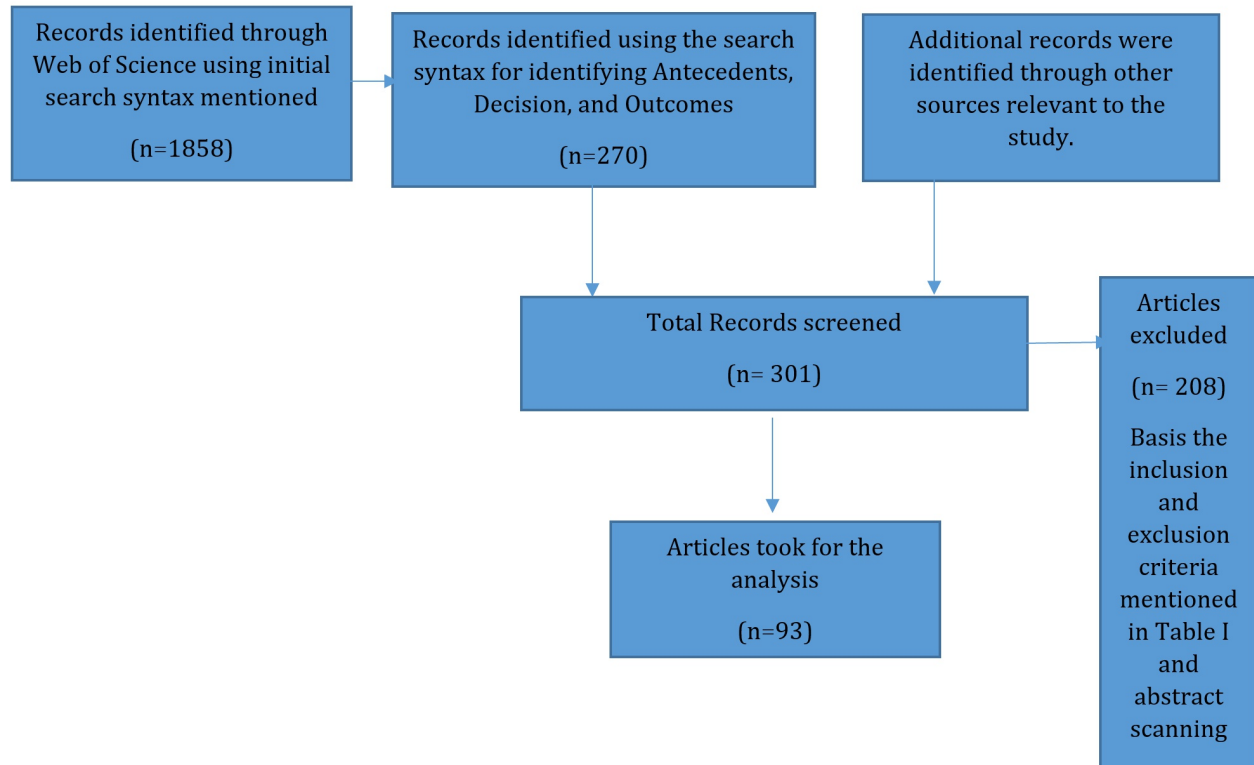
that "utilitarian", "hedonic", and "symbolic perceptions" of value have various impacts on millennia's. Stollery and Jun (2017) used the value elements "monetary value, hedonic value, novelty and social interaction and perceived risks [both] performance physical and psychological to examine the antecedents in the context of Air Bnb". Findings of the study reveal the positive impacts of monetary benefit, novelty, and social value, along with a negative impact of psychological risks. Zhang et al. (2019), in their study on mobile collaborative consumption, investigated the effects of individual sociability and enjoyment, motivation, social connection, trust, reputation, and embarrassment on participation. "Participation" here refers to the use of mobile collaborative consumption platform. Findings revealed that enjoyment, social connection, reputation, motivation, and embarrassment have positive impacts on participation.

Recent researcher has found that the main motivation of consumers to engage in "collaborative trading" (meaning, the transaction activities in collaborating

economies) through a SE is the economic value they perceive via reduction in transaction costs and financial outlay (Almeida et al., 2020). Most consumers participate in SEs or collaborative trading platforms with profit maximization as their main motive (Tussydiah, 2015; Tussyadiah & Pesonen, 2016; Retamel, 2017; Davlembayeva, 2019). The motive to save has as priority for consumers participating in SEs, with less expensive products and services enabled by new information and communication technology (ICT) platforms that reduce the underlying consumer search costs and buying prices. Barnes et al. (2016) in their exploratory study argued that technological and economic drivers rank highly in the minds of stakeholders when it comes to participating in SE platforms or collaborative trading.

A second major value driver for consumers is social value. Social value includes the experiences developed while interacting and transacting with a wide network of people. Developing social relationships, belongingness, connection is basically guided by the principal of "social capital". Social capital refers to the resources produced by the network of the human relations a person has,

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Table 2. Summary of some of the theoretical framework within SE Literature

Theoretical Underpinning	Definitions
Social Dilemma Theory	"Social Dilemma theory is used to investigate the pro environmental behavior of the consumers". For example, their decision to buy or not to buy green in the context of SE leading to sustainable consumption, as in Hartl (2016)
Theory of Reasoned Action (TRA)	TRA is an important model to explain human behavior in different concepts. The model has its roots in social psychology by Ajzen and Fishbein (1980). "Consumer intention to act in TRA are determined by two factors: attitude towards behavior and subjective norms", Barnes (2017).
Social Practice Theory (SPT)	"SPT has been recommended as an alternative approach to the prevailing objective choice approach on one hand, and the structuralist, norm following approach on the other hand", Huber (2017).
Frame Analysis	"Frame analysis is defined as the schemata of interpretation that can be used to decode the structure of experiences in individuals' social lives", Goffman (1974); Leung, Xue and Wen, (2019).
Transaction cost analysis	"Transaction cost theory states and considers the cost of providing some goods and services from the market rather than providing the same from within the firm", Akbar and Tracogna, (2018).
Business ecosystem approach	"Business ecosystem states that ecosystem is seen as a community of stakeholders including firms, government and other players that are mutually dependent on each other for survival", Parente (2018).
Ownership, Location and Internalization framework for internationalization (OLI)	"OLI is the framework most widely used for the internationalization of the firm. It states the reduction in cost via internalization of assets and coordination of the imperfect markets", Dunning (1980). He proposed that OLI is essential for firms to engage in cross- border activities.
Social Exchange theory (SET)	"SET states and consider that human interactions are based on certain basic economic principles revolving around rewards and costs", Homans (1950, 1958, 1961), Boateng et al. (2018).
Extended Valence framework	"Framework which states and considers two main factors for consumer purchase decision, perceived risk and perceived benefit", Peter and Tarpey (1975). Extended means trust and perceived platform qualities that are also considered to impact consumer decision, Lee et al. (2018).
Social Support Theory	"This theory has its roots in psychology Barrera (1986). It refers to the individual perception about the social resources which they have or is being provided by some formal group or informal setting impacting their behavior", Gottlieb and Bergen (2010), Nadeem et al. (2020).

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according to Ferrari (2017). The motivation for developing social capital could be intrinsic in nature, like enjoyment or having fun, which are also called "hedonic" motivations. Davlembayeva (2019) suggested that SE platforms can provide consumers with hedonic value, such as using products and services for enjoyment, which otherwise would not be possible for consumers to engage in or use due to high prices (Lawson et al., 2016). These kinds of consumption help consumers to maintain their status quo and thereby help customers satisfy their desire to seek status (Benoit et al., 2017).

Participating in SEs can have positive impacts on the environment (Botsman & Roger, 2010). Environmental value derived by consumers can include a sense of contribution towards sustainable consumption of products and services. Since these platforms provide access-based consumption to consumers, it impacts traffic, productivity, resource utilization, and efficiency, consequently fewer tools must be produced. The literature also argues, though, that these are not the strong motivator for consumers (Habibi et al., 2017), as access-based consumption might lead to over-consumption of the platforms and products, thus negatively impacting the environment (Benoit et al., 2017).

"Service providers" in SEs are defined as those individuals who give their under-utilized assets and services for the shared usage of consumers. The motivations for service providers to participate in SEs include entrepreneurial opportunity and social value. SEs and collaborative consumption are related phenomenon that emerged after the economic recession of 2008. The economic loss faced by people during the recession was seen as a driver to be recovered or mediated through the development of SE platforms or collaborative consumption platforms. Therefore, these consumption trends became one of the major drivers for service providers to utilize their unused or under-utilized assets as an avenue to recover economic losses, to have an additional income source, and to co-create value (Benoit et al., 2017)

Habibi et al. (2017) argue that in some collaborative consumption contexts social motivation drives participation. Airbnb stresses the community aspect of their platform and the locality of the accommodation on offer (Benoit et al., 2017). Hence, this also acts as a

motivating factor for service providers who can share their under-utilized asset and also create good social connections with travelers and other consumers.

Antecedents for the platform provider approach can be the economic benefit that these platforms (Airbnb, Uber etc.) receive through matchmaking activity between the consumer and service provider. Opportunities to innovate and react to market demand and supply dynamics arise through policies like surge pricing, discounting, etc. Lastly, social relationships created by platform providers can be a motivator to participate in the collaborative consumption of a SE.

Decision-making in Sharing Economies
Decisions are the key characteristics of a SE in deciding upon how participants are going to participate in that particular SE. As per the literature reviewed, various business model are available, including, 1) Consumer-to-consumer (C2C), where access to an under-utilized asset is temporary, and transactions take place directly between consumers, 2) Business-to-consumer (B2C) where rental of goods takes place from company to consumer, which we call a "product service economy", 3) On-demand economy, wherein we are dealing with peer-to-peer (P2P) service delivery, instead of P2P product delivery. Notably, consumers selling goods to each other is called a "second-hand economy", which does not fall under the category of SE as in this case permanent access is given to consumers rather than the temporary access (Frenken and Schor, 2017).

Andreassen et al. (2020) developed a paper to understand SE business models and how to create value for stakeholders with sustainability in a triadic business model. Hazee et al. (2020) investigated the design challenges and risks faced by sharing a product service system (PSS) by extending "unified service theory". The study revealed that consumers expect that risks should be minimized to enhance their perceived consumer value via structural and infrastructural design choices. Secondly, the study also revealed a value sharing proposition in customer supplied resources, with contingency factors as consequences that must be considered while designing the system. Vigneri (2020) investigated the role of dynamic management systems to understand which factors are crucial in making a crowdsourcing platform more effective for seekers and users. Platform performance parameters include the user base and resource structure. Kwok and Xie (2018)

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investigated the role of similarity between renters and consumers, including its impact on the transaction between the peer-to-peer accommodation provider, and the buyers those who are using the accommodation. The similarity they found was evaluated based on criteria like demographic information shared on the cyber marketplace. Hoskins and Leick (2019) posited that GDP will impact the likelihood that travelers will choose to book accommodation through online platforms in the SE context, with the role of online customer reviews role investigated for how they influence the decision. The findings of the study revealed that SE is seen as an acceptable alternative to the traditional incumbents. Total number of online reviews is a signal of popularity among prospective travelers, with average star rating as sign of accommodation, with positive online reviews more influential to drive rental bookings in the face of network externalities.

Regarding decision-making, consumers as users of product service systems must make a decision to participate in these SE platforms based on the utilities and motives behind the usage. Service providers have to make key decisions related to accessing assets (products and services). They also have to make service decisions while they behave as employees for customer contact representing the platform's brand. A platform provider in the given business model must make key decisions related to maintaining trust, reducing risk, ethical perceptions of customers, platform reputation through recommendation and positive network externalities, information quality as a platform service provider, and presenting the brand to users (Benoit et al., 2017).

Berger et al. (2020) estimated that increases in income for SE players are liable to become taxpayers to the government for the revenue they are earning in the form of income. Yet it has also been argued that these platforms are involved in false reporting of taxable income, which contradicts their sole objective of being pro-social. Hence, how ethical practices are conducted in the platform are another major characteristic for a SE platform.

Outcomes and Impacts on Shared Economies

Outcomes or impact of SE can be divided into 4 subheads: economic, social, environmental, and technological.

The economic impacts of SEs can be traced, for example, when a SE offers a new medium of entrepreneurship, job creation and economic benefit (Hossain, 2020). Participating actively in SEs can become a reasonable entrepreneurial avenue wherein a service provider with an innovative thought can participate in the SE phenomenon. Job creation helps the impact of a SE contribute reasonably to eradicating the issue of unemployment wherein people can work flexible hours and gain a source of income (Cheng, 2016). Economic benefit counts as one of the important drivers in this two-sided market. From a user's perspective, they have financial gains in terms of temporary access to the product service system that potentially contributes to savings.

SEs facilitate access-based consumption. This in turn contributes towards using underutilized assets and unused assets for a longer duration of time through accessibility. Using goods and services for longer durations of time facilitates more sustainable consumption goals. This form of consumption practices also contributes towards more efficient utilization of available resources. However, for SE firms with business models, sustainability plays an important role in long term development (Parguel et al., 2017; Piscicelli et al., 2018) and has a positive influence on peoples' attitudes towards SE (Joo, 2015; Tussyadiah, 2016).

Ma et al. (2018) developed an empirically testable framework using theories about SEs for value co-creation, sustainable consumption and production. A case comparison was done between "Mobile and EVCARD" in order to define the parameters of value co-creation involving sustainable consumption and production and their relation with SEs. Akylken et al. (2018) investigated sustainability implications of shared mobility and the need for new approaches to governance. Findings of the research revealed that any change on any element of a SE enhances the opportunity for sustainable mobility. Sabitzer et al. (2018) claimed that SEs have promising opportunities with many positive impacts on societies and environments, potentially providing sustainable solutions due to the reduction of resource consumption and wastage.

Social connections through social bonding amongst individuals participating in SE practices and activities, creates a community feeling, with networking, etc. These are some of the social and societal outcomes of SE.

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Discussion and Implications

We were motivated by the ambiguous literature on the context of SEs and the other synonymous concepts used like collaborative consumption, gig economy, access-based economy, platform-based business models, circular economy, etc. Another motivating factor was the kind of research reviews conducted to date in the context that were primarily inclined towards theoretical and conceptual foundations, or thematic analysis devoid of a possible framework to understand the phenomenon. Though it has been evident that the local market perspective is important in understanding business model innovation, here in this review we have included review articles both from emerging, as well as developed markets in attempting to gain a holistic perspective of the context and its associated variables. Various theoretical perspectives have been used and contributed by multiple researchers to investigate SE as a phenomenon like theory of reasoned behavior, social exchange theory, frame analysis, social practice theory, business ecosystem approach, OLI framework for internationalization, transaction cost analysis, etc. Meanwhile, all that the framework has become is sweeping statements in research based on mere conceptualization and lack strong empirical evidence.

In this paper, we propose the antecedents, decisions and outcomes (ADO) framework, based on the review we conducted to address SEs. Major antecedents emerging for various stakeholders to participate in SEs are: functional value, social value, hedonic value environmental value, and Entrepreneurial opportunity. The functional value of these antecedents is comprised of utilitarian motivations like perceived economic value or monetary benefits that consumers receive while participating in SEs. Social values are part of the motivation for joining a SE, in terms of gaining social belongingness, and resources developed because of social bonding while participating in a SE. Hedonic value denotes motivations like enjoyment, fun, and perceived emotional benefits that participants may experience while participating in a SE. Environmental value posits the environmental benefit that a SE platform provides through access-based consumption contributing towards sustainable consumption and development goals. Entrepreneurial opportunity addresses innovation opportunities provided by a SE platform by activating potential matching of underutilized assets for consumption.

Various decision criteria outlined by the review include product sourcing, comprised of decisions to be taken related to what should be the offering traded on a SE platform, from where to source the products/services, how to credibly verify the source, and what criteria should evaluate credibility. Establishing reputation, which to a larger extent is governed by reviews and online ratings given by consumers and other stakeholders, depends on service quality, information quality, and navigation ease provided by the SE platform. Risk management ultimately depends on the perceived level of mutual trust established between participants of a three-sided market: the consumer, service provider, and the platform provider. Infrastructural design is considered important to reduce the perceived risks of consumers thereby enhancing the value. Other decision criteria were found to be resource structure, network externalities, and dynamic performance management system, the latter which is a system dynamics application to manage common goods.

Outcomes proposed in the conceptual framework comprise a migration of consumption pattern from ownership to accessibility. This form of consumer behavior ensures the utilization of underutilized assets to be shared with others. It offers potential to lead to flexible employment opportunities, reduced resource usage, cost-saving, less waste, sustainable consumption, and a unique customer experience.

The impacts of SEs on incumbents have increased the competition amongst traditional players and new platforms with sharing-oriented business model innovation. It is because of this that many incumbents have started initiating and incorporating a sharing model into their traditional business model through various modes like value propositions, partnerships, infrastructure sharing, etc. Though SE platforms are giving very tough competition to the incumbents, not much is currently known about the governance of these platforms. Investigations have been done by researchers saying that the same regulatory policies applied to incumbents should apply to these platforms also, due to the consideration of being a potentially tough competitor. Some investigation has taken place on the regulatory front claiming that ethical reporting of taxable income is not being done by these platform organizations to avoid liable tax payments to the

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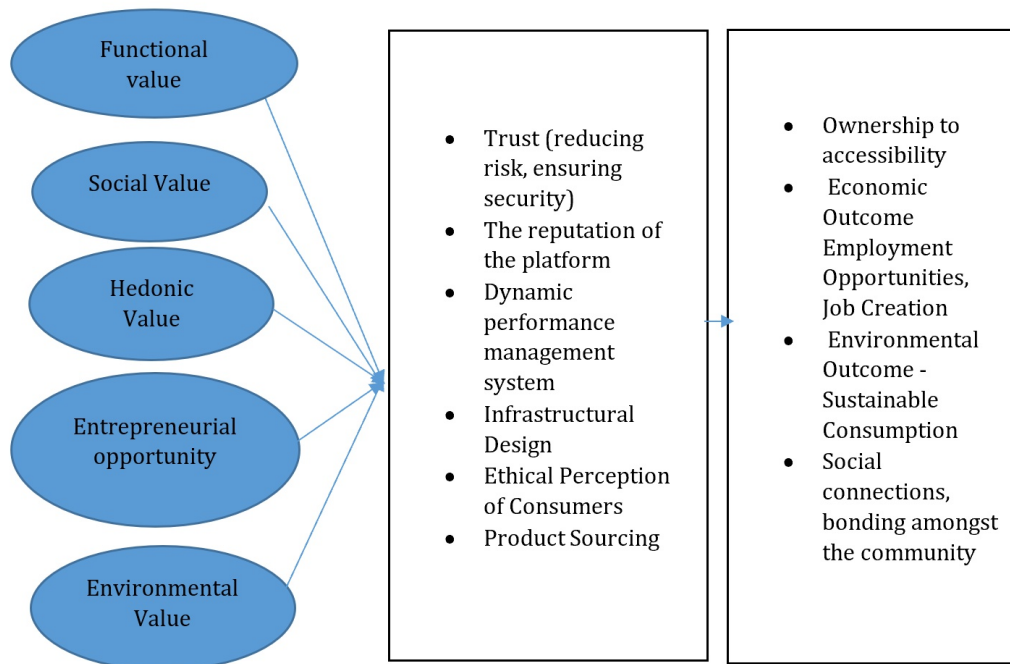*Shweta Shirolkar & Kanchan Patil*

Figure 2. Proposed Framework

government. Future investigations could enrich our understanding of this based on the above discussion and implications.

Based on the preceding discussions and review of prior literature, Figure 2 illustrates the proposed framework.

The managerial implications of this review can help SE platforms and traditional incumbents incorporate sharing-oriented business model innovations into their traditional business to understand the enablers and motivations of consumers. What could be the various decisions or ways in which they must decide to take up this entrepreneurial opportunity? Also, the possible outcomes or impacts it can have on business and society. This would help the incumbents with better decision-making to achieve long-term organizational goals. On the other hand, this research can also help SE platform owners to understand the major enablers and outcomes to increasing user participation.

The theoretical implication of the study extends our understanding of antecedents, decisions, and outcomes variables related to SE. The proposed ADO framework in the context of SE makes a contribution

that highlights the various value propositions serving as enablers for participation, different strategic decisions to be made, and probable outcomes of participating in SEs. This study addresses the different theoretical foundations that are available to study SEs. Our suggested framework differs from earlier foundations in the sense that it explains comprehensively what could be the major motivations of several stakeholders for participating in a SE. This framework also highlights the major strategic decisions that need to be made to facilitate platform participation and improve possible outcomes of the phenomenon.

Different variables proposed in the framework allow scholars opportunities for empirical analysis. Scale development and measurement development research can also be performed to operationalize some of the constructs like entrepreneurial activity, environmental value, and sustainable consumption, thereby contributing both to SE literature and sustainable development goals (SDGs) on a broader perspective. Platform sustainability and contribution to achieving the SDGs of sustainable consumption and production are the areas wherein empirical evidence should be researched to justify the present conceptual offering.

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The dynamic performance management system is another process that allows scholars to perform empirical research and achieve contributions.

Limitations and Future Research Direction
The present review has a certain limitation that reveals a potential future research direction. This review used only peer-reviewed articles and excluded other forms of literature available. Future research can include conference papers or policy papers. Secondly, the selection of articles used for the review was done from Web of Science, along with some relevant papers from other databases. Additional databases can also be searched to screen articles for future systematic reviews. In this review, the peer-reviewed articles selected were in the context of developed as well as developing countries. Future research can target studying the phenomenon in local contexts.

Future research in the context of SE can make an empirical investigation possibly related to pricing mechanisms, platform sustainability, regulations, or governance. These are the topics that become prominent for upcoming research as little research has been done in this context. The above-mentioned research should be conducted including the perspectives of all stakeholders in business model innovation and how each one gets benefitted.

Future studies can also be guided by better understanding of the market segmentation for SE services, how they can be made appealing to different types of various segments. One important outcome or impact of SEs, collaborative consumption is thought to be flexible when applied to employment opportunities termed as a "gig force". Future research in the context of gig economics can clarify the impacts of flexible employment opportunities on regular employment of human capital in various organizations.

Conclusion

The main aim of the paper was to conduct a systematic review of literature on "sharing economy" (SE). The present review was the first to propose the (antecedents, decisions, and outcomes) ADO framework to understand enablers, decisions, and outcomes of SEs. The findings of this research revealed the categories of social value, hedonic value, economic value, environmental value, entrepreneurial

opportunity as major antecedents to participate in SEs. Trust, the reputation of the platform, a dynamic performance management system, product sourcing, infrastructure design, and the ethical perception of SE consumers are some of the major decisions related to SEs. Outcomes of SEs were found to be a consumption pattern moving from ownership to accessibility, employment opportunities, social connections, environment impacts, and potential for more sustainable business.

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