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Research paper

Digital Twin: A New Paradigm in The World of Consumer Experience

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Abstract

Digital Twin (DT), as a virtual representation of physical entities, has emerged as a pivotal technology in enhancing consumer experiences across various industries. The study aims to explore the diverse DT applications in fashion, consumer electronics, healthcare, and the food industry, identifying key trends, benefits, and challenges. Using Bibliometric analysis (R package & VOSviewer) and Systematic Literature Review with the research articles published from 2018 to 2024, the study examines DT research advancements. Additionally, Topic Modeling and sub-field trend analysis (year-on-year trends, proportions) were conducted using Python. Findings reveal a growing scholarly interest, particularly in DT's integration with IoT, sustainability, and automation. Results highlight DT's role in enabling real-time monitoring, predictive analytics, and enhanced user engagement across sectors. The study concludes that DT is a game-changer, driving innovation, optimizing operations, and fostering sustainability, ultimately reshaping consumer industries for the future.

Keywords: *Digital Twin, Bibliometric analysis, Systematic Literature Review, Topic modeling, marketing, consumer, DT, SLR*

1. Introduction

One of the significant modern advancements in the digital era is that it has introduced new tools that have produced a lot of transformation in most sectors. Digital Twin (DT) has played an important role in recent years in all areas, including customer products, logistics & supply chain, and healthcare, where it has been used to create a virtual replica of a physical object or a system (Broo & Schooling, 2023). This emerging technology can transform the way customers interact with products and services, enabling a real-time experience through interaction with the products (Jones et al., 2020; Wang et al., 2023). DT is conceptualized as a simulated replica of a physical object that is used to analyze, process, and find the functioning of the real-time object (Van Hegelsom, 2021). Grieves (2002) introduced the word "Digital Twin" in the domain of total product lifecycle management (Grieves and Vickers, 2016). It goes by different names, digital mapping and digital reflection. Since then, its definition has changed, and numerous academics have offered different interpretations of this technology. But one of the best definitions is "The DT is a representation of an active, unique 'product' which can be a real device, object, machine, service, intangible asset, or a system consisting of a product and its related services." (Attaran & Celik, 2023)

Digital technologies have revolutionized the way people interact with their environment, enabling unprecedented levels of immersion and engagement. To create an immersive experience and interactions, DT is integrated with Augmented Reality (AR), Virtual Reality (VR), and Metaverse. Augmented Reality (AR) lets users view and interact with DT in their actual surroundings by overlaying digital data onto the real world (Kumar et al., 2024). Virtual Reality (VR) can explore and control DT in a virtual environment, enveloping them in a completely digital universe (Paul et al., 2024). The Metaverse combines Augmented Reality (AR), Virtual Reality (VR), and other technologies: a communal virtual shared space creates an always-linked digital environment (Yang, 2024). From entertainment to education and beyond, immersive experiences supported by Virtual Reality (VR), Augmented Reality (AR), and the emerging concept of Metaverse have attracted much interest from academics and businesses. They have the power to change many fields (Hwang & Lee, 2022; Petrov & Atanasova, 2021). VR and AR have added still another layer of spatial immersion (Crofton et al., 2019). For almost ten years, 3D-based virtual and Augmented Reality tools have been accessible. However, recent pronouncements by tech giants about improvements in online social media and communication tools using immersive virtual environments will greatly raise the usage of Metaverses (Baker et al., 2023). To maximize consumer engagement, marketing managers can develop an immersive AR experience (Scholz & Smith, 2016).

As DT is found to have numerous impacts on consumers and users in various industries, it is necessary to investigate the research carried out so far in the field of the same technology. Hence, the present study conducts a bibliometric analysis of research papers and further performs a Systematic Literature Review (SLR). This bibliometric analysis and Systematic Literature Review show a complete and impartial summary of the data, indicating the shortcomings and inefficiencies in current research and directing further studies, practice, and policy with firm evidence. Additionally, the study delves deeper and tries to examine the specific topics of research carried out in the domain of DT since 2018-2024 using the technique of Topic Modeling. Also, sub-field trend analysis year on year, their proportion, etc was carried out. Moreover, DT technologies are increasingly influencing industries in terms of economic efficiency, driving cost reductions

and productivity improvements. These advancements have significant implications for both operational and financial outcomes, especially in the context of cost-benefit analysis and market efficiency models. Furthermore, as DT enables the creation of digital assets, it presents unique accounting challenges related to the valuation, amortization, and depreciation of these assets, which must be addressed by evolving accounting standards.

2. Literature Review

Studies on Bibliometric, Systematic Literature Review (SLR), and Topic Modeling

Bibliometric analysis, Systematic Literature Reviews (SLR), and topic modeling are prominent methodologies employed to analyze research trends, map intellectual landscapes, and identify knowledge gaps across diverse domains. Bibliometric analyses utilize citation data to track influential publications and emerging trends, providing insights into the development and clustering of research areas (Donthu et al., 2021). Using rigorous bibliometric tools, the bibliometric study, (Fahimnia et al., 2015) found the clusters for topological analysis, identification of key research topics, interrelations, and collaboration patterns. Systematic Literature Reviews adopt a rigorous approach to synthesize findings from existing studies, often used to clarify the state of the art and formulate new research questions. For example, (Da Silva et al., 2011) present methodologies for conducting SLRs in software engineering, which are transferable to digital domains. Meanwhile, topic modeling techniques such as Latent Dirichlet Allocation (LDA) have been increasingly applied to large text corpora to uncover thematic structures and temporal shifts in academic literature(Lee et al., 2024). Collectively, these approaches have been leveraged in fields such as artificial intelligence, the Internet of Things (IoT), and blockchain technologies to evaluate their evolution and multidisciplinary impacts.

Studies on Existing Review Papers in Digital Twin Applications

Selvarajan & Manoharan (2024) provides a foundational review of DT concepts and their integration with IoT in smart manufacturing, emphasizing the real-time and predictive capabilities that can extend to consumer settings. Ariyachandra & Wedawatta (2023) explore the use of DT in smart cities, including personalized services for residents. The SLR and bibliometric analysis on Oil and Gas (O&G), gives the increasing number of new DT developments in the O&G industry and many new technologies available, also guides on the topic and promotes knowledge production and growth concerning the development of DTs for O&G (Meza et al., 2024). The SLR study of Digital technologies like AI, DT, and VR on urban regeneration comprehensively appraises how urban regeneration processes can be enriched by leveraging innovative technological applications. Also, the study suggests avenues for future digitally sustainable integrated approaches to urban regeneration (Moufid et al., 2024). In the retail sector, Mesquita et al. (2024) examine the use of DT to enhance customer experience and operational efficiency, highlighting applications such as personalized marketing and inventory management. The reviews are limited to a specific sector to fill this gap; we performed a sectoral analysis. Also, to give a comprehensive view of the DT area, the study performed Bibliometric Analysis, Systematic Literature Review (SLR), and topic modeling that provides insights not previously fully grasped or evaluated by other reviews on this area. The overall study addresses the following research questions.

RQ1 How has the research in DT evolved with time, and what are the key themes, trends, patterns, and future direction?

RQ2 What are the key author collaborations and networks in the field of DT?

RQ3 How does research in the fashion industry employ DT to address technological problems, improve consumer experience, and raise sustainability?

RQ4 How may DT in consumer electronics be utilized to maximize operations, improve decision-making, and stimulate innovation?

RQ5 How may the Metaverse and DT be used to improve disease prediction, personalize healthcare, and maximize consumer electronics to transform consumer health?

RQ6 How can digital technologies, like DT, blockchain, and machine learning optimally implemented to change the food sector?

RQ7 Examine the research topics and their proportions, co-occurrence network, year on year trends in the field of DT by utilizing topic modeling.

3. Methodology

The search results of this study have been collected with the keywords “DT” and “consumer” to search articles published between 2018-2024 from the Scopus database. The study obtained 369 articles to make the data more relevant it has been filtered by the language written in “English” only. Limited to the Document type, such as Article, conference paper, and book chapter. All the keywords except Table 1 were excluded. After the data had been filtered, some articles were manually removed due to the unavailability of abstracts and the duplication of articles. Article information, including publication year, author-keywords, abstract, title, author(s), source, etc., were also exported. Finally, the study obtained 262 articles with proper abstracts, which were used as primary data for topic modeling. For bibliometric analysis, all the information from the collected data has been used. A Systematic Literature Review performed by sectorial analysis, where the articles were classified under different sectors, from that, four sectors, i.e., fashion industry (6 documents), consumer electronics (23 documents), healthcare (21 documents), and food industry (11 documents) were taken since it is more relevant to the marketing domain.

This study applies a bibliometric analysis and Systematic Literature Review (SLR) method, which is a detailed inquiry into previous research literature. To evaluate the bibliometric analysis, the paper used R Studio (Bibliometrix) software. The goal of SLRs is to give a rich summary of the publications and to critically analyze the quality and nature of the literature and provide a clear and transparent classification of the most recent literature (Okoli, 2015). The SLR method is believed to be an effective method for this study because it makes it possible to collect, analyze, and report data in a single place and, in that regard, it becomes a standalone method that integrates existing materials and concepts, thus allowing the academic and the practitioner to fully comprehend the subject (van Dinter et al., 2021).

The study also analyzed topic modeling to get to know the current trending topics within DT in application to consumers. The paper employed all the abstracts from the collected corpus as primary data for the topic modeling analysis. Recently, text mining and topic modeling methods have been adapted by researchers because of the availability of access to the software. The study used Python programming for topic modeling. In topic modeling analysis, we preferred Latent Dirichlet Allocation (LDA), which is one of the three-layer Bayesian models developed by. Using the computer algorithm, each collected abstract (document) is converted into a single phase, and that phase is converted into a meaningful term. The stop words (“a”, “an”, “the”), punctuations, numbers, whitespace, prepositions (“with”, “on”, “under”), conjunctions (“and”, “but”), pronouns (“he”, “she”) and HTML tags like “#”, “@” were removed during the analysis. Also, we excluded common terms like “introduction”, literature”, “result”, and “findings” Because it has the potential to obtain a central theme (Lee et al., 2024). As a final output, similar terms form a group and are made into a topic. Besides, the procedure is also intended to identify the main gaps and potential areas that can be investigated in the future.

Table 1: Keywords

DT	IoT
Internet Of Things	Consumer Products
DT	Real-world
Virtual Reality	Digital Transformation
Artificial Intelligence	Sales
Metaverses	Extended Reality
Decision Making	Digital Technologies
Metaverse	Decision Support Systems
Blockchain	Consumer Healths
Simulation	Mixed Reality
Consumer Electronics	Marketing
Consumer Behavior	Decisions Makings
Blockchain	Consumer
Real Time Systems	Blockchains
Augmented Reality	Big Data
Commerce	3D Modeling
Robotics	Efficiency
Real-Time System	Data Transfer

3.1 Bibliometric Analysis

RQ1 How the research in DT has evolved with time and what are the key themes, trends, patterns, and future direction?
Figure 1. Reveals a significant increase in scholarly articles published on DT from 2018 to 2024. In 2018, only three articles were published, but this number steadily grew over the subsequent years, reaching a peak of 79 articles in 2024. This trend suggests a growing interest and research activity in this field, indicating its increasing relevance and importance. The data signals a shift towards more advanced and widespread applications of DT, with the potential for even greater development in the upcoming years. The rapid rise in publications could be attributed to several factors, including the adoption of enabling technologies like IoT, AT, and AR/VR, and the increasing demand across industries like healthcare, consumer electronics, and fashion. This highlights the expansion of DT beyond its initial industrial applications into the broader consumer market. The data also highlights the potential for further exploration and advancements in this study area.

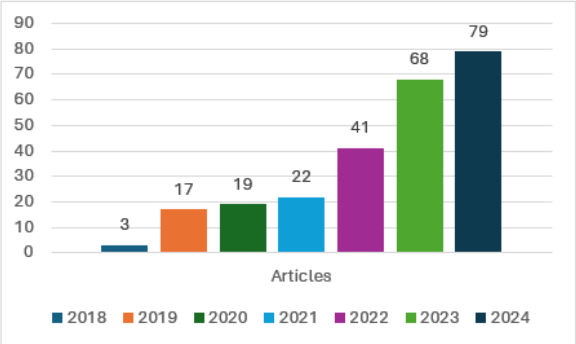

Fig.1: Source of publication data

Figure 2. Reveals the relevance degree (centrality) measures the importance of each theme within the field, with DT and industry 4.0 being central themes. Niche themes like computer-aided design and cold chain are emerging, while basic themes like DT and IoT are well-established. The development degree (density) indicates the level of research activity in each theme, with sustainability and automation showing high activity. The map highlights the growing importance of themes like sustainability and automation in automotive digital transformation, while niche themes like computer-aided design and cold chain are gaining traction. These themes underscore the increasing emphasis on operational efficiency, resource management, and sustainable practices within industries adopting DT.

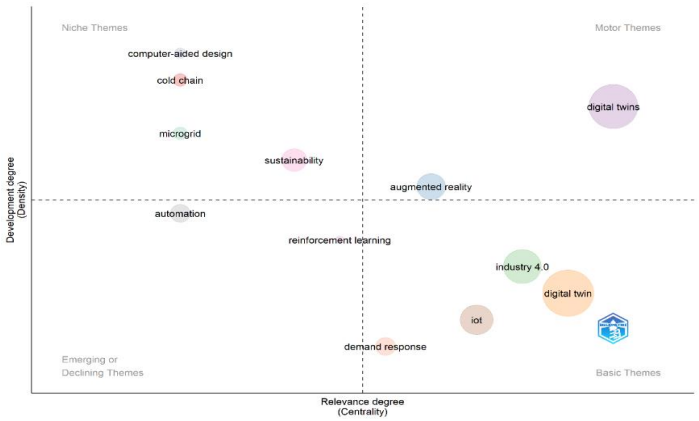

Fig. 2: Thematic map

Figure 3 shows a strong association between the 'DT' and 'internet of things' as central themes in the research landscape. These concepts are closely interconnected with a wide range of topics, including energy management systems, renewable energy, machine learning,

optimization, and smart grids. The visualization also highlights the growing importance of sustainability and digital transformation in various domains, such as Industry 4.0, smart cities, and healthcare. The presence of terms like data analytics, blockchain, and virtual reality shows the potential for innovative applications and future research directions. This reflects the growing interdisciplinary nature of DT research, with significant contributions from fields like sustainability, automation, and the metaverse.

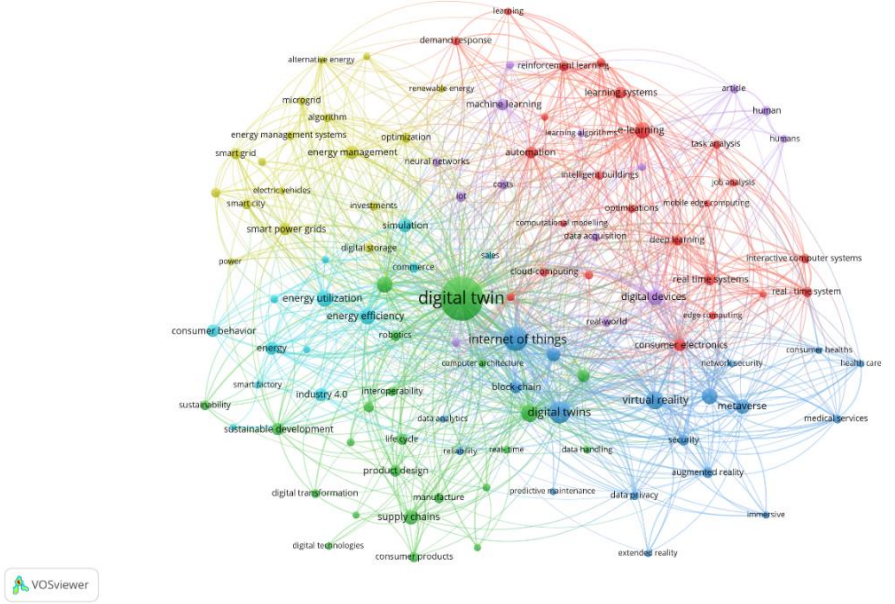

Fig. 3: Co-occurrence with all keywords.

RQ2 What are the key author collaborations and networks in the field of DT?
Figure 4 exposes a key collaboration complex network of linked authors and their published works on DT. The bigger circles, which stand for the center nodes, imply influential people in the field. Zhang Y and Tao F emerge as central figures, forming strong connections with multiple other authors. This suggests their significant influence and contributions to the field. The color-coded lines show co-authorship links; separate clusters are developed around research topics or collaborations by Fuentes S and Defragye T, Kavous-fard A, and Zhang J. In general, the picture emphasizes the cooperative character of research in this field and points out possible important participants and their contributions. This finding indicates a trend towards increasing collaboration across authors and institutions, reinforcing the interdisciplinary nature of DT research.

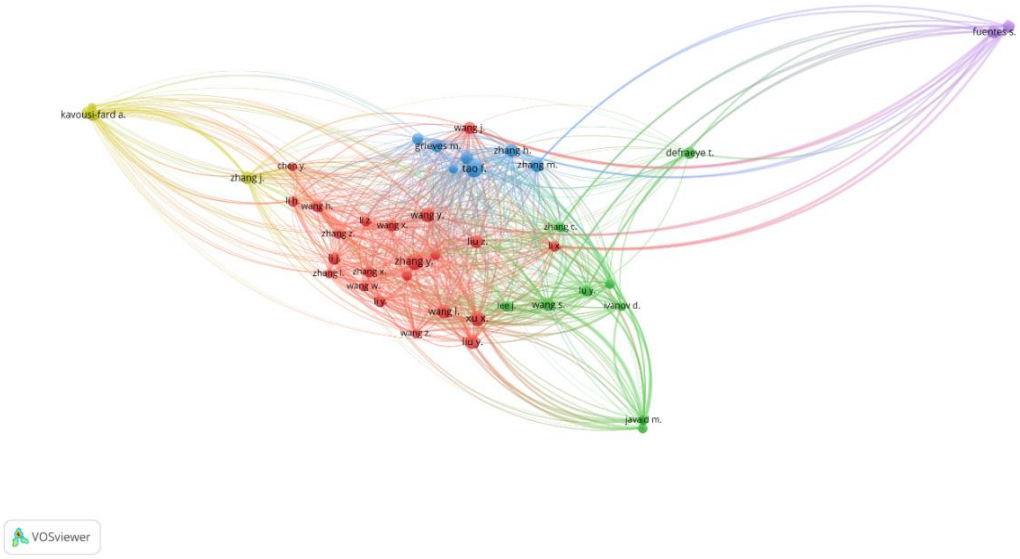

Fig.4: Co-citation with cited author

Table 2 shows a trend in citation trends spanning 2018–2024. The average number of citations per article has varied while the overall volume of published papers has continuously risen. The average number of citations per article in 2018 was 26.67, but this number has been declining steadily until it reached 0.94 in 2024. This implies that, based on citations, the influence of individual papers has dropped, even while the general research output has increased. This could be ascribed to several elements, including changing research tendencies, growing competitiveness, or changing citation style. Additionally, the growing volume of publications may be diffusing citations across a larger pool of articles, leading to a reduction in the citation impact of individual works.

Table 2: Citation analysis.

Year	Mean total citation per article	Total Number of articles	Mean Total Citation per Year
2018	26.67	3	3.81
2019	10.59	17	1.76
2020	13.00	19	2.60
2021	11.91	22	2.98
2022	10.37	41	3.46
2023	3.49	68	1.75
2024	0.94	79	0.94

3.2 Systematic Literature Review

RQ3 How does research in the fashion industry employ DT to address technological problems, improve consumer experience, and raise sustainability?
The SLR study found that DT in fashion industries will revolutionize design, manufacturing, and consumer experience (Kuzmichev & Yan, 2022). Virtual fitting rooms reduce returns and provide immersive try-ons; they will influence consumer psychology (Chung & Tan, 2024). Accurate digital clothing made possible by technology helps to encourage sustainable practices, reduce waste, and maximize manufacturing (Riedelsheimer et al., 2020). They enhance supply chains, enable data-driven decision-making, and help in real-time feedback (Casciani et al., 2022). Fashion companies that embrace DT will be able to survive in the sector. Fashion may also become more sustainable, efficient, and customer-responsive by using this technology (Gong et al., 2022; Pizana et al., 2024). From the inside out, a DT is transforming the fashion sector.
RQ4 How may DT in consumer electronics be utilized to maximize operations, improve decision-making, and stimulate innovation?
SLR of collected articles also pinpoints the idea that DT is transforming consumer electronics by simplifying manufacturing techniques and enhancing product design. Companies can test and improve their designs before manufacturing by building virtual versions of tangible goods, therefore lowering prototype costs and accelerating time-to-market (Cao et al., 2024; Huang et al., 2024). DT also offers real-time monitoring and analysis of product performance, enabling quick discovery and resolution of problems. This leads to reduced warranty costs, higher customer happiness, and better product quality (Liu et al., 2024; Sasikumar et al., 2024). DT also helps in collaborative design and development, which allows worldwide teams to operate more successfully (Sai, Prasad, Upadhyay, et al., 2024). They also enable predictive maintenance to lower downtime and increase overall efficiency (Sai et al., 2023). Employing DT will help consumer electronics firms to keep ahead of the competition and inspire creativity.
RQ5 How may the Metaverse and DT be used to improve disease prediction, personalize healthcare, and maximize consumer electronics to transform consumer health?
The SLR study further suggests that the emergence of DT and Metaverse in healthcare can help predict the disease & patient's condition and provide personalized treatment & streamlined medical services. DT produces a virtual version of people that enables customized health programs and predictive analytics for everyone separately (Kulkarni et al., 2024; Wang et al., 2024). Remote healthcare access is made possible by the Metaverse, which extends the reach and convenience (Sai, Prasad, Garg, et al., 2024; Stephanie et al., 2024). Using these technologies, researchers are getting deeper insights, enhancing data collection from the wearables, and improving health outcomes. Sessions of immersive therapy and virtual consultations are growing widespread (Ramu et al., 2024; Shah et al., 2022; Taneja & Rani, 2024). These developments are helping people to take charge of their well-being by addressing gaps in healthcare access and quality. Healthcare is growing more proactive, exact, and patient-centric by using DT and the Metaverse (Awan et al., 2024). This mix of healthcare and technology is changing people's lives and rewriting the course of medicine.
RQ6 How can digital technologies, like DT, blockchain, and machine learning optimally implemented to change the food sector?
The use of SLR techniques also communicates that digital technologies are changing the fast-moving consumer goods (FMCG) market. Researchers are using DT to replicate food production situations, project quality changes, and streamline operations (Onwude et al., 2022, 2024). Demand prediction, waste reduction, and inventory control enhancement are some of the uses for machine learning techniques (Doerr et al., 2022; Nikitina & Chernukha, 2020). These developments seek to produce a more ecologically friendly and effective food supply network. Real-time food quality monitoring is made possible by digital technologies, which lower contamination risks, simplify logistics, and therefore improve food quality (Fuentes et al., 2023, 2024; Guidani et al., 2024; Udugama et al., 2023). Adopting these technologies can help the FMCG industry to reduce waste, raise customer happiness, and support eco-friendly behaviour. The way we develop, distribute, and consume food is being transformed by this mix of agricultural production and technology (Melesse et al., 2022).
RQ7 Examine the research topics and their proportions, co-occurrence network, year on year trends in the field of DT by utilizing topic modeling.

3.3 Topic Modeling Analysis

We employed the Latent Dirichlet Allocation (LDA) model to reveal the latent intellectual topics within the literature corpus on DT applications for consumers. The LDA model requires setting the number of topics as its primary parameter. To determine the optimal number of topics, we computed the posterior likelihoods of models with different topic counts, selecting the model with the highest posterior likelihood as our optimal model. This analysis led us to identify three main topics. The coherence score for our model was 0.33, suggesting moderate cohesion among these topics.

3.3.1 Topic Interpretations

The study interprets the topics found from the topic modeling as follows.
Topic 1(DT Fundamentals): This topic comprises terms such as "digital," "twin," "consumer," "data," "model," and "technology," which indicate a focus on the fundamental components of DT technology. This topic likely pertains to the core aspects of DT, covering their digital nature, data-driven models, and applications across different consumer-driven sectors. It reflects how DT technology is conceptualized and applied in various contexts, including industry settings where data, modeling, and network infrastructures play pivotal roles.
Topic 2(DT for Energy and Sustainability): This theme includes words such as "energy," "grid," "smart," "consumer," and "system," pointing to the applications of DT in energy management and sustainability. It suggests that DT technology is employed within smart grids and energy distribution to enhance resource management, particularly in consumer energy usage and conservation efforts. This topic

underscores the role of DT in advancing energy sustainability, especially in relation to smart technologies and grid systems that engage with consumers in meaningful ways.
Topic 3(DT for Product Innovation and Consumer Experience): This topic features terms such as “product,” “technology,” “system,” and “data,” highlighting DT applications in product design, development, and consumer experience. This theme appears to center on using DT to simulate product performance, anticipate consumer preferences, and optimize the customer journey. It emphasizes how DT can be leveraged in consumer-centric industries to personalize experiences and innovate product offerings.
These grouping helps to illustrate the multi-dimensional nature of DT applications, with relevance spanning foundational technology, sustainable practices, and consumer engagement.

3.3.2 Topic Proportions

The 3-topic model assigned a topic proportion (Figure 5) to each abstract we collected. From that result, we found topic 1, “DT Fundamentals,” has a high frequency of 42.83%. The elements in Topic 1, like “Digital,” “consumer,” “System,” and “Energy,” have an estimated high frequency within the Topic. The topic covers applications to industries, concepts, digital nature, and data-driven modeling. Meanwhile, topic 2, “DT for Energy & Sustainability,” has 23.32%, and topic 3, “DT for Product Innovation & Consumer Experience,” has 33.26%.

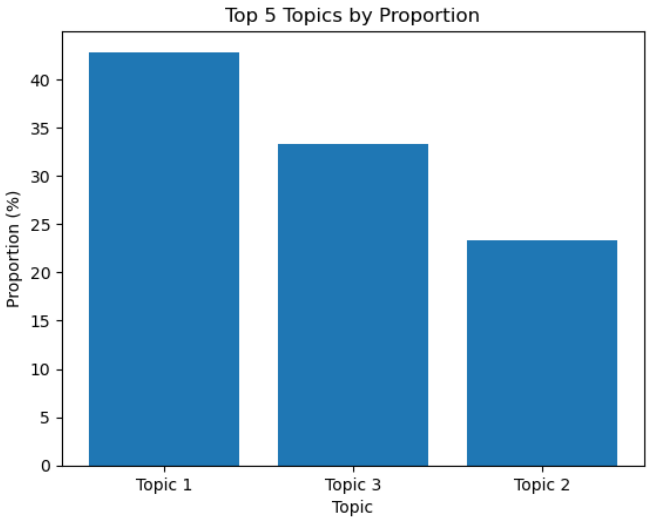

Fig. 5: Topic proportion

3.3.3 Co-occurrence Network

Figure 6 shows the network map. Each node(circle) represents a term or concept (e.g., "technology," "model," "product"). The node's size indicates significance or frequency, and the color of the nodes represents the topic. Red nodes likely represent the terms in topic 1. The yellow node represents the term in topic 3, and the white node represents the term in topic 2. The lines between nodes represent co-occurrence relationships. They are connected if two terms frequently appear together in the same context (e.g., a sentence, paragraph, or document). The thickness of the edges indicates the strength of the relationship; the thicker the edge, the stronger the co-occurrence.

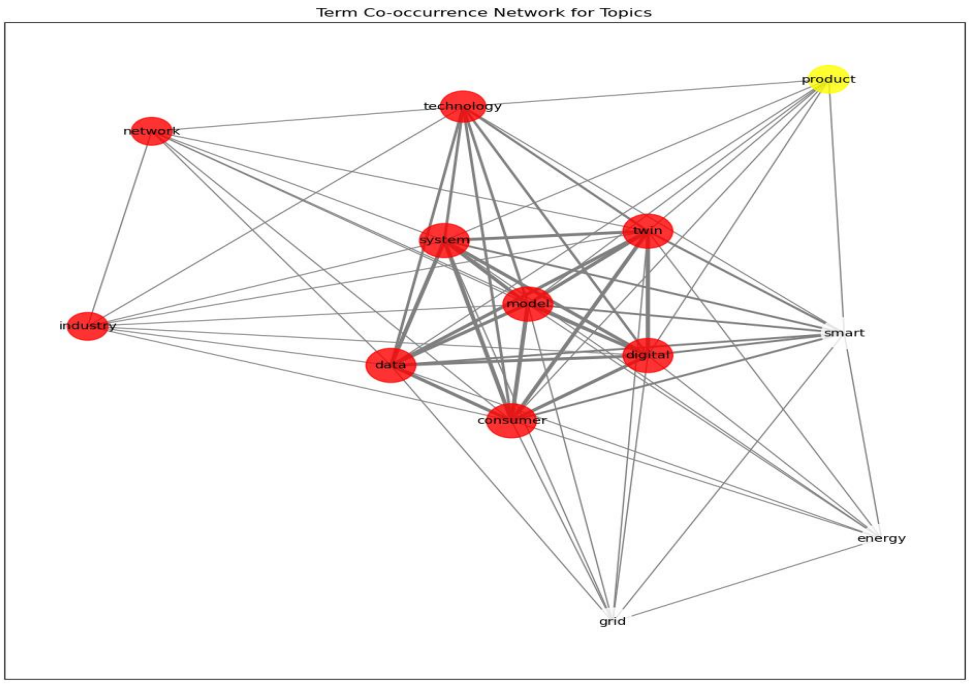

Fig.6: Term Co-occurrence Network for Topics

3.3.4 Topic Trend Analysis

We did a trend analysis (Figure 7) using the collected data, and also performed the Mann-Whitney test (Okorie & Akpanta, 2015) to determine the trends from 2018-2024 and the emerging and fading topics from the 3-topic models. As a result, we identified emerging topics: topic 1, "DT Fundamentals," and topic 2, "DT for Energy and Sustainability." Fading topic: topic 3, "DT for Product Innovation & Consumer Experience." The trend analysis shows a decline in the relevance of topic 3 from 2023, indicating a shift in focus towards more foundational and sustainable applications of DT, especially in energy management and digital transformation.

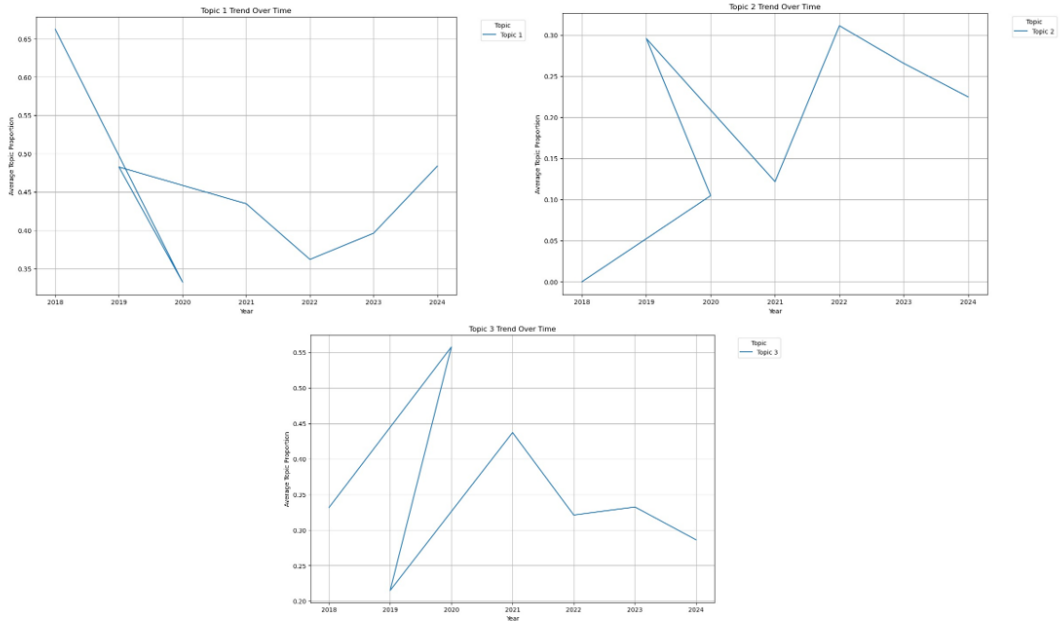

Fig.7: Topic trends during 2018-2024

4. Discussion

The results of this study provide a comprehensive overview of the rapidly evolving field of Digital Twin technology, with a particular focus on its applications across multiple industries, including fashion, consumer electronics, healthcare, and the food industry. The bibliometric analysis, Systematic Literature Review, and topic modeling have highlighted several emerging trends and shifts in the research landscape. The significant increase in the number of scholarly publications from 2018-2024, as revealed by the bibliometric analysis, demonstrates the growing importance and relevance of DT technologies across various sectors. The steady rise in publications indicates an increased interest in Digital Twin as they transform both industrial and consumer-facing sectors. One of the key drivers of this rise is the integration of DT with emerging technologies such as IoT, AI, and AR/VR, which allow for more immersive, real-time interactions between consumers and products. This trend is aligned with the growing emphasis on sustainability and automation, as highlighted by the increasing relevance of a broader industry shift towards greener practices and resources optimization, while automation is increasingly being integrated into DT applications, improving operational efficiency and reducing costs. The economic implications of these trends are evident. DT technologies, by enabling real-time monitoring and predictive analytics, provide significant efficiency gains, particularly in industries that rely on complex production systems or large-scale logistics operations. From an economic standpoint, this translates to improved cost structures, reduced waste, and higher profitability. However, as DT continues to evolve, accounting challenges related to the valuation of digital assets created within these systems remain critical. The amortization and depreciation of the digital replica of physical assets. For example, require new approaches in financial reporting. This challenge presents an opportunity for researchers and practitioners to further develop accounting frameworks that adequately reflect the value and utility of these digital assets in both operational and financial contexts. The fading significance of the topic 3 "DT for Product Innovation & Consumer Experience" as evidenced by its decline in recent years. While this topic remains an important application of DT, its decreasing frequency suggests a shift in the research focus toward more specialized and technologically advanced areas, such as energy management, smart grids, and sustainability. This shift may reflect the saturation of early-stage consumer-focused research, where the immediate potential of DT to enhance personalized experience and product innovation has already been explored. As industries begin to better understand and implement DT technology, the focus may have moved towards operational optimization and system integration, rather than purely enhancing the consumer experience. This finding highlights an important paradox. While consumer experience was once seen as one of the core applications of DT, the broader economic and operational benefits of DT may now be taking precedence. However, the fading interest in consumer-focused applications does not negate their significance. In fact, it might suggest a maturation of this period, with the next phase of research focusing on cross-sector applications where DT intersects with other technologies like AI, blockchain, and IoT, to create more integrated, sustainable, and efficient systems. The findings from both bibliometric analysis and topic modeling analysis underscore the interdisciplinary nature of DT research, which spans across multiple domains, including technology management, sustainability, consumer behavior, and industrial operations. The integration of sustainability with DT applications, especially in industries like healthcare, manufacturing, and agriculture, points of the need for future research to focus on sustainable business models. DT's role in resource efficiency, energy consumption, and waste reduction will become increasingly important as businesses strive to meet ESG (Environmental, Social, and Governance) goals. Furthermore, DT technology offers vast potential for economic efficiency and cost optimization, especially when combined with predictive analytics and automation. As DT enables industries to optimize their supply chains, manufacturing processes, and energy usage, they will contribute not only to financial growth but also to economic sustainability in an increasingly resource-constrained world.

4.1 Managerial implications

The findings of this study hold significant implications for managers and organizations striving to remain competitive in the digital age. To stay ahead, companies must embrace DT technology and its associated innovations to drive operational efficiency and sustainability. Furthermore, collaborative research and development efforts between industry stakeholders, academia, and technology providers are crucial for unlocking the full potential of DT. By prioritizing sustainability, efficiency, and customer-centricity, organizations can transform their operations, enhance product quality, and increase customer satisfaction, ultimately positioning themselves for success in today's rapidly evolving business landscape.

4.2 Theoretical implications

This review aligns challenges and extends existing theoretical perspectives on digital twin (DT) technologies in consumer-centric marketing across healthcare, consumer electronics, fashion, and food sectors. Supporting previous studies (Rojek et al., 2021)This review highlights DT's role in operational improvements and product lifecycle management, while extending the discussion to show how DT enhances real-time consumer personalization (Ahmadi-Assalemi et al., 2020; Sai et al., 2023). Challenging earlier studies' limited scope (Fukawa & Rindfleisch, 2023)This review emphasizes DT's role in consumer engagement frameworks, enabling immersive experiences, such as virtual product trials in fashion (Popescu et al., 2022) and real-time inventory feedback systems in food (Fukawa & Rindfleisch, 2023). Furthermore, this study integrates DT into sustainability marketing frameworks, demonstrating its consumer-facing potential in reducing waste and promoting eco-friendly practices (Jayalakshmi et al., 2024; Kaur, R., 2024).

4.3 Policy implications

The rise of Digital Twin (DT) technology also brings about significant policy implications. Governments and regulations will need to address several critical areas, including data privacy, intellectual property in virtual goods, and the need for public investment in digital infrastructure. As DT generates massive amounts of data, data privacy regulations must be enforced to protect consumer information, especially in sectors like healthcare and consumer electronics. Additionally, the ownership and intellectual property of digital assets created within DT systems will require new legal frameworks to ensure that the business and consumers are protected. Government may also need to invest in digital infrastructure to support the widespread adoption of DT, especially in areas like smart cities, healthcare, and manufacturing.

5. Conclusion, Future Direction, and Limitation

This study explored the themes, applications, and benefits of Digital Twin (DT) technology across sectors as fashion, consumer electronics, healthcare, and the food industry, highlighting its potential to enhance product design, manufacturing, and consumer experience. The study also explored the economic and accounting implications of DT technology, particularly in relation to efficiency gains, cost reduction, and the valuation of digital assets. The research revealed key shifts in the DT landscape, including a growing focus on sustainability, automation, and energy efficiency. The economic benefits of DT, particularly in terms of cost optimization and resource management, are clear and will likely drive further adoption across industries. However, they also identified a fading focus on “DT for Product Innovation & Consumer Experience”, suggesting that research and practice are shifting towards operational and technological optimization. In conclusion, DT technology is transforming industries by offering significant economic efficiency and sustainability benefits; it also poses new accounting challenges related to the valuation and reporting of digital assets. As DT continues to grow in complexity, new accounting standards will be needed to address these emerging issues. Future research should continue to explore the cross-sector applications of DT and develop frameworks for their integration with other emerging technologies, such as AI and blockchain, to drive economic sustainability and operational efficiency. Even though the study conducted topic modeling with the whole corpus, future studies can explore all the sectors by not limited to the marketing sectors, while performing SLR on DT technology, as it would provide deeper insights into its cross-domain applicability. Longitudinal studies tracking the evolution of DT’s application are required to understand long-term development trends that cross-sectional studies generally miss. A limitation of this study is its reliance on a single database, i.e., Scopus. As the study aimed to generate in-depth insights, multiple data sources were avoided to restrict the generalizability of findings. Thus, future studies should consider multiple data sources so that findings can be applied to a broader set of populations, increasing real-world relevance. Also, collaboration with industry stakeholders and the development of case studies would enhance the practical relevance of future research, providing actionable insights for businesses and policymakers.

Authors’ Contributions

This article is the outcome of collaborative academic work between the research scholar and the supervisor. Helen conceptualized the review paper in all three phases, data cleaning & reviewing, and drafted the manuscript. Dr. Anil Verma, as the research supervisor, provided critical guidance in refining, improving, and reviewing the manuscript drafts and offering valuable suggestions throughout the writing and revision process. Both authors read and approved the final version of the manuscript.

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Data availability

Data underlying conclusions from a database in the public domain of the Scopus collection is concluded with the key terms "DT and consumer" for data extraction searches.

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