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THE IMPACT OF DIGITAL TWIN TECHNOLOGY ON MARKETING

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ABSTRACT

By creating digital representations of items, the digital twin concept bridges the gap between the physical and virtual worlds. Digital twin is an emerging technology that has recently received a lot of attention. With advancements in data acquisition, processsing, simulation, visualization and many other associated technologies, the concept of digital twin becomes more mature and applicabale in numerous application domains where it has proven to be advantageous. In the marketing domain, the digital twin is a step towards implementing a customer-centric marketing approach. Marketing tactics can be modified and targeted based on collected data on customer activities, behavior, thoughts, and feelings, hence resulting in the increased marketing effectiveness. This paper attempts to summarize the impact of digital twin in the marketing domain, outlining all related benefits and challenges.

Keywords: digital twin, marketing, IoT, AI.

INTRODUCTION

A concept known as the Digital Twin has evolved rapidly over the last two decades. A digital twin is defined in a variety of ways by industry and academia and there is no single definition of the term (Trauer, Schweigert-Recksiek, Engel, Spreitzer, & Zimmermann, 2020). However, it can be stated that a digital twin is a virtual model of a process, product or service that can collect information from its real-world environment in order to represent, validate, and simulate the physical twin's current and future behavior (Botín-Sanabria et al., 2022). A number of phases must be completed in order to build a fully functional digital twin. For this purpose, a range of enabling technologies are required (Figure 1) (Tao et al., 2018). The most important enabling technologies for digital twin can be summarized into: Internet of Things (IoT), Data Analytics, Artificial Intelligence (AI), and Data visualization. Previously, digital twins were primarily utilized for problem diagnosis, predictive maintenance, and performance analysis, but now they are employed for the design, operation, and maintenance of complex systems (Tao et al., 2018). In other words, a fusion of the virtual and physical worlds enables data analysis and system monitoring to prevent problems from occurring, reduce downtime, discover new opportunities, and even plan for the future using simulations (Marr, 2017). As an emerging technology, the digital twin concept will usher in a revolution in a variety of domains, including industrial, automotive, healthcare, smart cities, agriculture, and so on (Figure 2). A recent research report encompassing industries including healthcare, utilities and transportation predicts that the digital twin market could grow to $35.8 billion by 2025. (Ringman, 2019). Digital twins can also be used in marketing, where they represent a collection of data that can be utilized to execute tests and predict outcomes linked to consumer actions, behavior, thoughts, and feelings. Understandings based on acquired data aid in the tailoring of marketing approaches and, as a result, contribute significantly to the success of marketing operations in general.

This paper discusses the role of the digital twin in the marketing domain. The remainder of this paper is organised as follows. The second section examines the enabling technologies for digital twin. The benefits and problems of incorporating the digital twin concept into the marketing domain are discussed in the third section. The last section draws conclusions.

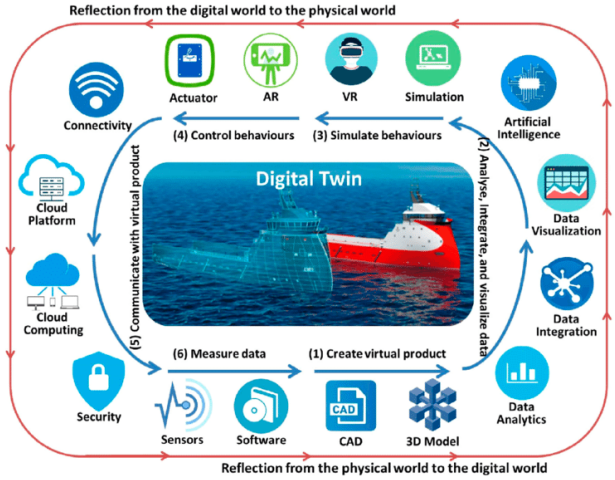

Figure 1. The digital twin's enabling technologies (Tao et al., 2018).

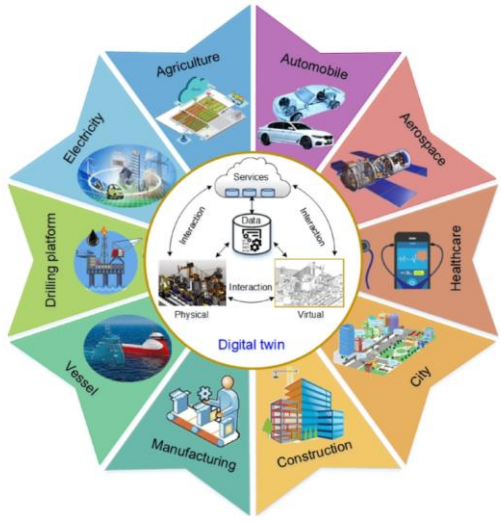

Figure 2. Digital twin's application domains (Qi et al., 2021).

DIGITAL TWIN

Digital twin allows users and stakeholders to gain a thorough understanding of any system's inner workings, the interactions between different sections of the system, and the future behavior of its physical counterpart. Digital twins are categorised into many varieties based on factors such as when they were created, their level of integration, their applications, their hierarchy, and their maturity level. However, the digital twin architecture has a fundamental structure that consists of three primary parts: the physical world, the virtual world, and the connectivity between the two. Depending on the designer's demands and requirements, each part will incorporate a range of components. The most fundamental components are: sensors, a physical twin, processing capabilities at the edge, data security, the digital twin itself, data processing capabilities, communication interfaces, and data visualization (Singh, Fuenmayor, Hinchy, Qiao, Murray, & Devine, 2021; Botín-Sanabria et al., 2022). In other words, digital twins (Lv, & Xie, 2021):

- build digital models using knowledge mechanisms, digitization, and other technologies,
- convert data and information from the physical world into general data using IoT and other technologies, and

- completely replicate physical entities in the digital world by combining Augmented Reality (AR) / Virtual Reality (VR) / Mediated Reality (MR) / Geographic Information System (GIS) and other technologies.

According to Eleftheriou & Anagnostopoulos (2022), important enabling technologies for digital twin can be summarized into:

IoT - is the backbone for the development of digital twin applications. It is a network of physical objects (or "things") that are embedded with sensors, software, and other technologies in order to gather, analyze, and exchange information with other entities, systems, and platforms over the Internet. The ability of the IoT to collect a vast amount of data and verify its security is critical for accurate simulation and modeling of an object, place, or system. As a result, real-time IoT data is used in the majority of digital twins created nowadays.

Data Analytics - refers to the act of analyzing datasets in order to derive conclusions about the information contained within them and make data-driven decisions. Data collection, transmission, storage, processing, fusion, and visualization are necessary to extract usable information from raw datasets. The data analytics can be classified into: descriptive, diagnostic, predictive and prescriptive. Electronic analytics, data mining, visual analytics, big data analytics, and cognitive analytics are some of the types of data analytics that have emerged. Data analytics is another enabling technology for digital twin, which allows applications to detect patterns, correlations, and other useful information from IoT data and show the data of interest to assist users make better decisions.

AI – AI and its subcategories, such as machine learning and deep learning, are critical for improving data manipulation and information extraction. Thanks to AI and its subcategories, machines can learn from their experiences, adjust to new inputs, and execute human-like jobs. Furthermore, AI can solve issues more efficiently, employing techniques that were previously unconsidered, predict future outcomes and make recommendations for how to avoid potential issues. Because optimal solutions are always selected, this saves time and money for users. Therefore AI, as a sophisticated analytical technology that can evaluate data and deliver significant insights automatically, is one of the most important technologies for the digital twin. Its importance is primarily represented in the digital twin ecosystem's huge data processing and system's self-optimization (Lv, & Xie, 2021).

Data visualization - is not a technology but is critical in the deployment of a comprehensive digital twin model. Real-time monitoring of physical assets and processes necessitates the use of visualization technology. With the large quantity of data and information that digital twins provide, essential data must be presented in a way that users can understand, allowing them to concentrate on what matters. The digital twin data can be represented in an intelligible and intuitive fashion via visual representation. The type of data has an impact on how it is visualized. Multidimensional data, for example, can be displayed using graphs and charts while geospatial data is visualized using distribution maps, cluster maps, and contour maps (Fuller, Fan, Day, & Barlow, 2020).

Depending on the type of digital twin, it may have distinguishing properties from others, but all digital twins share a few characteristics (Singh et al., 2021):

- High-fidelity - digital twin must be a near-identical clone of its physical counterpart.
- Dynamic – digital twin must evolve in tandem with the physical system what is accomplished by establishing a constant link and exchange between the physical and virtual worlds.
- Self-evolving - throughout its life cycle, to achieve a near-perfect approximation of the real-world model (its physical twin), the digital twin learns and updates continuously (self-adapts and self-optimizes).
- Identifiable - each physical asset need its own digital twin.
- Multiscale and Multiphysical - digital twin is a virtual replica of its physical twin and it must integrate the physical twin's properties at various scales or levels.

- Multidisciplinary – digital twin is the backbone of Industry 4.0 and it brings together disciplines like Information and Communication Technologies (ICTs), computer science, electrical, mechanical, and industrial engineering, automation, and many others.
- Hierarchical - because each component and element that make up the final product has their own digital twin model, a digital twin can be thought of as a collection of interconnected submodels.

DIGITAL TWIN'S ROLE IN MARKETING DOMAIN

With the current trend of digitalization, there is no doubt that digital twins will be ubiquitous across all industries and throughout the product lifecycle - from conception to completion, including production, distribution, installation, marketing, sales, usage, and service, as well as return and recycling. The contribution of digital twins in the production process is shown in Figure 3. As can be seen, marketers can experiment with a limitless number of render options with digital twins, making them an innovative and cost-effective solution tailored to consumers' needs. Platforms and marketplaces for digital twins will enable new revenue models for all ecosystem partners. Experts have great expectations for the concept of digital twins to help decrease costs, improve efficiency, reliability, security, and sustainability (Hummel, 2020).

Consumer marketing is projected to profit from digital twins as well. Customers nowadays expect to locate what they're seeking for quickly and easily, especially since that they have practically unrestricted access to product information. As a result, digitizing products is extremely crucial, and digital twins can help with this task. Digital twin offers an otherwise nameless product, process or a service a unique, immutable identity. The construction of highly realistic digital representations of all products would include all of the information generally required to persuade consumers to make a purchase (the whole content of the product, including photographs, descriptions, qualities, labels, and much more). Using personalized products, the brand becomes able to deliver relevant contextual information to the user, learn from their experiences, provide product-related services, and reward the user - completely privacy protected. In this way, the data collected by digital twins aid in better understanding consumers' interactions and demands (i.e. consumers' behavior in important areas including conversion, buy intent, brand preference, spending levels, their response to various marketing initiatives, what message will resonate with them the best), as well as testing variations for more focused product and service development while driving company innovation. Consumer interactions will be planned in tandem with the product lifecycle journey, resulting in increased customer intimacy and loyalty (Peterson, 2019; Mitros, 2020; Hummel, 2020).

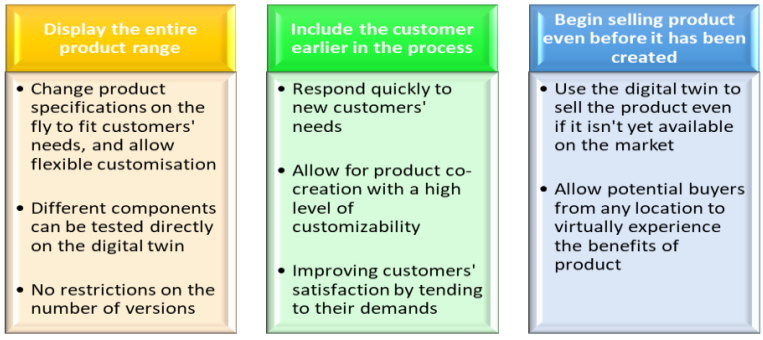

Figure 3. Digital twin's influence on the production process.

Data that is centralized in a product content catalog is used to create digital twins. The product content catalog is the only source of data required for communicating with consumers across all digital and physical touchpoints. The way a product is presented has a direct impact on sales, consumer engagement, and the formation of a real dialog with consumers. No matter how

good the product content is, its full potential can be realized only reaching a large number of consumers, what implies the use as many sales channels as possible. When new sales opportunities materialize, speed is crucial, and digital twins can help to connect a new sales channel faster. Digital twins are reusable and scalable because they simply connect to additional sales channels. It's critical to emphasize that the most significant step is to centralize product content and make it available to other systems via Application Programming Interfaces (APIs), allowing it to be sold on online marketplaces, comparison sites, social media, and virtually any other channel (Mitros, 2020).

More than half of the world's population (58.4%) currently utilizes social media, with 424 million new users joining in the last 12 months. The average amount of time spent on social media each day is 2h 27m (Chaffey, 2022). Every activity of consumers on the Internet, i. e. in the online environment, provides companies with certain data. To increase the effectiveness and efficiency of a business, companies strive to obtain information that will give them an answer to the question of how to meet the needs and demands of consumers better than the competition. With their transactions, from using search, e-mail, social media, navigation systems and other Internet services, consumers create raw data. This data is sometimes called a natural resource. Like physical natural resources, this data is not useable in its raw form, it must be processed to turn it into actionable insight. Individual raw data points are processed to become consumer profiles which are matched with application demands. In some cases, the data from entire user classes is matched with target demographics. In other cases, profiles are used to target individuals with messages to influence their decisions. Historically, statistical analysis was the method used for most of this processing. More recently, the advent of AI has enabled the processing of larger and more diverse data sets to deliver more differentiated and personalized results. Analyzing text, voice, and video data creates incredibly detailed consumer insights, consumers' digital twins (Figure 4). Thus, the value of actionable information depends on two components: the raw data and the algorithms to process the data. It can be argued that the raw data belongs to the consumers. The algorithms, however, are the tightly guarded intellectual property of the big tech companies. Without either ingredient, there is no value. In the current environment, without a regulatory framework and with much of the data flows and value transfers hidden from consumers, the big tech companies retain the enormous share for themselves (Kienzle, 2021). In the past, it was a big challenge for the company to conduct market research activities and collect data, while today companies have a large amount of data. The challenge for companies today is the analysis of collected data, the form of databases, and the evaluation of information relevant to the company in making business decisions.

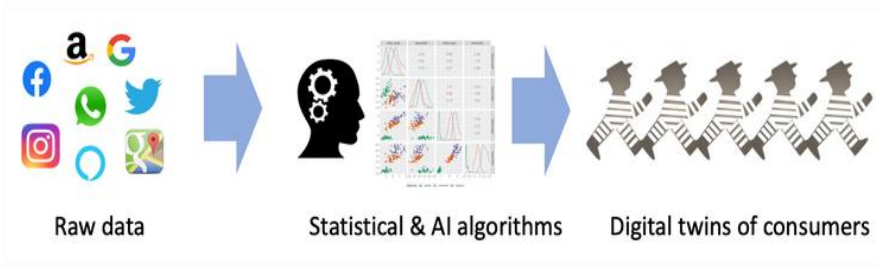

Figure 4. Consumers' digital twins (Kienzle, 2021).

Digital twin holds a big potential in marketing domain (Goebel, 2017; Hummel, 2020):

- Data from digital twins is used to establish marketing strategies and nurture potential clients, hence making positioning more relevant and personalized.
- It becomes possible to predict and announce sales, renovations, and other business opportunities based on a large amount of machines or assets data.

- Instead than depending on intermediaries such as advertising platforms or retailers, digital twin offers the manufacturer with a direct contact and marketing channel with its users.
- It enables the manufacturer to add additional value to their current business,
- It enables the manufacturer to transfer value in the form of cryptocurrency, allowing it to rethink sales and marketing procedures as well as create new business models.
- It can help companies accelerate their digital transformation.
- It is extremely data privacy friendly and General Data Protection Regulation (GDPR) compliant, as personal data is kept on the users' phones and not shared with the manufacturer.

Digital twins are significant in generating data on consumer behavior, contributing to a better user experience, establishing long-term relationships with consumers, and anticipating their needs and requirements. The great importance of digital twins is also recognized by companies that conduct their business activities in accordance with the principles of sustainable development and social marketing. Sustainable development refers to the socially responsible business of companies that, through their business activities, focus not only on increasing profits but also on solving global problems such as achieving the goals of sustainable development. The concept of social marketing implies that a modern company takes into account three goals: consumer satisfaction, profit, and social welfare, i. e. that the company's business contributes to sustainable development. As a digital representation of any physical entity in a production environment, the digital twins must serve as the foundation of an Information Technology (IT)-supported transformation towards a sustainable production by acting as an enabling technology for an improved execution of relevant strategies, thought patterns, methods and decisions. It is therefore essentially a tool that can support individual decisions or independently decide in terms of sustainability within a constant sequence of operations, as exemplified in Figure 5 (Miehe, Waltersmann, Sauer, & Bauernhansl, 2020).

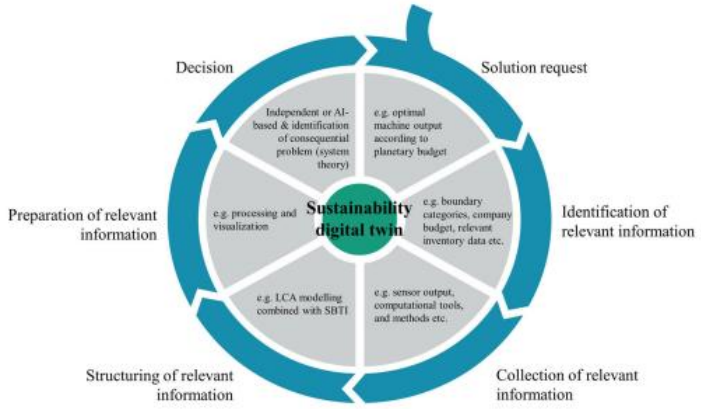

Figure 5. Digital twins as decision tool for sustainability within a constant sequence of operations (Miehe et al., 2020).

The challenges that arise when constructing a digital twin are dependent on its size, application domain and complexity, but there are several challenges that are universal (Fuller et al., 2020; Eleftheriou, & Anagnostopoulos, 2022):

IT infrastructure – is essential to the efficient operation of a digital twin. The IT infrastructure must include up-to-date hardware and software components in order to access and analyze large amounts of data. The digital twin will not be able to achieve its objectives without a well-designed and scalable IT infrastructure.

Useful data - the quantity and quality of IoT data are of immense importance for digital twin. A continuous, uninterrupted stream of high-quality data with no noise is crucial for the efficience use of digital twin.

Privacy and security - because of the large amount of data they use, and data sensitive nature, the primary enabling technologies for digital twins – IoT and Data Analytics, must adhere to current security and privacy policies and legislation. The GDPR, which ensures the privacy and security of personal data in Europe, should also be followed by digital twins. Consideration of security and privacy for digital twins data aids in the resolution of trust concerns with digital twins.

Trust - end-users and organizations must understand the benefits of a digital twin, and digital twins must work as expected, in order to overcome digital twin-related trust challenges

Expectations – despite the issues that digital twin shares with IoT and data analytics in terms of user experience, privacy, and infrastructure, there are also unique challenges related to the modelling and construction of the digital twin. The adequate IoT infrastructure, and a better knowledge of data required for analytics, will ensure that organization embrace digital twin technologies.

Standardized modelling - the next challenge is related to modelling digital twins since there is no standard for how each model should be built. An uniform approach from the initial design phase to the simulation of a digital twin is mandatory.

Design modelling - another issue arising from the necessity for standardised use is ensuring that information about domain use is conveyed to each of the development and functional stages of a digital twin's modeling. This enables compatibility with sectors like IoT and data analytics, allowing the digital twin to be used successfully in the future.

The global digital twin market size was valued at USD 7.48 billion in 2021 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 39.1% from 2022 to 2030. Production halts and supply chain disruptions during the COVID-19 pandemic led to the suspension of several other activities along the value chain of industries, such as aerospace, manufacturing, and automotive. This impacted the market during the first half of the pandemic in 2020. However, as the number of COVID-19 cases started reducing and restrictions were lifted, the market began recovering strongly as several industries started moving toward automation and virtualization of products as well as processes (Grand View Research, 2022). After the pandemic, the world economy is moving towards reforms that would accelerate the recovery period, and developed countries expect the implementation of digital twin technology to be an integral part of these activities.

CONCLUSIONS

Integrating digital twin technology with other technologies that drive the digital transformation process, such as AI, IoT, and Cloud Computing, allows for the implementation of business activities that lead to the growth and development of the market. The implementation of novel technologies provides data on current consumer behavior, based on which the possibilities of predicting the needs and desires of consumers are acquired. The importance of digital twin technology in marketing is examined in this research. This technology contributes to the improvement of marketing activities in the field of market research, data collection and analysis to meet the needs and requirements of consumers, implementing production processes in line with consumer expectations, better customization and sustainable development. All that indicates a higher level of consumer satisfaction, the effectiveness and efficiency of the business, and thus achieving a better business performance of the organization.

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