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Kumar, Jai

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<i>Exploring Consumers' Perception of Digital Twin-Based Marketing Communication: The Role of Privacy and Transparency</i>	<i>Vartotojų Požiūrio Į Skaitmeninių Dvynių Pagrindu Kuriamą Rinkodaros Komunikaciją Tyrimas: Privatumo Ir Skaidrumo Vaidmuo</i>

Prof. Dr. Sunil Sahadev

Name, surname, academic title,
scientific degree of the
supervisor

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SUMMARY

VILNIUS UNIVERSITY BUSINESS SCHOOL

Digital Marketing Master's Programme

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***Exploring Consumers' Perception of Digital Twin-Based Marketing Communication:
The Role of Privacy and Transparency***

Prof. Dr. Sunil Sahadev

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Brief Description and Problem: In this Master thesis, the author studies the perception of consumers towards digital twin-based marketing communication and how this is influenced by privacy concerns and transparency to affect the perceived risk and purchase intention. Digital twins are also increasingly being talked about as a means of immersive and personalized marketing, but usually need a lot of consumer data, which raises the question of privacy, control, and trust. The main issue is that, the way consumers perceive privacy and transparency cues in this new marketing situation is not clear yet, and whether this cue can decrease the perceived risk and raise the purchase intention under conditions when the consumers do not know much about digital twins marketing.

Aim and Objectives: To investigate consumers' perceptions of digital twin-based marketing communication, specifically the influence of privacy concerns and transparency on perceived risk and purchase intention.

Research Methods: The research involved a quantitative, cross-sectional study design on the basis of which the data was gathered through a structured online questionnaire (Google Forms). The survey measured the perceptions of privacy concern, transparency, perceived

risk, as well as purchase intention concerning the digital twin-based marketing. The hypothesized relationships were tested and model explanatory power was estimated through data analysis using PLS-SEM with bootstrapping (5,000 resamples).

Results: The results have demonstrated that the concept of privacy and transparency had a substantial impact on internal risk appraisal among consumers nevertheless, the model demonstrated to have partial support of the S-O-R pathway since the perceived risk failed to have significant influence on the purchase intention. It is worth noting that transparency (i) was significantly related to the perception of risk in the opposite direction than hypothesized (more disclosure, more risk salience), and (ii) the most direct positive impact on purchase intention. The model accounted 27.5% of variance in the perception of risk and 46.1% in purchase intention showing moderate explanatory power.

Conclusions: On the whole, the research finds that the consumers do make their definite judgments about the digital twin marketing, depending on the indicators of privacy and transparency, but the intention to buy in the given situation is influenced by the direct impacts of privacy/transparency, rather than by the risk mediation. The findings point out that transparency can serve two purposes: not only can it make an individual more aware of data practices (perceived risk), but also enhance purchase intention via the perceived honesty, competence, or decision confidence. In practice, this thesis suggests that to prevent the unnecessary increase in risk perceptions without reducing trust and intention outcomes, the organizations ought to provide an effective form of transparency (clear, user-friendly and accompanied with robust privacy provisions and user controls).

SANTRAUKA

VILNIAUS UNIVERSITETO VERSLO MOKYKLA

Skaitmeninės rinkodaros magistrantūros studijų programa

Kumar, Jai

***Vartotojų Požiūrio į Skaitmeninių Dvynių Pagrindu Kuriamą Rinkodaros
Komunikaciją Tyrimas: Privatumo Ir Skaidrumo Vaidmuo***

Prof. Dr. Sunil Sahadev

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Trumpas aprašymas ir problema: Šiame magistro darbe autoriai tiria vartotojų suvokimą apie skaitmeninę dvynių rinkodaros komunikaciją ir kaip tai įtakoja privatumo susirūpinimas ir skaidrumas, turintis įtakos suvokiamai rizikai ir pirkimo ketinimams. Apie skaitmeninius dvynius taip pat vis dažniau kalbama kaip apie įtraukiančios ir individualizuotos rinkodaros priemonę, tačiau dažniausiai jiems reikia daug vartotojų duomenų, todėl kyla privatumo, kontrolės ir pasitikėjimo klausimas. Pagrindinė problema yra ta, kad kol kas nėra aišku, kaip vartotojai suvokia privatumo ir skaidrumo ženklus šioje naujoje rinkodaros situacijoje ir ar šis užuomina gali sumažinti suvokiamą riziką ir padidinti ketinimą pirkti tokiomis sąlygomis, kai vartotojai mažai žino apie skaitmeninių dvynių rinkodarą.

Tyrimo tikslas ir uždaviniai: Ištirti vartotojų suvokimą apie skaitmeninę dvynių rinkodaros komunikaciją, ypač susirūpinimo dėl privatumo ir skaidrumo įtaką suvokiamai rizikai ir ketinimams pirkti.

Tyrimo metodai: Tyrimas apėmė kiekybinį, skerspjūvio tyrimo planą, kurio pagrindu duomenys buvo renkami naudojant struktūrizuotą internetinį klausimyną (Google Forms). Apklausa matavo susirūpinimą dėl privatumo, skaidrumą, suvokiamą riziką, taip pat ketinimus pirkti, susijusius su skaitmenine dvynių rinkodara. Hipoteziniai ryšiai buvo patikrinti ir modelio aiškinamoji galia įvertinta atliekant duomenų analizę, naudojant PLS-SEM su įkrovos įtraukimu (5000 pakartotinių pavyzdžių).

Tyrimo rezultatai: Rezultatai parodė, kad privatumo ir skaidrumo samprata turėjo esminės įtakos vartotojų vidinei rizikos vertinimui, tačiau modelis parodė, kad iš dalies palaiko S-O-R kelią, nes suvokta rizika neturėjo didelės įtakos ketinimui pirkti. Verta paminėti, kad skaidrumas (i) buvo reikšmingai susijęs su rizikos suvokimu priešinga kryptimi, nei buvo hipotezė (daugiau atskleidimo, daugiau rizikos), ir (ii) didžiausiu tiesioginiu teigiamu poveikiu pirkimo ketinimui. Modelis sudarė 27,5% rizikos suvokimo ir 46,1% pirkimo ketinimo dispersijos, o tai rodo vidutinę aiškinamąją galią.

Išvados: Apskritai tyrime nustatyta, kad vartotojai, atsižvelgdami į privatumo ir skaidrumo rodiklius, priima konkrečius sprendimus dėl skaitmeninės dvynių rinkodaros, tačiau ketinimą pirkti konkrečioje situacijoje įtakoja tiesioginis privatumo / skaidrumo poveikis, o ne rizikos tarpininkavimas. Išvadose nurodoma, kad skaidrumas gali tarnauti dviem tikslais: jis ne tik gali padėti asmeniui geriau suvokti duomenų naudojimo praktiką (suvokiamą riziką), bet ir sustiprinti ketinimus pirkti per suvoktą sąžiningumą, kompetenciją ar pasitikėjimą sprendimu. Praktikoje ši disertacija rodo, kad siekiant užkirsti kelią nereikalingam rizikos suvokimo didėjimui, nesumažinant pasitikėjimo ir ketinimų rezultatų, organizacijos turėtų užtikrinti veiksmingą skaidrumo formą (aiškia, patogia vartotojui ir kartu su tvirtomis privatumo nuostatomis ir vartotojų kontrole).

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1. INTRODUCTION

1.1 Background of the study

The digital media has disrupted the communication between businesses and customers (Abdullah, and Zeebaree, 2025). The era of interactive, real-life immersion has arrived. Among the most interesting new technologies of this digital transformation is the concept of digital twin technology which is defined as a virtual product, process, or system enables you to copy, view and improve things in real time. Digital twins are increasingly used in healthcare, city planning, and the smart cities, which were previously created in engineering and industrial sector (Mazzetto, 2024). They can help individuals make more accurate judgements and simplify things. Digital twin technology has improved since its introduction. It is a powerful tool that can forecast and replicate human behaviour as thanks to AI, IoT, and big data analytics (Li et al., 2022). Moreover, it is more useful in consumer-related markets such as Siemens which use digital twin technology for their product optimization.

Digital twins allow the tech industry to see and understand the behaviours of clients in real time and alter the nature of interaction between the tech marketers and consumers (OLOWE, RAJI, and YUSUF, 2025). Through these simulations, it is possible to change marketing messages, forecast consumer buying activities, and even customize all the touchpoints that exist online. Since customers are increasing their personalization demands, digital twins offer the marketer the opportunity to cease using traditional segmentation and start engaging dynamically and behaviorally. By monitoring the digital footprint of customers and building real-time profiles, tech marketers can enhance the processes of external distribution of content, product recommendations, and marketing (Gupta et al., 2024). This could improve sales and interest.

Integration of digital twin technology in marketing is never possible without real time consumers data. To create digital models of consumers, companies collect, integrate and analyze all types of interactional, behavioral and transactions data which ultimately help marketers to track consumers updated actions, preferences, their browsing history etc. and marketer with the help of that data can easily simulate the responses and can optimize marketing strategies according to personalized experiences and then to deploy marketing campaign (Hornik & Rachamim, 2025)

However, there are ethical and psychological concerns of using digital twins in marketing, especially in terms of customer privacy and transparency. Digital twins are capable of gathering and processing much personal information without consent (Baeumer et al., 2024). This undermines privacy and most of the individuals are not aware of the extent to

which behavioral information is captured, analyzed, and used to generate digital replicas of them. Unless they know more about data processes, individuals will not feel in control of their personal data. This can cause distrust between people using these technologies on the companies or platforms. Also, transparency, or how much consumers know about how their data is collected, processed, and used, is also important for easing these worries. Research indicates that when companies are transparent about how they handle data and give clear, easy-to-understand information, customers are more likely to prefer personalized experiences based on data (Phan, 2025; Crnjac Zizic et al., 2025). On the other hand, privacy notices that are hard to understand or too complicated might make people less trusting and make it harder for them to adopt new marketing technology like digital twins.

1.2 Research questions:

1. Do privacy concerns and transparency have an impact on perceived risk while using digital twin technology?
2. Do privacy concerns and transparency have an impact on purchase intention while using digital twin-based technology?

1.3 Research aims

The aim of this research is to investigate customers' impressions of digital twin-based marketing communication within tech marketers, focusing specifically on the influence of privacy concerns and transparency. As tech industry rapidly employ digital technologies to increase customer experience and competitiveness, the integration of digital twin applications—such as virtual product trials, store simulations, and personalized marketing—raises important challenges concerning consumer trust. This study will explore how privacy issues affect the perceived risk of digital twin-facilitated tech solutions by a consumer, especially amid the growing sensitivity of personal and transactional information in developed countries. Simultaneously, it is interested in knowing how the open communication, information processing, and the manner in which an organization functions can make people less risky and more trusting towards businesses.

Besides these connections, the study examines the direct impact of the perceived risk on the purchase intention. This assists in describing how the attitudes of people concerning risk influence their readiness to adopt novel technology used for business upgrading. The study also examines the direct relationship between privacy issues and openness and how this influences individuals to purchase something in order to gain a clearer understanding of how people behave as consumers.

Finally, the study will contribute positively to the academic and managerial practice by illuminating how customers judge and respond to digital twin-based marketing as a tech innovation. Through this, it will inform marketers which would benefit them in combining new technology to ethical marketing, respectful of privacy and openness. This will establish customer confidence and prompt the customers to make purchases.

1.4 Research objectives

- To investigate the role of privacy concern on perceived risk
- To examine the impact of transparency on perceived risk
- To investigate the influence of perceived risk on purchase intention
- To investigate the influence of privacy concern on purchase intention
- To investigate the influence of transparency on purchase intention.

1.5 Problem statement

Digital technology is growing so quickly that it has transformed how stores work all across the world. Digital twin applications will be useful in improving the consumer experience, displaying products and marketing to individual consumers through a tailored message (Cui, 2025). The tech industry worldwide is experiencing a massive online shift, and the adoption of such types of technologies has its advantages and disadvantages. Digital twins can make the purchasing experience more exciting and distinctive, but they require customer data, which is a significant problem of privacy and trust (Wang et al., 2023). There can be an assumption among people that it is worse to collect, store, and use personal information. This can make a difference to the extent people using systems based on digital twins. Openness regarding how companies share and use data is now becoming an important way of calming these fears, although we remain unaware of how this impacts the establishment of trust with customers. There is also yet to be researched in literature how the issues of privacy and transparency impact the intentions of customers to purchase goods, despite the increasing significance of digital innovations. Since the people are not much familiar with the existence of digital twin-based technology, for that instance, it is difficult for marketers to adopt it in terms of retaining their buyer's trust through lowering the risk. In order to ensure that Siemens while serving in the tech industry develops in a sustainable manner, addressing this is issue of utmost importance

1.6 Research Gap

Digital twin technology has garnered scholarly interest due to its disruptive potential in engineering, healthcare, and supply chain management (Bhandal et al.,

2022; Hossain et al., 2025), but its use in consumer-oriented sectors, especially tech marketing, is understudied. Existing researches largely examines digital twin's operational and technical benefits, not their effects on consumer psychology, behaviour, and decision-making. There is little data on customer privacy and transparency perceptions of digital twin-based marketing communication.

Privacy, transparency, perceived risk, and purchase intention have been studied in e-commerce and digital marketing (Bhandal et al., 2022; Hossain et al., 2025). However, the combined and interacting effects of these structures on digital twin applications are still unclear. While existing research focusses on developed economies where digital technology adoption is rising rapidly but consumer knowledge of data governance and privacy rights is still low, are neglected. Culture, regulation, and socioeconomic differences might affect customer opinions differently than in developed countries, making this contextual gap essential. Thus, theoretical and empirical research must combine privacy concerns and transparency into a single paradigm to understand how they affect perceived risk and buy intention in digital twin-based tech situations. Filling the gap of adopting modern technology like, digital twin based will aid scholarly discussions and real-world efforts to enhance customer trust in technology and data-driven marketing.

1.7 Significance of the study:

The study has both theoretical and practical implications in deciphering customer behaviour regarding digital twin-based marketing communication in tech industry. Theoretically, it contributes to the existing literature on the topic of digital marketing, privacy, and technology adoption by combining the notions of privacy concern, transparency, perceived risk, and purchase intention into a model. Previous studies have analyzed these traits separately but lacks studies that explore their combined effect in the new phenomenon of digital twins' application. The study can contribute to current theories on the use of technology and consumer behaviour, in addition to clarifying its applicability to the digital transformation process worldwide.

Practically, the study offers a lot to tech industry and marketers who want to embrace digital twin applications to enhance customer experience and competitiveness. The findings will assist organizations to develop marketing communication plans that are transparent, consider privacy and prioritize the

customer. This will reduce the perceived risks and increase the purchase intention. The results will also be useful in assisting the law makers design regulations that will safeguard consumers, and at the same time pave way to new ideas. Ultimately, the study will help the tech industry to use digital technologies responsibly, establish trust with clients, and grow in a sustainable manner within a rapidly-evolving Tech industry.

1.8 Structure of the study:

To arrange the research in a logical manner, the dissertation has been subdivided into five chapters. Chapter one, which is the introduction, discusses the background of the study, declares the problem, enumerates the research goals, objectives and questions. It also discusses the significance of research, constraints and scope of the research and provides an overview of the structure of the dissertation. The second chapter is Literature Review, which critically examines existing studies regarding the topic of digital twin technologies, privacy, transparency, perceived risk, and purchasing intention. It also examines major theoretical foundations and models, identifies a gap in the literature, and develops the conceptual model and hypotheses through which the investigation is going to be conducted. The third chapter is the Research Methodology, which discusses the design of the study, the philosophical attitude and research approach, the sampling techniques, the data gathering instruments, and how to ensure that the findings are valid and reliable. It also discusses the ethical problems and statistical approaches that are employed. The fourth chapter is the Data Analysis and Results where they indicate the results of the data collected, including demographic data, the test of measurements, and hypothesis outcomes. It achieves this with the aid of the correct analysis techniques such as Structural Equation Modelling.

In chapter five, the Discussion chapter, the results are examined against the background of what is already known on the subject and theories and combines both theoretical and practical implications of the results and discusses any unexpected findings. Lastly, there is the Conclusion and Recommendations section where the key findings of the research are summarized, significant conclusions are drawn, and valuable recommendations given to both the tech marketers and policymakers. It also discusses the limitations of the study and recommends on the direction that future research should take. It is this systematic approach that ensures that the dissertation is coherent, unambiguous and scholarly.

1.9 Summary:

Chapter One has framed the study by putting it in the context of the greater picture of digital transformation and the emergence of digital twin (DT) technology. Digital twins were initially created and intended to be used in the engineering and industry, however, it has rapidly moved to more consumer-oriented fields, such as the tech industry, where they can be used to simulate in real-time, offer personalized experiences and marketing communication that responds to behaviour. Such new concepts are transforming firms to stagnant segmentation to dynamic and data-driven consumer contact as depicted in the chapter. This development is problematic in terms of privacy and transparency since digital twin applications consume much customer data. Most consumers are unaware of the extent of data gathered and utilized and this poses an issue of trust, control and misuse. To solve these problems, the chapter recommended that one be open about data use to decrease the risk and build confidence.

The research problem was defined by the lack of clarity regarding the influence of the privacy issues and openness on the consumer perceptions of risk and consequently the intentions to make purchases in the tech industry of Germany. To examine these connections, the chapter formulated research questions and objectives by recognizing the unique challenge of digital adoption in an emerging economy. The aims of the study are aimed at improving the theoretical understanding of tech and practical solutions to tech by combining the ethical marketing and technological innovation. Finally, the chapter discussed the significance of the study to theory, practice, and the decision-making process, which preconditioned the literature review in Chapter Two and the development of the conceptual framework with the help of which the research will be conducted.

2. LITERATURE REVIEW

2.1 Introduction

In this chapter, the researcher reviews all the literature available on the topic of digital twin-based marketing communication with a special focus on the interplay between privacy issues, transparency, perceived risk, and intention to buy. Due to the acceleration of digital transformation, the range of more sophisticated technologies employed by companies to provide customers with unique and engaging experiences is expanding, including digital twins, augmented reality, and real-time analytics (Pandey et al., 2025). The new ideas are more interesting and can give businesses an upper hand yet they can present ethical and psychological issues, particularly with regards to the use and trust of consumer information by businesses.

According to the literature, privacy concerns often serve to increase a sense of vulnerability, culminating in a greater perception of risk, whereas data transparency leads to reduced uncertainty and consumer confidence. The chapter is a critical analysis of consumers' reactions to marketing environments that are technologically driven based on the established theoretical models like the Stimulus-Organism-Response (S-O-R) model. It also examines the way in which studies regarding information privacy, organizational transparency and risk perception have evolved over time within the broad spheres of e-commerce and digital marketing.

The review highlights the multi-faceted nature of the consumer behaviour by incorporating the various perspectives, and explains that perceptions of privacy and transparency have a strong impact on the willingness to adopt new technology. The chapter does not only provide the current contribution of researchers but also illustrates gaps in the current information, particularly in those emerging economies, where people are starting to use digital media and whose awareness of data control remains insufficiently good. Finally, the literature analysis provides the conceptual framework of the study with theoretical grounds and preconditions the development of the hypothesis and empirical investigation.

2.2 Digital Media Technology

The digital media technology has radically changed organizations through incorporation of sophisticated tools like augmented reality (AR), virtual reality (VR), interactivity of media and real-time analytics (Logeswaran et al., 2024). The technologies enhance the involvement of customers, the efficiency of company operations, and promote the emergence of new ideas in various spheres (Perez-Vega et al., 2021; Aithal, 2023). AR and VR have ensured the development of immersive experiences that confuse the difference

between the real world and the digital one. This has enabled businesses to provide interesting and engaging brand interactions to the customers. These technologies assist businesses in creating virtual showrooms, simplifying the process of people to collaborate with one another despite distance, and tell stories online as a means of connecting with customers (Parise, Guinan, and Kafka, 2016).

Interactive media such as dynamic content and gamification also ensure that the users are not bored since they are allowed to experience customized content. These channels will enable the businesses to customize digital content to the individual preferences of people thus customers are satisfied and they will be more willing to remain with the business. As an illustration, marketers have included dynamic advertisements, which evolve in real time in regards to the interactions between people and the advertisement. This makes marketing more topical and efficient. Online analytics are also highly relevant to the digital media technologies as it assists business in knowing how customers use their products, what they love to do and how they communicate with them (Tien, 2017; Gupta et al., 2020). Companies can use such types of data-driven insights to enhance their marketing, make the experience of users more comfortable, and ensure their operations run with a smoother process. The technology of digital media has evolved, which simplifies the process of personalization and adjustment of the way people interact with one another online (Khanom, 2023). These emerging concepts have altered much concerning the means to market products and sway individuals into purchasing them, yet they have not been fully examined in connection to digital twin technology. Being aware of how digital media tools work with digital twins might assist organizations to seek new way of offering customers experiences that are especially distinctive and involving.

2.3 Digital Twins

Digital twins represent one of the ground-breaking concepts in the modern business and industry worlds (Lawson, 2024). They enabled businesses and industries to imitate, keep a watch and make things even better in real time as never before. Increasingly, individuals are coming to the realization that digital twins can assist companies in being creative, efficient and flexible. It is particularly so in the cases of smart trade, where international competency and speed of response to emerging technologies are valued as valuable to success. Digital twins are also studied in numerous industries, including banking, healthcare, logistics, and manufacturing (Singh et al., 2022; Guo, and Lv, 2022; Hasan, and Crawford, 2025)

This is an indication of how this technology can transform the way businesses are conducted by companies. Within the framework of smart trade, which is characterized by the combination of Industry 4.0 technologies, automation, and data-driven decisions, digital twins

offer a solid framework of operational execution alignment to strategic goals (K Mwangi, O Mensah, and N Dlamini, 2025). This assists companies in better fulfilling the demands of the market, handling discontinuities, as well as addressing challenges regarding sustainability (Raja Santhi, and Muthuswamy, 2022). The concept of a digital twin was based on the initial development of virtual product models in the aerospace and industrial sectors and real-time monitoring and predictive maintenance were of particular relevance. Initial studies focused on the accurate depiction of physical assets with the help of virtual models, which provide the maintenance of a product lifecycle and improve the maintenance strategies (Sandu, Varganova, and Samii, 2023).

Digital twins were developed not only as a concept of asset management but also included the process-level modeling and even the organizational-level simulations. This proved people were starting to realize the ways in which digital replicas could be used to aid in strategic decision-making. As researchers have emphasized, the digital twins are not a one-dimensional model; they are dynamic systems that are constantly updated with new information on sensors and IoT devices (Lawson, 2024). They provide us with the information of what is going on in the present and may also foresee what will come in the future (Mihai et al., 2022; Grieves, 2023). Digital twins can be extremely useful in the circumstances where objects are very complex, evolving, and interdependent, such as the global trade networks.

The application of digital twins facilitates the integration of supply chain activities, logistical systems and corporate operations into digital ecosystems within intelligent commerce ecosystems (Zhang, MacCarthy, and Ivanov, 2022). They assist companies in the identification of unproductive areas, in preparation of failures and utilization of their resources to the optimal level by providing them with real time visibility and control. According to the growing amount of studies, data-driven simulations hold the potential to enhance both operations and financial performance of the company by improving demand forecasting, inventory management, and transportation planning (Gutierrez-Franco, Mejia-Argueta, and Rabelo, 2021; Jasiński, 2024). Simulation allows companies to experiment with a great number of scenarios prior to making decisions. This will allow them to apply more flexible and sound strategies that reduce the risks of the unknown with regard to supply and demand. This follows the bigger trend of digital business transformation, in which data and analytics play a central role in value creation and differentiation of the competition (Agustian et al., 2023).

The other literature is devoted to relations between digital twins and advanced analytics, artificial intelligence, and machine learning (Kaur, Mishra, and Maheshwari, 2019). It is argued that the maximum potential of digital twins can be realized only when combined with predictive and prescriptive analytics, and systems can not only replicate and monitor

operations but also propose and autonomously make optimized decisions (Omrany et al., 2023; Sajadieh, and Noh, 2025). With such an integration, it becomes possible to continue learning and improving because models evolve with increased data and experiences. When dealing with smart trade, when customer demands are volatile and the environment, politics, and economics influence the market and conditions, then one has to be adaptable to remain competitive. The literature highlights the symbiotic aspect of having digital twins and blockchain technology, particularly in enhancing transparency, visibility, and trust within the entire supply chains globally (Roumeliotis et al., 2024). Companies can enhance data accuracy and accountability by integrating blockchain into the digital twin systems. This will assist to overcome the historical issues in the trade across borders including fraud, fake production and adherence to regulations.

According to the literature, despite the high potential of digital twins, several barriers need to be overcome to ensure their widespread use in the optimization of business processes. One of the main concerns is related to data integration and interoperability because digital twins require a free-flowing communication between different systems, devices, and platforms (CiMihai et al., 2022). Older systems and data solutions with disordered data architecture can often hinder the creation of holistic digital models, limiting their usefulness and accuracy.

Additionally, issues related to the security and privacy of data have become serious barriers, particularly in the trade arena where secret information about the process, contracts, and other partners of the supply chain are to be protected against cyber-attacks (Colicchia, Creazza, and Menachof, 2019). Ethics should be considered too in relation to surveillance, the ownership of data, and prejudice by algorithms. This is due to the fact that digital twins are playing a more significant and extensive role in the decision processes that affect numerous individuals in the international trade systems.

Additional studies raise the likelihood of organizational readiness and cultural factors to be key to successful implementation of digital twin technology (Kober et al., 2024). The unwillingness to change, a lack of digital competencies, and lack of investment in learning and infrastructure are common barriers to adoption, particularly in small and medium-sized enterprises (SMEs) that might not have the resources of larger organizations (Omowoleet al., 2024).

Researchers emphasise that the transition to digital twin-enabled business models requires something more than the money on new technology. It must have strategic alignment, a good leader, as well as teamwork between various departments (Lawrie et al., 2016). Also, there are no regulatory frameworks and standards of digital twins that are completely developed yet.

This complicates the situation of the businesses that operate across several industries and jurisdictions. The interoperability and scalability of digital twins can be limited without unified standards, reducing their effectiveness in the global trade settings (Sun et al., 2025).

2.4 S-O-R Model

The number of items that can be included in the S-O-R model of customer behaviour is large and which have implications to the quality of goods or products. These include the price, promotions, the brand, and quality.

The Stimulus-Organism-Response (S-O-R) model, introduced by Mehrabian and Russell, is one of the most widely used theoretical models in the study of consumer behaviour. Environmental conditions (S) have an influence on internal organismic states (O), which now lead to behaviour (R) (Kim, Lee, and Jung, 2020). The researchers conceptualize privacy concerns and transparency cues in digital twin-based marketing communication as external stimuli within the study's context (Zhu et al., 2020). The perceived risk is taken as the organismic state. This captures consumers' cognitive and affective evaluations of the possible negative outcomes (Carrigan, and Attalla, 2001). Such outcomes can be related to data misuse, loss of control, or firms' opportunistic behaviour. Purchase intention is the behaviour response whether consumers like to interact or purchase the products (Peng, and Kim, 2014). The study organizes the relationships between these constructs into the process of the S-O-R model and thus can explain how the characteristics of digital twin-based communication as privacy and transparency trigger internal risk evaluation that leads to consumers' willingness to purchase. This gives us a clear behavioural logic that joins the antecedents (privacy concerns, transparency) and the mediator (perceived risk) and the outcome (purchase intention) (Jeong et al., 2022)

2.5 Privacy concerns

Companies are being pushed to come up with good answers to privacy concerns through information technology systems (Dinev, 2014) in a time when customers are asking for more privacy. Internet users' feelings of control over their personal information have also been shown to alter how likely they are to click on ads on social networking sites (Kelly, Kerr, and Drennan, 2017).

The emergence of social media, location-based services, the Internet of Things, and business concepts necessitates increased focus on information privacy, defined as the right to regulate and dictate the availability of personal information to third parties (Weber, 2010; Li, and Palanisamy, 2018; Rayes, and Salam, 2022), thereby maximizing individual autonomy and minimizing vulnerability (Margulis, 1977).

Prior research (Koops et al., 2016; Aftab, 2024) delineates three categories of privacy: (1) accessibility privacy, which encompasses the right to restrict access to personal information and to be shielded from external intrusions; (2) decisional privacy, which refers to the right to make autonomous and unencumbered choices regarding personal data; and (3) informational privacy, which pertains to the right to regulate the collection and subsequent utilization of personal information by third parties.

Bartol, Vehovar, and Petrovčič, (2021) created a scale to assess "Concern for Information Privacy" and delineated essential characteristics of privacy concerns with personal information: (1) collection, which is the worry that a lot of personal data is being collected and stored; (2) unauthorized secondary internal use, which is the worry that the information collected for one purpose is being used for another purpose without the person's permission; (3) unauthorized secondary external use, which is the worry that the information collected for one purpose is being used for another purpose after it is shared with an outside organization; (4) improper access, which is the worry that personal data is being made available to people who are not properly authorized to do so; and (5) errors, which is the worry that the protection against accidental or deliberate errors in personal data would not be appropriate.

Anić et al. (2018) delineated three fundamental characteristics of online privacy concerns: control, short-term relationships, and long-term relationships. The control dimension indicates the extent of the user's authority over the acquisition and utilization of their personal information. The short-run relationship dimension pertains to the individual's apprehension over the nature of the information provided online, as well as the corresponding information received in exchange (Wang, Durcikova, and Dennis, 2023). The long-term connection component indicates that the consumer and the organization own an existing relationship, reflecting the degree of individual concern stemming from online contact and engagement between both parties.

2.6 Transparency

Transparency refers to the willingness and organizational ability to collect and share pertinent information pertaining to the organization, therefore, making it assessable by its various target audiences that require knowledge of how the organization behaves and operates (Parris et al., 2016)

The literature analysis provided by Albu, and Flyverbom, (2019) is comprehensive as it provides a wide summary of the transparency study in various areas of study. They not only study its historical roots in the modern philosophy and policymaking (Dunstall, A., 2019), but also emphasise its similarities with effective governance in contemporary and regulatory frameworks, as well as research the attempts of such bodies as the European Union to

develop transnational standards and regulations of transparency promotion in organizations (Dudley, and Wegrich, 2016). Besides, numerous reports emphasized on the strong relationship between transparency and such concepts as trust and responsibility (Mabillard, and Zumofen, 2017; Kwan, Cysneiros, and do Prado Leite, 2021). When it comes to business ethics, openness is considered a tool to develop the trust, justice, and prudence (Parris et al., 2016).

Transparency has traditionally been seen as a strategic disclosure tool in the corporate social responsibility sphere, which strengthens organizational legitimacy and has a deterring effect on corruption (Muslim, and Mais, 2023; Agu, Nkwo, and Eneiga, 2024). It is the belief of management studies that transparency serves as a reputation management mechanism and a way of demonstrating trustworthiness. Transparency is particularly relevant in the context of online shopping, as customers can quickly identify the effectiveness of information of the products presented in the market, their qualities, and the relevance to their purchasing goals (Portes, N'goala, and Cases, 2020). Perceived transparency in this case refers to how individuals in e-markets opine that it is easy to discover and access market information (Thamik, and Wu, 2022; Budler, Quiroga, and Trkman, 2024). It assists the consumer by facilitating easy access to the best products they can get regarding the needs at the highest possible prices. The digital world, however, also exempts sellers to have the liberty of deciding on the amount and nature of information to share and this can influence the manner in which a consumer thinks and makes decisions.

2.7 Perceived risk

The online buying environment has some features that make consumers feel like they are at risk, which is different from how they feel in the offline world (Arshad et al., 2015). The perception of risk is widely recognized as a significant impediment to the advancement of electronic commerce (EC) and its establishment as a competitive advantage for organizations (Tzavlopoulos et al., 2019). Dam, (2025) discovered that in a B2C situation, an elevated perception of risk diminishes the influence of utilitarian value while amplifying the impact of hedonic value on the intention to repurchase.

According to Kamalul Ariffin, Mohan and Goh, (2018), the source of perceived risk assumes a four-dimension framework including technology risk, vendor risk, consumer risk and product risk. Perceived technology risk is the extent of perception of people that they will lose money in case they purchase things online due to problems with the internet and technology infrastructure such as downloading issues, searching issues, or security weaknesses. Vendor perceived risk refers to the extent to which individuals believe that they may lose money by purchasing online goods distributed by vendors not to mention that their

personal information may be used against their will (Han, and Kim, 2017). Consumer perceived risk is associated with the risk of making a loss because of social pressure as in the case of negative comments by family members, friends or coworkers about an online purchase. Perceived risk of the product is the extent to which individuals believe that they will lose money when they purchase products online (Kamalul Ariffin, Mohan, and Goh, 2018). Such losses may be due to lack of sufficient information on the site or uncertainty regarding the quality of the products, and purchase of defective products, or products that do not satisfy the expectations of the consumers.

Research (Pietrocola et al., 2021) suggested a three-dimensional classification of general perceived risk in the realm of electronic commerce, grounded in its underlying causes. The first dimension was called "failure to gain product benefit risk." This happens when the customer doesn't get the benefits they expected from the product from the online store. The second dimension is called "information misuse risk." It might happen when a customer loses their privacy when shopping online. The third dimension is called "functionally inefficiency risk." This happens when people squander time, money, or effort when they buy something online, which means they lose the resources they wanted to obtain (Kaur, and Arora, 2021).

A significant body of research has been developed that integrates the concept of online perceived risk into consumer behaviour studies, with many relying on the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM) (Nguyen et al., 2023; Raut, and Kumar, 2024). This research has demonstrated that perceived risk adversely influences attitudes towards internet purchasing.

2.8 Purchase intention

The notion of purchasing intention was initially presented in the domain of psychology. Spears, and Singh, (2004) explain the idea of purchase intention. He said that people's buying intention comes from a psychological thought, where they plan ahead to buy the goods they want and then do it. Subsequent research has consistently broadened and enriched the notion of consumer buying intention. Wang, and Tsai, (2014) stated in their study that buying intention refers to the customer's personal desire to acquire a product. Lee, and Lee, (2015) posited that intention represents the likelihood of an individual subjectively engaging in a particular behaviour, while purchase intention denotes the possibility of a client subjectively executing a purchasing behaviour. Marlien et al. (2021) also said that purchase intention is the consumer's subjective forecast of whether they would buy a product or service, and that the purchase behaviour can happen when the product meets the consumer's needs.

Gan, and Wang, (2017) examined techniques for assessing purchase intention via the lens of perceived value, categorising it into three dimensions: considering purchase, desiring

to purchase, and being likely to purchase. Based on this research, Akkarene, and Bouda, (2021) enhanced Zeithaml and Boulding's measurement method by categorising purchase intention into six dimensions: considering purchase, wanting to purchase, likely to purchase, repurchase rate, building platform reputation, and recommending to others. Wang et al. (2022) quantified privacy issues by categorizing them into repurchase rate, active purchase, and recommendation to others. The APCO model integrates the antecedents and outcomes of privacy concerns to effectively utilize empirical testing (Bartol et al., 2023). Antecedents encompass privacy experience, privacy awareness, individual differences, demographic variables, and cultural context, while outcomes include behavioural intention, trust, regulations, and perceived risk. The APCO model is appropriate for the unique context of the Internet of Things and is extensively utilized in privacy concern research, functioning as a core framework for investigating privacy issues in the digital economy.

Purchase intention has a big effect on whether or not a person buys something (Romadhoni et al., 2023). In general, user purchase behaviour happens after the user has made up their mind to buy anything. Once they have made up their mind to buy something, they are likely to do so. There is typically a lack of high consistency between user purchase intention and purchase behaviour because of several elements that affect people and limits in real life (Wu, and Huang, 2023). This makes it hard to predict when people will really buy anything. The more someone wants a product or service, the more money or time they are willing to spend on it. The more favorably buy intention affects the incidence of purchase behaviour, the more likely it is to happen. Nonetheless, owing to the intrinsic unpredictability of users, purchase intention may serve as an indicator of user behaviour, replacing behavioural prediction. Ang, (2021) also corroborated the coherence of intention and behaviour. Ho et al. (2025) indicated in their study on behavioural prediction that individuals' intentions may be incorporated as variables within the research framework.

2.9 Hypotheses Construction

2.9.1 Privacy concerns and perceived risk

Perceived risk refers to the degree of ambiguity customers feel regarding the prospective outcomes of their choices and the associated risks of those outcomes (Bernarto, Purwanto, and Masman, 2022). When it comes to digital twin-based marketing communication, perceived risk is significant, as it means using customer data to create virtual versions of products that make interactions more personalized, interactive, and predictive. These new technologies have many benefits, such as helping people make better decisions and giving them a clearer idea of what a product looks like, but they also leave people unsure about how their data is gathered, stored, and used. This uncertainty stems from both the dread

of unexpected results and the worry that they could be bad for consumers. For example, people are worried that unauthorized third parties could get to their personal information and use it for bad things (Chen, and Atkin, 2021; Kröger et al., 2022).

Mohammed (2024) emphasize that perceived risk is intricately linked to the ambiguity regarding possible adverse outcomes of actions. In digital marketing, this uncertainty often manifests as privacy risks arising from the potential exploitation of personal data (Shahriar et al., 2023). In tech, for instance, when people use digital twin apps such as virtual fitting rooms or product simulators, they may have to share personal information, such as preferences, biometric data, or patterns of behaviour. This information makes purchasing easier, but it also raises concerns that it could be used for other purposes without their knowledge or permission. This fits with bigger worries about service providers, including cloud platforms, selling customer data to third parties, which has led to less trust and more skepticism (Lenhart et al., 2023; Atalay, and Yücel, 2024).

In tech settings, privacy-related issues directly affect how consumers decide whether to use digital twin technology. When people think their data might be mistreated, they feel vulnerable, which makes them less likely to trust the company and less likely to buy from it (Yu, and Cai, 2022). So, perceived risk in digital twin-based marketing isn't just a theoretical idea; it's a real problem that stores need to address by being transparent, protecting privacy, and building trust in how they handle data. In the S-O-R model, the privacy issues (Stimulus) affect the internal assessment of vulnerability and uncertainty of consumers. This internal condition is represented as perceived risk (Organism), which is likely to go up with the increase of privacy concerns.

Therefore, it is proposed that:

H1: Privacy concerns have a significant positive impact on perceived risk while using digital-twin technology

2.9.2 Transparency and perceived risk

According to behavioural finance theory, the risk based on the perception plays a significant role in decision-making due to the presence of psychological factors (Almansour, Elkrghli, and Almansour, 2023). There is subjectivity in risk perception which depends upon personal judgement, prior knowledge, and external sources of information (Ameen et al., 2024). Tech customers are not certain of the quality of goods, whether their payments will be safe, and the confidentiality of their information. Certain studies argue that the perceptions of risk do not have any effect on decision making (Jiang et al., 2022), but other studies indicate a positive influence of the perceived risk in facilitating practical and informed decision making

(Xia, and Madni, 2024). Perceived risk is therefore a major concept in determining the reasons why people purchase items.

Transparency on the other hand demonstrates that a store is ready to provide an honest and helpful information about its policies, processes, and products (Ospital et al., 2023). Transparency in the case of tech would imply being more open with the prices, return policies, the functionality of the supply chain, and the use of customer data. It is a common practice in literature to associate transparency with trust, legitimacy and ethical governance, meaning that transparency reduces consumer skepticism and represents organizational reliability (Sun et al., 2025; Duan, and Zhu, 2025). Transparency, therefore, serves the purpose of decreasing uncertainty, perceived risk, and consumer confidence in transactions involving clothes (Li, and Lorenzo, 2025). In S-O-R terms, transparency (Stimulus) provides information cues that influence how consumers interpret the digital-twin environment. These cues can shape the perceived risk (Organism) consumers experience during usage. Therefore, it is proposed that:

H2: Transparency has a significant negative impact on perceived risk while using digital-twin technology

2.9.3 Perceived risk and purchase intention

Cognitive responses refer to the interior mental processes and states of consumers, encompassing memory, knowledge structures, imagery, beliefs, and thoughts (Yim, Kim, and Lee, 2021). In the realm of online shopping, the cognitive state pertains to how online shoppers process and interpret information available on the internet, therefore shaping their thoughts and opinions about the offered service or product. One of the mental responses that people have when they purchase online is feeling that they could be taking a risk with an online store. Okoye, Ojiaku, and Ezenyilmba, (2021) describe perceived risk in online commerce as the internet shopper's subjective assessment of financial, performance, psychological, and time/convenience risks while making a specific online purchase.

People are worried when they don't know if their purchase will help them reach their goals. Perceived risk is determined by the uncertainty over the potential consequences of a behaviour and the likelihood of adverse outcomes (Nazir, Yasin, and Tat, 2021). It reflects customer apprehension about prospective losses or gains in a specific transaction (Tran, and Vu, 2023). AL HLAICHI, (2023) posited that consumers' risk perceptions significantly influence their patronage decisions; purchasing outside of a store is regarded as riskier than shopping within one. This is due to customers' inability to physically inspect or test the things, coupled with their apprehension of not obtaining their desired items (Mohammed, 2024). Pillai et al. (2022) also discovered that consumers' perceived risk is a significant determinant affecting

their online purchase behaviour. Earlier literature (Jain, 2021; Phamthi, Nagy, and Ngo, 2024) discovered a negative correlation between perceived risk and purchase intention in the setting of online products. S-O-R claims that perceived risk (Organism) is an internalized judgement which determines behavioural responses. The higher the risk perceptions, the lower the purchase intention is likely to be among the consumers (Response). Therefore, it is proposed that:

H3: Perceived risk has a significant negative influence on purchase intention while using digital-twin technology.

2.9.4 Privacy concerns and purchase intention

As information and communication technology changes, both organizations and consumers are using new ways to interact and talk to each other (Heeter, 2023). The competitiveness in the global market has shown how important consumer privacy issues are since target markets know more about a company's products and can check the claims made by businesses. The growth of marketing has provided marketers new ways to advertise, but it has also raised concerns about user privacy. The Pew Research Institute (Roth-Cohen, Rosenberg, and Lissitsa, 2022) says that mobile search is the area of mobile advertising that is growing the fastest. By 2016, mobile activities would make up 15% of all internet ads around the world. Marketing has garnered the attention of practitioners and researchers due to its potential impact on business and industry (Shashi, Ertz, Cerchione, and Kumar, 2025).

Amil, (2024) research on the link between consumer privacy empowerment and trust and privacy issues in e-commerce found that people are less likely to buy things online if they think their personal privacy is at risk. This assertion aligns with Zhang, (2021) research on consumer trust, which indicated that consumer trust diminishes the perceived risk associated with mobile marketing transactions. So, to make mobile marketing better and help people who want to buy things, modern company people should focus on trust and privacy. Shah, Jan, and Jabarkhail, (2022) say that privacy is one of the most important factors that affect consumer trust, which is a critical part of mobile marketing in the 21st century. For instance, a high level of consumer trust will result in a comparatively low amount of perceived risk associated with mobile marketing initiatives.

Tang, Akram, and Shi, (2021) study on information disclosure on mobile devices found that people are less likely to share personal information when they think that new mobile apps pose a greater privacy risk. This will lead to more device use and stronger relationship marketing. Improving privacy makes it harder to promote on mobile devices, as shown by the risks and rewards that people see. So, consumers' adoption of mobile marketing is affected by the benefits they think they will get from it (Aldammagh, Abdeljawad, and Obaid, 2021).

With the S-O-R framework, the stimuli can affect the behaviour indirectly and directly. Therefore, privacy issues (Stimulus) can have a direct influence on purchase intention (Response) through the comfort, trust, and readiness to use the technology. Therefore, it is stated that:

H4: Privacy concerns have a significant negative impact on purchase intention while using digital-twin technology.

2.9.5 Transparency and purchase intention

Numerous studies have shown that how open a company has a big effect on how customers feel about it and whether they want to buy from it (Bhaduri et al., 2018). Camilleri et al. (2023) demonstrated that sustainable practices implemented by businesses influence consumer perceptions. Meanwhile, Buckley et al. (2025) underscored that corporate credibility and transparency, especially via community engagement and environmental initiatives, enhance consumer favorability and the probability of purchase. These studies indicate that transparent business practices substantially improve purchase intentions and assessments of items, brands, and enterprises. Transparency is especially important in tech because supply chains are complicated and customers want to know more about the items and how businesses act (Garcia-Torres et al., 2022). In tech settings, there are typically many people involved in broken and globalised networks, which makes it hard to find out where products come from and how they are made (Lee, and Ha-Brookshire, 2015).

Even Nevertheless, today's customers have a strong need-to-know attitude and expect stores to be open about product characteristics, ethical practices, and commitments to sustainability (Gil, 2021). They are looking for more than just items that do the least amount of harm and the best for society and the environment (Ki, and Ha-Brookshire, 2022). They also want to know that companies are honest and open about how they do business. Tech sector like Levi Strauss & Co. have reacted by letting customers follow the environmental effects of products from design to delivery (Vezzoli et al., 2022). This builds trust and helps people make buying decisions. Overall, the research substantially supports the idea that being open and honest with customers lowers their uncertainty, creates trust, and greatly boosts their intention to buy in the tech sector. Therefore, it is proposed that:

H5: Transparency have a significant positive impact on purchase intention while using digital-twin technology.

2.10 Framework

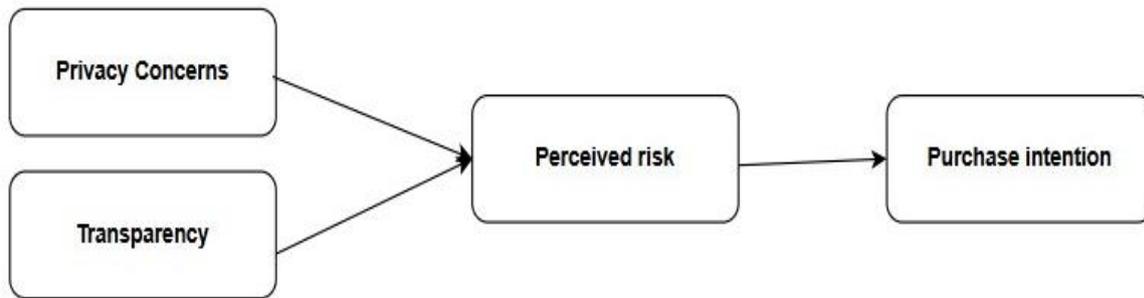


Figure 1: Conceptual Framework

2.12 Summary

Chapter Two has critically evaluated the study regarding digital twin technology and its impact on consumer behaviour with particular reference to privacy concern construct, transparency, perceived risk, and purchase intention constructs. It began by examining the digital media technologies such as augmented reality (AR), virtual reality (VR), and interactive platforms that have transformed the way people relate with brands by providing them with personalized and interactive experiences. The next thing the chapter discussed was digital twins, dynamic, and data-driven systems that are designed to simulate how individuals behave in real time. This enhances marketing communication, but also brings more ethical issues concerning data protection, monitoring and ownership. The review employed important theoretical concepts, in particular, the Stimulus-Organism-Response (S-O-R) model. A study on privacy questions revealed that individuals desire to have the option of managing their personal data besides having potential risks with using them without authorization. Studies on transparency, however, revealed that it may aid in the minimization of ambiguity and make organizations more credible. Perceived risk studies revealed a negative influence on online purchases particularly where there is a state of uncertainty in the quality of the product, reliability of the vendor and abuse of information. The chapter was closed with the discussion of purchase intention that is an important predictor of customer behaviour which is influenced by the feeling of risk and the mechanisms of building trust. The chapter concluded with a gap in the existing research: since privacy, transparency, and perceived risk have been studied

independently, their combined effect in digital twin-based marketing, specifically in an emerging market like Lithuania, has not been studied in detail.

3. RESEARCH METHODOLOGY

3.1 Introduction

The chapter 3 offers the methodology that is to be used to explore the perceptions of digital twin-based marketing communication among the consumers through the prism of privacy and transparency. The chapter is important in the sense that the validity and reliability of a given study is directly influenced by selecting the effective research tools and procedures, and by extension, the credibility of the study results (Shaheen et al., 2023). Considering the delicacy of the issue of privacy, the significance of open communication to consumer reaction formation, the research design should be systematic, coherent, and ethically based. To do so, the study is organized based on the Research Onion as the methodological framework because it gives a transparent step-by-step rationale when selecting the research philosophy, methodology, strategy, and methods and data-collection techniques, not to mention justifying every methodological choice in a transparent manner (Wimalaratne, and Kulatunga, 2022; Gamage, 2025).

3.2 Research design

The study design may be taken as the common purpose and plan of the research. It offers a clear outline of the way in which data shall be gathered and analyzed, and it represents the most important methodological choices concerning what the research shall be given priority. The design in the context of digital twin and marketing communication is determined by the necessity to investigate the reaction of consumers to the most important characteristics of communication, especially, privacy and transparency and how these reactions determine the consumer attitudes and behavioural intentions. The study takes a quantitative research design in order to produce quantifiable evidence on the perception of consumers and the correlations between variables. More precisely, it is a mono-method quantitative design, which implies that it involves the application of a single quantitative data collection method (Ojebode et al., 2018).

The purpose of the research is explanatory since the study aims to test and explain the relationship between important constructs, such as the order of perceived transparency to reduce privacy concerns and the effect of such perceptions on trust, attitudes, and intention to engage or buy based on digital twin marketing communication. A quantitative explanatory design also has a bigger sample size to facilitate the process of determining patterns and drawing cautious generalizations. Since the study only captures a perception at a given time; it is done in a cross-sectional and not a longitudinal design (Nardi, 2018; Mthuli, Ruffin, and

Singh, 2022). This choice is appropriate due to the time limits of the practical aspect and the relative novelty of the digital twin marketing field in terms of which using older secondary data may be incorrect in terms of the current consumer consciousness and privacy demands (Nyquist, Farshid, and Brown, 2025). Yet, the cross-sectional quantitative method is effective to test the relations, but it might be unhelpful in understanding how consumers perceive privacy and transparency in a particular manner since it is concerned primarily with variables presented in the survey questions.

3.3 Data collection Method

Questionnaires and surveys are actually common in the research world and they are used to gather data concerning a particular subject that the researcher intends to explore. When creating a questionnaire, one must be very careful with the general design, nature of questions, mode of distribution and the questionnaire may be most appropriate instrument to respond to the research question (Roopa, and Rani, 2012; Fife-Schaw, 2020). Such decisions may affect the response rate, the validity and reliability of the results (Taherdoost, 2016). In the case of the current research on the perception of consumers towards digital twin-based marketing communication, a questionnaire was suitable as it facilitates the effective determination of the most important perceptions, in particular, the concern over privacy and the perceived transparency in a relatively large sample of the respondents. Since the selected brand does not publicly employ digital twin marketing, responses reflect consumers' perceptions of the concept rather than evaluation of an existing brand implementation.

Surveys are also not expensive and fast to administer, as well as they enable the respondents to stay anonymous which can help prompt more honest results on sensitive issues like personal data usage and privacy (Cho, and LaRose, 1999; Vogel, 2018). Nonetheless, a questionnaire may be insufficient when it comes to depth because it will not be able to deliver the richness that an interview or focus group may allow.

It is also significant that it does not direct the respondents to the direction of the anticipated responses to reinforce the validity and reliability. There are also a risk of non-response and the reluctance of the participants to take part in surveys (Haunberger, 2011). In order to mitigate bias, the questionnaire used in the present research only gave the required instructions but did not go into excessive detail explaining the intent of every question because too much detail may influence the responses unknowingly. Simultaneously, active distribution measures were employed in order to have an adequate number of the completed responses to statistical analysis (Bie et al., 2012).

Since the purpose of the proposed research was to test the relations between the perceptions of privacy and transparency and consumer reactions, the structured questionnaire

was an effective approach based on its practicality. The questionnaire was designed with the help of the Google Forms service and had closed-ended Likert-scale questions to facilitate the quantitative analysis. The following sections elaborate on the questionnaire design, how it will be developed and the major design decisions that will be employed in its designing.

3.4 Sample size

The population to be targeted in this research was consumers of various demographic profiles who are attracted by online or digital marketing messages and who have encountered online shopping and the digital platforms. Since the marketing communication via digital twins is a relatively new practice, the research sought to elicit the perceptions of the participants in various settings as opposed to the sample, which was restricted to one setting (Nyquist, Farshid, and Brown, 2025). Thus, the survey was shared with the respondents in Pakistan, Lithuania, Germany, and other areas, which allowed getting cross-contextual understanding of the perception of privacy and transparency in the context of digital marketing communication.

Concerning the size of the sample, a previous guideline indicates that 10 or more respondents per variable would be recommended in the regression analysis process to have a constant estimation (Taherdoost, 2016). The sample size that was intended to be used in this study was about 150 respondents, which is a large enough sample of variables to execute several regression and other quantitative tests and is not prohibitive in terms of time and accessibility.

3.5 Data collection Technique

Questionnaires are usually open-ended and closed-ended. Nevertheless, open ended questions are time-consuming to analyze and can give repetitive or unstructured answers. That is why numerous studies based on surveys give more attention to close-ended questions, which can be faster to answer and code and compare with statistical methods (Reja et al., 2003). The use of closed-ended questions in this study was deemed the most appropriate since the objective is to quantitatively understand the perceptions of consumers towards digital twin-based marketing communication, especially on the issues of privacy and transparency. Ambiguity was minimized by using a clear language, simple answer choices, and a logical flow of the questions, which minimizes respondent burden and helps to increase the quality of responses (Lenzner, Kaczmirek, and Lenzner, 2010; Sharma, and Ruikar, 2025)

A survey is a systematic process of gathering information on the attitudes, perceptions and behaviours of a sample that depicts a larger population. It employs a standardized form of questions so that patterns and variation between sets of respondents can be captured. This

is especially true when it comes to digital marketing research since the perception of privacy and transparency may also differ depending on demographic and contextual factors like age, gender, income, and experience of shopping online (Alanen, 2025). In this regard, the questionnaire contained demographic questions and questions that capture online behaviour in order to make the differences in perception be looked at in a more meaningful way.

This research questionnaire was structured according to the research objectives and based on close-ended Likert-scale items to assess the main constructs of perceiving the message as transparent, the perceptions of a privacy concern, the perceptions of control over the personal data, trust, attitude towards the communication and intention to engage or purchase. This design allows the explanatory aim of the research because it allows testing the relationship between variables in a statistical way (Myers, Well, and Lorch Jr, 2013; Bentouhami, Casas, and Weyler, 2021).

To collect the data, the survey was designed on Google Forms and was sent out online to cover the consumers in various settings. The connection was distributed both on a personal and extended level (e.g., friends, family, and their acquaintances) and disseminated even through the means of online technology to reach more people and variety of answers. The sample was selected consisting of the citizens of various countries, such as Pakistan, Lithuania, Germany, and so on, to represent a wider cross-national understanding of privacy and transparency perceptions in the digital twin marketing communication. This methodology assisted the research in reaching socio-geographically varied respondents and making the procedure cost and practical in terms of cross-sectional quantitative research.

3.6 Validity and reliability of data

The validity and reliability were considered to make sure that the results of the research concerning the perceptions of consumers towards digital twin-based marketing communication, specifically the roles of privacy and transparency, can be regarded as valid and stable. The content validity was addressed by formulating the questionnaire items based on the study objectives and operational definitions of each construct (Almanasreh, Moles, and Chen, 2019) (e.g., privacy concern, perceived transparency, trust, attitude, and behavioural intention) with similar Likert scale quantities enabling one to compare the respondents. The survey design was made simple and logically arranged and the language in the questionnaire was simple, neutral and non-leading, to ensure there was minimal confusion and response fatigue thus enhancing face validity and minimizing measurement error. Standardization of administration using Google Forms (all the participants had the same instructions and items) and multi-item scales to measure major variables instead of single questions were used to

enhance reliability when the variables are statistically analyzed to examine perceptions. This study used PLS-SEM and bootstrapping (5,000 resamples).

Data quality was also aided by inspecting the responses against blatant incompleteness (e.g., large numbers of missing answers) and prior to analysis consistency checking (Zhang, Indulska, and Sadiq, 2019). A self-report survey is vulnerable to social desirability or other concepts that emerge, but these concerns were mitigated by making the survey anonymous and not being judgmental or using short non-technical context when needed to ensure the respondents knew what was being talked about without being pressured to answer a specific response.

3.7 Ethical consideration

Ethical concerns were the priority in this paper since it explores the perception of consumers towards digital twin-based marketing communication in which privacy and transparency play a key role and may be sensitive issues. The engagement was voluntary and informed: a small information statement was given to the respondents prior to the start of the Google Forms questionnaire giving the purpose of the study, what taking part would mean, how long this would take, and their right to refuse. There was no deception offered and participants were given the chance to drop out of the survey at any point without any sanction (McCaul, and Wand, 2018).

To maintain the confidentiality, the questionnaire did not need any identifying information (i.e. full name, phone number, address) and the answers were analyzed in aggregate format so that any person cannot be described. Data were properly collected and secured, and the researcher was the sole individual to access and analyze them, but in an academic context, as per the principles of data protection (ex. minimizing data collection, access, and secure storage) (Ducato, 2020). Since the survey aimed at getting the attitudes towards privacy and transparency data, but did not require the provision of sensitive personal information, the risk level on the participants was low, but the use of neutral wording was followed to prevent any distress or pressure, and the contacts of research participants were also given (where needed). On the whole, these measures served to make sure that the research fulfilled the main ethical principles of respect, confidentiality, and responsible data processing which is particularly critical when dealing with marketing practices that are associated with data use and protection of consumer privacy.

4. DATA ANALYSIS & FINDINGS

4.1 Introduction

Chapter Four provides the analysis and results of this research because it relies on the primary data gathered to study the perception of the consumers about digital twin-based marketing communication, especially in privacy issues, transparency, perceived risk, and purchase intention. Accordingly, to the study objectives and hypotheses, the statistical results of the measurement and structural tests were first represented in a summary of the demographic profile of the respondents and the second purpose of the chapter is to discuss the quality of the measures and the relationships that were hypothesized to be tested in a clear manner. The results are presented in a rational order i.e. the description of the results is succeeded by testing the hypothesis in a logical order employing proper analytical methods (such as Structural Equation Modelling) to give concrete evidence towards answering the research questions.

4.2 Demographic Information

4.2.1 Gender distribution

Table 1: Gender distribution

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	20	21.3	21.3	21.3
	Male	73	77.7	77.7	98.9
	Other	1	1.1	1.1	100.0
	Total	94	100.0	100.0	

The number of the respondents was 94. The gender composition indicates that sample mainly comprised of males with 73 (77.7) respondents declaring themselves as males. Comparatively, 20 respondents (21.3%) revealed themselves to be female which means that the participation of the women was significantly less. Moreover, one of the respondents (1.1%) has chosen the category that has been reported as Other instead of male or female. This can either be a third-gender/other response available in the questionnaire or it is a coding/entry problem in the data. The cumulative percentages prove that 21.3% of the respondents were female, and 98.9% after counting the males, the remaining 1.1% was added to the

third/unspecified category. All in all, the results indicate that the results are mostly based on the views of male respondents.

4.2.2 Age Group Breakdown

Table 2: Age Group Breakdown

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	18	19.1	19.1	19.1
	25-31	39	41.5	41.5	60.6
	32-38	32	34.0	34.0	94.7
	39-45	5	5.3	5.3	100.0
	Total	94	100.0	100.0	

The sample size used in the study was 94 respondents, and the age breakdown shows that the respondents were most concentrated in the 25- 38 age bracket. In particular, the age group of 25-31 years was the most numerous in the data set (39 people or 41.5%). This was then succeeded by 32 respondents (34.0) whose age range was 32-38, with the good representation of early-mid-career adults. By comparison, there were 18 respondents (19.1% 1824) who were between 18 and 24 years, which is not a significant number, yet still represents a significant proportion of younger respondents. The 3945 age category had the fewest respondents with 5 (53 percent) which indicates that there was not much contribution of the older respondents in the respondent sample. Combining the above, it can be seen that 60.6 percent of the respondents were 31 years old or younger, and 94.7 percent were 38 years old or younger, therefore, the results are mostly based on the opinions of younger and middle-aged adults.-

4.2.3 Educational Background

Table 3: Educational Background

Education					
		Frequency	Percent	Valid Percent	Cumulative Percent

Valid	A-levels	4	4.3	4.3	4.3
	Bachelor	30	31.9	31.9	36.2
	Master	46	48.9	48.9	85.1
	Other	14	14.9	14.9	100.0
	Total	94	100.0	100.0	

There were 94 respondents who took part in the research and the education profile shows that there was a highly educated sample. The highest number of the respondents had a Master degree, and 46 respondents (48.9) indicated that nearly half of the respondents were post-graduate level. This was then succeeded by those with a Bachelor degree of 30 (31.9), which implies that almost a third of the respondents had attained undergraduate level. Conversely, respondents with A-levels as their highest qualification were 4 (4.3) in number implying that there was relatively few representation of respondents educated to pre-university levels. Also, 14 respondents (14.9) chose other which could be professional qualifications, diplomas, vocational education, or other academic pathways that could not be found in the list. This trend is supported by the cumulative percentages: by the category of the Bachelor the cumulative percentage is 36.2 and when the Master's holders are included in the percentage, it rises dramatically to 85.1, suggesting that the overwhelming majority of the respondents had at least an undergraduate degree. In general, this allocation will mean that the results will tend to measure views that have been influenced by higher education and this could affect the awareness and attitudes as well as decision making concerning the topic of the study.

4.2.4 Income status

Table 4: Income status

Income					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Up to 2500	76	80.9	80.9	80.9
	2501-5000	11	11.7	11.7	92.6
	5001-7500	1	1.1	1.1	93.6
	7501-10000	2	2.1	2.1	95.7
	Above 10000	4	4.3	4.3	100.0
	Total	94	100.0	100.0	

Of the 94 respondents who responded on the income, the distribution indicates that the respondents were largely distributed in the lowest income category. The vast majority of respondents, 76 (80.9%) mentioned that they earned less than 2500 a month, which means that most of them operate within a fairly narrow income bracket. The second largest category was the ones earning 2501-5000 with 11 respondents (11.7) and this cumulative percentage stood at 92.6, and thus almost all were 5000 or below. Those earning over 5001-7500, 7501-10000, and above 10000 were only somewhat represented 1 respondent (1.1%), 2 respondents (2.1%), and 4 respondents (4.3), respectively. On the whole, the results may indicate that the perceptions of low-income respondents were more or less embodied in the findings of the study and can define the attitudes toward pricing, perceived value, and risk in the assessment of products or marketing experiences.

4.2.5 Marital Status

Table 5: Marital Status

Marital Status					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single	53	56.4	56.4	56.4
	Married	41	43.6	43.6	100.0
	Total	94	100.0	100.0	

There were 94 respondents who gave their marital status. The findings indicate that 53 participants (56.4%) are single and hence they form the largest group in the sample. In the

meantime, the number of respondents who are married was 41 (43.6), which means that the represented number of married participants was also significant. The cumulative percentages verify that all the respondents belonged to one of these two categories and this resulted in 100 percent when the married respondents were added and this indicates that, there are no missing values of this variable and the other marital-status variables were not recorded in the data (e.g., divorced, widowed). In general, the sample is a fairly balanced distribution, even though it is a little biased towards an individual. This profile is pertinent since the marital status could affect the way of life, priorities of spending, and pattern of decision making, hence the results of the study could reflect the views of independent consumers (single) and those who make decisions under the context of family or household setting (married).

4.2.6 Familiar with Siemen

Table 6: Familiar with Siemen

Familiar with Siemen					
		Frequenc y	Percent	Valid Percent	Cumulative Percent
Valid	Very familiar	26	27.7	27.7	27.7
	Familiar	22	23.4	23.4	51.1
	Slightly familiar	21	22.3	22.3	73.4
	Not familiar	25	26.6	26.6	100.0
	Total	94	100.0	100.0	

In total, 26 respondents (27.7% said they were very familiar, which is the biggest individual group. Another 22 (23.4) respondents affirmed to be familiar, which added up to a cumulative of 51.1, which is slightly more than half of the sample was aware of the brand/company at least at a solid level. Moreover, there were 21 respondents (22.3) slightly familiar, which means that an individual is not well aware but rather has little knowledge or experience. On the other hand, 25 participants (26.6%), said that they were not familiar, which indicated that about a quarter of the sample did not know much about Siemens. The percentages, as cumulative values, affirm that familiarity is distributed within the entire spectrum of high to none implying that the responses of the respondents in their evaluation of familiarity might vary based on their prior exposure which can affect the trust, perceived credibility, and responsiveness to marketing communication.

4.2.7 Purchased Siemen's Product

Table 7: Purchased Siemen's Product

have you ever purchased any Siemen's product					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	48	51.1	51.1	51.1
	No	35	37.2	37.2	88.3
	Not sure	11	11.7	11.7	100.0
	Total	94	100.0	100.0	

The total number of respondents who answered the question of whether they ever bought a Siemens product is 94, and the data demonstrates that an immediate experience of purchase was rather widespread. In particular, 48 of the respondents (51.1%) answered the question Yes, which is slightly more than a half of the sample purchased a Siemens product. On the contrary, 35 of the respondents (37.2%) responded with No, which is indicative of over a third of respondents having no purchase experience with the brand. Moreover, 11 respondents (11.7%), picked the option of Not sure, this could be an element of not knowing whether a product they have purchased was manufactured by Siemens (e.g., because of indirect purchases, co-branding, or a lack of focus on brand names). The sum of the percentages proved that purchase experience and non-experience have 88.3 and the rest 11.7 are uncertain responses. On the whole, the results show that both experienced and inexperienced consumers are present in the sample, and this aspect could affect the perceptions of the respondents with regard to the credibility of Siemens, marketing messages, and trust in its products.

4.2.8 Interact with Siemens

Table 8: Interact with Siemens

Do you follow or interact with Siemens on digital platforms					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	46	48.9	48.9	48.9
	No	48	51.1	51.1	100.0
	Total	94	100.0	100.0	

The number of respondents (94) observed the use of digital platforms based on the question on whether they follow or engage with Siemens, and the findings indicate a very close balance in digital engagement. To be precise, 46 of the respondents (48.9) expressed that they do and that is why almost 50 percent of the sample actively follows or engages with Siemens via digital platforms, i.e., social media, web-based resources, or Internet communities. On the other hand, 48 respondents (51.1%) answered No and this indicates that a slightly higher percentage does not follow Siemens online. The amounted percentages affirm that all the answers were in these two categories to the total of 100 that indicates full data of this item. On the whole, the results suggest that the digitally based presence of Siemens has a significant share of the sample, although the engagement is not universal. This is important since the digital respondents engaged with Siemens might be exposed more to the online communication, campaigns and innovations of the company, which might influence higher brand awareness, perceptions of credibility and attitudes that are more informed than those of non-followers.

4.2.9 Country belong to

Table 9: Country belong to

Country		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lithuania	37	39.4	39.4	39.4
	Germany	4	4.3	4.3	43.6
	Pakistan	47	50.0	50.0	93.6
	Other	6	6.4	6.4	100.0
	Total	94	100.0	100.0	

The respondents provided their country and a total of 94 respondents were distributed with concentration places being concentrated in mainly Pakistan and Lithuania. The biggest proportion of respondents was of Pakistani origin, 47 (50.0) respondents, which implies that half of the respondents are Pakistani. This was succeeded by Lithuania which had 37 respondents (39.4%), with this European background also being well represented. Conversely, the number of German respondents (4.3) was the smallest indicating that German respondents were represented weakly on the questionnaire and their opinions could play less role in influencing the general trends. Also, 6 respondents (6.4) answered Other, which suggests that there were very few respondents who do not belong to the three countries listed.

The aggregate percentages confirm that 93.6% of the responses were attributed to the combination of Pakistan, Lithuania and Germany with the rest 6.4% being attributed to other locations. In general, the results are mostly based on Pakistan and Lithuanian views, and therefore, should be approached with caution when comparing Germany and other countries because the subgroup is relatively small.

4.3 Variable frequencies

4.3.1 Perceived Risk

Table 10: Perceived Risk

Response option	PR 1	PR 2	PR 3
Strongly Disagree	1 (1.1%)	2 (2.1%)	6 (6.4%)
Disagree	3 (3.2%)	10 (10.6%)	12 (12.8%)
Neutral	28 (29.8%)	21 (22.3%)	27 (28.7%)
Agree	40 (42.6%)	46 (48.9%)	35 (37.2%)
Strongly Agree	22 (23.4%)	15 (16.0%)	14 (14.9%)
Total (N)	94 (100.0%)	94 (100.0%)	94 (100.0%)

The descriptive findings of the Perceived Risk (PR1-PR3) indicate that the respondents tend to agree on the Perceived risk, thus, the level of risk concern is visible, but there is a significant proportion of respondents who are neutral. In the case of PR1, the majority of respondents concurred (40; 42.6%) or strongly concurred (22; 23.4%) i.e. 66.0% respondents indicated a clear sense of risk in this question. The proportions were almost the same with neutral (28; 29.8%) and no significant disagreement (3; 3.2%), and strong disagreement (1; 1.1%), indicating that few were rejecting the risk statement. In the case of PR2 perceived risk is even more, with 46 (48.9) agreeing and 15 (16.0) strongly agreeing, which amounts to 64.9 percent agreement. The neutral statement (21; 22.3% agree) was higher than PR1 (10; 10.6% disagree and 2; 2.1% strongly disagree) and it was found to suggest that the avenues were rather neutral. In PR3, agreement prevails, but it is relatively high as compared to PR1 and PR2: 35 (37.2) agreed and 14 (14.9) strongly agreed, which resulted in an overall agreement of 52.1. Again, neutral answers were the highest (27; 28.7%), and there was considerably more disagreement (12; 12.8% disagree; 6; 6.4% strongly disagree), which means that the respondents were even more divided about the particular risk factor that PR3 measures. In general, in all three items, there is an overall pattern, that perceived risk is significantly present in the sample with the strongest support on PR1 and PR2 with PR3 representing greater uncertainty and diversity- perhaps because the risk

outlined in PR3 is less known, less relevant to each person or being perceived in different ways by the respondents.

4.3.2 Purchase Intention

Table 11: Purchase Intention

Response option	PI1:	PI2:	PI3:	PI4:	PI5:
Strongly Disagree	0 (0.0%)	1 (1.1%)	1 (1.1%)	1 (1.1%)	1 (1.1%)
Disagree	5 (5.3%)	5 (5.3%)	8 (8.5%)	8 (8.5%)	6 (6.4%)
Neutral	17 (18.1%)	16 (17.0%)	11 (11.7%)	22 (23.4%)	14 (14.9%)
Agree	38 (40.4%)	44 (46.8%)	51 (54.3%)	41 (43.6%)	45 (47.9%)
Strongly Agree	34 (36.2%)	28 (29.8%)	23 (24.5%)	22 (23.4%)	28 (29.8%)
Total (N)	94 (100.0%)	94 (100.0%)	94 (100.0%)	94 (100.0%)	94 (100.0%)

The descriptive findings on the Purchase Intention (PI1–PI5) show that there is a strong desire to purchase and majority of the respondents answered as agree or strongly agree to all the five questions, and the negative feedback is minimal. In PI1, 38 (40.4) respondents said yes and 34 (36.2) strongly said yes indicating that 76.6% of the respondents had positive purchase intention in this item. The indifferent answers were 17 (18.1%), and the number of those who disapproved of it was 5 (5.3) only, and there was no intense disapproval, which indicated little opposition. In the case of PI2, positive intention is high: 44 (46.8) agreed and 28 (29.8) strongly agreed (76.6% total), with the neutrality being 16 (17.0) and disagreement 5 (5.3), and only 1 respondent (1.1) strongly disagreeing. In the case of PI3, the most significant purchase intention is observed, with 51 responding (54.3) agreeing with and 23 (24.5) strongly agreeing (78.8%), the lowest level of neutrality is (11; 11.7) and the level of disagree is (8; 8.5) and 1 (1.1) strongly disagreed. In PI4, the endorsement is also still dominant but significantly weaker: 41 (43.6) agreed and 22 (23.4) strongly agreed (67.0), and the proportion of neutral in this case is the largest (22; 23.4). In the case of PI5, 45 (47.9) agreed and 28 (29.8) strongly agreed (77.7), and neutrality of 14 (14.9) and limited disagreement (6; 6.4) and strongly disagree (1; 1.1). In general, the tendency is that purchase intention is always positive, and PI3 has already expressed the most positive confidence, and PI4 has expressed the most hesitancy, which is probably due to the fact that it is a more conditional or effort-related aspect of making a purchase.

4.3.3 Transparency

Table 12: Transparency

Response option	T1:	T2:	T3:	T4:	T5:
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Strongly Disagree	3 (3.2%)	1 (1.1%)	2 (2.1%)	3 (3.2%)	0 (0.0%)
Disagree	7 (7.4%)	9 (9.6%)	9 (9.6%)	5 (5.3%)	5 (5.3%)
Neutral	26 (27.7%)	30 (31.9%)	25 (26.6%)	24 (25.5%)	21 (22.3%)
Agree	41 (43.6%)	31 (33.0%)	38 (40.4%)	46 (48.9%)	48 (51.1%)
Strongly Agree	17 (18.1%)	23 (24.5%)	20 (21.3%)	16 (17.0%)	20 (21.3%)
Total (N)	94 (100.0%)	94 (100.0%)	94 (100.0%)	94 (100.0%)	94 (100.0%)

The descriptive findings of Transparency (T1–T5) imply that the respondents tend to have an average to high degree of transparency, but the degree of neutrality is also prominent in all the items. In the case of T1, most of them agreed with it with 41 people (43.6) indicating that they agreed and 17 (18.1) strongly agree, making a total of 61.7% people to respond positively. Another (26) had a neutral response (27.7%), and disagreement was relatively low (7; 7.4% disagree and 3; 3.2% strongly disagree). In the case of T2, the percentages of positive perceptions are still dominant and low, 31 (33.0) agreed, 23 (24.5) strongly agreed (57.5), but the neutrality percentages are 30 (31.9) and disagreement percentages are 10.7 combined. In the case of T3, 38 (40.4) respondents replied affirmatively and 20 (21.3) strongly affirmative (61.7%), 25 (26.6) were neutral and 11.7% were disagreeing. In T4 and T5, the highest transparency seems to be true. In T4, 46 respondents (48.9) agreed with and 16 strongly agreed (17.0) providing 65.9% positive responses, 24 were neutral and lowly agreed (8.5% combined). In case of T5, support is the highest: 48 (51.1) said yes and 20 (21.3) strongly yes, or 72.4% agree, 21 (22.3) undecideds, and no strong disagree. On the whole, the trend shows that all respondents are more likely to perceive the topic as transparent, especially those that T4 and T5 measure, and the always significant proportion of the neutral (about a quarter to a third) can possibly reflect the fact that some participants do not have sufficient information or confidence to provide a strong answer to some of the items of transparency.

4.3.4 Privacy Concern

Table 13: Privacy Concern

Response option	PC1:	PC2	PC3:	PC4:	PC5:	PC6:	PC7:	PC8:	PC9:	PC10 :
Strongly Disagree	1 (1.1%)	2 (2.1%)	2 (2.1%)	3 (3.2%)	2 (2.1%)	1 (1.1%)	1 (1.1%)	1 (1.1%)	3 (3.2%)	2 (2.1%)

Disagree	2 (2.1%)	1 (1.1%)	0 (0.0%)	4 (4.3%)	4 (4.3%)	1 (1.1%)	3 (3.2%)	2 (2.1%)	2 (2.1%)	2 (2.1%)
Neutral	14 (14.9%)	15 (16.0%)	16 (17.0%)	16 (17.0%)	15 (16.0%)	14 (14.9%)	16 (17.0%)	15 (16.0%)	14 (14.9%)	18 (19.1%)
Agree	44 (46.8%)	50 (53.2%)	46 (48.9%)	43 (45.7%)	41 (43.6%)	49 (52.1%)	46 (48.9%)	43 (45.7%)	44 (46.8%)	34 (36.2%)
Strongly Agree	33 (35.1%)	26 (27.7%)	30 (31.9%)	28 (29.8%)	32 (34.0%)	29 (30.9%)	28 (29.8%)	33 (35.1%)	31 (33.0%)	38 (40.4%)
Total (N)	94 (100.0%)									

The descriptive findings of Privacy Concern (PC1-PC10) show that the respondents are highly concerned with internet privacy and the control of personal information of which the agreement and strongly agree stand out in all the items. In the case of PC1, 46.8% were in agreement and 35.1% strongly agreed (81.9% positive) indicating that there was a great deal of support to consumer control over personal information. The same tendency can be observed in PC2 (agree 53.2; strongly agree 27.7 = 80.9) and PC3 (agree 48.9; strongly agree 31.9 = 80.8), indicating that the perceptions of the possibility of an invasion of online privacy and the necessity to protect it are widespread. In the case of PC4 and PC5, the consensus is also high (75.5 and 77.6 respectively) which means that the respondents believe that companies should adhere to responsible conduct and have decent privacy policies. PC6 is also highly endorsed (52.1% agree; 30.9% strongly agree = 83.0%), meaning that the participants should be aware of their data-handling. Questions that indicate emotional unease concerning data demands PC7, PC8 and PC9 again are overwhelmingly positive with a percentage ranging between 78.7 to 80.8 percent agreement/strong agreement indicating that still many respondents are annoyed when companies request or demand personal information. Lastly, PC10 demonstrates the greatest concern: 36.2% agreed and 40.4% strongly agreed (76.6%), with the highest level of neutral (19.1%), so some worry about data collection is strong, but a minority is quite uncertain. The level of disagreement on all items is low (usually 0-8.5 percent), whereas the neutral answers are moderate (14.9-19.1 percent),

which suggests that even though the issue of privacy concern may be shared by many, there are smaller numbers of individuals uncertain about the issues or not interested in them.

4.4 Descriptive analysis:

Table 14: Descriptive analysis

Descriptive Statistics									
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis		
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PR01	94	1	5	3.84	.859	-.412	.249	.131	.493
PR02	94	1	5	3.66	.945	-.669	.249	.189	.493
PR03	94	1	5	3.41	1.092	-.487	.249	-.309	.493
PI01	94	2	5	4.07	.871	-.646	.249	-.299	.493
PI02	94	1	5	3.99	.886	-.832	.249	.675	.493
PI03	94	1	5	3.93	.895	-.955	.249	.870	.493
PI04	94	1	5	3.80	.934	-.553	.249	-.090	.493
PI05	94	1	5	3.99	.898	-.889	.249	.719	.493

T01	94	1	5	3.66	.968	-.646	.249	.346	.493
T02	94	1	5	3.70	.982	-.272	.249	-.611	.493
T03	94	1	5	3.69	.984	-.518	.249	-.123	.493
T04	94	1	5	3.71	.923	-.817	.249	.944	.493
T05	94	2	5	3.88	.801	-.425	.249	-.129	.493
PC01	94	1	5	4.13	.820	-.960	.249	1.43 7	.493
PC02	94	1	5	4.03	.822	-1.126	.249	2.56 4	.493
PC03	94	1	5	4.09	.825	-1.100	.249	2.45 2	.493
PC04	94	1	5	3.95	.966	-1.063	.249	1.26 5	.493
PC05	94	1	5	4.03	.933	-1.039	.249	1.17 9	.493
PC06	94	1	5	4.11	.769	-.911	.249	1.90 6	.493
PC07	94	1	5	4.03	.835	-.852	.249	1.10 1	.493

PC08	94	1	5	4.12	.828	-.921	.249	1.25 0	.493
PC09	94	1	5	4.04	.926	-1.246	.249	2.10 7	.493
PC10	94	1	5	4.11	.933	-1.028	.249	1.09 3	.493
Valid N (listwise)	94								

4.5 Reliability

Table 15: Reliability

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
PC	0.897	0.908	0.916	0.523
PI	0.879	0.915	0.911	0.672
PR	0.559	0.587	0.773	0.535
T	0.808	0.817	0.865	0.563

Measurement model was tested to measure internal consistency reliability and convergent validity with the help of Cronbach/alpha, composite reliability (rho a and rho c) and average variance extracted (AVE). All in all, the findings suggest that the constructs have fair reliability and validity, and one of them should be interpreted with caution. All the measures have high internal consistency (Privacy Concerns, Purchase Intention and Transparency) as indicated by the scores of Cronbach alpha exceeding the acceptable alpha value of 0.70. Their composite reliability coefficient (or ρ_c) is also more than 0.80, which proves that the indicators always cover their constructs. Moreover, the AVE of PC, PI, and T exceed 0.50, which provides sufficient convergent validity, and states that over 50 percent of the variance in the indicators is covered by the underlying constructs. The Cronbach's alpha (0.559) and rho a (0.587) values are lower than the traditional value, and they are perceived to have a less risky value (PR). Nevertheless, its composite reliability (0.773) is greater than the acceptable minimum of 0.70, and its AVE (0.535) is greater than 0.50. In PLS-SEM, composite reliability is said to be

a more suitable measure of reliability to use instead of Cronbach's alpha, especially in the case where the constructs are small, in terms of the number of indicators used to measure them. Thus, the PR construct considered to be satisfactory in the reliability and convergent validity can be considered acceptable, even in spite of the reduced alpha. In general, the measurement model has adequate psychometric characteristics and can be further analyzed in terms of structural model.

4.6 Discriminant Validity

Table 16: 6 Discriminant Validity

	PC	PI	PR
PC			
PI	0.555		
PR	0.597	0.470	
T	0.435	0.703	0.641

The heterotrait monotrait ratio (HTMT) was used to determine the discriminant validity. Table X showed all the values of HTMT were lower than the conservative value of 0.85, which means that there was sufficient discriminant validity among the constructs. This proves that the concepts of privacy issues, transparency, perceived risk, and purchase intention are empirically different and gauge different issues of perceptions among respondents.

4.7 Hypotheses Testing

Table 17: Hypotheses Testing

Hypothesis	Path	β	t-value	p-value	Decision
H1	Privacy Concerns (PC) → Perceived Risk (PR)	0.313	1.991	< 0.05	Supported
H2	Transparency (T) → Perceived Risk (PR)	0.316	2.443	< 0.05	Supported
H3	Perceived Risk (PR) → Purchase Intention (PI)	-0.024	0.249	> 0.05	Not Supported
H4	Privacy Concerns (PC) → Purchase Intention (PI)	0.321	3.923	< 0.001	Supported (but opposite sign)

H5	Transparency (T) → Purchase Intention (PI)	0.499	5.566	< 0.001	Supported
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PLS-SEM bootstrapping (5,000 resamples) was used to evaluate the hypothesized interrelations between privacy concerns, transparency, perceived risk and purchase intention in the environment of digital-twin technology in relation to the structural model. The results demonstrate that there are significant and positive predictors of perceived risk, which include privacy concerns (0.313, $t = 1.991$, $p < 0.05$): the higher the apprehensions of users with respect to personal data gathering, tracking, or possible abuse, the more they will tend to perceive the use of digital-twins as risky. Perceived risk is also greatly influenced positively by transparency (0.316, $t = 2.443$, $p < 0.05$). This implies that the increased disclosure concerning the way in which the technology works, the type of data gathered, and how they are analyzed might increase the awareness of the users regarding the vulnerability of the technology, and thus perceived risk increases as opposed to the perceived risk being decreased. Conversely, observed risk has no significant effect on purchase intention ($\beta = -0.024$, $t=0.249$, $p > 0.05$) suggesting that the influence of risk perceptions alone on purchase intention is not critical in this sample, perhaps due to the presence of other factors such as perceived benefits, novelty or trust cues to guide the decision-making. Purchase intention is influenced directly in a way that provides more information.

The relationship between privacy issues and purchase intention has a negative correlation of significance (0.321, $t = 3.923$, $p < 0.001$), a trait that is opposite of the hypothesized correlation. A plausible explanation is that more consuming or knowledgeable consumers, at the same time, report greater privacy cognizance and are as well more eager to embrace the technology given that it has got a perceived value, causing a positive net effect. The greatest positive effect on purchase intention is transparency ($= 0.499$, $t = 5.566$, $p < 0.001$), indicating that the level of transparency and openness may boost consumer confidence and help to adopt. In general, the model can explain 27.5 percent of the variance in perceived risk and 46.1 percent in purchase intention, showing that it has a moderate explanatory ability especially in behavioural intention.

5. DISCUSSIONS OF FINDINGS

5.1 Discussion

5.1.1 Privacy concerns and perceived risk

These findings confirm H1 where privacy issues are found to have significant impact on perceiving risk when using digital-twin technology (0.313, 1.991, $p < 0.05$). According to the results of the PLS-SEM, the path between the two variables has a positive and statistically significant value, i.e. the more concerned the respondents are about privacy, the riskier the technology is regarded to be. Substantively, such a relationship is not surprising since issues of privacy are sensitive among the users in terms of how their personal information are gathered, processed, stored and possibly with third parties. It is more likely that when people feel they have less control over their information, and are afraid that it might be misused, such as by being spied on, having their identities revealed, and profiled, they will perceive digital-twin environments as unpredictable threats. Within the context of marketing technologies, this uncertainty may produce the increased level of perception as the financial, social and psychological risks, as the users expect to suffer adverse consequences of data leaks or misunderstanding of the digital identity.

Even though there is a great deal of predictability of perceived risk on the basis of privacy concerns (0.313, $t = 1.991$, $p = 0.03$), the overall model explains the perceived risk in a moderate manner ($R^2 = 0.275$). It implies that privacy issues and transparency can predict 27.5% of the variance in perceived risk, and the rest of the variance is presumably explained by other factors that are not contained in the model, including prior experience with comparable technologies, trust in the brand/platform, perceived value, digital literacy, and broader institutional or cultural norms are expected to guide data governance. In practice, this means that to minimize perceived risk, it is necessary not just to increase privacy protection, but also to make sure that the user is able to comprehensively perceive and control his data (e.g. meaningful consent, user-friendly privacy controls, data minimization, and understandable explanations of how his information is used and why). This result is consistent with the existing literature on the value of privacy-related risks in an online setting (Lenhart et al., 2023; Atalay and Yucel, 2024)

5.1.2 Transparency and perceived risk

The findings of the structural model show that transparency is statistically significant as a predictor of perceived risk in the digital-twin environment ($\beta = 0.316$, $t = 2.443$, $p = 0.05$).

This result justifies H2 as significant; but the relationship direction is converse to the negative effect hypothesis. Instead of increasing the risk, increased transparency in this

sample relates to increased perceived risk. One of the reasonable explanations is that transparency is an amplifying piece of information: the more users are provided with explanations on what data is gathered, how it is analysed, how long it will be stored, and whether third parties will be able to access or use them, the more aware they might be of the possible vulnerability. That is, transparency will help decrease the uncertainty regarding what is happening, but at the same time, more salient data practices may cause the user to evaluate the situation as riskier.

This trend does not mean that transparency is bad in nature. Rather, it implies that transparency may be a two-sided process that may be associated with that which is revealed and the way of its presentation. Transparency can also increase worry, inadvertently, when it highlights widespread monitoring, sharing in general, complicated algorithmic operations, or lack of control by users. On the other hand, when transparency is coupled with explicit guarantees (e.g. high-security measures, less data gathering, significant consenting choices, and viable user controls), then it is more apt to reduce perceived risk by creating signals of accountability and security. Thus, the content and format of transparency can be the determinant of whether it will provide more of a reassurance cue or a risk-salience one.

Lastly, the model describes 27.5% of the variation in perceived risk ($R^2 = 0.275$) and thus the issues of transparency and privacy explain a significant albeit incomplete portion of risk perception, and other factors such as trust, prior encounters with similar technologies, perceived benefits, digital literacy, and situational expectations regarding data control are probably relevant.

In practice, organizations ought to strive to achieve successful transparency, i.e. easy to understand and disclosed publicly in a manner that the openness does not cause the perceived risk to rise unnecessarily (Sun et al., 2025; Duan and Zhu, 2025)

5.1.3 Perceived risk and purchase intention

The results confirm the hypothesis that the perceived risk is an important factor that determines purchase intention because the regression model is significantly acceptable ($F(1,92) = 11.202, p = .001$). This finding, when discussed in the context of willingness to buy by consumers, implies that it is not the benefits of the products or their advertising messages that influence the willingness to buy them, but also the evaluation of the perceived negative effects. However, the larger the level of uncertainty perceived by the respondents (fears of losing money, failure in performance, misuse of data, or post purchase regrets), the more they tend to hesitate or delay their buying decision or not purchase at all. This is in line with the consumer behaviour theory in which risk is a form of psychological cost that lowers the perceived value and diminishes intention.

The residual variance however shows that the perceived risk only explains part of the story i.e. purchase intention is also influenced by other factors including transparency, privacy concern, brand trust, perceived usefulness and previous experience. Notably, significance but not direction is confirmed by the output, however, the majority of the marketing and technology-adoption literature anticipates the negative direction of the effect, as increased perceived risk should decrease purchase intention. When you see this negative sign in your coefficients table, it would support the meaning that the risk reduction measures, which have been so effectively considered as ensuring clear guarantees, secure payment system, privacy protection and credible communication, are important in reinforcing consumer confidence and increasing purchase intention. When the coefficient is positive, this might mean a niche scenario in which risk is viewed as a source of uncertainty in innovation but can be beneficial to some consumers, and this needs to be clarified.

5.1.4 Privacy concerns and purchase intention

The structural model gives good evidence to the fact that the issue of privacy is a major factor to the purchase intention in the case of the digital-twin, though the relationship is in a contrary direction to the initial hypothesis. In particular, the issue of privacy demonstrates that it has a significant positive influence on a purchase intention ($\beta = 0.321$, $t = 3.923$, $p = 0.001$). It is that the more respondents said they had higher privacy concerns, the more they said they were willing to purchase, and not the reverse (H4). Instead of bearing the implication of the lack of the value of privacy, this trend indicates that privacy has become a constructive and relevant factor in the decision-making of consumers: privacy-conscious individuals can be highly active, better informed, and more conscious users of computer technologies. Privacy concern can also be indicative of increased attention and engagement with the technology in this type of situation and in this type of situation these people may still be willing to buy when they feel that benefits will be greater than the risks, or when they feel that there are protective methods.

Such a counterintuitive observation has had a variety of interpretations. First, consumers who have high privacy concerns can use the risk-management strategy they are still ready to purchase but would like to control (e.g., check policies, settings, sharing) their privacy. Second, there can be the presence of privacy concern and high perceived value: users can be aware of privacy risks, but still buy the technology because of its perceived usefulness, novelty, or competitive advantage of digital-twin technology. Third, the finding can imply that privacy concern is a proxy of overall awareness and savvy in online settings, privacy-sensitive consumers may not be avoidant but rather make more rational choices.

Meanwhile, privacy concerns are not the only ones affecting the purchase intention. It has explained 46.1% of the variation in the purchase intention ($R^2 = 0.461$), meaning that other predictors, especially transparency ($\beta = 0.499$, $p < 0.001$) influence intention to purchase significantly. In usability, the implications of the results are that companies cannot presume that privacy issues will lead to a decrease in purchase; they should offer credible privacy protections, meaningful consent, and controls such that privacy-conscious buyers can make a purchase without doubts and their intentions to buy will not be weakened.

5.1.5 Transparency and purchase intention

The results of structural model show great support to H5, which indicates that transparency is a significant and positive influence on purchase intention in the case of digital-twin ($\beta = 0.499$, $t = 5.566$, $p = 0.001$). This correlation shows the greatest direct impact in the model that transparency is an important determinant of the willingness of consumers to buy. PLS-SEM results indicate that increase in transparency directly leads to increased behavioural intention through less ambiguity and increased confidence in the decision-making process. Provided that firms can articulate the mechanisms of working with digital-twin technology, the types of data that are gathered, the manner of using the data, and the decisions made, consumers can more effectively calculate the value and judge ethical behavior, and trust in the company grows and purchase intention strengthens.

It is especially significant in digital and virtual spaces, where consumers are not able to touch on the products or see how the service is provided. Transparency in these environments replaces the physical cues as it communicates honesty, accountability and reliability. Positive attitudes and reduced psychological barriers to adoption are therefore able to be achieved through clear and accessible disclosures which can be translated to higher purchase intention. Meanwhile, transparency does not always turn out to be a positive thing. In case the disclosures are too technical, vague, or expose too much information without due protection, then it might become suspicious instead of reassuring the users. Therefore, transparency effectiveness is based on the clarity, relevance, and user orientation.

The model predicts purchase intention with a significant contribution yielding a model with a R^2 of 0.461, which places a lot of weight on the use of transparency in addition to other predictors. In practice, the results would imply organisations to focus on meaningful transparency with straightforward explanations, clear purposes of data usage, opt-in control system and obvious guarantees like guarantees of security or third party certifications to convert openness to constitute greater purchase purpose.

5.2 Conclusion

This dissertation explored the influence of privacy issues and transparency in purchase intention of consumers in digital twin-based marketing communication, perceived risk was considered as a possible mediating factor. Applying PLS-SEM bootstrapping (5000 resamples) the result demonstrates that the perceived risk is considerably greater in case of privacy concerns (H1 supported: 0.313, $p = 0.05$). The predictability of the perceived risk by transparency was also significant statistically but the relationship was in the opposite direction as hypothesized by the negative relationship (H2: 0.316, $p < 0.05$) indicating that increased disclosure can actually increase the risk salience among the consumers but not decrease. Perceived risk, however, was not a significant predictor of purchase intention (H3 not supported: 0.024, $p > 0.05$) implying that perceptions of risk were not in itself a powerful predictor of intention in this sample. Rather, the direct effects were mostly identified as the primary factors to determine purchase intention: transparency had the greatest positive effect on purchase intention (H5 supported: 0.499, $p < 0.001$), and privacy concerns had a significant direct relationship with purchase intention but in the negative direction of the hypothesis (H4 significant, opposite sign: 0.321, $p < 0.001$). On the whole, the model accounted 27.5 and 46.1 percentage of the variance in the perceived risk and purchase intention, respectively, which has moderate explanatory power.

When put together, the findings indicate that the S-O-R logic is partially supported in this domain: privacy and transparency indicators have a clear impact on the internal risk appraisal, although the purchase intention does not seem to be as a result of risk mediation as a result of the direct impact of such indicators. The results also suggest that transparency can just work in several psychological pathways of creating risk awareness and at the same time consolidating intention in other psychological pathways like confidence, perceived control, or perceived value. Future studies should hence experiment with other organismic states (e.g. trust, perceived benefits, perceived control) and perceived risk to achieve greater explanation as to why consumers can still have intentions to adopt or purchase despite recognition of risk.

5.3 Implications

5.3.1 Theoretical implications

In theory, the study will add to the research concerning digital-twin consumer behaviour by revealing the relationship between privacy and transparency cues and perceived risk and purchase intention. The findings suggest to some extent that there is evidence to support an S-O-R explanation: the issues of privacy and transparency (stimuli) had a significant impact on perceived risk (organism), which proves that consumers are capable of developing internal

risk appraisal when they are perceived as intensive data collection or when disclosures are made to them in more elaborate forms. The perceived risk was however not a significant predictor of the purchase intention and this means that the organismic risk state did not translate into the behavioural response in this sample. This implies that the information cue to intention pathway in a digital twin marketing setting might be more direct than anticipated or that perceived risk alone might not be adequate as a mediator of adoption or purchase intention.

The second theoretical input is the directionality insight of transparency. Although the hypothesis was that transparency would lower perceived risk, the empirical findings demonstrate that there is a strong correlation between these variables in reverse to the expected direction. It implies that transparency itself can be used as a risk-salience signal, such that more detailed disclosures can make consumers more aware of the amount of data gathered and manipulated, which will make them feel more vulnerable despite an organisation being transparent. Meanwhile, transparency displayed the most positive direct effect on the purchase intention meaning that the effect of transparency on intention could be amplified by other mechanisms than risk reduction (e.g., perceived honesty, competence or confidence in decision-making). This two-fold role underscores the idea that the concept of transparency cannot be defined as always risk-reducing in theory building but it might be influencing various internal states at the same time and that the developing models must explicitly test parallelograms of mediating factors like trust, perceived control and perceived benefits in conjunction to the risk.

Lastly, the important direct relationship between the issue of privacy and buying purpose was found to be opposite the hypothesis. This observation indicates that the privacy concern might not be an ever-present deterrent in environments where technology is being used; in certain situations it can indicate higher digital literacy, higher level of awareness or more conscious privacy-calculus where consumers will adopt it when they have high perceived value or high reputability of the platform. This should theoretically tighten up privacy-calculus arguments by suggesting that there may be a coexistence of concern and intention especially where other cues (e.g. transparency) reinforce adoption motivation. Future investigation must thus differentiate between concern as avoidance and concern as awareness, and investigate the relationship between the concerns and behavioural intention which depends on the individual differences (e.g., experience, literacy, perceived value)

5.3.2 Practical implications

The implications of the results to managers who employ digital-twin marketing are as follows: to enhance purchase intention, the perceived risk has to be reduced actively. First,

privacy-by-design (data minimization, purpose limitation, strong security, limited retention, and controlled third-party sharing) practices should be embraced by the brands and conveyed in user-friendly language at the most important points of contact (sign-up, app permission screens, checkout), since the perception of risk and intention repression due to privacy issues. Second, companies ought to think of transparency as a conversion device, rather than compliance: make it very clear what information is gathered, why it is required, how the twin uses it to customize results, and what the customer benefits (accuracy, convenience, value). Make the use of layered notices (short summary + learn more), visual dashboards, and just-in-time notices easily available such that when the decision is made, the information is visible.

Third, offer the option to user control and turn trust into action: opt-in defaults, granular consent, easy opt-out, pause tracking, download/ delete data and preference centers. These decrease uncertainty and are indicative of fairness, which minimizes perceived risk. Fourth, enhance credibility by using independent cues: third-party auditing/certification, express GDPR-compliant messages where applicable, and conspicuous security signals (encryption, MFA), as well as rapid incident-response communication policies.

Since the relationships maintained between the countries (e.g., Lithuania, Germany, Pakistan) the firms are advised to adopt a global standard of privacy and transparency, and localize the examples, language, and support channels to the specific market, and its digital literacy and expectations. Lastly, KPIs that indicate this pathway should be monitored by teams: perceived-risk scores, opt-in rates, drop-off at consent screens, trust metrics, and purchase conversion, and A/B test transparency formats and control features should be tracked in order to determine what minimizes risk.

5.4 Future guidelines and limitations of the study

There are a number of limitations that this research would have had on the interpretation of the findings. First, the approach used in the research was cross-sectional, which means that it only captures perceptions at a specific point and fails to prove the actual cause-effect relationships and the change in perceived risk and transparency as consumers experience digital-twin services. Second, the data was based on self-reported questionnaire results, which may be influenced by common method bias, social desirability, and respondent interpretation of scale questions. Third, even though the respondents of various countries (Lithuania, Germany, Pakistan, etc.) were used in the study, the sampling method might still lack representative (e.g. more digitally active) participants, so the results can not be generalised to the whole range of consumer groups. Fourth, the model also prioritized the importance of key predictors (privacy concerns and transparency) but failed to incorporate other potentially significant effects like trust, perceived usefulness, brand reputation, previous

privacy experiences, or type of digital-twin application (health, retail, finance), which can moderate the relationships determined. One of the drawbacks is that the focal brand does not offer any digital-twin marketing implementation that can be observed today. Thus, the responses of the respondents can be based on attitudes to the concept of the digital twin marketing, but not to a confirmed brand practice. Future studies need to put the model to test in brands that have proven to use digital twin technologies or controlled experimental settings.

Future research needs to adopt longitudinal or experimental designs (e.g., manipulating transparency formats or consent controls) and test causality as well as observe how perceived risk changes with time. Researchers may elaborate on the model by incorporating trust, perceived value/usefulness, consumer innovativeness, regulatory awareness and brand credibility as mediators or moderators. Measurement invariance across countries should also be tested by comparative research to make sure that the constructs are perceived in the same manner in other cultures and languages. Moreover, new employment opportunities might divide the digital-twin contexts (e.g., fashion vs. healthcare) to investigate the sensitivity of risks that varies with data sensitivity and perceived impacts. Lastly, a mixture of survey data and behavioural variables (real opt-in rates, clicks on privacy notices, purchase history) and qualitative interviews could give deeper information and avoid the use of intention-only results.

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Appendix- A Questionnaire

Appendix- A Questionnaire

Dear Respondent,

This questionnaire is designed for the Master dissertation. I am going to survey to evaluate your data on the topic of *"Exploring Consumers' Perception of Digital Twin-based Marketing Communication: The role of privacy & transparency."* I request that you join my project by completing the following survey questionnaire. It may take around 3-5 minutes to complete the survey. However, I will use the research information for academic purposes. Additionally, I will keep your responses anonymous and confidential. Your support for my following research will help me conduct the study ideally. Thank you very much.

Section A: Socio-Economic

Characteristics

1: Gender

Female	Male
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2: Age

18-24	25-31	32-38	39-45	Above 45
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3: Education

A-levels	Bachelor	Master	Other
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4: Income (£ Month)

Up to 2500	2501-5000	5001-7500	7501-10000	Above 10000
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5: Marital status?

Single	Married
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6: Are you familiar with Siemen?

Very Familiar Familiar Slightly Familiar Not familiar

7. Have you ever used or purchased Siemen's Product?

Yes No Not Sure

8. Do you follow or interact with Siemen on Digital Platform on website, social media, virtual demons?

Yes No

9. Which country do you belong to?

Lithuania Germany Pakistan Other

SECTION- B

Perceived risk						
Sr. No	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	There is too much uncertainty associated with the digital twin-based service	5	4	3	2	1
2	Compared with other ways of making digital banking, I think that using the internet is riskier	5	4	3	2	1
3	I feel safe giving my personal details to a digital banking service using digital twin	5	4	3	2	1
4	I feel safe making digital twin-based banking service					

Purchase Intention						
Sr. No	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	I would intend to become an online shopper when seeing digital twin-based marketing	5	4	3	2	1
2	My willingness to become online shopper is great when I see digital twin-based marketing	5	4	3	2	1
3	I am willing to become an online shopper when seeing digital twin-based marketing	5	4	3	2	1
4	I have a high intention to become an online shopper when seeing digital twin-based marketing	5	4	3	2	1
5	The new time I am web browsing for a product, I planned to purchase online.	5	4	3	2	1

Transparency						
Sr. No	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	If I wanted to, I could easily find (digital twin) technology uses to shop the product	5	4	3	2	1
2	If I wanted to, I could easily find (digital twin) technology would be honest and sincere in addressing the issue	5	4	3	2	1
3	I believe there isn't anything to hide while using this technology	5	4	3	2	1
4	I can rely on using more technology to solve any problem while shopping	5	4	3	2	1
5	Using (digital twin) technology would make any effort to improve the quality of shopping.	5	4	3	2	1

Privacy concern						
Sr. No	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Consumer online privacy is really a matter of consumers' right to exercise control and autonomy over decisions about how their information is collected, used, and shared.	5	4	3	2	1
2	Consumer control of personal information lies at the heart of consumer privacy.	5	4	3	2	1
3	I believe that online privacy is invaded when control is lost or unwillingly reduced as a result of a marketing transaction.	5	4	3	2	1
4	Companies seeking information online should disclose the way the data is collected, processed, and used.	5	4	3	2	1
5	A reasonable consumer online privacy policy should have a clear and conspicuous disclosure.	5	4	3	2	1
6	It is essential to me that I am aware and knowledgeable about how my personal information will be used.	5	4	3	2	1
7	It usually bothers me when online companies ask me for personal information.	5	4	3	2	1
8	When online companies ask me for personal information, I sometimes think twice before providing it.	5	4	3	2	1
9	It bothers me to give personal information to so many online companies.	5	4	3	2	1
10	I'm concerned that online companies are collecting too much personal information about me	5	4	3	2	1