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Value Drivers of Artificial Intelligence

Timo Phillip Böttcher
Technical University of Munich, timo.boettcher@tum.de

Michael Weber
Technical University of Munich, mic.weber@tum.de

Jörg Weking
Technical University of Munich, joerg.weking@tum.de

Andreas Hein
Technical University of Munich, andreas.hein@in.tum.de

Helmut Krcmar
Technical University of Munich, krcmar@in.tum.de

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Completed Research

Timo Phillip Böttcher
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timo.boettcher@tum.de

Michael Weber
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mic.weber@tum.de

Jörg Weking
Technical University of Munich
joerg.weking@tum.de

Andreas Hein
Technical University of Munich
andreas.hein@tum.de

Helmut Krcmar
Technical University of Munich
helmut.krcmar@tum.de

Abstract

Artificial intelligence (AI) holds great potential for firms to create new business models and gain competitive advantages. While some pioneers are effectively leveraging AI, most firms are struggling to capitalize on the opportunities for value creation. Previous research has highlighted the performance benefits, success factors, and challenges of adopting AI. However, the value drivers of AI, specifically regarding how AI creates value, remain unclear and need exploration so that firms can adapt their value creation to leverage the potential. To clarify how AI creates value, we conduct a case survey of 61 firms to identify six value drivers: efficiency, novelty, knowledge from data, ecosystem, personalization, and human resemblance. We discuss how these value drivers differ from other digital technologies. For practitioners, we provide valuable insights into the business value of AI and business model (BM) design opportunities to build on.

Keywords

Artificial intelligence, value creation, business model, case survey.

Introduction

Artificial intelligence (AI) is a highly promising technology that influences the value creation process of firms (Davenport and Ronanki 2018). By 2025, the business value created globally by AI is expected to nearly double from today's three trillion US$ to over five trillion US$ (Gartner 2019). Some firms, like Uber, have recognized the opportunities of AI early on and pioneer its application; Uber uses AI for fraud detection, risk assessment, marketing budget allocation, driver and rider matching, route optimization, and driver onboarding. Such firms have successfully aligned their business models (BMs) with AI and created a competitive advantage (Lee et al. 2019). Simultaneously, many firms have hardly implemented any AI applications yet (Ransbotham et al. 2017). Due to the complexity involved, these firms often face significant issues at all levels, such as a missing AI strategy, a lack of technical expertise, and an ill-defined understanding of how AI can create value (Lee et al. 2019).

To fully leverage AI and create value, firms need to embed it in a BM (Teece 2010). Firms need to adapt their BMs to take full advantage of AI's benefits, but also need AI and other digital innovations to create a competitive digital BM (Chesbrough 2007). A BM is a tool for the development, innovation, and evaluation of firms' business logic (Veit et al. 2014). It is "the design or architecture of how value is generated, delivered, and monetized" (Teece 2010). If AI is included, firms need to understand how it can create value. However, advances in AI and other deep-tech technologies have led to increased complexity as they increase interdependencies between technologies, processes, and firms in the ecosystem (Benbya et al. 2020).

Research has analyzed AI from multiple perspectives, such as financial and strategic performance of firms (Reis et al. 2020), adoption and barriers to adopting (Alsheibani et al. 2020; Jöhnk et al. 2021), BM characteristics (Weber et al. 2021), AI-capabilities (Schmidt et al. 2020), and top management influence (Li et al. 2021).

AI "as the frontier of computational advancements that references human intelligence in addressing ever more complex decision-making problems" (Berente et al. 2021) creates manifold opportunities for value creation, such as autonomous robots organizing warehouses (e.g., Nimble Robotics) and intelligent software optimizing sales (e.g., Outreach), time management (e.g., Clockwise), or product development (e.g., BenchSci). Yet, the value drivers of AI, describing how AI creates value, remain unclear and need clarity so that firms can adapt their value creation to leverage AI's potential (Schmidt et al. 2020).

Various theoretical and practical models exist in the literature to assess technology-driven value creation, such as the "sources of value creation in e-business" model (Amit and Zott (2001). This model consists of four value drivers in BMs enabled by the Internet: *efficiency*, *novelty*, *lock-in*, and *complementarities* (Amit and Zott 2001). The Internet digitalized value creation by enabling online transactions, such as matchmaking on digital platforms, which was done offline before. AI changes value creation by enabling new processes, products, and BMs, that were not feasible before (Borges et al. 2021). Therefore, we propose the following research question to analyze how AI creates value and how it differs from previous digital innovations like the Internet: *what are the sources of value creation in AI-enabled business models?*

We conduct a case survey (Larsson 1993) to reveal sources of value creation in AI-enabled BMs. We developed a structured questionnaire based on extant literature on value creation, digital BMs, and applications of AI. We identified 61 firms with AI-enabled BMs and answered the questionnaire for each firm using publicly available information. For the questionnaire analysis, we conducted open, axial, and selective coding (Corbin and Strauss 1990) to identify value drivers of AI and create a model of how AI creates value in BMs. The model displays the variety of AI value creation and how it differs from previous digital innovations. For practice, we provide insights into the business value of AI and BM design options firms can build upon.

Related Work

A BM represents a firm's business logic (Veit et al. 2014). It defines how a firm "creates and delivers value to customers, and then converts payments received to profits" (Teece 2010). In their BM Canvas, Osterwalder and Pigneur (2010) formulate nine elements. These are the *value proposition*, *customer segments*, *customer relationships*, *sales channels*, *revenue streams*, *key partners*, *key activities*, *key resources*, and *cost structure* of the BM.

Along digital transformation, the BM has become relevant in articulating the value creation from digital innovations. Vial (2019) even describes the BM as a central outcome of the digital transformation, that is, a digitally transformed BM or just digital BM. A BM is digital if digital innovations bring fundamental changes in the way business is done, transacted, and value is created (Veit et al. 2014). Thus, many digital BMs have fundamentally changed the way value is created (Steininger 2019). For example, a very prominent type of digital BMs is digital platforms, such as Uber or Amazon, creating multi-sided markets by matching multiple actors via the Internet.

Value creation is a core component of BMs and summarizes all activities related to creating the value proposition for the customer (Amit and Zott 2001). The topic of how digital innovations enable new forms of value creation has been a major focus of BM research in information systems (Steininger 2019). It has become indispensable in the business world and influences all core processes and operations in firms (Wang et al. 2014). Digital technologies are resources, through which value can be created (Lee et al. 2014) and (Steininger 2019) articulated four roles of digital technology in value creation to enable digital BMs: a facilitator of business operations (e.g., robot process automation for business processes), a mediator of value delivery to the customer (e.g., online shops), an outcome of the value creation (e.g., software development), and a ubiquity where the entire BM is digital (e.g., digital platforms). Already with the emergence of the Internet Amit and Zott (2001) examined how it enabled new forms of value creation. They identified four value drivers: first, value is created on the Internet through more efficient transactions ("efficiency"); second, due to a complementary product offering, products are often sold together, which in turn increases the value created ("complementarities"); third, fewer customers switch to competitors due

to the "lock-in" effect; and fourth, the Internet enables completely new types of BMs ("novelty") (Amit and Zott 2001).

Following Berente et al. (2021), AI is "the frontier of computational advancements that references human intelligence in addressing ever more complex decision-making problems," such as predicting the shape of proteins from the sequence of its amino acids. Thus, it represents what Information Technology is currently capable of and the opportunities for value creation seem endless. To understand how AI can create value today, we summarize three major applications to demonstrate its capabilities as a comprehensive list is beyond this paper's scope.

First, AI can analyze large data sets and discover patterns and logical relationships. Thereby, it can make predictions concerning time series or the probability of events (Agrawal et al. 2019). Compared to traditional data analysis, AI models are constantly evolving through self-learning algorithms, implying that the ability to make predictions or categorize things is constantly improving (Davenport and Ronanki 2018). Second, AI can recognize, classify, and process objects, images, videos, and text. Machine vision enables AI systems to perceive visual content such as images and videos in their environment just like humans (Goodfellow et al. 2016). This property is important for several visual recognition AI applications. Natural Language Processing (NLP) enables the understanding of human language by AI systems (Goodfellow et al. 2016). NLP can recognize languages, analyze grammar and sentence structures, and understand the meaning of written and spoken language. For example, AI can recognize spam, fake news, and even emotions. Third, AI can autonomously control physical objects, such as robots (Murphy 2019). AI responds to changes in the environment and controls objects accordingly. For example, it enables an autonomously driving car to handle different traffic situations, known and unknown.

Ever since AI became an economically relevant technology, research looked into the competitive benefits of its implementation and how it provides benefits for firms, their strategies, and BMs (Brynjolfsson and Mcafee 2017; Teece 2018). AI and its related technologies, such as machine learning, are already shown to positively influence firm performance (Reis et al. 2020; Wamba-Taguimdje et al. 2020). BM research has developed taxonomies of AI-enabled BMs (Weber et al. 2021) and AI-enabled value propositions in particular (Nowacki 2019) to analyze how firms build viable BMs based on AI. The value creation aspect has been analyzed from detangled viewpoints, such as multi-stakeholder perspective (Güngör 2020), value co-creation (Kaartemo and Helkkula 2018), or AI-capabilities (Schmidt et al. 2020). Borges et al. (2021) propose a conceptual framework connecting AI technologies and business strategy and suggest four sources of value creation based on extant literature that needs further investigation.

However, firms still face various organizational challenges, such as strategic goals, business value demonstration, or top management support, when implementing AI that hinder successful value creation (Alsheibani et al. 2020; Someh et al. 2020). In summary, extant research demonstrates the benefits and challenges of AI. However, more research is needed to explain how and why AI creates value and if the value drivers differ from the ones known from other digital innovations (Amit and Zott 2001; Benbya et al. 2020; Borges et al. 2021; Teece 2018).

Methodology

To identify the value drivers of AI, we use the case survey method to create generalizable insights from qualitative data (Larsson 1993). The case survey allows us to analyze shared elements of AI value creation and develop a theoretical model of their interdependencies. The method consists of four steps. First, we developed a structured questionnaire based on extant literature. Second, we identified our case sample of firms with AI-enabled BMs. Third, we answered our questionnaire for all firms using public information. Fourth, the qualitative data in the questionnaire were analyzed using open, axial, and selective coding (Corbin and Strauss 1990) to develop the value drivers and a model of AI value creation.

The questionnaire consists of four parts. The first part comprises general information about the firms, such as industry, headquarter location, and initial public offering (IPO) date. The second part uses the BM Canvas (Osterwalder and Pigneur 2010) to capture all components of the BM including how AI is relevant for the value proposition, the revenue model, or the customer relationships. The third part examines what the firms specifically use AI and data for. This includes a summary of specific AI use cases, a description of the role of data and what it is used for, and if the AI affects products, processes, or services. The fourth part

records how Amit and Zott's (2001) Amit and Zott (2001)four value drivers apply to the analyzed AI-enabled BMs.

We created the case sample for our case survey from Crunchbase. We selected firms assigned to the "Artificial Intelligence" industry. Following Amit and Zott (2001), we only included firms listed on a stock exchange to ensure that sufficient and reliable information was available. This resulted in 155 relevant firms that were analyzed if they fit our research purpose. Therefore, we applied exclusion criteria (Larsson 1993): firms that are no longer active (-4), firms without information in English (-42), firms without sufficient public information to answer our questionnaire (-32), and firms that we did not consider to be implementing an AI-enabled BM (-16; e.g., WISeKey provides a digital identity platform that uses AI elements, but does not rely on it). The final sample had 61 relevant firms.

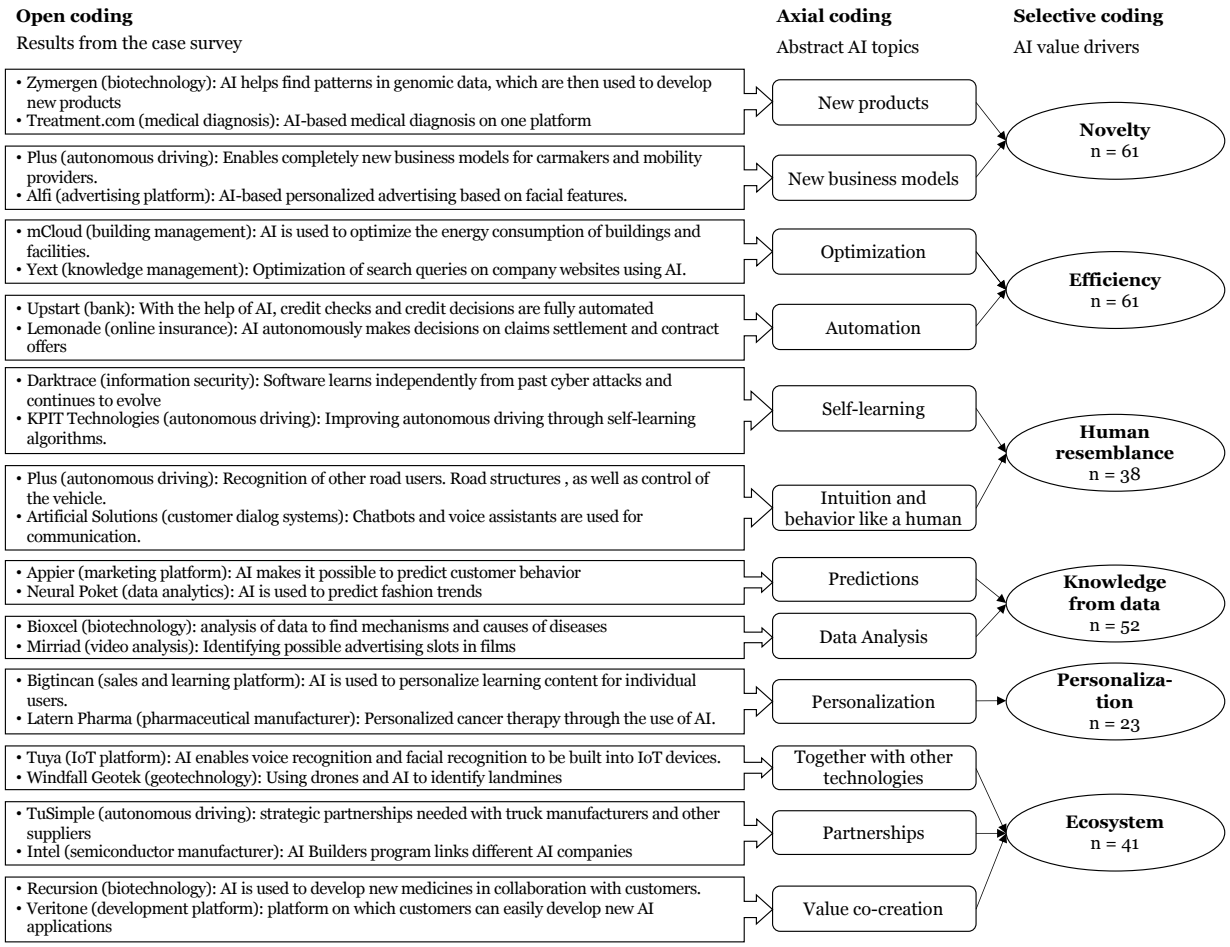

Figure 1. Coding procedure

We collected information about the firms' AI usage from several data sources (Amshoff et al. 2015), such as the firms' publications, such as their financial reports (e.g., 10-K forms), firm announcements, and websites. Since we restricted our case sample to publicly listed firms, we assumed the correctness of these information. We triangulated this information with other sources such as renowned newspapers' (e.g., Financial Times, Wall Street Journal) articles, academic and practitioner case studies, analysts' investment reports, and public databases to get a comprehensive view on the firms' strategic use of AI and avoid potential biases (Amshoff et al. 2015; Yin 2017). In total, we collected 341 sources for the completion of the questionnaire.

Figure 1 shows how abstract AI topics were initially derived from the individual results of the case survey. We first collected text fragments as open codes. With axial coding, these were grouped into different, abstracted AI topics, such as "self-learning." Finally, we applied selective coding to derive themes

representing the value drivers of AI. We further analyzed the relationships between the value drivers, looking into dependencies and interactions, to create a theoretical model of AI value creation.

Results

Case Sample

Our case sample consists of 61 firms. The firms are software firms (56%, n = 34), platform firms (25%, n = 15), biotechnology firms (10%, n = 6), autonomous driving firms (3%, n = 2), computer chip firms (3%, n = 2), and finance firms (3%, n = 2). Most are headquartered in North America (56%, n = 34) followed by Asia (25%, n = 15) and Europe (19%, n = 12). For the date of foundation, 48% (n = 30) were founded in the last ten years, and 30% (n = 18) from 2001 to 2010. This temporal trend is even more apparent in the date of the IPO: 78% (n = 48) of the firms had their IPO in the last ten years.

Value Drivers

Analyzing the 61 firms revealed that value creation through AI can be mapped by the six inductively derived value drivers of *efficiency*, *novelty*, *knowledge from data*, *ecosystem*, *personalization*, and *human resemblance*. Furthermore, we identified strong interdependencies between them.

Efficiency. AI contributes to an increase in efficiency; it is primarily used to automate processes and services, whereby automation here refers to replacing manual human work. An example is Upstart, which uses AI to automate the entire loan origination process. By using AI, the customer's creditworthiness can be predicted more accurately. This, in turn, allows the cost of the loan to be cheaper than conventional loans.

Novelty. A range of novel products, processes, services, and BMs are enabled that would not be possible without AI. One example is Minerva Intelligence, which has AI find the optimal location for mines. The traditional mine search process is expensive because it involves a lot of drilling and analysis. Using AI, Minerva creates 3D models of potential mine sites and predicts the best potential sites.

Knowledge from data. AI is often used to analyze vast amounts of data, gain new insights, and make predictions. For example, Neural Pocket uses AI to analyze fashion trends by using Deep Learning to analyze data from social networks to predict new trends. This enables firms to react to new fashion trends early.

Ecosystem. Additional value can be created through collaborations with partners, customers, and other stakeholders. For some firms, this ecosystem is even a prerequisite for their business activities. The value creation takes place within the firm itself and in collaboration with its customers. One example is Veritone, which offers a platform for its customers to develop AI applications using a modular system. Veritone also supports its customers in developing AI applications on the platform, meaning that value creation occurs jointly.

Personalization. Many firms use AI to tailor content, advertising, and even medical therapies to individuals or groups. The sales and learning platform, Bigtincan, uses AI to provide each user with individualized learning content and training. As a result, each sales employee receives only the relevant information and can thus focus more effectively on the critical tasks. AI is needed to determine the individual needs of each user from the user and behavioral data.

Human resemblance. AI enables bots, robots, and software to behave similarly to people. This human-like behavior can allow AI to take over complex tasks previously performed by humans. For example, Artificial Solutions enable customer service that is very similar to interacting with a human representative through chatbots and intelligent virtual voice assistants.

Dependencies Between the Value Drivers

The analysis of relationships between the six value drivers resulted in Figure 2. *Efficiency*, *novelty*, *knowledge from data*, *personalization*, and *human resemblance* all interact with each other, while *ecosystem* has an overarching role in value creation in digital contexts.

The relationship between *novelty* and *efficiency* described by Amit and Zott (2001) persists regarding AI. The mechanisms that enable efficiency cannot be realized without the novelty created by new AI-based products or services. Simultaneously, the efficiency enabled by AI increases the rate of innovation, thus creating novelty. BioXcel Therapeutics, for example, uses AI to analyze structured and unstructured data from science, like trial data and scientific publications, to develop new therapies and drugs faster and more efficiently. *Novelty* is similarly linked to *personalization*, *knowledge from data*, and *human resemblance*. For example, ALFI's facial recognition enables personalized advertising that creates novel value for advertisers. Autonomous driving features from Plus creates new BMs by imitating human drivers. *Knowledge from data* enables *novelty*, for example, by finding patterns in data to develop new products.

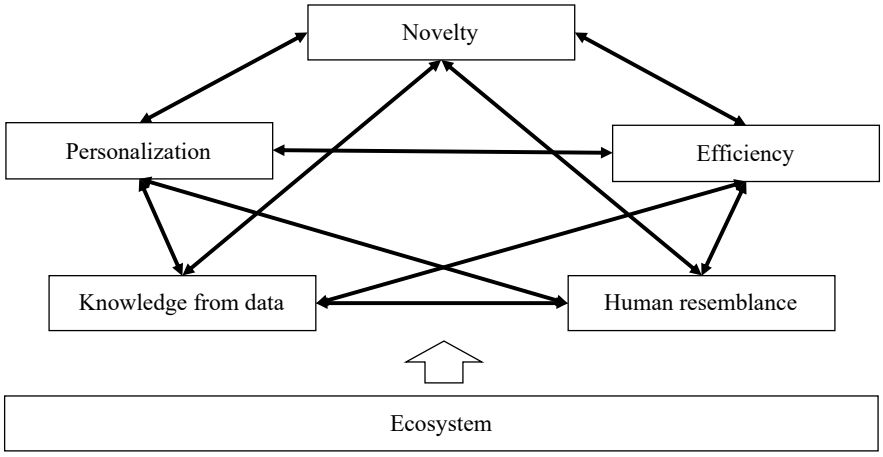

Figure 2. Value creation from AI

Efficiency influences *human resemblance*, especially when AI is used to automate processes that go beyond rule-based executions and typically require human intuition. For example, with Lemonade, an online insurance firm, AI evaluates insurance claim data and images to approve or deny claims. This way, AI accelerates customer service by mimicking human decision-making and increasing efficiency. The link between the *efficiency* and *knowledge from data* value drivers stems from the observation that analyzing data enables predictions that make processes more efficient. *Efficiency* and *personalization* are linked, as personalization allows direct targeting. For example, AI is used to play ads on Kuasishou Technology's video platform based on personalized user behavior. This optimizes the placement of advertising for efficient targeting.

Furthermore, *human resemblance* and *personalization* share dependencies for value creation. The human-like behavior, Chatbots for example, and self-learning capabilities of AI support and improve personalization. For example, Treatment.com creates an artificial conversation with patients to diagnose illnesses and recommend personalized treatments. *Human resemblance* and *knowledge from data* are related, especially in the self-learning capability of AI. If an AI creates knowledge from data, it remembers this knowledge to improve functionality and thereby resembles human capabilities. For example, Darktrace provides a self-learning AI to detect cyber attacks, that reports suspicious behavior in a system to prevent cyber attacks and improves its accuracy with every new suspicious event.

Finally, *knowledge from data* and *personalization* are related since data analysis is needed to personalize content or services. As such, knowledge from data is a prerequisite for personalization. Lantern Pharma illustrates this when using AI for the personalization of cancer therapies based on the knowledge identified from individual health records and genome data.

Discussion

Most firms struggle to harness the potential of AI and effectively create value. Extant research has identified the potentials, performance implications, and also challenges to overcome when implementing AI in BMs. The progress in AI has led to increased complexity for value creation, but also great new opportunities (Benbya et al. 2020). Yet, the value drivers of AI remained unclear (Schmidt et al. 2020). Thus, firms still struggle to determine the value that is created from using AI and integrating it successfully in their BMs

(Amit and Zott 2012; Ransbotham et al. 2017). To understand how AI creates value, and how this is different from the value creation from other digital innovations (Benbya et al. 2020; Teece 2018), we analyzed 61 firms employing an AI-based BM and identified six value drivers of AI. Based on these value drivers, we created a model of AI value creation (Figure 2).

Our model shows that value creation from AI is different from previous digital innovations. Similar to the Internet, AI still creates value through *novelty* and *efficiency*, but differ in detail. The Internet mostly created novel and more efficient ways to perform transactions, such as matchmaking on digital platforms. While digital platforms and online shops were new BMs, they are "only" digitalized versions of known BMs. *Novelty* and *efficiency* enabled by AI, create new value by enabling processes, products, and BMs that were not feasible before (Borges et al. 2021; Weber et al. 2021). AI enables value creation by making business processes more efficient. It allows replacing human labor with automated and intelligent solutions that can replace human actions (Lee et al. 2019; Raisch and Krakowski 2021; Schmidt et al. 2020). The processes can be executed faster and with fewer errors through AI, leading to cost and time savings (Wamba-Taguimdje et al. 2020). The value creation is revealed in the achieved saving, but also in the additional value that the human workers can create, for example in creative tasks, instead of engaging in the automatable tasks (Agrawal et al. 2019; West 2018). AI also creates value by enabling novel processes, products, services, and BMs that are sources of value creation through innovations such as AI (Chesbrough et al. 2018; Schumpeter 1934). Since AI presents a moving "frontier of computational advancements" (Berente et al. 2021) the value creation through novelty is likely to increase further. The new possibilities offered by the digital innovations in AI continue to enable new products, services, and BMs such as humanoid robots or autonomous driving.

Additionally, we identified *human resemblance*, *knowledge from data*, *personalization*, and *ecosystem* to complete our model. In the literature, AI is often referred to as human-like (Davenport and Ronanki 2018; Teece 2018). While AI is still not able to fully mimic humans, it can solve specific problems better than humans, for example by finding new solutions to a problem, thereby creating new value (Goodfellow et al. 2016; Hartmann 2019). As AI technologies are further improving to mimic human intelligence (Goodfellow et al. 2016; Wodecki 2019), the opportunities for value creation through human resemblance and the associated novelty will further increase. *Knowledge from data* is a core driver of AI value creation (George and Lin 2017; Hartmann 2019). The ability to analyze vast amounts of data, detect patterns, and predict future values enables tremendous value creation (Kitsios and Kamariotou 2021). This knowledge creation goes beyond what humans or traditional computational methods could perform. Creating this new knowledge presents a competitive advantage for firms (Grant 1996). However, this also requires large amounts of data for analysis. For AI value creation, data becomes a strategic resource that has to be collected, managed, and leveraged (Hartmann and Henkel 2020; Mikalef and Gupta 2021). The value creation from *personalization* stems from AI's higher precision in targeting and forecasting individual needs (Lee et al. 2019). Personalization is possible without AI, but AI allows responses to individual preferences and habits, emotions recognized in images or text, or complex data combinations such as genome data in medicine (Nowacki 2019; Wodecki 2019). Finally, the *ecosystem* takes a special role in value creation. In many cases, value is no longer created at the firm alone, but together with others. This so-called value co-creation involves other organizations in the value creation process, for example, creating new products together with customers (Hein et al. 2019). The ecosystem also becomes relevant for the strategic resource data. Through collaborations, data can be combined to improve AI application and enhance value creation (Hartmann and Henkel 2020).

The various potential applications of AI create complexity in its value creation. The growing dependencies in the ecosystem between technologies, processes, and organizations are even increasing this complexity (Benbya et al., 2020). It is also reflected in the dependencies between the value drivers for AI value creation. The value drivers display strong interdependencies to create a value and therefore cannot be regarded in isolation. The AI-enabled BMs in our case sample always combine multiple value drivers. To create value from AI, firms need to understand the individual value drivers and their interdependencies. Data and the creation of knowledge from data is a key driver of AI value creation, which was present for almost all our cases. Without AI creating new knowledge that could not be created before, value creation will be impaired. Similarly, the novelty of AI will enable new forms of value creation if technology keeps improving as fast. For firms, this implies insecurity and complexity for their value creation that needs to keep up.

Theoretical Contributions and Practical Implications

This work contributes to strategy and AI research. First, we contribute to strategy research by showing how value is created from AI-based BMs. We show the six value drivers of AI that create value and the case firms draw their competitive advantage from the use of AI. Our model displays the complexity of AI-based value creation and thus the underlying BMs. It shows that digital BMs increase the variety of value creation and BM design options firms can build upon. Thereby we respond to calls for research on how AI impacts a firm's business logic (Weber et al. 2021). Second, we contribute to AI research by showing how AI creates value and how it differs from previous digital innovations (Berente et al. 2021). The understanding of how AI can contribute to value creation and competitive advantage justifies investments in AI projects. For practice, we provide insights into the business value of AI. Understanding how AI creates value is essential for firms to successfully transform their BMs. Based on our model of AI value creation, firms can detect value creation potentials from using AI.

Limitations and Future Research

The chosen methodology leads to some limitations. First, AI applications are currently being developed at a rapid pace, resulting in constant new opportunities for AI-based BMs (Wamba-Taguimdje et al. 2020; Wodecki 2019). This, in turn, means that in the future it may be necessary to revisit the established model. Second, due to the topic's novelty, the data focus on start-up firms, even though already listed on stock exchanges. Therefore, limited information was available on some of these firms. Third, the data were coded using publicly available information, which meant that individual AI applications could not be considered at the process level. It limits our analysis as we could not analyze the AI (data) models, algorithms, or other internally used technology infrastructure that might affect the firm-internal value creation from AI. In our future research, we will acknowledge these limitations, especially regarding the data collection, by collecting primary data from the analyzed firms to validate our analysis.

Building on this work, several opportunities for future research arise. First, this work explored value creation through AI at the BM level. However, not every firm uses AI at the BM level to improve operational business processes (Wodecki 2019). Value creation at this operational level may be different from strategic value creation at the BM level. Second, our cases show that AI is often linked to other digital innovations. Quantum computing and faster mobile communications with 5G networks will soon enable even more AI applications. Thus, value creation from AI can change as quickly as digital innovations emerge. Therefore, future research should analyze new ways of value creation and, if necessary, to supplement our model, for example with interdependencies between multiple digital innovations. Third, we identified an ecosystem as an overarching value driver that influences value creation from AI. Future research could refine our model to include the ecosystem perspective of how value can be co-created by multiple firms combining AI technologies and capabilities. Fourth, we considered only the positive value created by AI, but its implementation can also destroy value at the individual and organizational levels. Possible downsides should be investigated.

Conclusion

The rapid development of AI applications offers firms entirely new opportunities to create value. This work investigates the value creation potential of AI. To this end, a case-survey-based analysis of 61 firms and their BMs yielded two key findings: first, value creation through AI can be mapped by six value drivers. Second, we present a model of AI value creation displaying strong interdependencies between the individual value drivers that need to be considered when designing AI-based BMs. This work thus contributes to a more detailed understanding of how value can be created at the BM level through AI. Firms that are about to transform to an AI-based BM can thus be supported in identifying the value drivers that are suitable for them. Additionally, this work contributes to the AI research community's understanding of how AI can be used to generate a competitive advantage.

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