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Factors Influencing Industry 4.0 Technologies' Suitability for Adoption in Marketing Functions within the SMEs

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Management (S 003)

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Veiksniai, turintys įtakos 4.0 Pramonės revoliucijos technologijų įgalinimo tinkamumui rinkodaros veiklose smulkiose ir vidutinėse įmonėse

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MAIN TERMS USED IN THE DISSERTATION

Term in English	Lithuanian equivalent
4th Industrial Revolution, Industry 4.0	4-toji Pramonės Revoliucija, Pramonė 4.0
Small and Medium-sized enterprises, SMEs	Mažosios ir vidutinės įmonės, MVĮ
4Ps Marketing Mix model	4P Rinkodaros modelis
The Theory of Reasoned Action, TRA	Pagrįsto veiksmo teorija
The Theory of Planned Behaviour, TPB	Planuotos elgsenos teorija
Diffusion of Innovations Theory, DOI	Inovacijų difuzijos teorija
Technology Acceptance Model, TAM	Technologijų priėmimo modelis
Technology-Organisation-Environment framework, TOE	Technologinio, organizacinio ir aplinkos kontekstų visumos modelis
Perceived relative advantage of Industry 4.0 technology	Suvokiamas santykinis Pramonės 4.0 technologijos pranašumas
Perceived compatibility of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos suderinamumas
Perceived complexity of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos sudėtingumas
Perceived observability of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos pastebimumas
Perceived trialability of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos išbandomumas
Perceived usefulness of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos naudingumas
Perceived ease of use of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos naudojimo paprastumas
Top management support	Aukščiausios vadovybės palaikymas
Competitive environment	Konkurencinė aplinka
SME size	MVĮ dydis
Attitude towards Industry 4.0 technology suitability for adoption in marketing function within SMEs	Požiūris į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje mažoje ir vidutinėje įmonėje (MVĮ)
Behavioural intention to adopt Industry 4.0 technology in marketing function within SMEs	Ketinimas įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje mažoje ir vidutinėje įmonėje (MVĮ)

EXPLANATION OF THE MAIN TERMS USED IN THE DISSERTATION

Term in English	Lithuanian equivalent	Explanation of the term
4th Industrial Revolution, Industry 4.0	4-toji Pramonės Revoliucija, Pramonė 4.0	4th Industrial Revolution is the technological revolution, during which, the technologies like Artificial Intelligence (AI), Big Data, etc. are being enabled within the company, which leads to an increased interconnection (Schmidt et al., 2020).
Small and Medium-sized enterprises, SMEs	Mažosios ir vidutinės įmonės, MVĮ	SMEs include enterprises which employ less than 250 employees and have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million (European Commission, 2018).
Perceived Relative advantage of Industry 4.0 technology	Suvokiamas santykinis Pramonės 4.0 technologijos pranašumas	The degree to which the new technology is perceived as better than the idea it supersedes. Relative advantage results in an increased efficiency, economic benefits, and enhanced status (Rogers, 2003).
Perceived compatibility of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos suderinamumas	A level to which the new technology is consistent with the needs of consumer past experiences, existing sociocultural beliefs and values (Rogers, 2003).
Perceived complexity of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos sudėtingumas	The degree to which the new technology is perceived as relatively difficult to understand and use (Rogers, 2003).
Perceived observability of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos pastebimumas	The degree to which the results of the technology are visible to others (Rogers, 2003).
Perceived trialability of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos išbandomumas	The degree to which the technology may be experimented with on a limited basis. This may include trying out parts of a technology or having the opportunity to watch others using a new technology (Rogers, 2003).
Perceived usefulness of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos naudingumas	It is a user's subjective probability that using a specific technology will increase their job performance (Venkatesh & Davis, 1996).
Perceived ease of use of Industry 4.0 technology	Suvokiamas Pramonės 4.0 technologijos naudojimo paprastumas	Is the degree to which a user expects the target technology to be free of effort (Venkatesh & Davis, 1996).

INTRODUCTION

Relevance of the dissertation topic

The importance of the SMEs growth in the context of Global business expansion is tremendous, as these firms account for 99% of the total number of enterprises, contributing more than 50% of the total created value and employing more than 60% of the working-age population within the European Union (EU). However, the current business environment in which SMEs are operating is extremely dynamic. Although, after the challenging situation of the COVID-19 pandemic, SMEs had a significant turnaround within the second semester of 2021, and finished the total year with an even higher total value generated by +2.1% in comparison with the pre-pandemic level in 2019 (European Commission, 2022). In 2022, due to the rapid growth of the inflation ratio, SMEs' value added declined by 1.4% in 2022, and a stagnation period was predicted for 2023 (European Commission, 2023). In addition to that, recent studies estimate that the digitisation of products and services will add more than €110 billion of revenue for the industry per year in Europe during the next five years; however, the traditional sectors and SMEs operating in it are particularly lagging in their digital transformation, and this creates an additional challenge in the extremely competitive environment for the SMEs (Ministry of the Economy and Innovation of Lithuania, 2019).

The current rapid business digitalisation processes in the scientific and business-related literature are often referred as the *4th Industrial Revolution*, or *Industry 4.0*. Such terms were firstly mentioned and discussed in public at the Hannover Technology Fair in Germany in 2011. According to Brkljac and Sudarevic (2018), many technological breakthroughs, which have been achieved in the last few years, such as the *Internet of Things* (IoT), *Artificial Intelligence* (AI), *Augmented Manufacturing* (AM), etc. are the main enablers of this revolution, and their strong influence is especially noticeable in the manufacturing industry. According to multiple recent researches (Młody, 2018; Saniuk et al., 2020; Yadav et al., 2020; Schmidt et al., 2020; Fathi & Ghobakhloo, 2020), the 4th Industrial Revolution massively reshapes various aspects of the micro and macro level business environment. It largely affects the competitiveness of the economy, forms new types of cooperation structures between the industry players, and impacts the emergence of new forms of business models as well as their subsequent adoption within separate business units. Consequently, Industry 4.0 provides opportunities to create value and meet customer expectations in terms of innovation, personalisation, and rapid market introduction.

Therefore, for SMEs, it is highly important to have a guidance in finding a proper strategy to enable the Industry 4.0 principles. Ibarra et al. (2018) suggest four ways of conducting digital transformation in companies according to the innovation degree applied. Meanwhile, Mittal et al. (2018) concluded that most of the roadmaps, frameworks and maturity models towards Industry 4.0 enablement identified in the currently available literature assume that the companies already have an access to the necessary resources, such as advanced and connected machines and IT-integrated systems. However, as some companies can carry out a comparatively smooth technological revolution in their environment – while others undergo very slow evolutionary processes (Da Silva et al., 2019). Governments of the countries take note of Industry 4.0 implementation challenges particularly within SMEs, and pursue strategic analysis about how the public sector would be able to help SMEs stay competitive in the context of Industry 4.0. Consequently, some strategic initiatives have already emerged across the World, including *Industry 4.0* in Germany, *Industry of the Future* in France, *Smart Manufacturing* in the United States, *Internet +* in China, *DigitaliseSME* and *Digital Europe* within the European Union countries (Moeuf et al., 2017). In this context, Lithuania is not lagging behind. Lithuania elaborates on the new initiative, called *Lithuanian Industry Digitisation RoadMap 2019–2030*, whose main goal is to ensure the global competitiveness of the Lithuanian business, while digitalising SMEs (Ministry of the Economy and Innovation of Lithuania, 2019). Nonetheless, the *Annual Report on European SMEs 2020/2021* shows that much more remains to be done within the EU. For instance, the level of digitalisation varies markedly across the SME size class, whereas a significant proportion of SMEs, especially micro SMEs, are of the opinion that digitalisation is not useful or necessary for them, or else they believe that the assumed costs outweigh the expected benefits (European Commission, 2021).

Scientific novelty of the dissertation research

In recent years, the interest of scholars researching the Industry 4.0 impact on SMEs has been increasing, and the currently available researches support the claim that the Industry 4.0 impact is noticeable not only within manufacturing-related business. For instance, Cagle et al. (2020) highlighted the importance of each business function regarding the Industry 4.0. implementation within the firm. Pranjić and Rekettye (2019) state that Industry 4.0-related technological changes enable an absolute breakthrough in the marketing philosophy – to identify, predict, and even influence the

behaviour of the consumer. The spread of the Industry 4.0 technologies is a significant opportunity for companies to enable the newest marketing tools and customer-oriented approaches to reach audiences that were previously only available to large companies. Consequently, new sales promotion methods, such as gamification, improvements in product packaging, or the new use of media have been rising (Ungerman & Dědková, 2019). Accordingly, Guven (2020) states that the demands and needs of consumers have also changed, and, in order to respond to all these requests, businesses must adopt a consumer-oriented approach instead of the product-oriented approach in all the marketing mix elements.

To define the marketing functions within the SMEs, one of the most influential Marketing Mix models – the *4Ps Model*, which was suggested by McCarthy in 1960, can be used. This model includes the product, the price, the place, and the promotion marketing functions. Over the years, various authors proposed additional variables to extend the Marketing Mix model, for example, Booms and Bitner (1981) extended the model by adding further variables, such as participants, physical evidence, and process, to the original set of 4Ps to apply the marketing mix concept to the service industry. According to Goi (2009), the Marketing mix used by a particular firm varies according to its resources, market conditions, and the changing needs of its clients. Consequently, when emphasising the importance of Industry 4.0 technologies and the changing environment of SMEs, it is crucial to investigate the key factors of the adoption suitability of such technologies within the firms' marketing functions. However, most of the current studies related to Industry 4.0 are concentrated on the implementation possibilities of specific technologies (Guo et al., 2020), roadmaps for the Industry 4.0 principles implementation within manufacturing SMEs (Erol et al., 2016; Ibarra et al., 2018) or discussing possibilities on how the 4th Industrial Revolution could change the SMEs business models and act as an enabler for more sustainable production (Prause, 2015).

Moreover, it is worth observing that the most commonly used theoretical frameworks in the researched studies include the *Diffusion of Innovations Theory* (DOI) (Rogers, 1962), the *Technology Acceptance Model* (TAM) (Davis et al., 1989), the *Technology-Organisation-Environment Framework* (TOE) (Tornatzky & Fleischer, 1990), followed by the *Unified Theory of Acceptance and Use of Technology* (UTAUT) developed by Venkatesh et al. (2003), as well as various combinations of the presently mentioned models, such as TOE+DOI, etc. However, it is crucial to emphasise that, within small and medium-sized enterprises (SMEs), the decision-making role of the owner/manager is particularly significant (Gilmore et al., 2001;

Walsh & Lipinski, 2009; Resnick et al., 2016). Consequently, when investigating the suitability of Industry 4.0 technologies for adoption in marketing functions within SMEs, additional attention must be directed towards the individual behavioural aspects of the SMEs managers. Management-related theoretical frameworks, such as the *Agency Theory* (Berle & Means, 1932; Ross, 1973; Jensen & Meckling, 1976), the *Stewardship Theory* (Davis et al., 1997), and the *Upper Echelons Theory* (Hambrick & Mason, 1984) primarily focus on the managerial decision-making processes within organisations. However, these frameworks are often more applicable to the behaviour of large corporations. Thus, next to the presently mentioned theoretical frameworks, such as TAM, DOI and TOE, this study aims to concentrate on the behavioural aspects of the individual SME owner/manager through the lens of the *Theory of Planned Behaviour* (Ajzen, 1985), seeking to uncover novel insights into the adoption process of the Industry 4.0 technologies in marketing functions within SMEs.

Current level of scientific research on the dissertation topic

After a detailed analysis of the scientific literature, it was established that there are only a few scientific studies in which the factors of the Industry 4.0 technologies' adoption suitability within the SMEs business functions are investigated (Prause, 2019; Eze et al., 2019; Nair et al., 2019; Maroufkhani, 2020). Analysis conducted by Calabrese et al. (2020) demonstrated that large firms adopt the Industry 4.0-derived technologies because of internal motivation(s), i.e., motivations arising from the expectation of improvements in the internal activities, meanwhile SMEs feel motivated toward Industry 4.0 adoption because of both the demand from large customers and their own internal motivations. Additionally, for a company to acquire the characteristics of Industry 4.0, it is indispensable to meet the technological requirements, whereas also some other requirements are applicable as well, such as: strategy, leadership, organisational culture, products, operations, and people (Da Silva et al., 2019).

Nonetheless, till now, a research gap is notable regarding the main drivers influencing the intention to adopt the Industry 4.0-enabled technologies in marketing functions within SMEs. Therefore, **the research problem** of this study is: *What are the main factors influencing the suitability of Industry 4.0 technologies for adoption in marketing functions within the SMEs*?

Object of the dissertation

Considering the analysis of the scientific literature and the identified knowledge gaps, the dissertation research focuses on the analysis of the factors influencing the suitability of Industry 4.0 technologies for adoption in marketing functions within the SMEs.

The central figure of the research is the SMEs manager/owner perception towards the suitability of Industry 4.0 technologies for the adoption in marketing functions within SMEs. Analysis of the factors of the *Theory of Planned Behaviour*, the *Diffusion of Innovations Theory*, and the *Technology Acceptance Model* aims to answer the question of how the perceived characteristics of the Industry 4.0 technology (the perceived relative advantage, the perceived compatibility, the perceived complexity, the perceived observability, and the perceived trialability), the technology acceptance model factors (the perceived usefulness and the perceived ease of use of the Industry 4.0 technology) and the SMEs manager behaviour-related factor (attitude towards the Industry 4.0 technology suitability for adoption in marketing functions) affect the intention to adopt the Industry 4.0 technologies in marketing functions within SMEs. Moreover, this study also explores the moderation effect of the TOE framework factors (the SME size, its top management support, as well as the competitive environment), along with some additional elements, such as the type of the Industry 4.0 technology (universal vs. niche) and the type of the marketing function (product, price, place, and promotion).

In the opinion of the author of the dissertation, answering the raised research question would fill the knowledge gaps currently detected in the scientific literature and reveal how the selected factors influence the decision of SMEs to adopt Industry 4.0 technologies in the marketing functions. The results of this study aim to determine the integrity (combination) of four theories – the *Diffusion of Innovations Theory*, the *Technology Acceptance Model*, the *Theory of Planned Behaviour*, and the *Technology-Organisation-Environment Framework* (TOE).

The aim and the objectives of the dissertation

The **aim** of the study – to investigate the factors influencing the suitability of Industry 4.0 technologies for adoption in marketing functions within the SMEs.

The **objectives** of this research are:

1. To analyse the fundamental principles of the Industry 4.0 phenomenon and their relation to the business functions of SMEs.
2. To conduct a descriptive analysis of the Industry 4.0-derived technologies which can be applied across different marketing functions in SMEs.
3. Based on the analysis of the scientific literature sources, to identify the key factors that influence the suitability of Industry 4.0-derived technologies for adoption in marketing functions within SMEs.
4. To explore the theoretical frameworks of the technology adoption as documented in the scientific literature sources, and to develop the research methodology.
5. To employ the qualitative research methods to identify the universal and niche Industry 4.0 technologies suitable for adoption across four marketing functions within Lithuanian SMEs.
6. To utilise quantitative research methods to examine the impact of the selected factors on the suitability of the niche and universal Industry 4.0 technologies for adoption across four marketing functions within Lithuanian SMEs.
7. To provide the conclusions and recommendations for scientists and practitioners.

Research methodology and data analysis methods

The literature used in this study consists of the scientific publications in the field of Industry 4.0, emphasising the importance of changes to the marketing functions within SMEs. To answer the study's questions, a systematic literature analysis method was applied; also, both qualitative and quantitative research was conducted. Qualitative research analysis consisted of semi-structured interviews which were carried out in the third quarter of 2023. Eleven selected SMEs C-Level Executives participated in the semi-structured interviews, which helped to identify the most universal and niche technologies of Industry 4.0 suitable for the adoption in marketing functions within Lithuanian SMEs. The purpose of the quantitative research study was to test the hypotheses about the suitability of the selected universal and niche Industry 4.0 technologies for adoption in four marketing functions within Lithuanian SMEs. In the first quarter of 2024, a quantitative research study was undertaken, with data acquisition performed by the market research organisation *Rinkos Tyrimų Centras* [en. Market Research Center]. A total of 241 respondents took part in the survey. All of them were responsible for

marketing-related decision making within SMEs, and the majority of them had more than five years of work experience in their present position.

Statements to be defended in the thesis:

1. Industry 4.0 technologies can be categorised in two groups by their adoption suitability in marketing functions within SMEs. Industry 4.0 technologies, such as Artificial Intelligence and Big Data, can be referred to as the universal Industry 4.0 technologies (suitable for adoption in a wide group of marketing functions), meanwhile such Industry 4.0 technologies as 3D printing or Chatbots can be considered as niche Industry 4.0 technologies.
2. The greatest variety of Industry 4.0 technologies can be adopted in the product marketing function within SMEs, out of the four marketing functions (product, price, place, and promotion).
3. The perceived characteristics of the Industry 4.0 technology in different manner impact the perceived usefulness and the perceived ease of use. While the perceived compatibility positively impacts both variables, the perceived usefulness is also positively impacted by the perceived relative advantage and the perceived trialability. Meanwhile, the perceived ease of use is positively impacted by the perceived observability and is negatively impacted by the perceived complexity.
4. The perceived ease of use mediates the impact of the perceived usefulness on the attitude towards the suitability of the Industry 4.0 technology for adoption in the marketing function within SMEs.
5. Marketing functions (product, price, place, and promotion) and Industry 4.0 technologies (universal and niche) do not moderate the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.
6. Top management support positively moderates the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.

Structure of the dissertation

The dissertation consists of an introduction, a chapter of theoretical analysis, research methodology, qualitative and quantitative empirical research data analysis, conclusions, limitations, recommendations for the scientific community and practitioners, and appendices.

The theoretical analysis chapter is divided into three parts. The first part examines the core principles of Industry 4.0 and its associated technologies. The second part focuses on identifying the marketing functions using Marketing Mix models, such as the 4Ps and 7Ps frameworks, and analyses various potential applications of the Industry 4.0 technologies within marketing functions. The third part discusses theoretical frameworks, such as TAM, TPB, DOI and TOE, which are utilised to explore the factors influencing the intention to adopt the Industry 4.0 technologies in the marketing functions within SMEs. This section delves into the key factor groups, i.e., technology-specific factors, managerial behaviour-related factors, firm-specific factors, resource-based factors, and external factors.

The second chapter outlines the research methodology. It includes the development of the research model, the formulation of hypotheses, the design of the qualitative and quantitative research, and a discussion of the data collection instruments (constructs and questionnaires).

In the third chapter, the results of the qualitative research stage are presented. This chapter highlights the main business functions, in which the widest group of Industry 4.0 technologies can be applied, while also revealing the ratings results produced by C-level Executives of SMEs of fourteen pre-selected Industry 4.0 technologies, thereby highlighting their application suitability in the marketing functions within SMEs.

In the fourth chapter of the dissertation, the results of the quantitative research stage are presented. This chapter introduces the results of the data analysis of the empirical study, i.e., the demographic characteristics of the respondents, factor analysis, the reliability of the scales used in the study, and it also reveals the results of the hypotheses testing while employing correlation, regression, mediation, and moderation analysis. The chapter is concluded with a scientific discussion of both qualitative and quantitative research analysis.

The dissertation ends with conclusions, limitations, recommendations for the scientific community as well as for the practitioners, a list of references, and appendices.

The dissertation contains 13 figures, 74 tables and a bibliography consisting of 175 sources.

1. THEORETICAL ANALYSIS OF THE IMPACT OF INDUSTRY 4.0 TECHNOLOGIES TOWARDS SMEs MARKETING FUNCTIONS

1.1. The Main Principles and Derived Technologies of Industry 4.0

The 4th Industrial Revolution can be described as the technological revolution during which a strong emphasis is put on the digitalisation processes within the company, which leads to an increased interconnection inside and outside of the company (Schmidt et al., 2020). Balmer and Yen (2017) emphasise that, historically, three industrial revolutions already happened which, till now, have been exerting a strong influence on different business processes, such as the way the products are being manufactured, delivered, and consumed. The first Industrial Revolution (Industry 1.0) took place at the end of the eighteenth century and involved the introduction of the steam machine in mechanical production systems. The beginning of Industry 2.0 started at the end of the nineteenth century and is associated with the emergence of mass production systems based on the use of electricity. Meanwhile, the third phase (Industry 3.0) started at the end of the 1960s and was derived because of the usage of electronics and Information Technology systems in the process of further automation of production (Wielki & Koziol, 2019).

According to Bettiol et al. (2017), the main difference between Industry 4.0 in comparison with the previous Industrial Revolutions is the ability to involve the customers in the manufacturing processes. This is achieved by combining the real and the virtual worlds, including the interaction between objects and people, which leads to the improved efficiency of production and other business processes (Balmer & Yen, 2017; Sima et al., 2020). Additionally, according to Nakayama et al. (2020), Industry 4.0 helps to achieve not only the efficiency of the business processes, but also the flexibility and agility within the company. The same authors also identify eight potential sub-goals for Industry 4.0 implementation:

- Meeting individual customer requirements (*Flexibility and Agility*);
- Flexibility (*Flexibility*);
- Optimised decision-making (*Efficiency*);
- Resource productivity and efficiency (*Efficiency and Agility*);
- Creating value opportunities through new services (*Flexibility*);
- Responding to demographic change in the workplace (*Agility and Flexibility*);

- Work-life-balance (*Flexibility and Efficiency*);
- A high-wage economy that is still competitive (*Efficiency*).

As the key instrument of Industry 4.0 implementation within firms is the enablement of various technologies, it is important to analyse such technologies. Based on the conducted literature analysis, Industry 4.0 technologies can be categorised into seven different groups, such as network technologies, cybersecurity technologies, data analytics technologies, sharing technologies, smart work technologies, computing technologies, and production line technologies which are supporting the transition from the traditional manufacturing towards Industry 4.0. The description of such technologies is presented in Table No. 1.

Table 1. Key technologies of Industry 4.0

TECHNOLOGIES	DESCRIPTION
NETWORK TECHNOLOGIES Internet of Things (IoT), Internet of Services (IoS)	• Internet of Things (IoT) is the core technology for connecting objects and devices in manufacturing systems allowing communication and cooperation. It uses devices and sensors, which, through centralised controllers, communicate the information about equipment, components, products, etc. both in the company and throughout the supply chain. • The Internet of Services (IoS) technology is oriented towards establishing a direct link between the product consumers and manufacturers, through supplementary services.
CYBER SECURITY TECHNOLOGIES Cyber Physical Systems (CPS)	• Cyber-physical systems control and protect processes and systems which operate on the Internet, recognise changes and vulnerabilities, and verify that whoever has access to the system is an authorised user.
DATA ANALYTICS TECHNOLOGIES Big data	• Big data analysis refers to the tendency observed in communications and information technologies, which is to process a large amount of data to make a more efficient decision-making process and increase the productivity.
SHARING TECHNOLOGIES Cloud computing, Cloud manufacturing	• Cloud solutions allow access to software and data storage in the cloud representation of the Internet. The usage of cloud solutions opens up opportunities for productivity growth and cost optimisation as business units can share information among different

TECHNOLOGIES	DESCRIPTION
	branches of the company and quickly respond to it from anywhere in the world, by using Internet.
SMART WORK TECHNOLOGIES Artificial Intelligence, Augmented Reality, Virtual reality, Smart glasses	• Artificial Intelligence provides key technologies for Industry 4.0 system solutions. These are the principles of organisation, management, and decision-making as well as procedures to integrate autonomous systems. • Virtual reality allows the user to find oneself in a simulated environment associated with user interaction. Virtual reality creates the illusion of a real world or a fictional world. • Augmented reality uses intelligent devices in which the physical reality is combined with virtual elements. Current applications are focused on smartphones and tablets that enable visualisation of virtual tours, composing product groups, etc.
COMPUTING TECHNOLOGIES Simulation, Digital twin	• Simulation is the process of creating and designing a real or imaginary system by using physical or mathematical models. It is considered as the best option for saving time and resources as it helps to evaluate and predict the system behaviour, to test the effectiveness of the changes, and to identify the flaws of the system.
PRODUCTION LINE TECHNOLOGIES Additive manufacturing, 3D, Robots	• Additive manufacturing makes it possible to produce diverse parts of the product without the need for lengthy programming preparation. This process is advanced by the creation of prototypes which goes hand-in-hand with the use of intelligent machinery and 3D printing solutions. • Robots are machines developed to perform specific tasks autonomously or by using remote-control commands. It is closely related to the levels of automation that the company possesses because robots increase the level of efficiency of the production lines and, to some extent, optimise the system.

Source: *created by the author based on* (Saucedo-Martínez et al., 2018; Cimini et al., 2017; Brkljac & Sudarevic, 2018; Młody, 2018; Da Silva et al., 2019; Ćoćkalo et al., 2019; Ungerman & Dědková, 2019; Saniuk et al., 2020; Calabrese et al., 2020)

It must be noted that one of the most emphasised technologies of Industry 4.0 in the researched literature was the Internet of Things (IoT). Miskiewicz (2020) observes that machine-to-machine communication within the companies allows expanding the opportunities for data collection, processing, and distribution, which could be transferred into information or knowledge, and it also creates the base for the Industry 4.0 implementation. In practice, enterprises use IoT both in manufacturing and in supplying the production lines (Ungerman & Dědková, 2019). Balmer and Yen (2017) emphasise the IoT importance in the context of the marketing business function. According to the authors, by attending to customers' needs before their recognition, IoT provides businesses with competitive advantages to increase the customer satisfaction and confers a positive image, as it helps to analyse previous customers' behavioural data concerning the product, brand, or corporate relationships. Additionally, Da Silva et al. (2019) in their study mention other supporting technologies associated with the Industry 4.0 implementation, such as advanced traceability systems, real-time location systems, cognitive computing, streamlined logistics, smart solutions, smart innovation, a smart supply chain, etc., hence, it can be concluded that some of the presently mentioned Industry 4.0 technologies can be used broadly, while others are more narrowly specialised for clearly defined business activities (Ćoćkalo et al., 2019).

It is worth remarking that the enablement of Industry 4.0 technologies has an impact on different areas of the economy and business processes. This revolution massively reshapes various aspects of the macro-level business environment and offers new opportunities – it affects the competitiveness of the economy, forms new types of cooperation structures between the industry players and impacts the emergence of new forms of business models and their adoption. Also, Sima et al. (2020) note that customer behaviour will be different, with them being significantly more involved in the act of buying and selling. Consequently, such changes may be challenging for some companies as some of the industries and companies lack the know-how and exchange of experience to be fully integrated into new clusters; also, the required changes in labour competencies influence the position of companies in the market. As new jobs are bound to replace the traditional roles, the workforce must be qualified to adapt to the effects of the Industry 4.0 technologies introduction because of transforming the role of employees from being *operators* to being *problem solvers*. According to Halse and Jaeger (2019), leveraging the advantages of new technologies within the concept of Industry 4.0 is seen as an important factor to maintain competition for companies. Based on various

authors' studies (Młody, 2018; Saniuk et al., 2020; Yadav et al., 2020; Schmidt et al., 2020; Fathi & Ghobakhloo, 2020), the identified opportunities and challenges for the business environment regarding technological changes are listed in Table No. 2.

Table 2. Changes in ecosystems due to Industry 4.0-enabled technologies

INFLUENCED AREA		OPPORTUNITIES / CHALLENGES & THREATS
ECONOMY AND MARKET	**OPPORTUNITIES**	1.Reindustrialisation/inhibition of the offshoring trend; 2.Competitiveness of the economy based on aspects other than cost advantage; 3.Partial elimination of problems with labour supply; 4.Elimination of institutional barriers (including bureaucracy, tax system); 5.Elimination of the competency gap.
	CHALLENGES & THREATS	1.Investment/incentive financing; 2.Institutional support; 3.Technological unemployment; 4.Risk of non-return on investment (public); 5.Problems with full technology implementation; 6.Regulation at the supranational level; 7.Lack of social acceptance.
INDUSTRY	**OPPORTUNITIES**	1.Creation of clusters (i.e., information technology firms becoming an integral part) and improvement of the competitive position; 2.Shifting free labour to labour-intensive industries.
	CHALLENGES & THREATS	1.Lack of solutions at the level of industries, including institutional support; 2.Problems with the flow of knowledge, know-how and exchange of experience; 3.Infrastructure integration; 4.Risk of overinvestment due to a strong competitive fight; 5.Cannibalism between industries, resulting in excessive business diversification;

INFLUENCED AREA		OPPORTUNITIES / CHALLENGES & THREATS
		6.The need to search for new cooperation opportunities and cyber networks; 7.Companies face increasing market dynamics, while new markets are developing.
BUSINESS UNIT	**OPPORTUNITIES**	1.Based on a comprehensive usage of data, novel forms of business models emerge (Service-oriented and Service-dominant); 2.Realignment of strategies and transformation of whole companies, and the establishment of new departments; 3.Collaborative working conditions (collaboration between humans and machines); 4.Enabling more customer-oriented and sustainable business processes; 5.Improvement of the competitive position of SMEs (subject to availability of technology).
	CHALLENGES & THREATS	1.Novel forms of business models that are emerging might lead to the elimination of the traditional products; 2.Changes regarding human factors – new competences and qualifications are required; 3.Privacy issues and sharing data with external stakeholders; 4.Investment in infrastructures for machines connections, digital solutions.

Source: *created by the author based on* (Cimini et al., 2017; Młody, 2018; Saniuk et al., 2020; Yadav et al., 2020; Schmidt et al., 2020; Fathi & Ghobakhloo, 2020)

Moreover, Rüßmann et al. (2015) conclude that Industries and countries will embrace Industry 4.0 at different rates and in different ways. Industries with a high level of product variants, such as the automotive and food-and-beverage industries, will benefit from a greater degree of flexibility that can generate productivity gains, whereas those industries which demand high quality, such as semiconductors and pharmaceuticals, will benefit from data-analytics-driven improvements that reduce the error rates. Countries with high-cost skilled labour will be able to capitalise on the higher degree of

automation combined with the increased demand for more highly skilled labour. However, many emerging markets with a young, technology-savvy workforce might also jump at the opportunity and might even create entirely new manufacturing concepts.

To sum up, Industry 4.0 can be described as a complex technological system which combines digital manufacturing, network communication and integration systems inside and outside the companies, and the technological advances are the base of the Industry 4.0 implementation. However, for some businesses, the challenge of changing the way they are operating is not an easy task. Cimini et al. (2017) state that the implementation of Industry 4.0 concepts requires not only implementing the new technology and infrastructure, but tactually the adoption of a completely different organisational structure and a set of processes that are different from those found in the traditional SMEs. Accordingly, further analysis is dedicated to the Industry 4.0 implementation aspects within SMEs.

1.2. Industry 4.0's impact on SMEs Business Models and Management Changes

The official definition of the SME considers three different factors: the level of its employment, the level of turnover, and the size of the balance sheet. Henceforth, SMEs may be defined as enterprises which employ less than 250 employees and have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million (European Commission, 2018). Recognising the changes of Industry 4.0, small organisations are becoming increasingly proactive in improving their business operations and transforming their business models (Rauch et al., 2018; Młody, 2018; Ungerman & Dědková, 2019; Sima et al., 2020).

As the business strategy of SMEs is often based on flexibility, reactivity, and customer proximity, the Industry 4.0 concept appears appealing concerning potentially providing a more streamlined flow of information and thus better planning and control processes (Moeuf et al., 2017). From the perspective of strategic management, a business model is considered as a set of activities that companies use to create and capture value in an enterprise. The business model is based on the logic of value creation for all stakeholders and the consideration of the key value-creating activities that are also carried out by external entities concerning the enterprise (Młody, 2018). Brkljac and Sudarevic (2018) state that, in the context of Industry 4.0, the scope of the business models' elements changes will depend not only on the technology

used, but also on the pace of their implementation and the acceptance of changes by the internal environment and the external environment of the companies.

Various authors (Młody, 2018; Saniuk et al., 2020; Yadav et al., 2020) identify potential opportunities for the business models' changes due to the new technological implementations of Industry 4.0. According to Brkljac and Sudarevic (2018), the value proposition in Industry 4.0 business models is highly affected by customisation possibilities. Through digital platforms, companies can cooperate with customers and offer them the most suitable products. Such a co-creation strategy improves a customer's experience and their overall satisfaction. Hybrid service bundles are also part of the value offerings (Schmidt et al., 2020). On the side of value creation, Industry 4.0 implies the cooperation of manufacturing companies within the industry, enabling resource sharing and data-driven decision-making processes. According to Młody (2018), each element of the value chain can be impacted due to Industry 4.0., i.e., product development might be improved while using simulation processes or 3D product models, whereas, for better sales and marketing process, big data solutions, integration of customer intelligence, digital marketing and e-commerce solutions might be used. Value delivery combines a unique product proposition for the customers and the possibility of the sales channel diversification. Schmidt et al. (2020) state that Industry 4.0 implementation must be closely aligned to industrial ecosystems, as many core technologies depend on or enable interconnection leading to the capture of an optimised value.

The main characteristics of changes in individual areas of the SMEs business models in the context of Industry 4.0 implementation are presented in Table No. 3.

Table 3. Potential changes in SMEs business models due to the implementation of Industry 4.0 technologies

VALUE	DESCRIPTION
Value proposition	**Unique offerings:** • Highly personalised products and high added-value products; • Product-service hybrids & Modular and configurable products. **Drivers of customer value:** • New service based on acquired data and information; • Combining existing services and web services of other enterprises; • Comprehensive service, concentration on the end customer.

VALUE	DESCRIPTION
Value creation	**Resources & capabilities:** • Sharing of manufacturing resources; • Shortening the implementation time of new employees (simulations/virtual reality); • New jobs with high added value focused on automation, IT and human-machine interfaces; • Improvement of work safety (dangerous work will be done by devices or robots). **Processes:** • Individual, customer-specific criteria will be included in all stages of the manufacturing process; • Improvement of the responsiveness and decision-making, improved product development; • Increase in productivity by shortening the production time of products, a decrease in the equipment failure rate, limitation of product storage, etc.; • Improved integration and collaboration & Connection of machine to machine (internal processes); • Data-driven decision-making, big data collection and a close relationship with the clients. **Value networks:** • Horizontal and vertical integration: more efficient production, logistics, quality control, inventory management; • Business infrastructure combined with the infrastructure of partners.
Value delivery	**Target market segments:** • A more flexible offer based on the individualisation of production; • Co-creation of products, smart products & access to new customer segments; • Knowledge about the real needs of clients acquired because of personalised marketing; • More direct contact with the client. **Distribution channels:** • Diversification of sales channels (digital sales); • The possibility of additional earnings by renting free resources, i.e., cars, designer clothing.
Value capture	**Cost structure:** • Cost optimisation (efficient processes, production time reduction);

VALUE	DESCRIPTION
	• Diversification of costs and risks due to innovative revenue structures and reduction of production errors and waste. **Revenue model and profit allocation:** • New revenue streams (pay-per-use, dynamic pricing) & improvement of flexibility and quality; • Real-time information and improved secure information sharing and collaboration; • Increased productivity and profitability to gain competitive advantage; • Agility in manufacturing (quickness of response in all manufacturing related process(es)); • Possibility to improve the work-and-life balance through remote work; • Increased compliance with sustainability guidelines and higher capacity for innovation; • Improved management and planning processes and increased integration among businesses.

Source: *created by the author based on* (Młody, 2018; Da Silva et al., 2019; Botha, 2019; Saniuk et al., 2020; Yadav et al., 2020; Calabrese et al., 2020; Arromba, 2021)

However, as Industry 4.0 requires people with completely new competencies and skills (flexibility, IT competencies, analytical skills), rapid business process transformation of manufacturers might be not entirely possible (Młody, 2018). Also, Nakayama et al. (2020) state that basic technologies, such as IoT and IoS, which comprise the Industry 4.0 infrastructure, are not ready and are not yet fully integrated into the companies. Sima et al. (2020) state that, so far, Industry 4.0 adoption appears to be more successful in large-scale organisations than in SMEs. Additionally, for a company to acquire the characteristics of Industry 4.0, it is indispensable to meet the technological requirements, but other requirements are needed as well. Accordingly, Da Silva et al. (2019) identify the main managerial requirements for the successful implementation of Industry 4.0 which are noted in Table No. 4:

Table 4. Requirements for company management for Industry 4.0 implementation

NECESSARY ACTION	REQUIREMENTS FOR MANAGEMENT
Understanding	Managers need to deeply understand the different elements of Industry 4.0 and gain the required knowledge and skills for successful implementation.

NECESSARY ACTION	REQUIREMENTS FOR MANAGEMENT
Diagnosis	Managers need to understand and evaluate the current state of the technological and managerial maturity of their company.
Planning	Managers need to define and analyse different managerial strategies according to which they will make the business decisions and plan the implementation actions concerning the scope of Industry 4.0.
Execution	Managers need to set up pilot projects, configure collaborative networks, define the internal application of the business model, reconfigure human work, define the corporate strategy as Industry 4.0 triggers organisational and cultural changes; also, the company must understand the customer's needs and utilise digital technologies for creating and delivering value to them.

Source: *created by the author based on* (Da Silva et al., 2019)

Also, Ibarra et al. (2018) conclude that the main requirements to face digital transformation for SMEs are standardisation, work organisation, availability of products, new Business Models, know-how protection, availability of skilled workforce, research investment, professional development and legal frameworks. Even though the full implementation of the Industry 4.0 platform is still distant, it is important to depict the size and the main issues of that change, which could mean a different arrangement of the production and manufacturing platform, while pointing to disrupting new business models, production processes, development of intelligent technologies and new curriculum designs in academic programs (Saucedo-Martínez et al., 2018; Nakayama et al., 2020).

Halse and Jaeger (2019) in their study identify the costs associated with the investment in new technology as the most important barrier to implementing Industry 4.0. Meanwhile, according to Cimini et al. (2017), the main challenge faced by smaller companies is the alignment of their business strategy with the vision proposed by the smart manufacturing paradigm as it requires a deep understanding of the concepts as well as a clear idea of the aims each company wants to achieve while exploiting new technologies. The authors also suggest that some barriers depend on the companies' business models and their positioning in the supply chain. Młody (2018) identifies another important barrier due to the Industry 4.0 implementation for SMEs,

specifically, the resistance to change and the lack of understanding of technological transformation among customers. In Table No. 5, there is a summary of the main identified barriers regarding Industry 4.0 implementation in the researched literature.

Table 5. Barriers of Industry 4.0 implementation

CATEGORY	BARRIER DESCRIPTION
Governmental and Legal	• Lack of governmental regulation and policies; • Flaws in the legal regulatory framework threaten adoption of the 4th paradigm of the industry, regarding corporate data ownership or protection, as well as the liability at stake.
Financial	• Need for high financial investments; • Increasing expenditure on R&D; • Uncertainties regarding the measurement of return of investments; • The high cost of security and protection of databases.
Technological	• The poor technological infrastructure of the companies; • The complexity of the technologies; • Management of new technologies, provision of immature technologies; • Challenges for data and information management in the supply chain.
Data Security	• The systems of Industry 4.0 are vulnerable to cyber-attacks.
Organisational	• Lack of multidisciplinary practical knowledge; • Lack of methodological procedures for adopting the concept of Industry 4.0; • Lack of understanding of the concept, practice, and actions; • Lack of understanding of the potential benefits stemming from the collaboration between partners; • Responsibility of HR departments (modification of the corporate culture); • The increased level of integration and data exchange will lead to an increase in the complexity of business processes; • Simultaneous management of multiple teams and people.
Market-customer oriented	• Meeting customers' new demands and requirements which are constantly rising; • Uncontrolled disclosure of preferences by the customer might threaten his anonymity;

CATEGORY	BARRIER DESCRIPTION
	• Crossing the border between sales persuasion and surveillance; • Customisation may take it difficult for the customer to make a purchase decision (companies compete in the scope of the offer, hence the selection of this specific product may be difficult).
Human capital	• Internal resistance to organisational changes; • Lack of skilled labour (knowledge, experience); • Risk of losing a job (especially in the case of performing physical work or not requiring many operations); • Temporary employment forms, virtual work, teleworking, which, in turn, can lead to the loosening of the bonds in the employer-employee system.

Source: *created by the author based on* (Młody, 2018; Da Silva et al., 2019; Halse & Jaeger, 2019; Calabrese et al., 2020; Sima et al., 2020)

Ulas (2019) analysed the linkage between the digital transformation process and SMEs. Obstacles in adopting of digital transformation are budget deficiencies of SMEs, impossibility of investment due to high operational costs, inability to understand the technologies, various inconvenience(s) manifested in a specific sector, data security, privacy concerns, technological developments, insufficient information regarding digital standards, being unaware of the benefits of digitisation, having connection problems and the lack of qualified employment. In general, it can be stated that the smaller the SMEs are, the greater is the risk that they will not be able to benefit from this revolution. In addition to it, according to authors (Moeuf et al., 2017), most SMEs also have a short-term strategy, which prevents significant long-term investments, whereas these are important in the context of Industry 4.0. In addition, there is a lack of expert support functions in SMEs, such as the supply chain management, information technologies, or financial management.

Consequently, to cope with the challenges imposed by Industry 4.0 and to transform the business model of the SMEs, it is important to evaluate in which stage of Industry 4.0 the specific company currently finds itself. Müller et al. (2018) state that SMEs follow different response strategies to Industry 4.0. and suggest that many large companies act as suppliers to SMEs and have SMEs as suppliers. Their actions affect the actions of their smaller supply chain partners, and their requirements influence the positioning of SMEs towards the technological developments derived from Industry 4.0. The study results are shown in Figure No. 1.

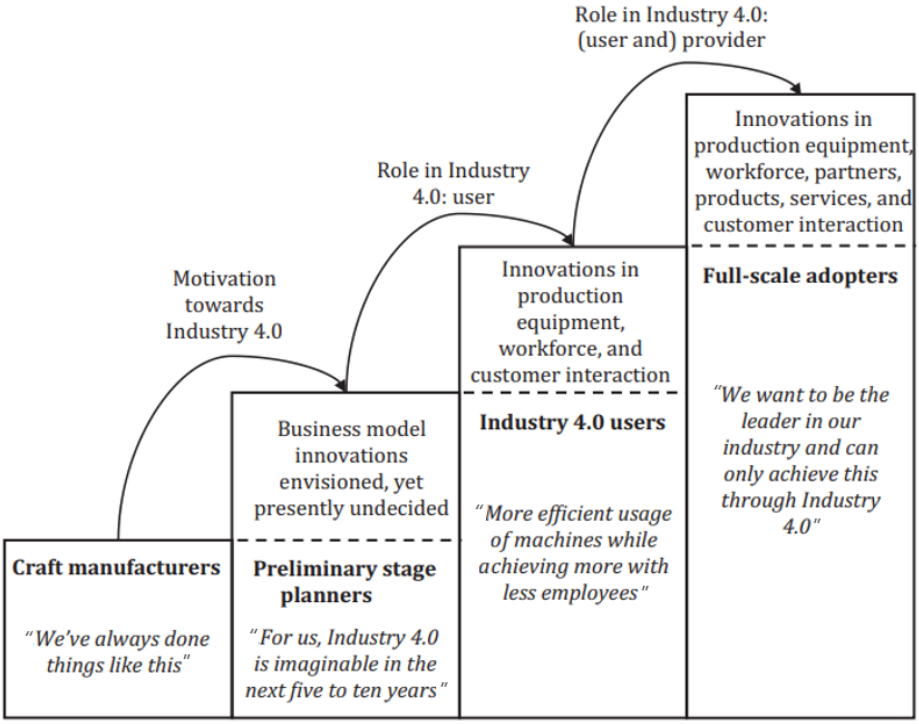

Figure 1. Stage model for manufacturing SMEs in the context of Industry 4.0
Source*: created by the author based on* (Müller et al., 2018)

According to Müller et al. (2018), SMEs can be categorised into four groups: Craft manufacturers, Preliminary stage planners, Industry 4.0 users, and Full-scale adopters. What is striking about the last stage strategy (full-scale adopters) is that such companies are interested in supporting and equipping other companies with tools for Industry 4.0, hereby preparing to act as providers or users/providers. Nonetheless, Erol et al. (2016) state that developing an Industry 4.0 vision is still a challenging task. Although many executives are aware of the potential benefits of Industry 4.0-related technology and changes in business models, they had substantial problems to go a step further and develop their own company-specific vision; rather, they had the expectation that Industry 4.0 is the solution itself.

As a consequence, various authors (Ganzarain & Errasti, 2016; Lee et al., 207) proposed process models for the systematic transformation of a company's vision and strategy towards Industry 4.0 readiness. Accordingly, Mittal et al. (2018) provide an overview of the existing roadmaps, frameworks and maturity models towards Industry 4.0 identified in the literature. The most important findings are noted in Appendix No. 1. Some researchers suggest that Industry 4.0 can be implemented by using an iterative and continuous

improvement approach, such as Lean manufacturing (Kolberg and Zühlke 2015, cited in Moeuf et al., 2018). Authors suggest that, as Industry 4.0 aims at speeding up the flows of information and Lean Manufacturing focuses on the elimination of waste to speed up physical flows, the synergy between the two methods could be considered to target operational excellence.

Meanwhile, Ibarra et al. (2018) suggest four ways to conduct the digital transformation in manufacturing companies which has been identified according to the innovation degree applied that goes from modifying such a few elements of the business model through an incremental innovation to the transformation of all the elements of the business models due to a radical innovation. However, Mittal et al. (2018) conclude that a unique method which would allow integrating self-assessing approaches for evaluating the current level of Industry 4.0 readiness is still needed, and technologies as well as enabling factors for directing the individual manufacturing system towards Smart Manufacturing or Industry 4.0 capabilities are still missing.

To summarise the points stated above, Industry 4.0 technologies provide opportunities to create value and meet customer expectations in terms of innovation, personalisation and rapid market introduction. Nonetheless, until now, most SMEs still lack technological, financial and managerial resources to fully explore the Industry 4.0-derived benefits. However, based on Ungerman and Dědková (2019) study results, the application of the modern management and marketing techniques can help smaller SMEs to become more competitive. As the recent changes in the classical business models of SMEs are taking place on the customer relationship side and supporting customer-oriented solutions, further analysis will consist of the marketing related functions' changes regarding Industry 4.0 implementation.

1.3. The Role of Marketing Functions and their Significance for SMEs

In order to analyse the marketing functions, firstly, it is necessary to examine the 'Marketing' concept evolution itself. According to Balmer and Yen (2017), the concept of Marketing over time has been involved in four different revolutions. The classification of marketing revolutions is outlined in Figure No. 2.

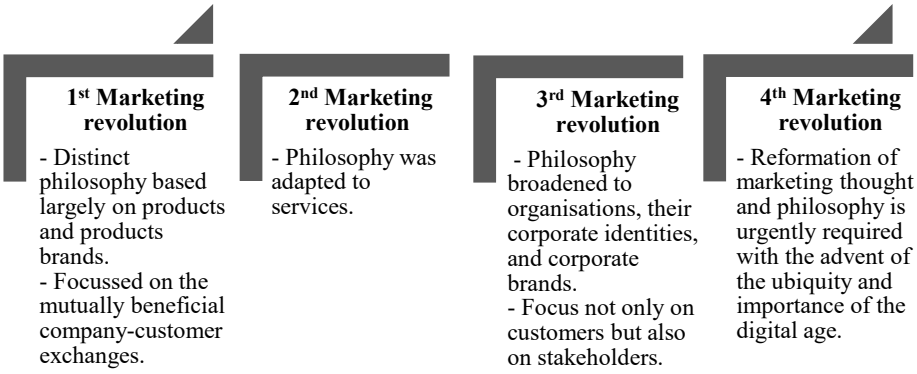

Figure 2. The development of the Marketing concept
Source*: created by the author based on* (Balmer & Yen, 2017)

The figure above explains the broadening concept of the marketing philosophy over the years, which firstly evolved from a distinct philosophy about the brands and products. Later on, the marketing philosophy was adapted to services. The main trait of the 3rd marketing revolution is the marketing philosophy application to the corporate identities. Meanwhile, the current 4th marketing revolution emphasises the importance of the digital era.

It is of importance to state that the role of marketing in explaining firms' business performance has received significant attention throughout the history of the marketing discipline. Morgan (2012) developed an integrative theory-based conceptual framework linking marketing with the firms' business performance. According to the model, marketing capabilities within the firm together with marketing resources (knowledge, finance, etc.) exert the impact on marketing strategy decision making and its implementation. This turns into the competitive advantage through marketing mix elements which influence the market performance factors of the firm through sales, satisfaction, retention, as well as through financial performance indicators, such as the cash flow, costs, margin, ROI, profits, etc. Joensuu-Salo et al. (2018) researched more than 100 Finnish SMEs and revealed that the marketing capability mediates the effect of the market orientation on the firm performance. For internationalised firms, the market orientation and the marketing capability are crucial to their success in foreign markets. Meanwhile, Sadiku-Dushi et al. (2019) study revealed that opportunity focus, resource leveraging, and value creation are the dimensions of the entrepreneurial marketing that are positively related and have a significant impact on the overall SMEs performance.

To define marketing functions within the firm – the marketing mix model can be used. According to Jain and Jain (2022), the marketing mix can be identified as a collection of controllable variables which are being employed by a company to affect its target market. Consequently, the authors state that the marketing mix parts are the fundamental, tactical components of a marketing strategy. It must be mentioned that McCarthy (1960) was the first to suggest the 4Ps Marketing Mix model, which included these variables: price, promotion, product, and place.

The 4Ps of the Marketing Mix model can be explained as follows: the product refers to all of the components of the item or the service which is being marketed by the company, and it adds value to the customer while being purchased. The price refers to the handling of the process of different inquiries by the customers in getting the benefits from the generated services or the purchased products and can be seen in the price and other charges of the service. Meanwhile, the place attribute indicates a company's decision where the product and services should be distributed to the clients. The final element of the model – promotion – refers to the company's decision and ability how to communicate the offer to the client (Davies & Brush, 1997). The 4Ps model attributes are listed in Table No. 6.

Table 6. 4Ps Marketing Mix Model

PRODUCT	PRICE	PLACE	PROMOTION
Includes an item or service. Product or service is being marketed through its features, quality, benefits and quantities. *A company can make high quality products/services.*	Includes the price of the item. Includes product assortments and lines, as well as price changes and payment methods. *A company can offer a competitive price.*	Refers to the location where the product or service is available to the customer. Includes distribution channels. *Place implies that, for the consumer, it is easy to get the product.*	Refers to market communication, which is achieved by personal selling, advertising, direct marketing, public relations, sales promotion and sponsorship. *Promotion means that a company can communicate to the consumer about their products.*

Source: *created by author based on* (McCarthy, 1960; Cengiz & Yayla, 2007; Shahhosseini & Ardahaey, 2011; Khan, 2014)

Over the years, the 4Ps Marketing Mix model was discussed and argued regarding its suitability only for the traditional marketing methods (Goi, 2009). Consequently, various authors proposed to include additional variables

to improve the 4Ps Marketing Mix model. Booms and Bitner (1981) added the variables of participants, physical evidence, and process to the original 4Ps model. Meanwhile, Goldsmith (1999) suggested that there should be 8Ps (product, price, place, promotion, participants, physical evidence, process, and customisation). It is of importance to note that most of the suggested extended 4Ps Marketing Mix models enhance the influence of humans in the delivery of goods or services. Also, the newly added elements, such as the process management, highlight the importance of a good process in place and the management of the company (Khan, 2014). According to Al Muala (2012), physical evidence pertains to the environment in which the services are produced. Similarly, the clients' perceptions of the service quality might be influenced by their environment. Examples of extended Marketing Mix models are provided in Table No. 7.

Table 7. 4Ps and extended Marketing Mix Models

AUTHOR	MARKETING MIX ELEMENTS
McCarthy (1960)	4Ps: Product, Price, Place, Promotion
Booms and Bitner (1981)	7Ps: Product, Price, Place, Promotion, Participants, Physical evidence, Procedure
MaGrath (1986)	7Ps: Product, Price, Place, Promotion, Personnel, Physical evidence, Process management
Goldsmith (1999)	8Ps: Product, Price, Place, Promotion, Participants, Physical evidence, Process, Customisation

Source: *created by the author based on* (Goi, 2009; Khan, 2014)

According to Goi (2009), the importance of some elements within the marketing mix will vary at any one point in time. For instance, Al Badi (2018) aimed to highlight the role of a marketing mix (product, price, place, and promotion) on achieving the competitive advantage of SMEs in Oman. According to the data analysis, the results show that all of the marketing mix elements have a significant impact on achieving the competitive advantage, but the most effective element when it comes to achieving the competitive advantage was found to be the pricing element.

However, some authors (Gilmore et al., 2001; Walsh & Lipinski, 2009; Resnick et al., 2016) state that SMEs tend to have different characteristics in the ways of practising marketing from those of large companies. According to Gilmore et al. (2001), these characteristics may be determined by the inherent characteristics and behaviours of the entrepreneur or owner, and they may be determined by the inherent size and stage of the development of the enterprise. Such limitations can be summarised as: limited resources, lack of specialist

expertise, and limited impact in the marketplace by SMEs. Thus, SMEs marketing is likely to be haphazard, informal, loose, unstructured, spontaneous, reactive, built upon and conforming to the industry norms. This idea was also confirmed by Walsh and Lipinski (2009) while analysing the role of the marketing function in small and medium-sized enterprises on the competitive advantage gain, and, therefore, its importance to the firm. According to the authors, the marketing function is not as well developed or influential in SMEs as it is in large corporations. Two environmental factors, the type of the market (consumer) and the firm orientation (hierarchal), facilitate the influence of marketing within a firm. Nonetheless, authors suggested that additional factors should also have to be included into researches, such as the personnel factors (background and experience of the marketing department personnel) and the firm politics to fully disclose the marketing function role within SMEs.

Resnick et al. (2016) researched the extent to which the traditional marketing theory and practice can be applied in SMEs. According to the study, SMEs are not doing 'textbook' marketing but are intuitively aware of the core marketing principles to which they are adding a unique 'personal brand' of their own knowledge, skills, and personality. Meanwhile, Bocconcelli et al. (2018) carried out a systematic literature review about SMEs and marketing within the period of 2006–2015. The study revealed that great attention is paid to the SMEs marketing topic, and that there is a growing role of networks and the application of information and communication technologies in SMEs' marketing functions. However, the study still highlights a distance in the reviewed studies between their theoretical bases and analyses of the marketing behaviour and practices by SMEs. The main differences between the marketing practices within SMEs and large corporations are summarised in Table No. 8.

Table 8. Characteristics of SMEs and Large corporations marketing

Characteristics of marketing practices in enterprises	SMEs	Large corporations
• Impact in the marketplace	Limited	Major
• Resources (such as finance, time, marketing knowledge)	Limited	Developed
• The role of owner/manager in marketing decisions	Major (owner/manager make most decisions on their own)	Limited
• Ways of working	Haphazard and informal	Structured, formal

Source: *created by the author based on* (Gilmore et al., 2001; Walsh & Lipinski, 2009; Resnick et al., 2016)

To summarise, the philosophy of marketing evolved within the years to become the critical framework for gaining competitive advantage. Even though the concept of the 4Ps has been criticised by a number of studies claiming that it has flaws, the 4Ps framework remains a staple of the marketing mix, with the common usage of the 7Ps Marketing Mix model to define the main functions of marketing. Such functions include product, pricing, promotion, place, process, physical evidence, and people. However, while comparing the marketing practices between SMEs and large corporations, it was found that, typically, marketing practices of SMEs lack structure as well as resources, and are highly influenced by the SME owner or its manager.

In the next subchapter, Industry 4.0 technologies and SMEs marketing functions relations will be investigated.

1.4. The Relation between Industry 4.0 Technologies' Enablement and Marketing Functions of SMEs

Various authors (Nosalska & Mazurek, 2019; Krafft et al., 2020) provide guidelines for successful marketing strategies to be implemented in the context of Industry 4.0. The authors emphasise that companies must fulfil five important principles to achieve smooth marketing function alteration. Such principles include connectivity (between the customer and the product), cognitivity (real-time information adoption), co-creation (an opportunity to co-create value with the customer at every stage of product creation), communication (personalised customer communication), and cooperation (in the supply chain). According to the authors (Nosalska & Mazurek, 2019; Caliskan et al., 2020) as new technologies of the Industry 4.0 should be integrated within the traditional marketing strategies, new sources of information coming from business partners and various stages of the product life are the major challenges to reshape a full marketing mix of the companies.

In order to identify the relationship between the marketing functions and the application suitability of Industry 4.0-derived technologies, a systematic analysis was carried out. The marketing mix approach of 7Ps was selected based on the research carried out by Caliskan et al. (2020). Also, the results of the analysis combine two additional aspects, analysed in the previous sections, such as the marketing principles (Nosalska & Mazurek, 2019; Krafft et al., 2020) and Industry 4.0 technologies (Saucedo-Martínez et al., 2018; Cimini et al., 2017; Brkljac & Sudarevic, 2018; Młody, 2018; Da Silva et al., 2019; Ćoćkalo et al., 2019; Ungerman & Dědková, 2019; Saniuk et al., 2020; Calabrese et al., 2020).

Systematic research revealed that the *product* element of the 7Ps Marketing Mix model is the most widely analysed marketing function by the researchers. According to Caliskan et al. (2020), as this Industry 4.0 provides a unique opportunity for the customer to be the co-creator of the product while enabling different types of technologies (AI, AR, 3D), not only will consumers be closer to contributing to innovation in the products and services they require, but they will also be enabled to perform this innovation assisted by intelligent machines. This development will be supported by social commerce, a new way of looking at e-commerce, and new channels of marketing.

The element of *place* is also influenced by Industry 4.0 technologies. It not only enables the online shopping opportunity, but also allows choosing the delivery method the customer needs. Omnichannel offers customers to receive whatever they want at the preferred time and place (Caliskan et al., 2020). Thus, the use of location-based services allows users to receive integrated information based on time, location, and context, thereby streamlining the shopping experience (Sima et al., 2020).

With the Fourth Industrial Revolution, the shape-shifting *promotional* element focuses on the interactive communication with customers; therefore, it is especially important to examine customer behaviour and to guide promotional activities accordingly. Ungerman and Dědková (2019) mention that digital marketing trends are being widely used in the promotion element, i.e., artificial intelligence enables to autonomously evaluate the behaviour of users on social networks, conversational marketing allows to engage people in natural communication with chatbots to find out everything a customer wants, omnipresence enables customers use multiple channels at once, and enterprises must spread their communications across all types of communication channels. Industry 4.0 alters the communication with consumers from one-way to interactive communication, which becomes much more personal, thus increasing the accuracy of segmentation and targeting the desired audience. Also, IoT allows the creation of large networks, which will connect all the members of the value chain, and it will affect the tendencies of the buying and consuming behaviour (Sima et al., 2020).

Digitalisation also influences *the pricing* policies of the companies. Now, instead of fixed pricing, a dynamic pricing policy is often applied. Dynamic pricing focuses on the product, and, more importantly, on the customer with the help of advanced analytics to generate the optimal revenue and to build a successful relationship with the customer (Caliskan et al., 2020). Moreover, transparency in price sharing through Internet technologies is an important aspect of the marketing activity, where stakeholders have an increased knowledge about the market.

Meanwhile, employing different tools of Industry 4.0 business *processes* can be optimised and automated. It helps to avoid staying behind the competitors in the marketing strategies. In contrast, *physical evidence* is related to the customer experience of the process of the product or service delivery, so, in this case, AR and virtualisation have a key role in enhancing the customer experience. The *people* element regarding the Industry 4.0 enablement will be changed by using robots instead of salespersons, also the usage of virtual assistants will increase. Systematic research results are shown in Table No. 9.

Table 9. Integration of Industry 4.0 technologies with the 7Ps Marketing Mix framework

7Ps approach	Marketing principles (5CS)	Supporting Industry 4.0 technologies	Changes brought by the supporting technologies into the marketing mix
Product marketing function	Connectivity Cooperation Communication Co-creation	• Internet of Things • 5G • 3D printing • Additive production • Simulation • Cloud computing • Augmented reality • Virtual Reality • Big Data	1.Technologies enable customers to take part in fast prototyping and testing of products already at the research and development stage. 2.Technologies extend the spectrum of product personalisation offering and the highest possible level of customisation. 3.Technologies make it possible to obtain data on the use of products directly from the customer in real time. 4. Technologies facilitate the building of a digital ecosystem and the creation of new business models (a business platform model or product as a service). 5.Digital experience is offered by Virtual Reality. 6.Standardisation is provided through interoperability.
Place marketing function	Cooperation	• Mobile app marketing • Augmented Reality • Internet of Things	1.Real-time communication between stakeholders for transparency. 2.Labelling technologies for inventory management.

7Ps approach	Marketing principles (5CS)	Supporting Industry 4.0 technologies	Changes brought by the supporting technologies into the marketing mix
		• E-commerce • Big Data	3.Product and service accessibility. 4.Seamless Omnichannel logistics through data analytics, IoT, and automation. 5.Consumer online shopping performance has improved due to the diversification of information sources.
Promotion marketing function	Communication	• Chatbots, Virtual assistants • Social media • Advergaming, Mobile app marketing	1.The voice assistant solutions, such as *Siri* or *Google Assistant*, can 'talk' with the customer on the level of human bonding and revolutionise the assumptions made for brand promotion strategies. 2.Inventory visibility across channels through personalised advertising. 3.Interactive communication.
Price marketing function	Cognitivity	• Artificial Intelligence • Internet • Big Data • Internet of Things	1.The Internet makes it easier for customers to control prices through auctions and negotiations with multiple suppliers of the desired item. 2.The Internet also allows companies to adjust their prices dynamically to the current demand or the preferred customer profile in real time. 3.Tailor-made and personalised pricing.
Process marketing function	Connectivity Cooperation Communication	• Internet of Things	1.It is the Internet that forms the basis of the digital ecosystem that gives the exact ability to exchange data gathered from sensors. All digital technologies indeed achieve their real value only when such connectivity is employed.

7Ps approach	Marketing principles (5CS)	Supporting Industry 4.0 technologies	Changes brought by the supporting technologies into the marketing mix
			2.Automated process for zero defect. 3.Real-time monitoring systems provide continuous improvement. 4.Enhanced customer experience is offered with digital tools.
Physical evidence marketing function	Connectivity	• VR/AR • Fitting rooms • Mobile technologies	1.Flexible physical area designs by augmented reality. 2.Reduced complexity and attractive spaces by mobile technologies.
People marketing function	Connectivity Cooperation	• Artificial Intelligence • VR/AR • Additive production • Robots	1.High-level customer experience with robots-personal assistants. 2.Real-time expert advisors by virtual assistants. 3.Robots instead of a salesperson.

Source: *created by the author based on* (Ungerman & Dědková, 2019; Botha, 2019; Krafft et al., 2020; Caliskan et al., 2020; Sima et al., 2020)

Based on the findings of the systematic analysis, the identified Industry 4.0 technologies were ascribed to being the most suitable for the application within the specific marketing functions concerning the 7Ps Marketing Mix model. A summary is placed in Table No. 10. The findings show that the network technologies, such as the Internet of Things, as well as Data analytics technologies, such as Big Data, can be described as the most universal Industry 4.0 technologies as these technologies have the most application possibilities within several marketing functions, such as the product and place marketing functions. Meanwhile, computing technologies, such as simulation, can be classified as a niche technology of Industry 4.0, as it can only be applied in the product marketing function. The same applies to sharing technologies, such as cloud computing, which could be suitable for the application only in the product marketing function.

Table 10. Summary of the main Industry 4.0 technologies application possibilities within marketing functions

MARKETING FUNCTIONS	INDUSTRY 4.0 TECHNOLOGIES						
	NETWORK TECHN.	**CYBER SECURITY TECHN.**	**DATA ANALYTICS TECHN.**	**SHARING TECHN.**	**SMART WORK TECHN.**	**COMPUTING TECH.**	**PRODUCTION LINE TECHN.**
PRODUCT	IoT		Big Data	Cloud computing	VR, AR	Simulation	3D printing, AD
PLACE	IoT		Big Data		AR		
PROMOTION					Chatbots, Virtual assistants		
PRICE	IoT		Big Data		AI		
PROCESS	IoT						
PHYSICAL EVIDENCE					VR, AR		
PEOPLE					AI, VR, AR		AD, Robots
Meanings:	**IoT –** Internet of Things **AI** – Artificial Intelligence **AR** – Augmented Reality **VR** – Virtual Reality **AD** – Additive Production						

Source: *created by the author based on* (Saucedo-Martínez et al., 2018; Cimini et al., 2017; Brkljac & Sudarevic, 2018; Młody, 2018; Ungerman & Dědková, 2019; Botha, 2019; Da Silva et al., 2019; Ćoćkalo et al., 2019; Krafft et al., 2020; Caliskan et al., 2020; Sima et al., 2020; Saniuk et al., 2020; Calabrese et al., 2020)

To summarise, it can be stated that, with the Fourth Industrial Revolution, all the elements of the marketing mix are potentially subject to changes. According to the scientific literature, the Industry 4.0 technology which has the most application possibilities in the several marketing functions is actually the Internet of things, followed by the Big Data, Virtual Reality and Augmented Reality technologies. The group of smart work technologies can be applied in the widest spread of the marketing functions, however, then, analysing the specific technologies of such a group, it is eminently visible that some technologies of such group could be defined as more niche Industry 4.0 technologies rather than the universal technologies, as it can be applied only in one specific marketing function (i.e. Chatbots). The marketing function, in which the widest range of the Industry 4.0 technologies can be applied, were found to be the product marketing function.

The following analysis will consist of the research of the current level of the adoption of digital technologies in the marketing functions within SMEs and its motivation for adopting.

1.5. SMEs Motivation towards Industry 4.0 technologies' Adoption in Marketing Functions

Dumitriu et al. (2019) explored a perspective over modern SMEs by managing Brand equity, growth and sustainability through digital marketing tools and techniques. According to the authors, some of the leading SMEs from the Western countries of European Union, followed closely by the ones from the Central and Eastern countries of the European Union, are already taking advantage of this dynamic development of the digital marketing. They do this also by leveraging the other key ingredients for success: engaging executives, investing in people and systems, fine-tuning their business models, measuring and tracking progress, setting sustainable goals by producing great marketing campaigns on all available media channels with an increasingly stronger emphasis on the digital one. This idea was also supported by Zutshi et al. (2021) in their systematic research, which aimed to examine how SMEs can mitigate against COVID-19-related crisis. The authors made a framework of recommendations to help enhance SMEs' resilience and responsiveness in the context of COVID-19. One of the provided recommendations included the need for digital skills and Internet-based marketing as it helps to attain business goals and develop products or services of a higher quality.

It must be mentioned that the two main methods that are prominent in modern day society are *traditional* and *digital* marketing. According to the

authors (Salehi et al., 2012), traditional marketing includes many forms and tools of marketing, and they are the most common forms of advertising methods which one sees every day (e.g., television, radio). In contrast, digital marketing (e.g., social media, digital advertising) can be seen as the use of information technology to communicate, deliver value, and build relationships with one's customers in such a way as to benefit the investors and the organisation as a whole. Moreover, nowadays, digital media becomes interactive media where people can communicate almost all the time. Consequentially, the consumer power is magnified, and customers influence other customers at every stage of the purchasing lifecycle – from visitors to post-purchase behaviour (Mangold & Faulds, 2009).

In the context of Industry 4.0, it is of importance to mention that digital marketing is a new approach to marketing, and not merely traditional marketing boosted by digital elements (Järvinen et al., 2012). It has its own characteristics and dynamics, which should be understood in order to be able to select effective marketing tactics and strategies for SMEs. Digital tools can be classified in various ways. One way to classify them is to present them based on the viewpoint of whichever party controls the communications (the company or the target audience), and whether the communications are one-way or two-way (Taiminen & Karjaluoto, 2015). It must be mentioned that SMEs adopt digital technologies to enhance customer communication and information processing (Harrigan et al., 2011), as well as to increase their operating efficiency (Borges et al., 2009), and also for organisation growth (Bhaskaran, 2013). Yasmin et al. (2015) found out that online advertising, email marketing, social media and search engine optimisation (SEO) are highly positively correlated with an increase in sales. Moreover, Dinner et al. (2014) state that paid search and online display advertising has the greatest impact on both online and offline sales, and both are more effective than traditional advertising primarily because of strong cross-effects on the offline channel. Nevertheless, both traditional and digital marketing have their own advantages and disadvantages. While the modern methods can help reach more people, their metrics are complicated. In comparison, traditional marketing has a proven success rate, but it is usually too expensive for SMEs.

In order to investigate the usage of digital marketing tools within SMEs, some authors researched the adoption of specific online tools and applications by SMEs (Low & Johnston, 2009; Palmer et al., 2012). The studies' results imply that, generally, the positive consequences of technological adoption were recognised. However, some researchers carried out the analysis of the usage of digital tools within particular countries, e.g., Romania and Finland (Dobrescu et al., 2018; Taiminen & Karjaluoto, 2015). According to the

authors, many SMEs still do not use the full potential of the new digital tools. The findings of such researches are noted in Table No. 11.

Table 11. Study findings on digital marketing tools adoption within SMEs

Authors	Subject of the study	Main Findings
Taiminen and Karjaluoto (2015)	The penetration of the Internet and social media usage in Finland SMEs	Regardless of the firm size, SMEs use social media in the same way they use other digital channels. Many SMEs do not use the full potential of the new digital tools.
Stankovska et al. (2016)	Usage of digital channels by SMEs within the UK	There is no linkage between the company's size and the usage of digital channels.
Foroudi et al. (2017)	Impact of digital technologies on UK SME's core competencies	Digital technology has an enormous impact on marketing capabilities, which leads to the development of core competencies in UK firms.
Dobrescu et al. (2018)	Degree of use of digital technology in the marketing mix of SMEs in Romania	Digital marketing is a fairly new concept for the Romanian managers, and only around 53% of them are familiarised with the terms of digital marketing.

Source: *created by the author based on* (Dobrescu et al., 2018; Stankovska et al., 2016; Taiminen, & Karjaluoto, 2015; Foroudi et al., 2017)

This idea is also supported by Torsten Eriksson et al. (2008) research in which they state that SMEs, in general, are still at an early stage of adopting technologies, and especially digital marketing tools. Moreover, Bordonaba-Juste et al. (2012) state that the firm size has a strong influence on the adoption of digital marketing tools, and that micro firms are the slowest adopters. This can be explained by the fact that large businesses are more likely to have the required resources and knowledge to successfully adopt new tools. Research of Karjaluoto and Huhtamaki (2010) classified the reasons to adopt digital channels in micro firms under three main categories. The findings are provided in Table No. 12.

Table 12. Factors determining the reason to adopt digital marketing tools in Micro SMEs

Firm-specific and owner-manager factors	Resource-related factors	Environmental factors
Capabilities, motivation, background and experience are the focal factors determining the strategic business choices of SMEs.	Factors related to the perceived benefits of the new channel, e.g., usefulness of technology as well as the ease of use of the new channels.	These factors are outside the company's control, such as the product or service type, competitive landscape, or the industry sector.

Source*: created by the author based on* (Karjaluoto & Huhtamäki, 2010; Taiminen & Karjaluoto, 2015)

The table No. 12 shows factors determining the reason to adopt digital tools in micro SMEs. The factors in the first group are mostly related to the expertise and the skill to use new technologies, whereas the second group resource-related factors are more related to the knowledge of how to benefit from them in business. Karjaluoto and Huhtamaki (2010) also state that environmental factors are very important, as some products and services are simply more suitable to be communicated through digital channels.

Meanwhile, seeking to investigate firms' motives towards the implementation of Industry 4.0 technologies into marketing functions, Bettiol et al. (2017) carried out analysis of manufacturing firms in Italy. The study results showed that, for both B2B and B2C firms, the improvement of services offered to their customers is the main motivation concerning the adoption of the Industry 4.0 technologies. The results of this analysis are shown in Table No. 13.

Table 13. Main marketing-related motives and Value chain activities towards Industry 4.0 implementation in SMEs

Motivations about the adoption	Value chain activities where firms focused on the investment in the new technologies
• Improving the customer service	• New product(s) development
• Improving the firm's efficiency	• Prototyping
	• Manufacturing activities
	• Marketing activities

Source: *created by the author based on* (Bettiol et al., 2017)

According to the research, the main marketing functions-related activities of the value chain where firms focus their investment on Industry

4.0 were new product development, prototyping, and manufacturing/marketing activities. Therefore, it can be stated that the marketing perspective about the adoption of these new technologies of Industry 4.0 has a strategic role for both B2C and B2B markets (Bettiol et al., 2017).

Meanwhile, Sima et al. (2020) list the main drivers for the consumer behavioural changes in the context of Industry 4.0: digitalisation, Internet of Things, Artificial Intelligence, and data mining. Consequently, it can be stated that the application of various technological tools seeks to meet the customer demand with solid organisational structures that work in synergy and add maximum value while developing services or products (Saucedo-Martínez et al., 2018).

Literature review shows that the adoption of the Industry 4.0 technologies has extensive benefits and opens up new perspectives for SMEs marketing-related functions, which should be the main motivation drivers towards technology application within SMEs. According to the authors (Młody, 2018; Ungerman & Dědková, 2019; Calabrese et al., 2020) the main benefits of the Industry 4.0 implementation for SMEs are: an improved operational efficiency, revenue growth, an improved productivity and product quality, more efficient usage of resources, inventory management, workplace safety, increased competitiveness of the company, increased customer satisfaction, and the new ways products can be designed and developed. Meanwhile, Ungerman et al. (2018) identified that the most important impacts related to the marketing innovation implementation in enterprises due to Industry 4.0 are: improved communication with customers, increased competitiveness of the company, and change in the number of costs. Another research carried by Ungerman and Dědková (2019) revealed twelve positive impacts, such as *product-related* – quality improvement and product uniqueness, *cost-related* – the facilitation of product purchasing, the gradual disappearance of cash, *convenience* – expansion of direct sales, a change in the appearance and furnishing shops, *communication* – better presentation of the transferred products, creative communication and thus better awareness, *services* – service orientation, shared economy, *knowledge of needs and wants* – empathetic design of products, customer loyalty, and only one negative impact – *product price increases*. In addition to that, Arromba et al. (2021) identify further implications, such as agile marketing decision-making caused by the data processing capacity, making it possible to rapidly identify new market opportunities, as well as causing an improved product development and operations process. However, in the context of Industry 4.0, the presence of security information can influence consumers, and therefore influence their buying behaviour; consequently, the user's privacy will remain

an important concern for all applications regarding the Industry 4.0 technologies.

To summarise, based on the scientific research, the adoption of Industry 4.0 technologies within SMEs' marketing functions provides a substantial number of benefits, as it helps to improve the quality of the product and its uniqueness, while also providing the chances for more creative and close communication with the final consumer. Nonetheless, SMEs are still not fully using the opportunity to gain competitive advantage and implement new technologies within their marketing functions, which can be explained by a number of factors, such as firm-specific and managerial aspects, resource availability, and environmental factors.

The further study will focus on the analysis of the theoretical frameworks, based on which, scientists previously explored the key factors influencing the intention to adopt Industry 4.0 technologies in the marketing functions within SMEs.

1.6. Theoretical Frameworks of Technology Adoption within Firms

It is worth noting that the phenomena of technology adoption within firms have been thoroughly studied by scientists since the late 1970s. To investigate this relation and its causes, different theories and frameworks have been developed over the years, whose roots come from various scientific areas, such as sociology, psychology, communications, and management (Taherdoost, 2018).

Firstly, it is worth highlighting the managerial scientific literature-related theoretical frameworks, based on which, the decision to adopt new technologies within the firms can be explored. For instance, the *Agency Theory*, initially articulated by Berle and Means (1932), and subsequently expanded by Ross (1973), as well as by Jensen and Meckling (1976), was designed to elucidate and conceptualise the roles and behaviours of agents, including managers and directors within corporate entities. This theoretical framework posits that the principal challenge lies in determining how the principals (shareholders in corporate governance) can ensure that the agents (directors) act in alignment with the principals' interests, rather than in pursuing their own agendas. However, it is worth mentioning that this divergence in interests is particularly prevalent in large corporations, rather than in SMEs, where the ownership and control are typically separated, with shareholders owning the company, but not directly managing its operations. Also, according to the Panda and Leepsa (2017), this theory has limitations, as it considers the managers as opportunistic, while ignores the actual

competence of the managers. In contrast, the *Stewardship Theory* argues that managers (stewards) naturally align their interests with those of the firm and its owners due to intrinsic motivation. This theory posits that the relationship between the owners and stewards is built on trust, thereby making control mechanisms redundant (Davis et al., 1997). However, Keay (2017) contends that, although individuals may act professionally and trustworthily for most of their careers, this does not preclude the possibility of self-serving behaviour at some point; therefore, the *Agency* and *Stewardship* theories alone are unlikely to fully explain the behaviour of SMEs' managers, and more factors should be included into the research.

Additionally, *The Upper Echelons Theory* (UET) was created by Hambrick and Mason in 1984. This theory suggests that the cognitive base and values of senior-level executives, as reflected in observable characteristics, such as their age and education, affect how they interpret and respond to strategic situations through their choices, thereby influencing the organisational performance (Hambrick & Mason, 1984). However, according to Bekos & Chari (2023), studying the characteristics of a firm's upper echelons as a whole (i.e., the entire top management team) yields stronger predictions of the strategic outcomes than focusing on the chief executive officer (CEO) alone; thus, the application of this theory might be more suitable for decision-making analysis of the larger companies in terms of introducing new technologies within the entity than exploring the SMEs behaviour. Therefore, to holistically approach analysis of the Industry 4.0 technology adoption suitability within SMEs, it is important to focus not only on the internal antecedents of the behaviour of the SMEs managers, such as their values and intentions, but also to focus on the external SME-related factors, such as norms, incentives, and institutional constraints (Taherdoost, 2018). Consequently, the combination of the theoretical frameworks which explore the individual aspects of the behaviour of the SMEs managers and the technology acceptance-related factors can be the most useful choice for this research.

According to the scientific literature, the most widely used models among scientific studies exploring the technology impact within SMEs include: the *Diffusion of Innovations Theory* (DOI) by Rogers (1962), the *Theory of Reasoned Action* (TRA) by Fishbein and Ajzen (1975), the *Theory of Planned Behaviour* (TPB) by Ajzen (1985), the *Technology Acceptance Model* (TAM) by Davis et al. (1986; 1989), the *Technology-Organisation-Environment Framework* (TOE) by Tornatzky and Fleischer (1990), followed by the *Theory of Interpersonal Behaviour* (TIB) (Triandis, 1997), the *Unified Theory of Acceptance and Use of Technology* (UTAUT) by Venkatesh et al.

(2003) and others. It is worth noting that each of the theoretical frameworks concentrates on the specific factors of the technology adoption within the firms. For example, the *Diffusion of Innovations* model focuses on the technology characteristics playing the most important role of technology implementation, meanwhile, the *Theory of Planned Behaviour* focuses on explaining the behaviour of individuals, who, in the case of SMEs, is typically the owner or the manager of the SME. Thus, the variety of the existing technology adoption models provide the opportunity for scientists to research the technology adoption phenomena from different angles, while providing valuable implications for the business (Lai, 2017). Consequently, Table No. 14 shows the historical perspective of the development of technology adoption frameworks throughout the years.

Table 14. Evolution of technology adoption frameworks and models

THEORY FRAMEWORK	AUTHORS, YEARS	CONSTRUCTS	CORE OF THE FRAMEWORK
Theory of Reasoned Action (TRA)	Fishbein and Ajzen (1975)	Subjective Norms, Attitudes, Behavioural intention, Behaviour	Derives from psychology & sociology to measure behavioural intention and performance of an individual. The lack of addressing the role of habit, the cognitive deliberation, misunderstanding through a survey and the moral factors are the main criticised points of this theory.
Theory of Planned Behaviour (TPB)	Ajzen (1985)	Perceived Behavioural Control, Subjective Norms, Attitudes, Behavioural intention, Behaviour	Extends TRA by adding an additional variable – Perceived Behavioural Control to determine the behavioural intention and the performance of an individual. TPB may be viewed as the more suitable theoretical framework which is influenced by the degree of the individual's voluntariness to choose or not to choose the use of a technology.

THEORY FRAMEWORK	AUTHORS, YEARS	CONSTRUCTS	CORE OF THE FRAMEWORK
Theory of Interpersonal Behaviour (TIB)	Triandis (1977)	Affect, Habit, Social Factors, Perceived Consequences, Intention, Facilitating condition, Behaviour	This model not only contains all aspects of TRA and TPB, but is also extended by adding habits, facilitating conditions, and affect in order to improve the prediction power. The main disadvantage of TIB is its complexity and lack of parsimony compared to TRA and TPB.
Technology Acceptance Model (TAM)	Davis et al. (1989)	Perceived usefulness, Perceived ease of use, Behavioural Intention to use, Actual System Use	This model is a derivate from the TRA model, explaining the user acceptance of technology. TAM focuses solely on beliefs about the technology, and intrinsic motivations are not addressed in the model.
Technology Acceptance Model 2 (TAM2)	Venkatesh & Davis (2000)	Subjective Norms, Image, Voluntariness, Result Demonstrability, Job Relevance, Output quality, Perceived usefulness, Perceived ease of use, Behavioural Intention to use, Actual System Use	Developed from TAM by adding two groups of constructs, such as social influence and cognitive influence, to the model of TAM to improve the predictive power of the perceived usefulness.
Social Cognitive Theory (SCT)	Bandura (1986) and Compeau & Higgins (1995 a, b)	Encouragement by others, Others' Use, Support, Computer Self-efficacy, Outcome expectations, Affect, Anxiety, Usage	The Social Cognitive Theory is derived from social psychology and is based on three main factors: behaviour, the personal factor, and environment, which are interacted bi-directionally in order to predict both group and individual behaviour.

THEORY FRAMEWORK	AUTHORS, YEARS	CONSTRUCTS	CORE OF THE FRAMEWORK
Diffusion of Innovations Theory (DOI)	Rogers (1962)	Socioeconomic characteristics, Personality Variables, Communication Behaviour, Relative Advantage, Compatibility, Complexity, Trialability, Observability, Adoption, Rejection	The DOI model integrates three major components: adopter characteristics, characteristics of an innovation, and the innovation decision process. DOI focuses more on the system characteristics, organisational attributes, and environmental aspects, it has less power in explanatory aspects, and is less practical for the prediction of outcomes compared to other adoption models.
Perceived Characteristics of Innovating Theory (PCIT)	Moore & Benbasat (1991)	Relative advantages, Compatibility, Trialability, Ease of use, Visibility, Demonstrability result, Image, Voluntariness, Intention to use	This model expanded the DOI theory by identifying three additional features, such as: image, voluntariness, and behaviour.
Motivational model (MM)	Davis et al. (1992)	Extrinsic Motivation, Intrinsic Motivation	The Motivational Model also derives from psychology to explain behaviour. Basically, system use is determined by two aspects: intrinsic motivation and extrinsic motivation.
Combined TAM and TPB (C-TAM-TPB)	Taylor & Todd (1995)	Perceived Usefulness, Perceived Ease of Use, Attitude, Subjective norm, Perceived Behavioural Control, Behavioural Intention	The combined model provides a more complete understanding of behaviour and behavioural intention by accounting for the effects of normative and control beliefs.
Unified Theory of Acceptance and Use of	Venkatesh et al. (2003)	Effort expectancy, Performance	The combination of TAM, TRA, C-TAM-TPB, TPB, DOI, MM, SCT and

THEORY FRAMEWORK	AUTHORS, YEARS	CONSTRUCTS	CORE OF THE FRAMEWORK
Technology (UTAUT)		expectancy, Social influence, Facilitating conditions, Behavioural Intention, User Behaviour	Model of PC Utilisation results in UTAUT with 4 moderating variables – gender, experience, age, and voluntariness of use.
Technology-organisation-environment framework (TOE)	Tornatzky & Fleischer (1990)	External environment (Industry Characteristics, Market Structure, Technology Support Infrastructure, Government Regulations), Technological environment (Availability, Characteristics), Organisation environment (Formal & Informal Linking Structures, Communication Processes, Size, Slack, Technological innovation decision	The TOE Framework identifies three aspects of an organisation's context which influence the process of adopting and implementing a technological innovation, namely, the technological context, the organisational context, and the external environmental context.

Source*: created by the author based on* (Rogers,1962; Fishbein and Ajzen, 1975; Triandis, 1977; Ajzen, 1985; Bandura, 1986; Davis et al., 1989; Tornatzky & Fleischer, 1990; Moore & Benbast, 1991; Davis et al., 1992; Taylor & Todd, 1995; Compeau & Higgins, 1995 a, b; Venkatesh & Davis, 2000; Venkatesh et al., 2003; Taherdoost, 2018; Wibowo, 2019)

Also, it is worth mentioning that the recent studies exploring the Industry 4.0 technology adoption phenomena most commonly use TAM, DOI, TOE frameworks along with various combinations between the model's variables to research the adoption of the 4th Industrial Revolution technologies within SMEs. For example, the technology acceptance model's framework (TAM) was used to research the adoption of the Industry 4.0 technologies

within SMEs by Herzallah and Mukhtar (2016), Camilleri (2019), and Masood and Sonntag (2020). Various authors (Eze et al., 2019; Nair et al., 2019; Ghobakhloo & Chingc, 2019) in their researches used an extended TOE framework. Meanwhile, other authors used combined TOE and DOI frameworks in their researches (Nguyen & Waring, 2013; Kumar et al., 2017; Prause, 2019; Maroufkhani, 2020) to study the adoption of the Industry 4.0 technologies.

As the theoretical analysis revealed that, typically in SMEs, the major role for the decision-making is played by the owner/manager of the SMEs, the primary focus of the theoretical research will concentrate on the SMEs owners'/managers' behaviour and their perception towards the adoption suitability of the Industry 4.0 technologies within the firm. Literature analysis has shown that various management-related theoretical frameworks can be used to research it, such as the *Agency Theory*, the *Stewardship Theory*, or the *Upper Echelons Theory*. However, as such theories most typically explore the behaviour of the larger companies, the current research will focus on the *Theory of Planned Behaviour* as this theoretical framework provides an opportunity to analyse the attitude towards new technology adoption within SMEs of the individual SME manager/owner. Additionally, further study will concentrate on the factors of the *Diffusion of Innovations Theory* with the objective to explore how the perceived characteristics of the Industry 4.0 technology and the technology acceptance factors of the *Technology Acceptance Model* might affect the decision of the SMEs manager/owner to adopt the Industry 4.0 technologies. Moreover, the TOE framework will be analysed to evaluate the additional external factors which influence the decision to adopt the Industry 4.0 technologies in marketing functions within SMEs.

Consequently, the further research will focus on the four selected theoretical frameworks (TPB, TAM, DOI and TOE) and their in-depth analysis and an explanation of the relation among its variables.

1.7. Factors Influencing Industry 4.0 Technologies' Adoption Based on the Theory of Planned Behaviour and the Technology Acceptance Model

According to the literature, the *Technology Acceptance Model* (TAM) has evolved from the *Theory of Reasoned Actions* (TRA) developed by Fishbein and Ajzen in 1975. In 1985, Ajzen extended this theory into the *Theory of Planned Behaviour* (TPB) by including the perceived behavioural control variable as a determinant of both behavioural intention and behaviour. According to the Theory of Planned Behaviour, the immediate determinant of

the human behaviour is the behavioural intention. Intention, in turn, is jointly determined by the individual's evaluations of the consequences of performing the behaviour, by his or her perceptions of the normative pressure to perform the behaviour, and by the degree of control the individual perceives that he or she has over successful performance of the behaviour. These three determinants of behavioural intention are known as the attitude, the subjective norm, and the perceived behavioural control, respectively (Manstead & Parker, 1995). At present, the Theory of Planned Behaviour is arguably the most dominant model of attitude-behaviour relations (Armitage & Christian, 2003). The main framework and variables of this theory are shown in Figure No. 3 and in Table No. 15.

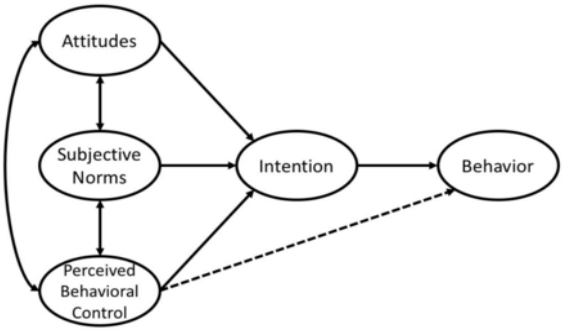

Figure 3. Theory of Planned Behaviour
Source: Ajzen (1985)

Table 15. Variables of the Theory of Planned Behaviour

Independent Variables	Dependent Variables
Attitude (AT) refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour of interest. It entails a consideration of the outcomes of performing the behaviour.	**Behavioural intention (BI)** refers to the motivational factors that influence a given behaviour where the stronger is the intention to perform the behaviour, the more likely it is that the behaviour will be performed.
Subjective Norms are an individual's perception about the particular behaviour which is influenced by the judgment of significant others (e.g., parents, spouse, friends, teachers).	**Behaviour –** the final behaviour.
Perceived behavioural control is an estimate of the extent to which the person has control over whether he or she is able to perform the behaviour. Perceived behavioural control varies across situations and actions, which results in a person having varying perceptions of behavioural control depending on the situation.	

Source*: created by the author based on* (Ajzen, 1985)

As mentioned above, the Theory of Planned Behaviour was the grounding base for the proposed Technology Acceptance Model (TAM) in 1986 by Davis. Over the years, this model has evolved to become the key model in understanding the predictors of the human behaviour toward potential acceptance or rejection of the technology. The strength of the model is confirmed by numerous studies emphasising its broad applicability to various technologies (Marangunić & Granić, 2014).

According to the TAM model as proposed in 1986 by Davis, the Technology Acceptance Model consists of external variables which influence independent variables – the Perceived Usefulness (PU) and the Perceived Ease of Use (PEOU), which affects dependent variables – the attitude towards using the technology, which finally affects the actual use (U) of the technology (Li et al., 2008). It must be mentioned that, over the time, the Technology Acceptance Model was refined to include more variables and modify the relationship that was initially formulated (Chuttur, 2009). In 1996, Venkatesh and Davis eliminated the attitude (AT) construct from the model and a new construct – the behavioural intention – was introduced. The main variables of the final TAM model are shown in Table No. 16.

Table 16. Variables of the Technology Acceptance Model

External Variables	Independent Variables	Dependent Variables
External variables include the system characteristics, user training, user participation in design, and the implementation of the process.	**The perceived ease of use (PEOU)** is the degree to which a user expects the target technology to be free of effort.	**Behavioural intention (BI)** represents a person's readiness to perform a given behaviour and is the primary predictor of the actual behaviour.
	The perceived usefulness (PU) is a user's subjective probability that the use of a specific technology will increase his/her job performance.	**Actual technology usage (U)** is the final use behaviour.

Source*: created by the author based on* (Fishbein & Ajzen, 1975; Davis, 1986; Venkatesh & Davis, 1996; Li et al., 2008)

This change in the model resulted in the direct influence of the perceived usefulness and the perceived ease of use on the behavioural intention (BI), the final model of TAM is shown in Figure No. 4.

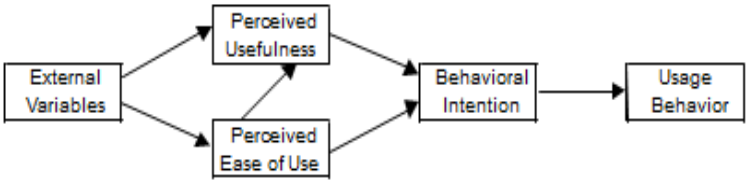

Figure 4. Technology Acceptance Model
Source: Davis et al. (1989)

To investigate the relationships between the first version of the TAM variables, developed by Davis in 1986, Li et al. (2008) researched 90 articles published between 1980 to 2005. The study results showed that, in general, the relationships between AT and BI or U are strongly significant. Nonetheless, some researchers noted that the significant relationships between AT and BI are not that strong, which confirms the suitability of the TAM model as refined by Davis et al. in 1989 for the future researches. Moreover, Li et al. (2008) conducted research revealing that the significant relationship between PEOU and PU is not persistence, which is reflected in different stages of user acceptance: in the initial stage of the user acceptance, there is direct relationship between PU and BI, but, with the process of acceptance, these relationships become more and more indirect throughout PEOU.

It must be mentioned that, nowadays, the extended TAM versions are commonly used while researching the Industry 4.0 technology acceptance within SMEs. Herzallah and Mukhtar (2016) extended the classical model of TAM while including perceived trust into their research. Their investigation confirmed the classic relationship that PEOU positively relates to PU; also, their research confirmed that PU and Perceived Trust positively relate to the manager's intention to accept and use e-commerce services. Although PEOU is positively related to perceived trust, the research did not show the relationship between PU and perceived trust. Also, no significant relationship was found between PEOU and the manager's intention to accept and use e-commerce services.

Hussein et al. (2017) researched the factors influencing intention to adopt information and communication technologies in SMEs in Oman while using the TAM model with an included additional variable – the perceived benefits. The findings of this paper exhibited a positive relationship between the perceived benefits and technology adoption.

Another research was conducted by Camilleri (2019) who grounded the research by TAM elements and investigated SMEs owner-managers' attitudes

toward the pace of technological innovation, as well as the perceived usefulness and the ease of use of digital media. The investigation revealed that there is a positive and significant relationship between the SMEs' online engagement and the owner-managers' perceived usefulness of the digital media. This study indicated that the pace of technological innovation, the owner-managers' perceived ease of use of the digital media, as well as the commercial responsibility were significant antecedents for the businesses' online communication of their responsible behaviours.

Ritz et al. (2019) aimed to explore the motivations and the expected outcomes of small business participation in digital marketing while using TAM and the do-it-yourself (DIY) behaviour model which incorporates the marketplace characteristics (the perceived economic benefits, the perceived lack of quality, and the perceived lack of availability) along with outcome variables (senses of control, fun and excitement, and self-improvement). Their research revealed that PU and PEOU are related to the intentions to use digital marketing. Meanwhile, Vahdat et al. (2021) researched shopping via model app technology phenomena by using the extended TAM model which included social factors. The findings showed that PU does not have a significant effect on the attitude towards the mobile app use, but PEOU, social influence, and peer influence were found to positively affect the attitude in this regard.

Rahman et al. (2021) investigated the adoption of artificial intelligence in banking services by using the TAM+TPB framework. The empirical findings of this research confirmed that seven factors, specifically, PEUO, PU, awareness, perceived risk, perceived trust, subjective norms, and attitude towards the intention to adopt technology account for 74.1% of variance to the AI adoption intention in banking services. According to the study, PU had a much greater influence on developing a favourable attitude towards the intention to adopt technology than PEOU.

In addition to that, Nazir and Khan (2022) explored the impact and factors affecting the adoption of information and communication technologies (ICT) by SMEs in Pakistan using TAM as an extended theoretical framework. This study confirms that the adoption of ICT is strongly influenced, not only by the perceived characteristics of information technologies, but also by other determinants, and particularly emphasises the important role of individual entrepreneurs' characteristics and government and local (national) institutional support.

It is also worth mentioning that one of the most recent theoretical frameworks named the UTAUT model, as developed by Venkatesh et al. (2003), is an extension of TAM, which incorporates additional variables, such

as performance expectancy, effort expectancy, social influence and facilitation conditions, as well as four key moderators, namely, gender, age, voluntariness, and experience. This model is also commonly being used while investigating the adoption of the Industry 4.0 technologies within SMEs.

Abu et al. (2015) in their study about the adoption of technology for Malaysian Small Medium Enterprises (SMEs) in the Food Industry used the UTAUT model, and, for the future studies, proposed a modified model with the extension of a new construct of *resistance to use* (RTU). According to the authors, the combination of both positive and negative constructs may better explain the behavioural intention of the users. Kumar and Ayedee (2021) analysed technology adoption as a solution for SMEs to overcome problems during COVID-19 by using the TAM + UTAUT frameworks. According to the authors, the different components of technology adoption can also help in avoiding physical contact, forecasting demand, increasing the overall sales and turnover, as well as market access, and turn them towards profitability. Based on the researched studies above, in Table No. 17, the relationship of the TAM and TPB models variables are summarised.

Table 17. Relationship between TAM and Theory of Planned Behaviour variables

TAM & TPB Variables	Impact	Dependent Variable
The perceived usefulness (PU)	Positively impacts → Supported by: Matikiti et al. (2018), Rahman et al. (2021), Alhashmi et al. (2019)	***Attitude (AT)***
The perceived usefulness (PU)	Positively impacts → Supported by: Herzallah & Mukhtar (2016), Tripopsakul (2018), Camilleri (2019), Ritz et al. (2019), Al-Rahmi et al, (2019), Rahman et al. (2021), Yuen et al. (2021), Nazir and Khan (2022) Has stronger impact on BI than PEOU: Supported by: Rahman et al. (2021), Yuen et al. (2021)	***Behavioural intention (BI)***
The perceived ease of use (PEOU)	Positively impacts → Supported by: Matikiti et al. (2018), Alhashmi et al, (2019)	***Attitude (AT)***
The perceived ease of use (PEOU)	Positively impacts → Supported by: Tripopsakul, (2018), Camilleri (2019), Ritz et al. (2019), Al-Rahmi et al. (2019), Alhashmi et al. (2019), Vahdat et al. (2021), Rahman et al. (2021), Nazir and Khan (2022)	***Behavioural intention (BI)***

TAM & TPB Variables	Impact	Dependent Variable
The perceived ease of use (PEOU)	Positively impacts & mediates the relationship towards BI → Supported by: Tripopsakul (2018), Herzallah and Mukhtar (2016), Al-Rahmi et al. (2019), Alhashmi et al. (2019), Yuen et al. (2021)	***The perceived usefulness (PU)***
Attitude (AT)	Positively impacts → Supported by: Alhashmi et al. (2019), Rahman et al. (2021)	***Behavioural intention (BI)***
Behavioural intention (BI)	Positively impacts → Supported by: Herzallah and Mukhtar (2016), Camilleri (2019), Ritz et al. (2019), Al-Rahmi et al. (2019), Vahdat et al. (2021), Rahman et al. (2021), Nazir and Khan (2022)	***Actual technology usage (U)***

Source*: created by the author based on* (Fishbein & Ajzen, 1975; Davis, 1986; Venkatesh & Davis, 1996)

To summarise the ideas presented above, it can be stated that the frameworks of TPB and TAM are suitable for Industry 4.0 technologies' adoption investigation within SMEs. An independent variable of the TPB model, the *Attitude*, as well as two independent variables of the TAM model, *PU* and *PEOU*, were found to be the grounding elements towards a positive behavioural intention to use/adopt technologies. Nonetheless, as Industry 4.0 is a complex phenomenon, most of the recent researches include additional variables into the research models, such as the perceived benefits, the perceived trust, or additional variables from the UTAUT model, for instance, social influence, or facilitation conditions.

Moreover, literature analysis reveals that variables from the *Diffusion of Innovations Theory* (DOI) can also be used to explore the adoption of the Industry 4.0 technologies and even influence the TAM independent variables, such as PU and PEOU. Accordingly, this theory is being analysed more in depth in the next section.

1.8. Factors Influencing Industry 4.0 technologies' Adoption Based on the Diffusion of Innovations Theory

Another widely used method to research the adoption of new technologies is by using Rogers Everett's *Diffusion of Innovations Theory* (DOI) framework (Al-Jabri & Sohail, 2012). This framework can be applied to both organisation and individual levels, and it was first proposed by Rogers (1962), followed by later editions of the same framework (Rogers, 1983; Rogers & Shoemaker, 1971; Rogers, 1995; Rogers, 2003). The theory defines

innovation as an idea, object or practice which is perceived by an individual while the diffusion is a process where innovation is communicated to the social system (Ali et al., 2019). Through this way, the members adopt or reject the innovation (Rogers, 1995). Rogers (2003) also identified several attributes of an innovation that are key influences on the adoption behaviour. The framework is presented in Figure No. 5, and the main variables of this model are shown in Table No. 18.

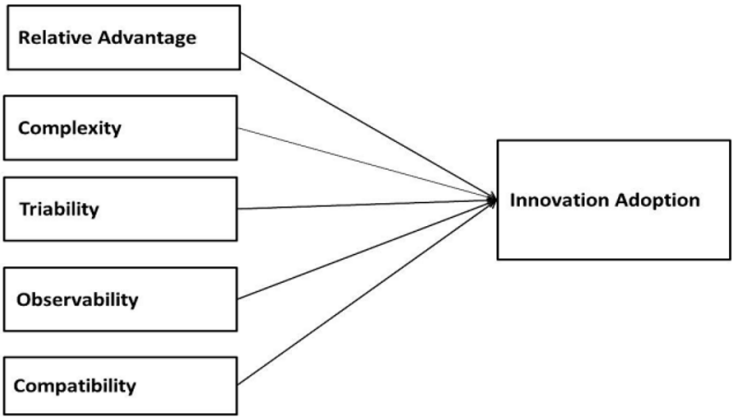

Figure 5. Framework of the Diffusion of Innovations Theory
Source: Rogers (1983)

Table 18. Variables of the Diffusion of Innovations Theory

Independent Variables	Dependent Variable
Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. A relative advantage results in an increased efficiency, economic benefits and enhanced status.	**Innovation adoption** can be measured by implementation, usage, utilisation, or satisfaction.
Compatibility is defined as a level to which an innovation or a new idea is consistent with the needs of the consumer's past experiences, the currently existing sociocultural beliefs and values.	
Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use.	
Observability is the degree to which the results of an innovation are visible to others. Observability explains the visibility of innovation outcome to the population.	
Trialability is the degree to which an innovation may be experimented with on a limited basis. This may include trying out parts of a program or having the opportunity to watch others using a new program.	

Source: *created by the author based on* (Rogers, 2003; Al-Jabri & Sohail, 2012)

Based on the DOI framework, Al-Jabri and Sohail (2012) investigated the adoption of mobile banking. Their research revealed that compatibility was found to be the most significant determinant to predict mobile banking adoption. Observability was found to have a significant effect on the adoption of mobile banking. Complexity and trialability were found to have an insignificant effect on mobile banking adoption. An additional variable was included into this model; perceived risk was found to have a negative significant effect on mobile banking adoption. Relative Advantage had a positive effect on mobile banking adoption. Also, the authors implied that relative advantage is largely similar to perceived usefulness in the technology acceptance model.

Al-Rahmi et al. (2019) combined the TAM and DOI frameworks to analyse students' Intention to Use E-Learning Systems. The research confirmed that PEOU positively influences PU. The research results revealed that the relative advantage positively impacts PU and PEOU, complexity negatively impacts PEOU, but not PU, trialability and observability positively impact PU, but not PEOU, meanwhile perceived compatibility, and perceived enjoyment positively impact PU and PEOU. Both PE and PEOU were confirmed to exert impact on the behavioural intention.

Yuen et al. (2021) investigated factors influencing autonomous vehicle adoption, while also combining the TAM and DOI frameworks. The research revealed that PEOU positively influences PU, however, PU had a stronger impact on the behavioural intention than PEOU. The elements of DOI – relative advantage, image, compatibility and result demonstrability had positive effects on PU, and they explained 86% of PU. Meanwhile, compatibility, result demonstrability, visibility, and trialability are positively related to PEOU, and they collectively explained 77% of PEOU.

Table No. 19 represents the expected relationship of the DOI and TAM model variables.

Table 19. Relationship between DOI and TAM variables

DOI & TAM Variables	Impact	Dependent Variable
Relative Advantage	Positively impacts → Supported by: Al-Jabri & Sohail (2012), Nazari et al. (2013), Kumar et al. (2017), Al-Rahmi et al. (2019), Usman et el. (2019), Prause (2019), AlBar & Hoque (2019)	***Innovation Adoption***
	Positively impacts → Supported by: Al-Rahmi et al. (2019), Tripopsakul (2018), Yuen et al. (2021)	***The perceived usefulness (PU)***

DOI & TAM Variables	Impact	Dependent Variable
	Positively impacts → Supported by: Al-Rahmi et al. (2019), Tripopsakul (2018)	***The perceived ease of use (PEOU)***
Compatibility	Positively impacts→ Supported by: Al-Jabri & Sohail (2012), Kumar et al. (2017), Usman et al. (2019)	***Innovation Adoption***
	Positively impacts→ Supported by: Al-Jabri & Sohail (2012), Tripopsakul (2018), Al-Rahmi et al. (2019), Yuen et al. (2021)	***The perceived usefulness (PU)***
	Positively impacts→ Supported by: Al-Jabri & Sohail (2012), Tripopsakul (2018), Al-Rahmi et al. (2019), Yuen et al. (2021)	***The perceived ease of use (PEOU)***
Complexity	Negatively impacts→ Supported by: Nazari et al. (2013), AlBar & Hoque, (2019), Usman et al., (2019), Skafi et al. (2020)	***Innovation Adoption***
	Negatively impacts → Studies not found	***The perceived usefulness (PU)***
	Negatively impacts→ Supported by: Al-Rahmi et al. (2019)	***The perceived ease of use (PEOU)***
Observability	Positively impacts→ Supported by: Al-Jabri & Sohail (2012), Nazari et al. (2013), AlBar & Hoque (2019)	***Innovation Adoption***
	Positively impacts→ Supported by: Al-Rahmi et al. (2019), Yuen et al. (2021)	***The perceived usefulness (PU)***
	Positively impacts→ Supported by: Yuen et al. (2021)	***The perceived ease of use (PEOU)***
Trialability	Positively impacts→ Supported by: Nazari et al. (2013)	***Innovation Adoption***
	Positively impacts→ Supported by: Tripopsakul (2018), Al-Rahmi et al. (2019)	***The perceived usefulness (PU)***
	Positively impacts→ Supported by: Tripopsakul (2018), Yuen et al. (2021)	***The perceived ease of use (PEOU)***

Source: *created by the author based on* (Rogers, 2003; Al-Jabri & Sohail, 2012)

To sum up, the findings of the above-mentioned studies imply that both TAM and DOI are complementary and can be used to explain the behavioural intention to adopt new technologies. The researched scientific papers revealed that DOI variables, such as compatibility, positively impact both PU and PEOU, meanwhile, other variables usually have a significant impact either on PU or PEOU. However, in order to better understand those factors which influence the adoption of Industry 4.0 technologies, an additional theoretical framework can be used, which is called the *Technology-Environment-Organisation Framework*. Accordingly, this theoretical framework shall be analysed in the next section.

1.9. Factors Influencing Industry 4.0 Technologies' Adoption Based on the Technology-Environment-Organisation Framework

Developed in 1962 by Rogers with further work on it by Tornatzky and Fleischer in 1990, the *Technological, Organisational and Environmental Framework* (TOE) represents how the business context and components of enterprises affect the adoption of innovation. The model of the theory is shown in Figure No. 6, and the variables are explained in Table No. 20.

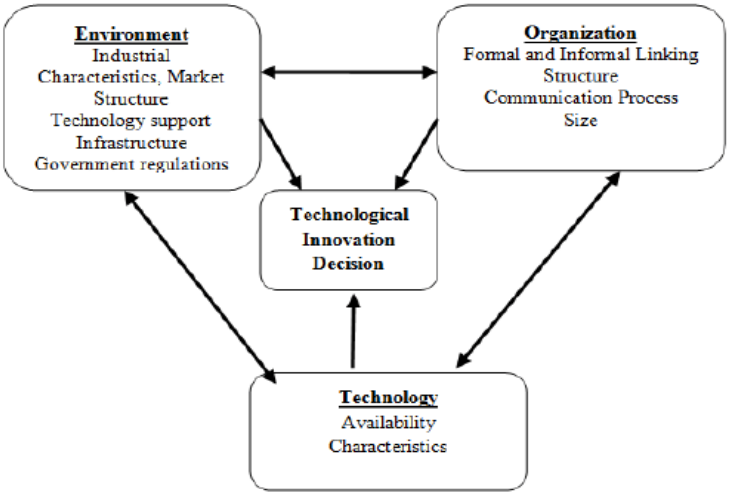

Figure 6. Technological, Organisational and Environmental Framework (TOE)
Source: Tornatzky & Fleischer (1990)

Table 20. Variables of the Technology-Environment-Organisation Framework

Independent Variables	Dependent Variable
The technological context refers to characteristics of the technologies which are available for possible adoption by the organisation and the current state of technology in the organisation. This current state of technology can be expressed in both material (e.g., equipment owned by the organisation) and immaterial (e.g., methods currently in use).	**Technological Innovation decision** is the final use behaviour.
The organisational context consists of the organisation's structure, presence of innovation – enabling processes such as informal communication and strategic behaviour of the top management, slack resources, and the size of the organisation.	

Independent Variables	Dependent Variable
The environmental context combines elements such as the market structure, the external support available for adopting new technologies and government regulations. These elements interact with each other to influence the technology adoption decisions.	

Source*: created by the author based on (*Tweneboah-Koduah et al., 2014; Skafi et al., 2020)

Based on the researched studies, in Table No. 21, the expected impact of the TOE variables towards the adoption of technologies are summarised.

A study of Nguyen and Waring (2013) about the adoption of the Customer Relationship Management (CRM) technology in SMEs showed that the decision to implement a CRM system is influenced by management's perception of CRM, employee involvement, the firm's size, its perceived market position, but not the industry sector. Kumar et al. (2017) researched the suitability of cloud computing for small and medium-sized enterprises in India and found out that the perceived benefits, the top management support, and the competitive pressure and the perceived concerns are significant factors influencing the intention of SMEs to adopt cloud computing. Unexpectedly, the factors such as security and privacy and reliability were not found significant in this study.

Nair et al. (2019) states that owner's attitude to IT implementation, the size of the SME, and the owner's knowledge of IT and age are significant for preparedness, and for the achievement of the benefits for IT implementation. Eze et al. (2019) studied the mobile marketing technology adoption in service SMEs and highlighted that the TOE framework factors influence the mobile marketing technology adoption, but the extent to which these factors shape the mobile marketing adoption varies by the technology, organisation, environment, and value anticipation contexts. Ghobakhloo and Chingc (2019) in their research concluded that the adoption of the Industry 4.0 technologies is still costly for the majority of SMEs, and smaller manufacturers are generally characterised by financial resource limitation. The study findings show that compatibility and strategic road-mapping for manufacturing digitalisation are crucial to SMEs' decision on the adoption of smart manufacturing technologies.

Maroufkhani (2020) conducted a study about a Big Data analytics adoption model for small and medium enterprises, which revealed that the adoption of Big Data in SMEs mediates the impact of the TOE contexts on the financial performance. Big Data analytics adoption mediates the effects of the

organisational and technological contexts on the market performance, while the environmental context does not have any relationship with the market performance in both direct and indirect estimations. In addition to this, Masood & Sonntag (2020) revealed that flexibility, cost, efficiency, quality, and competitive advantage are found to be the key benefits to Industry 4.0 adoption in SMEs. Whilst many SMEs show a desire to implement the Industry 4.0 technologies for these reasons, financial and knowledge constraints are found to be the key challenges. Matikiti et al. (2018) researched the social media marketing use in the South African tourism industry while using the TAM and TOE frameworks. The research revealed that the support of the top management, managerial characteristics such as the educational level, as well as pressure stemming from competitors, positively impacted the attitude towards technology adoption. Meanwhile, the perceived benefits and PEOU positively affected the attitude towards the social media marketing usage. According to the authors, this study confirms that TOE and TAM are among the most important theories to explain the adoption of the Industry 4.0 technologies.

Table 21. Relationship between TOE and technology adoption

TOE Variables	Impact	Dependent Variable
The technological context		**Technological Innovation adoption decision**
Technology Readiness, Prior Technological experience	Positively impacts→ Supported by: Usman et el. (2019), Skafi et al. (2020)	
Owner's knowledge of IT	Positively impacts→ Supported by: Nair et al. (2019)	
Manager characteristics, like age, educational level	Positively impacts→ Supported by: Matikiti et al. (2018), Nair et al. (2019)	
The organisational context		
Top management support	Positively impacts→ Supported by: Kumar et al. (2017), Matikiti et al. (2018), AlBar and Hoque (2019), Prause (2019), Usman et al. (2019), Skafi et al. (2020)	
Management's perception of technology	Positively impacts→ Supported by: Nguyen and Waring (2013), Nair et al. (2019), Usman et el. (2019)	
Employee involvement	Positively impacts→ Supported by: Nguyen and Waring (2013)	
The firm's size	Positively impacts→ Supported by: Nguyen and Waring (2013), Kumar et al. (2017), Nair et al. (2019), Usman et al. (2019), Skafi et al., (2020)	

TOE Variables	Impact	Dependent Variable
The environmental context		
Perceived market position	Positively impacts→ Supported by: Nguyen and Waring (2013)	
Market Uncertainty	Positively impacts→ Supported by: Prause (2019)	
Regulatory Environment	Positively impacts→ Supported by: AlBar and Hoque (2019), Usman et el. (2019)	
Competitors Pressure, External Pressure	Positively impacts→ Supported by: Kumar et al. (2017), Matikiti et al. (2018), AlBar and Hoque (2019), Usman et al. (2019)	

Source: *created by author based on* (Tweneboah-Koduah et al., 2014; Skafi et al., 2020)

To summarise, it can be stated that the TOE framework variables are important while investigating the Industry 4.0 technologies' adoption, as it provides the bigger perspective than the TAM model alone. The TOE framework concentrates not only on the technologies themselves, but also considers variables related to the micro and macro environment(s) of the SMEs.

Emphasising the importance of the holistic approach while exploring the factors towards the adoption of the Industry 4.0 technologies within SMEs, the following section covers the combination of the several models to investigate the phenomenon of the technologies adoption and summarises all of the key factors which influence the SMEs decision to adopt the Industry 4.0 technologies in marketing functions.

1.10. Holistic Approach towards TPB, TAM, TOE and DOI Factors

Some authors investigated the technology adoption phenomenon while combining the TOE and DOI models (AlBar & Hoque, 2019; Prause, 2019; Usman et al., 2019; Skafi et al., 2020). AlBar and Hoque (2019) explored factors affecting the cloud enterprise resource planning (ERP) systems adoption in Saudi Arabia. The study revealed that the TOE framework variables, such as the ICT Infrastructure, the top management support, the regulatory environment, and the competitive environment positively impacted the ERP adoption, meanwhile the selected DOI variables – compatibility, trialability, and TOE framework variable – the organisational culture were not found to have a significant influence. Meanwhile, Usman et el. (2019) researched the determinants of the adoption of cloud-based ERP of the Nigerian SMEs Manufacturing Sector. The research results revealed that

technology readiness, cloud ERP knowledge, competitor pressure, regulatory support based on the TOE framework and variables of DOI, such as compatibility and the relative advantage, were found to be the most influential factors on the cloud ERP adoption by SMEs. However, the top management support, the firm size and complexity were not significant. In addition to that, Prause (2019) found that the market uncertainty regarding the firm's business is a significant driver for the adoption of technologies in the short, medium and long term. Meanwhile, the relative competitive advantage matters in the short term, and the top management support matters in the long term.

Moreover, Skafi et al. (2020) investigated factors influencing SMEs' adoption of cloud computing services in Lebanon. The research revealed that the support of the top management and prior technological experience have a positive impact towards the adoption of cloud computing services. Meanwhile, a poor infrastructure and complexity have a negative impact towards the adoption of cloud computing services. However, trialability, the organisation size, a high rivalry level among companies within an industry do not exert a significant influence. Kumar et al. (2017) researched factors influencing cloud computing adoption by small and medium-sized enterprises (SMEs) in India while using the combined TAM + DOI + TOE frameworks approach. According to the research, the DOI theory variable relative advantage, and the TOE framework variables, such as the top management support, external pressure, or service providers' support had a positive influence towards the cloud computing adoption. Meanwhile, such TAM elements as PU and PEOU, an element of DOI – (compatibility), and two TOE framework elements – technology readiness and the firm size – did not have any influence.

Summarising the points discussed above, literature analysis shows that digitisation in its various forms is positively related to small business growth, performance, and competitiveness. In addition to it, the enablement of Industry 4.0 technologies can have a positive impact on various marketing-related functions, such as the product quality improvement or the customer loyalty. Also, literature analysis has shown that the main groups of factors influencing the enablement of the Industry 4.0 technologies in SMEs are related to the technology-specific factors, such as the level of complexity to use the new technology, firm-specific factors, such as the manager capabilities, resource-based factors, such as the financial capabilities and the necessary skills, as well as the factors which are outside of the control of the companies, like the competitive landscape, or the sector of the industry. Based on the investigated studies, it can be stated that classical technology adoption frameworks, such as the TAM, TPB, UTAUT, DOI and TOE are most

commonly used while exploring the implementation factors of the Industry 4.0 technologies within SMEs. A summary of the key researched factors in the discussed studies are presented in Table No. 22.

Table 22. Theories and explored factors in the research of Industry 4.0 technologies' adoption

AUTHOR/ARTICLE	THEORIES	CONSTRUCTS
Prause, 2019 Challenges of Industry 4.0 Technology Adoption for SMEs: The Case of Japan	TOE framework + independent variables to match the context of small and medium-sized enterprises	Relative Advantage, Complexity, Compatibility, Cost, Top management support and championship, Satisfaction with existing systems, Organisational structure, Market uncertainty, Industry cluster, Market transparency, Security concerns
Eze et al., 2019 Mobile marketing technology adoption in service SMEs: a multi-perspective framework	The extended TOE framework	Operational effectiveness, Adaptive capability, Simplicity, Safety issues, Expandability, Shared understanding, The extent of business collaboration and diversity in knowledge, Training period, Service delivery, Customer satisfaction, Competition, Cost business growth, Differentiation, Return on investment
Nair et al., 2019 Readiness factors for information technology adoption in SMEs: testing an exploratory model in an Indian context	The extended TOE framework	Customer pressure, Supplier pressure, Government pressure, IT infrastructure, Information intensity, Business size, Age of the SME owner, SME owner's innovativeness regarding IT, SME Owner's attitude towards IT implementation, SME owner's knowledge of IT perceived benefits (tangible, intangible)
Ghobakhloo & Chingc, 2019 Adoption of digital technologies of smart manufacturing in SMEs	TOE framework	Perceived value, Perceived costs, Perceived compatibility, Information processing requirements, IDT knowledge competency, Strategic road mapping for manufacturing digitalisation imposition by environment, Competitive pressure

AUTHOR/ARTICLE	THEORIES	CONSTRUCTS
Maroufkhani, 2020 Big data analytics adoption model for small and medium enterprises	TOE framework +DOI	Technological context (Relative Advantage, Compatibility, Complexity, Risk and insecurity, Trialability, Observability), Organisational context (Top management support, organisational readiness), Environmental context (competitive pressure, external support, government regulations), Big Data analytics adoption (BDA), Financial performance, Market performance
Kumar et al., 2017 Exploring suitability of cloud computing for small and medium sized enterprises in India	TOE framework +DOI	Perceived cost benefits, Relative advantage, Top management support, Competitive pressure, Security and privacy, Reliability, Perceived concerns, SME's intention to adopt clouding computing
Nguyen & Waring, 2013 The adoption of Customer Relationship Management (CRM) technology in SMEs an empirical study	Framework of DOI	Management characteristics (gender, age, education background, their innovativeness and their positive attitude toward CRM). Employee characteristics (the management's view of their employee involvement, contribution and acceptance of changes). IT resources (IT abilities, capacities and capabilities of the firm). Firm characteristics (the industry sector, the firm size (by the number of employees), its perceived market position, and the firm's innovativeness
Herzallah & Mukhtar, 2016 The Impact of Perceived Usefulness, Ease of Use and Trust on Managers' Acceptance of e-Commerce Services in Small and Medium-	Extended TAM framework	Perceived usefulness, Perceived ease of Use, Perceived trust, Intention to use e-commerce

AUTHOR/ARTICLE	THEORIES	CONSTRUCTS
Sized Enterprises (SMEs) in Palestine		
Camilleri, 2019 The SMEs' technology acceptance of digital media for stakeholder engagement	TAM + additional variables	The pace of technological innovation, Perceived ease of use, Perceived usefulness, Technological anxiety, Commercial responsibility, Ethical responsibility, Social responsibility, Support to responsible stakeholders
Masood & Sonntag, 2020 Industry 4.0: Adoption challenges and benefits for SMEs	An adapted TAM model	Business size, Manufacturing complexity, Perceived benefits of a technology, Perceived challenges of a technology, Attitude towards Industry 4.0, Intention or attitude towards use
Kumar & Ayedee, 2021 Technology adoption: a solution for SMEs to overcome problems during Covid19	TAM, UTAUT models	Owner's characteristics, Perceived usefulness, Perceived ease of use, Facilitating conditions
Abu et al., 2015 Modified of UTAUT Theory in Adoption of Technology for Malaysia Small Medium Enterprises (SMEs) in Food Industry	Modified UTAUT Model	Performance expectancy, Social influence, Resistance to use, Facilitating condition, Behavioural intention

Source: *created by the author based on* (Nguyen & Waring, 2013; Abu et al., 2015; Herzallah & Mukhtar, 2016; Kumar et al., 2017; Camilleri, 2019; Prause, 2019; Eze et al., 2019; Nair et al., 2019; Ghobakhloo & Chingc, 2019; Maroufkhani, 2020; Masood & Sonntag, 2020; Kumar & Ayedee, 2021)

2. METHODOLOGY OF THE RESEARCH ON THE FACTORS INFLUENCING INDUSTRY 4.0 TECHNOLOGIES' SUITABILITY FOR ADOPTION IN MARKETING FUNCTIONS WITHIN LITHUANIAN SMEs

2.1. Research Aim and Objectives, Development of the Research Model and Hypotheses

In the first part of this thesis, the main theoretical aspects of Industry 4.0 have been analysed. The analysis revealed the different types of the Industry 4.0 technologies derived in the context of Industry 4.0, their impact on business, and their adoption motives towards the marketing functions in SMEs. Also, the theoretical analysis explored those theoretical frameworks which are most commonly used while investigating aspects of technology adoption within SMEs.

To analyse the suitability of the Industry 4.0 technologies for adoption in the marketing functions within the SMEs, the methodological part of the study presents the research object, the aim, the objectives, the research model, the research hypotheses, and the research methods.

The object of the research: Factors, influencing Industry 4.0 technologies' (*universal and niche*) suitability for adoption in four marketing functions (*product, price, promotion, and place*) within Lithuanian SMEs.

Research aim: to investigate the factors influencing the suitability of the Industry 4.0 technologies (*universal and niche*) for adoption in four marketing functions (*product, price, promotion, and place*) within Lithuanian SMEs.

Research objectives:

- To construct a research model and develop research hypotheses based on the findings of previous researchers.

- To establish a qualitative data collection instrument to identify the most universal and niche technologies of Industry 4.0 suitable for adoption in the marketing functions within Lithuanian SMEs.

- To establish a quantitative data collection instrument to collect the data regarding the factors influencing the suitability of Industry 4.0-derived technologies (universal and niche) for adoption in the marketing functions (*product, price, place, promotion*) within Lithuanian SMEs.

- To test the raised hypotheses by conducting correlation, regression, mediation and moderation analyses.

- To derive results and propose suggestions based on them.

According to the findings in the theoretical part, the proposed research model combines elements from four different theoretical frameworks (the *Diffusion of Innovations Theory*, the *Technology Acceptance Model*, the *Theory of Planned Behaviour*, as well as the *Technology-Environment-Organisation Framework*). This combination of elements in the model is expected to be more holistic and more aptly evaluate and explain the factors influencing the suitability of the Industry 4.0 technologies for adoption in the marketing functions within Lithuanian SMEs.

The proposed research model highlights the importance of the SMEs manager's/owner's perception towards the suitability of the Industry 4.0 technologies adoption in the marketing functions within SMEs. Based on the research model, the perceived characteristics of the Industry 4.0 technology (the Diffusion of Innovations Theory elements – *perceived relative advantage, perceived compatibility, perceived complexity, perceived observability, perceived trialability*) impact the Industry 4.0 technology perceived usefulness and the perceived ease of use (the Technology Acceptance Model elements (*perceived usefulness, perceived ease of use*). Also, the relationship between DOI and TAM constructs is moderated by the type of the Industry 4.0 technology (*universal and niche*).

Consequently, the perceived usefulness and the perceived ease of use of the Industry 4.0 technology impact the attitude of the SMEs manager/owner towards the Industry 4.0 technology suitability for adoption in the marketing functions (the Theory of Planned Behaviour element – *attitude towards Industry 4.0 technology suitability for adoption in the marketing function in SME).* This relationship is also moderated by the type of the Industry 4.0 technology and the type of the marketing function (*product, price, place, promotion*). Additionally, the perceived ease of use of the Industry 4.0 technology mediates the impact of the perceived usefulness on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs. Finally, the attitude of the SMEs manager/owner towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs impacts the behavioural intention to adopt the Industry 4.0 technologies in the marketing functions within SMEs. This relationship is moderated by the elements of the TOE framework (*SME size, top management support, competitive environment*) and the type of the marketing function as well as by the type of the Industry 4.0 technology.

The proposed research model posits that the most significant variables in the model are hypothesised to have the direct impact. It includes the following variables: the perceived characteristics impact both the perceived usefulness and the perceived ease of use, the perceived usefulness and the

perceived ease of use impact on the attitude of the SMEs manager/owner towards the suitability of the Industry 4.0 technology for adoption in the marketing functions within SMEs. Also, the attitude of the SMEs manager/owner exerts an impact on their behavioural intention to adopt the Industry 4.0 technology in the marketing functions within SMEs. Moreover, the model includes additional mediating and moderating variables that are hypothesised to influence the relationships between the primary variables. These moderating variables include the type of the Industry 4.0 technology, the type of the marketing function, the SME size, the top management support, and the competitive environment. The research model is illustrated in Figure No. 7, and the accompanying legend which clarifies the different types of relationships among the variables in the research model.

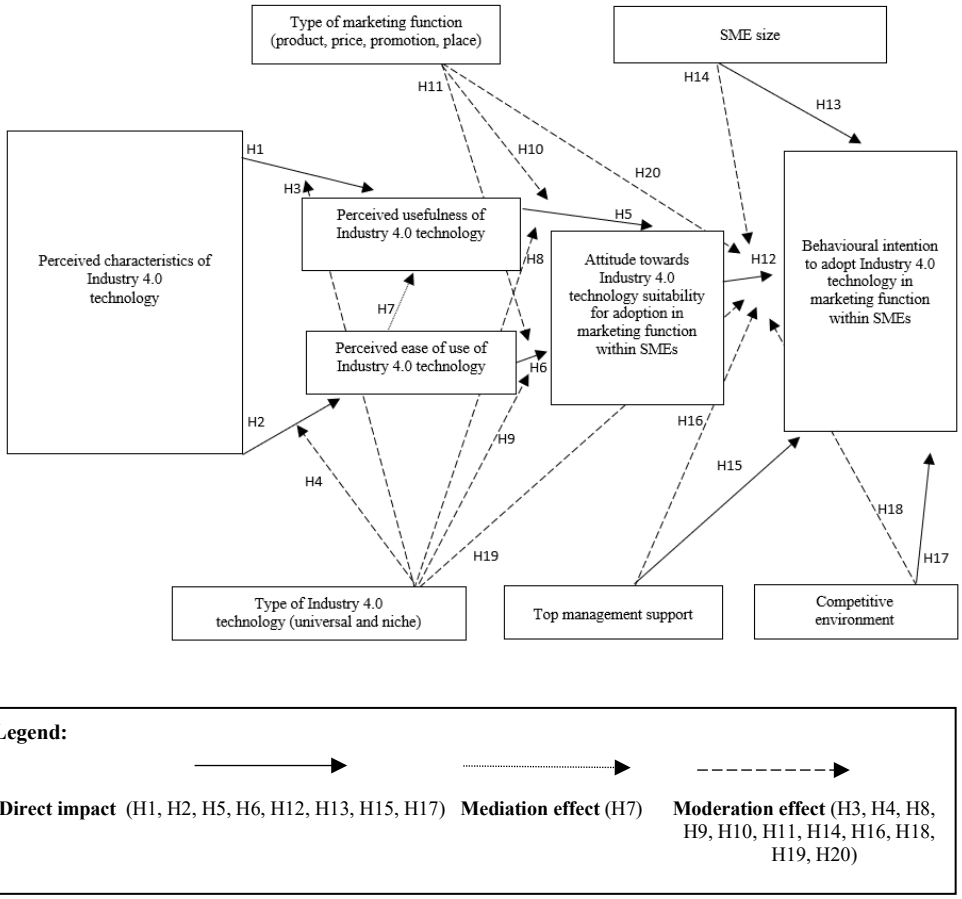

Figure 7. Research Model
Source: created by the author

By incorporating the direct and mediating, as well as the moderating effects, the research model aims to provide a comprehensive understanding of the factors influencing the adoption of the Industry 4.0 technologies in the marketing functions of SMEs.

It is of importance to note that, for the purposes of further analysis, the research model is segmented into three distinct parts: *Part A*, *Part B*, and *Part C*. The hypotheses underpinning the research model are summarised below. A detailed theoretical grounding of these hypotheses will be provided in the subsequent sections corresponding to each part of the research model (A, B, and C). This structured approach facilitates a comprehensive examination of the factors and their interrelationships within the framework of the Industry 4.0 technology adoption in the SMEs marketing functions.

The hypotheses covering the relationships in the research model are formulated as follows:

H1: *Industry 4.0 technology characteristics affect the perceived usefulness of the Industry 4.0 technology.*

H2: *Industry 4.0 technology characteristics affect the perceived ease of use of the Industry 4.0 technology.*

H3: *The impact of the perceived characteristics of Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H4: *The impact of the perceived characteristics of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H5: *The perceived usefulness of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

H6: *The perceived ease of use of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

H7*: The perceived ease of use of the Industry 4.0 technology mediates the impact of the perceived usefulness on an attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

H8: *The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.*

H9: *The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for*

adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.

H10: *The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for the adoption in the marketing function within SMEs is moderated by the type of the marketing function.*

H11: *The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the marketing function.*

H12: *The attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H13: *The SME size positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H14: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger in the case of a bigger size of the SME.*

H15: *The top management support positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H16: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for the adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is stronger for a higher level of the SME top management support.*

H17: *A competitive environment positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H18: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is stronger for a higher level of the competitive environment.*

H19: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0*

technology in the marketing function within SMEs is stronger in the case of the universal Industry 4.0 technology adoption.

H20: *The impact of the attitude towards Industry 4.0 technology suitability for the adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is moderated by the type of the marketing function.*

The research model Part A explores the perceived characteristics of the Industry 4.0 technology impact on the Industry 4.0 technology perceived usefulness and the perceived ease of use. Also, this model investigates the possible moderating effect of the type of the Industry 4.0 technology. The research model Part A is depicted in Figure No 8. The hypotheses are raised and grounded below.

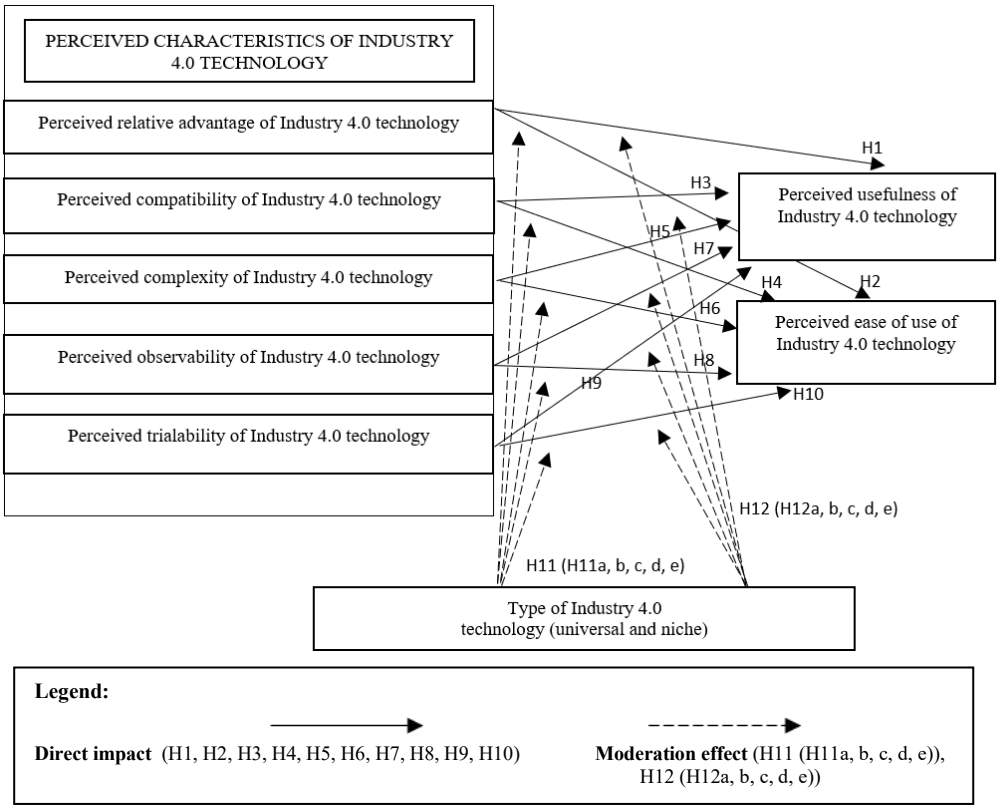

Figure 8. Research Model Part A – perceived characteristics of Industry 4.0 technology and PU & PEOU
Source: created by the author

Research Model Part A Hypotheses development

According to Rogers (1962), the relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. Consequently, the higher the perceived relative advantage of the technology of Industry 4.0 is, the more it is likely that the innovation will be adopted. In the context of the Industry 4.0 technologies adoption, the benefits such as the product quality improvement, the expansion of direct sales, an improved and creative communication with the customers, an increased customer satisfaction, an increased competitiveness of the company, and the change in the number of costs were mentioned as the most important ones for the SMEs (Młody, 2018; Ungerman et al., 2018; Ungerman & Dědková, 2019). Many previous studies proved the relative advantage as an important factor influencing the Industry 4.0 technologies adoption (Al-Jabri & Sohail, 2012; Nazari et al., 2013; Kumar et al., 2017; Al-Rahmi et al., 2019; Usman et al., 2019; Prause, 2019; AlBar & Hoque; 2019).

However, the relationships between the perceived relative advantage, the perceived ease of use and the perceived usefulness have received little attention from researchers. Nonetheless, some literature suggests that the perceived relative advantage is an antecedent of PU, for example, the positive relationship between the perceived relative advantage and the perceived usefulness, as well as the perceived ease of use of the Industry 4.0 technologies enablement, was confirmed by several authors (Al-Rahmi et al, 2019; Tripopsakul, 2018). Also, Yuen et al. (2021) conducted a study which confirms a positive relationship between the perceived relative advantage and the perceived usefulness, thus the following hypotheses are formulated:

H1: *The perceived relative advantage of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

H2: *The perceived relative advantage of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

Compatibility is described as the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of the potential adopters. If the innovation is perceived as an extreme change, then it will not be compatible with past experiences and is less likely to be adopted (Rogers, 1962). Compatibility was found to be influential while adopting cloud computing in SMEs in India (Kumar et al., 2017), as well as in other studies (Al-Jabri & Sohail, 2012; Usman et al., 2019).

Previous studies have investigated the perceived compatibility regarding different aspects, resulting in support for its impact on PU and

PEOU. Also, the studies conducted by Al-Rahmi et al. (2019), Yuen et al. (2021), Al-Jabri and Sohail (2012), and Tripopsakul (2018) confirm such relationships. Accordingly, the following hypotheses are formulated:

H3: *The perceived compatibility of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

H4: *The perceived compatibility of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

Based on Rogers (1962), complexity is the degree to which an innovation is perceived as relatively difficult to understand and use; consequently, those innovations which are perceived as complex are less likely to be adopted. The previous empirical studies provided evidence indicating that complexity had a significant negative effect on the intention to adopt or use the Industry 4.0 technologies (Nazari et al., 2013; AlBar & Hoque, 2019; Usman et al., 2019; Skafi et al., 2020).

Moreover, a negative relationship between perceived complexity and PEOU was revealed in a study conducted by Al-Rahmi et al. (2019). However, no studies were found to confirm the relationship between the perceived complexity and the perceived usefulness. Nonetheless, to test the relations, the following hypotheses are raised:

H5: *The perceived complexity of the Industry 4.0 technology negatively affects the perceived usefulness of the Industry 4.0 technology.*

H6: *The perceived complexity of the Industry 4.0 technology negatively affects the perceived ease of use of the Industry 4.0 technology.*

Observability is the degree to which the results of an innovation are visible to others. If the observed effects are perceived to be small or non-existent, then the likelihood of adoption is reduced (Rogers, 1962). In the context of Industry 4.0, observability can be defined as seeing the effect of the adoption of technologies in the marketing activities immediately. Several studies supported that observability has a direct positive influence on the adoption intention of the Industry 4.0 technologies (Al-Jabri & Sohail, 2012; Nazari et at., 2013; AlBar & Hoque, 2019).

Also, similarly to the previously discussed diffusion of the innovation factors, some researchers found a positive relationship between the perceived observability and the perceived usefulness and the perceived ease of use. For example, Yuen et al. (2021) conducted a study which confirmed the positive relationship between the perceived observability and the perceived usefulness as well as between perceived observability and the perceived ease of use. Meanwhile, Al-Rahmi et al. (2019) in their study rejected the positive

relationship between the perceived observability and the perceived ease of use, however, the authors confirmed the significant relationship between the perceived observability and the perceived usefulness. Accordingly, the following hypotheses are raised:

H7: *The perceived observability of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

H8: *The perceived observability of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

Trialability can be defined as the degree to which an innovation may be experimented with on a limited basis. This may include trying out parts of a program or having the opportunity to watch others using a new program. Moreover, based on Rogers (1962), trialability is positively related to the likelihood of adoption. The importance of trialability regarding the adoption of the Industry 4.0 technologies was confirmed by Nazari et al. (2013). However, this relationship was not detected in the study conducted by Al-Jabri and Sohail (2012). Moreover, based on Al-Rahmi et al. (2019), trialable innovation tends to have less uncertainty perceived by individuals who consider adopting it, and those individuals tend to learn through this experience.

Consequently, some authors investigated the relationship between the perceived trialability and the perceived usefulness, as well as the perceived ease of use. According to the study findings of Al-Rahmi et al. (2019), perceived trialability has a positive effect on the perceived usefulness, however, no significant relationship was found between the perceived trialability and the perceived ease of use. Nonetheless, the study of Yuen et al. (2021) confirmed the relationship between the perceived trialability and the perceived ease of use. Additionally, a study carried out by Tripopsakul (2018) confirms the significant relationship between both TAM variables and perceived trialability. Accordingly, the following hypotheses are raised:

H9: *The perceived trialability of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

H10: *The perceived trialability of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

Additionally, this study aims to test the moderating role of the type of the Industry 4.0 technology on interaction between the perceived characteristics of the Industry 4.0 technology on the perceived usefulness, as well as between the perceived characteristics of the Industry 4.0 technology and the perceived ease of use; thus, the following hypotheses are raised:

H11: *The impact of the perceived characteristics of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H11a*: The impact of the perceived relative advantage of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H11b*: The impact of the perceived compatibility of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H11c*: The impact of the perceived complexity of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H11d*: The impact of the perceived observability of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H11e*: The impact of the perceived trialability of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H12: *The impact of the perceived characteristics of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H12a*: The impact of the perceived relative advantage of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H12b*: The impact of the perceived compatibility of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H12c*: The impact of the perceived complexity of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H12d*: The impact of the perceived observability of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H12e*: The impact of the perceived trialability of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

The research model Part B examines the relationship between the perceived usefulness and the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. Also, the relationship between the perceived ease of use of the Industry 4.0 technology and the perceived usefulness of the Industry 4.0 technology is explored. As in the research model Part A, this model also investigates the possible moderating effect of the type of the Industry 4.0 technology; in addition, it investigates the moderating effect of the type of the marketing function. The research model is placed in Figure No. 9. Hypotheses are raised and grounded below.

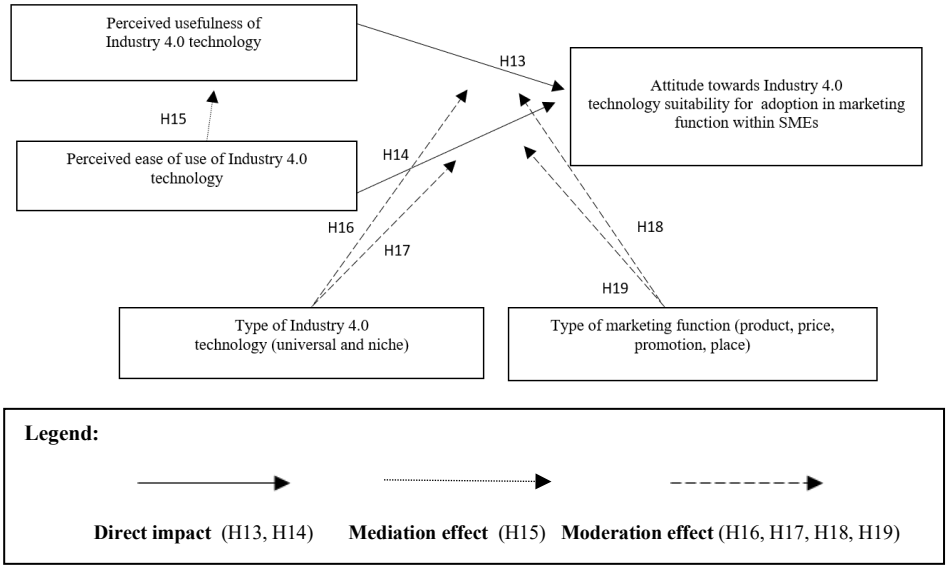

Figure 9. Research Model Part B – PU & PEOU and attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs

Source: created by the author

Research Model Part B Hypotheses development

According to Davis et al. (1989), the perceived usefulness can be defined as the extent to which a technology is expected to improve a potential user's performance. Accordingly, in the context of Industry 4.0, the perceived usefulness specifies the degree to which users perceive that the usage of the Industry 4.0 technologies will increase the job productivity, performance, and effectiveness. Various authors raise hypotheses about the direct positive relationship between the perceived usefulness of the Industry 4.0 technologies

and the intention to adopt the technologies. The positive relationship was also confirmed in the studies carried out by a number of authors (Herzallah & Mukhtar, 2016; Camilleri, 2019; Tripopsakul, 2018; Ritz et al., 2019; Rahman et al., 2021; Yuen et al., 2021; Al-Rahmi et al., 2019; Nazir & Khan, 2022).

However, some authors state that the attitude towards technologies mediates the relationship between the perceived usefulness and the actual decision to adopt the technology. Based on the investigated literature sources, the higher is the perceived usefulness of the technology, the more positive is the attitude toward the intention to adopt the technology (Matikiti et al., 2018; Rahman et al., 2021; Alhashmi et al., 2019). Thus, the following hypothesis is formulated:

H13: *The perceived usefulness of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

The perceived ease of use is the extent to which a person believes that using a technology will be free of effort (Davis et al.,1989). In the present context, if the manager/owner of an SME finds the Industry 4.0 technology easy to use and less complicated, then the chances of such technology adoption will increase in that SME. This positive relationship was confirmed by the studies carried out by (Tripopsakul, 2018; Camilleri, 2019; Ritz et al., 2019; Al-Rahmi et al., 2019; Alhashmi et al., 2019; Vahdat et al., 2021; Rahman et al., 2021; Nazir & Khan, 2022).

Some authors (Matikiti et al., 2018; Alhashmi et al., 2019) also propose the idea that the perceived ease of use has a positive relationship with the attitude towards the adoption of the Industry 4.0 technologies. Accordingly, the following hypothesis is raised:

H14: *The perceived ease of use of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

According to the original TAM model, the perceived ease of use has an impact on the users' intended use, which is realised through the perceived usefulness. This means that such an effect of the perceived ease of use on the behavioural intention is indirect (Davis et al., 1989). This relationship was also confirmed by various authors (Tripopsakul, 2018; Herzallah & Mukhtar, 2016; Al-Rahmi et al., 2019; Alhashmi et al., 2019; Yuen et al., 2021).

Moreover, some studies (Rahman et al, 2021; Yuen et al., 2021) raise the idea that the perceived usefulness has a bigger impact on the intention to

adopt the Industry 4.0 technologies than the perceived ease of use. Accordingly, the following hypothesis is raised:

H15*: The perceived ease of use of the Industry 4.0 technology mediates the impact of the perceived usefulness on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs*.

Additionally this study aims to test the moderating role of the type of the technology on the interaction between the perceived usefulness of the Industry 4.0 technology on an attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and between the perceived ease of use of the Industry 4.0 technology on an attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs; thus, the following hypotheses are raised:

H16: *The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.*

H17: *The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.*

Moreover, it is hypothesised that the type of the marketing function will moderate the relationship between the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. Also, the type of the marketing function will moderate the relationship between the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. Accordingly, the following hypotheses are raised:

H18: *The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the marketing function.*

H19: *The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the marketing function.*

The research model Part C examines the impact of the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. The model also tests the possible moderation effects on this relationship: by the elements of the TOE framework (*SME size, top management support, competitive environment*) and additional elements, such as the type of the Industry 4.0 technology and the type of the marketing function. The research model is presented in Figure No. 10. Hypotheses are raised and grounded below.

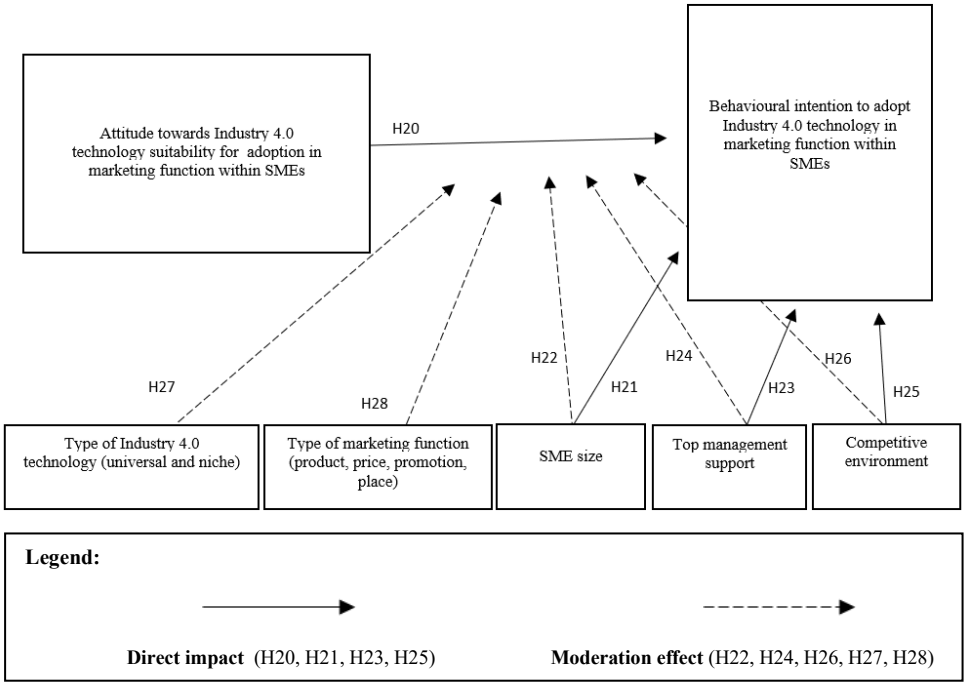

Figure 10. Research Model Part C – The relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the Behavioural intention
Source: created by the author

Research Model Part C Hypotheses development

Attitude refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour of interest, and it entails a consideration of the outcomes of performing the behaviour (Ajzen, 1985). The behavioural intention to adopt a new technology is influenced by the attitude towards that technology (Davis et al., 1989). Consequently, if the owner or manager has an e-'vision', they will not hesitate to adopt and implement new

technologies. This relationship was confirmed by previous studies (Alhashmi et al., 2019; Rahman et al., 2021). Consequently, the following hypothesis is raised:

H20: *Attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

According to Skafi et al. (2020), the organisation size is to be considered as a significant factor for small businesses, as small companies believe that their size enables them to adopt innovations as they can change their vision and mission easily and with flexibility. Also, researches caried out by Nguyen and Waring (2013), Kumar et al. (2017), Nair et al. (2019) and Usman et al. (2019) proved that the size of the company positively impacts its ability to adopt the Industry 4.0 technologies, while also proving that large firms have what it takes to adopt innovation as compared with small firms because of the availability of resources and the ability to take higher risks regarding the adoption of innovation. Additionally, it is thought that the SME size will moderate the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. Thus, the following hypotheses are raised:

H21: *SME size positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H22: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger in the case of the bigger size of the SME.*

According to Kumar et al. (2017), in an SME context, where, generally, a simple and flat organisational structure is followed, the top management refers to the owner of the SME unit. The owner of the SME unit is the head of all the functions and is the final decision-maker. Therefore, if the owner of the SME perceives the Industry 4.0 technologies as beneficial for the firm and easy to implement, then, the chances of its adoption increase significantly. Also, if the top management is dissatisfied based on the advantages of the Industry 4.0 technologies to the organisation business, then its adoption would simply be rejected (Usman et al., 2019). Such relationships were confirmed in

various studies (Kumar et al., 2017; Matikiti et al., 2018; AlBar & Hoque, 2019; Prause, 2019; Usman et al., 2019; Skafi et al., 2020).

Also, the present study aims to test the moderating effect of the top management support towards the relationship between the attitude towards the Industry 4.0 technology adoption and the behavioural intention to adopt the technology; thus, the following hypotheses are proposed:

H23: *The top management support positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H24: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger for a higher level of the SME top management support.*

According to some authors (Halse & Jaeger, 2019; Ungerman & Dědková, 2019), leveraging the advantages of the new technologies within the concept of Industry 4.0 is seen as an important factor to maintain competition for SMEs. Consequently, various studies confirm the relationship between the competitive environment and the intention to adopt new technologies (Kumar et al., 2017; Matikiti et al., 2018; AlBar & Hoque, 2019; Usman et al., 2019). Additionally, this study aims to test the moderating effect of the competitive environment towards the relationship between the attitude towards the Industry 4.0 technology adoption and the behavioural intention to adopt the technology; thus, the following hypotheses are proposed:

H25: *The competitive environment positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H26: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger for a higher level of the competitive environment.*

Additionally, it is assumed that the type of the Industry 4.0 technology will moderate the relationship between the attitude towards the Industry 4.0 technology suitability for the adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. Accordingly, the following hypothesis is raised:

H27: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger in the case of the universal Industry 4.0 technology adoption.*

Moreover, it is hypothesised that the type of the marketing function will moderate the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. Accordingly, the following hypothesis is raised:

H28: *The impact of the attitude towards the Industry 4.0 technology suitability for adoption in marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is moderated by the type of the marketing function.*

To investigate the suitability of the Industry 4.0 technologies for adoption in marketing functions within Lithuanian SMEs, the research will be divided into two parts:

1. In the first part, the qualitative empirical research design will be used, aiming to identify the most universal and niche technologies of Industry 4.0 suitable for adoption in the four marketing functions within Lithuanian SMEs.
2. The second part of the research will consist of the quantitative research methods, aiming to identify the factors influencing the suitability of the selected niche and universal Industry 4.0 technologies for adoption in the four marketing functions within Lithuanian SMEs.

In the next sub-chapter, the research stages, the research design, and the data collection instrument will be described.

2.2. Qualitative Research Design and Data Collection Instrument

In the first stage of the research, the qualitative empirical research design will be used. According to some authors (Veile et al., 2020; Khin & Kee, 2022), qualitative research is a suitable research form as it provides profound and deep-rooted information, gives a unique depth of understanding of the chosen topic, while the informants can freely disclose their experiences and thoughts.

The aim of the qualitative empirical research is to identify the most universal and niche technologies of Industry 4.0 suitable for the adoption in the four marketing functions within Lithuanian SMEs.

The requirements for the interviewees were as follows: to gather the most accurate data, the requirements for the interviewed informants were set up as:

(1) All C-level Executives must be working in SMEs based in Lithuania.

(2) All C-level Executives must be closely involved in or be responsible for Industry 4.0 implementation projects.

All C-Level Executives must have management positions or be in charge of their company operations.

The target population for the qualitative research stage was intentionally selected to include C-level executives from SMEs who already have practical experience with Industry 4.0 projects. This selection aims to validate the applicability of the Industry 4.0 technologies as documented in the existing scientific literature and to generate novel insights on this phenomenon. These newly gathered insights in the qualitative research stage will subsequently be used in the second phase of this study to test the hypotheses and deepen the understanding of the factors influencing the adoption of different Industry 4.0 technologies in the SMEs marketing practices.

Sample size and criteria for the semi-structured interview: based on the results of previous studies related to Industry 4.0, as noted in Table No. 23, the sample size of the semi-structured interview should include 10–12 participants.

Table 23. Qualitative research sample size comparison

AUTHORS	STUDY	CRITERIA FOR THE INTERVIEWEES	NUMBER OF INTERVIEWEES
Veile et al., 2020	Lessons learned from Industry 4.0 implementation in the German manufacturing industry	1. All experts have management positions; 2. All experts are closely involved in or responsible for Industry 4.0 implementation projects and know the relevant markets and their company's strategic orientation.	**13 PARTICIPANTS**
Yunus, 2021	The mark of Industry 4.0:	1. The informant should be an operation manager	**12 PARTICIPANTS**

AUTHORS	STUDY	CRITERIA FOR THE INTERVIEWEES	NUMBER OF INTERVIEWEES
	how managers respond to key revolutionary changes	or a person who is in charge of the company operations; 2. The informant should be working in the manufacturing industry; 3. The informant should have been working for at least one year in the current company.	
Khin and Kee, 2022	Factors influencing Industry 4.0 adoption	1. The interviewed informants were owners or managers, including CEOs, managing directors, general managers and production or operation managers.	**15 PARTICIPANTS**
Rahman et al., 2021	Adoption of artificial intelligence in banking services: an empirical analysis	1. The interviewees include experienced bankers at the managerial level and above, IT professionals and analysts.	**6 PARTICIPANTS**

Source: *created by the author based on* (Veile et al., 2020; Yunus, 2021; Khin & Kee, 2022; Rahman et al., 2021)

The design of the interview: during semi-structured online interviews, the respondents were asked about the suitability of the Industry 4.0 technologies for adoption in the marketing functions of SMEs. The interview guideline consists of three parts. It was prepared based on the previous examples of researches (Veile et al., 2020; Yunus, 2021; Khin & Kee, 2022; Rahman et al., 2021). The full interview guideline is presented in Appendix No. 2.

The first part of the interview deals with the personal facts, such as the job position, the company and industry field. The second part focuses on the five open questions related to the application of the Industry 4.0 technologies in SMEs to verify the interviewees' level of knowledge regarding Industry 4.0. The third part consists of the interviewees rating the suitability of fourteen (14) selected Industry 4.0 technologies (from very not suitable to very suitable) for the adoption in the four (4) marketing functions of SMEs.

The fourteen Industry 4.0 technologies for the interviewees' ratings were pre-selected based on a thorough review of the relevant scientific literature (Brkljac & Sudarevic, 2018; Calabrese et al., 2020; Cimini et al., 2017; Ćoćkalo et al., 2019; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Da Silva et al., 2019) due to their noted applicability in the marketing functions within SMEs. The selected fourteen technologies for the interviewees' ratings included the following Industry 4.0 technologies: Big Data, Artificial Intelligence, Mobile Apps/Technologies, Internet of Things, Cloud computing, 5G network, Augmented Reality, Chatbots, Virtual Assistants, Virtual Reality, 3D printing, Simulation/Digital Twin, Blockchain, and Autonomous Robots.

The four marketing functions for the C-level Executives' ratings were pre-selected based on the 4Ps Marketing Mix model developed by E. Jerome McCarthy (1960). It is of importance to note that, according to the literature (Gilmore et al., 2001; Walsh & Lipinski, 2009; Resnick et al., 2016), SMEs exhibit distinct characteristics in their marketing practices compared to the larger corporations. Typically, the marketing functions in SMEs are not as developed or influential as those in large enterprises. Therefore, this research focuses on the four primary marketing functions: the product marketing function, the price marketing function, the promotion marketing function, and the place marketing function.

The purpose of this Industry 4.0 technology rating is to elucidate the differences in the suitability of various technologies for the adoption in main marketing functions within small and medium-sized enterprises (SMEs). This investigation focuses on categorising the fourteen technologies as either universal or niche, thereby identifying those that merit further examination. Subsequently, the selected two technologies (one universal technology and one niche technology) will be subjected to a second stage of research involving the quantitative methods to test the hypotheses concerning various aspects of their applicability in the four aforementioned marketing functions within SMEs.

Data collection. The duration of an interview lasted between 20–30 minutes. The interviews were conducted in the English language. To avoid any informant bias, before starting the interviews, it was made sure that the informants are very clear on the nature and topic of the research and how the interview will be conducted. The time and budget limitation of the research project was acknowledged; therefore, this study used purposive sampling, which involves selecting the respondents who would best guarantee the comprehension of the studied phenomenon, while directly contacting the

potential informants via the Internet through a business social media platform (LinkedIn) and e-mails.

Data analysis. The interviews were conducted during the period of July and August 2023. This study coded the informants' responses, found similarities and differences, and attempted to make relations in terms of the application suitability of the Industry 4.0 technologies in SMEs marketing-related functions.

For the open questions, qualitative content analysis was applied for the answers of each interview to compare one informant's response with the others to gain insights and to elicit deeper meaning. For the Industry 4.0 technologies' suitability in the marketing functions rating part, the rating values were used for the statistical assessment. Each rating value was summed up, and their average, mean, median, the minimum and maximum values with a 95% confidence interval were calculated to detect the most suitable and niche Industry 4.0 technologies to be applied in marketing functions.

2.3. Quantitative Research Design and Data Collection Instrument

The second part of the research will consist of the quantitative research methods. The quantitative data collection method was chosen because it allows for a convenient data analysis regarding the relationships between the variables. Quantitative research entails numerical evaluations of variables to test whether the proposed hypotheses are accepted or rejected. This type of research also ensures standardised answers, which alleviates the process of data analysis. The causal technique is employed in this study design because it comprises investigating the strength of the relationships between the variables while employing regression analysis.

In this stage the gathered information from the semi-structured interviews with the C-level Executives of SMEs about the universal and niche technologies of the Industry 4.0 suitability for adoption in the marketing functions within Lithuanian SMEs will be used to test the raised hypotheses of the research model (Part A, Part B, Part C).

The aim of the quantitative empirical research is to identify the factors, influencing the suitability of niche and universal Industry 4.0 technologies for adoption in four marketing functions within Lithuanian SMEs.

Data collection instrument. The research will be analysing the suitability of two selected Industry 4.0 technologies to be adopted within the marketing functions of SMEs. Based on the qualitative research results, the selected technologies for the further research are: Big Data as a universal

Industry 4.0 technology and Chatbots as a niche Industry 4.0 technology. These two technologies were selected because they best represent the contrasting categories within the Industry 4.0 technologies. Big Data was rated as universally suitable across the price, place, promotion, and product marketing functions, thereby indicating its broad applicability. In contrast, Chatbots were rated as highly suitable for the promotion function but not as suitable for other marketing functions, thus highlighting this Industry 4.0 technology targeted applicability. By examining these two distinct technologies, the study will explore different aspects of technology adoption, by contrasting Big Data's broad utility with the specific application of Chatbots. This approach seeks to provide a comprehensive understanding of the Industry 4.0 technology adoption in the SMEs marketing functions.

The instrument of the research consists of the eight surveys. Four surveys will analyse the selected universal Industry 4.0 technology 'Big Data' suitability to be adopted within one selected marketing function of SMEs per survey: price, product, place, promotion. Meanwhile, the other four surveys will analyse the selected niche Industry 4.0 technology 'Chatbots' suitability to be adopted within one selected marketing function of SMEs per survey: price, product, place, promotion. This type of instrument was chosen to have the best accessibility to the target population. The questionnaire was compiled based on the relevant literature and other acknowledged sources and was ensured to be ethical, anonymous, and conforming to the applicable standards. The questionnaire was provided for the respondents in the Lithuanian language. The content of the survey is as follows:

- Part 1: Introduction of the survey and the aim of the survey, explanation to the respondents that the survey is fully anonymous, and the responses that they give are going to be used only for research purposes.
- Part 2: Screening questions to ensure that the answers given are of the target population. The target population are people who are currently working in Lithuanian SMEs, and their duties are related to marketing functions. This is also applicable to SMEs which did not apply the selected Industry 4.0 technologies (Chatbots, Big Data) in the above-mentioned four marketing related functions yet, but the respondents are aware about the selected technology in the questionnaire. If a respondent did not align with the requirements, the respondent would be informed that he/she would not be able to continue the survey.
- Part 3: DOI construct-related questions.
- Part 4: TAM construct-related questions.

- Part 5: TOE framework construct-related questions.
- Part 6: TPB construct-related questions.
- Part 7: Demographic questions: such as the SME industry sector, the respondent's work experience, etc.
- Part 8: Expression of gratitude for the time spent answering the survey.

These surveys include the following variables: the perceived relative advantage, the perceived compatibility, the perceived complexity, the perceived observability, the perceived trialability of the selected Industry 4.0 technology which impacts the Industry 4.0 technology perceived usefulness and the perceived ease of use. Consequently, the variables, such as Industry 4.0 technology' perceived usefulness and perceived ease of use impact attitude towards Industry 4.0 technology suitability for adoption in marketing function within SMEs. Accordingly, the attitude towards the Industry 4.0 technology suitability for the adoption in the marketing function within SMEs impacts the behavioural intention to adopt the Industry 4.0 technology within SMEs. All these presently mentioned relationships are moderated by the type of the Industry 4.0 technology. Additionally, the relationship between the Industry 4.0 technology perceived usefulness and the perceived ease of use on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is also moderated by the type of the marketing function. Finally, the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is moderated by the SME size, the top management support, the competitive environment, and the type of the marketing function.

Each variable was measured by using pre-validated scales of a construct developed by previous researchers with some modifications made in the terminology, as presented in Table No. 24. The full original and adjusted constructs and their items measured are provided in Appendix No. 3. An example of the surveys of the study is presented in Appendix No. 4 (in Lithuanian), as well as in Appendix No. 5 (translation in English).

Table 24. Constructs used in the research and their reliability

Constructs	Number of Items	Cronbach's alpha
Relative advantage (AlBar & Hoque, 2019), based on Premkumar and Roberts, 1999	3	0.733

Constructs	Number of Items	Cronbach's alpha
Compatibility (Kumar et al., 2017), based on Wang et al., 2010	4	0.869
Complexity (AlBar & Hoque, 2019), based on Premkumar and Roberts, 1999	3	0.848
Observability (Duan et al., 2010), based on Moore and Benbasat, 1991	5	0.771
Trialability (Yuen et al., 2021), based on Yuen et al., 2018	3	0.855
Perceived usefulness (Rahman et al., 2021), based on Belanche et al., 2019	4	0.972
Perceived ease of use (Rahman et al., 2021), based on Belanche et al., 2019	4	0.932
Attitude toward technology suitability for adoption (Rahman et al., 2021), based on Belanche et al., 2019	3	0.948
Top management support (Kumar et al., 2017), based on Ifinedo, 2011	4	0.915
Competitive environment (AlBar & Hoque, 2019), based on Al-Qirim & Corbitt, 2002	3	0.799
Intention to adopt (Kumar et al., 2017), based on Gangwar et al., 2015	3	0.936
SME Size (Sun et al., 2020), based on Wang et al., 2010	3	0.895

Source: *created by the author* based on the sources listed in the table

The response options for the factor-related questions were created by using a seven-point Likert scale ranging from 'strongly disagree' – one point in the scale, to 'strongly agree' – seven points in the scale. This allowed the respondents to express their level of agreement or disagreement with the given statements. This method was chosen due to its usefulness for analysing and applying the findings. The constructs mentioned in Table No. 24 were chosen due to their compatibility and adaptability to the research at hand, as most of them had been previously used for the Industry 4.0 technologies suitability analysis.

Sample size and data collection method. To collect and examine the data, it is critical to have a research sample size determined beforehand. The target population for the research are such people who are currently working in Lithuanian SMEs and are in charge of marketing-related functions. The research is interested in such SMEs which did not apply any Industry 4.0 technologies (Chatbots, Big Data) in the marketing-related functions yet, but

the respondents are aware about them. The target population for the quantitative research stage was intentionally selected to include SMEs who have not yet adopted the selected Industry 4.0 technologies. This decision was driven by the focus of the study on identifying the factors that are hypothesised to be significant in the decision-making process for the initial adoption of the Industry 4.0 technologies in the marketing practices within SMEs.

The sample size must ensure the reliability and representativeness of the data collected. It is necessary to identify and analyse numerous qualities of the research subjects, as well as to develop the general conclusions. Previous researches are used as a guide for determining the necessary sample size which is displayed in Table No. 25. Based on the studies of previous authors, a sample size should be between 250 and 300.

Table 25. Quantitative research sample size comparison

Author of the study	Article Title	Basic Research Procedure
Bettiol et al., 2017	Industry 4.0: the strategic role of marketing.	Exploratory study of 650 Italian firms' motivations for adopting or not adopting Industry 4.0 technologies
Ungerman & Dědková, 2019	Marketing innovations in Industry 4.0 and their impacts on current enterprises.	Pilot research followed by primary research in industrial enterprises in the Czech Republic: 210 enterprises
Pech & Vrchota, 2022	The product customisation process in relation to Industry 4.0 and digitalisation.	Conducted research of 313 Czech Republic enterprises

Source: *created by the author* based on the sources listed in the table

The chosen data collection method for this study is non-probability convenience sampling. It was chosen for the ease of acquiring the data needed for the research. Since non-probability sampling focuses on sampling techniques that are based on the researcher, the aim of achieving a sample size of 240 respondents is set, which is remarkably close to the calculated sample size mean. Therefore, respondents were invited to take part in the research until the sample size was reached. It is worth noting that precisely determining the features of the general population is extremely difficult, and the availability of similar research does not provide a sufficient technique for evaluating the representativeness and trustworthiness of the sample and the research outcomes. There is no guarantee that the sample represents the target

population accurately. As a result, it is unclear if the findings based on a convenience sample would apply to the entire population.

The respondents' data was gathered via telephone interviews executed by *Rinkos Tyrimų Centras* from February 15 to March 12, 2024. *Rinkos Tyrimų Centras* is a market research company which is an official member of *ESOMAR* (European Society for Opinion and Marketing Research) and a member of the *Lithuanian Market Research Association* (abbreviated in Lithuanian as *RITA*).

Data analysis methods. The data collected from the respondents was exported to *Microsoft Excel* and then imported to the *SPSS* statistical tool for data processing to evaluate the hypotheses.

Before conducting the statistical examination of the data, it was ensured that there are no mistakes or missing values in the answers.

3. RESULTS OF THE QUALITATIVE RESEARCH ON THE SUITABILITY OF INDUSTRY 4.0 TECHNOLOGIES FOR ADOPTION IN MARKETING FUNCTIONS WITHIN LITHUANIAN SMEs

3.1. Respondent Profiling of the Semi-Structured Interviews in Relation to Industry 4.0 Knowledge

To investigate the suitability of the Industry 4.0 technologies for adoption in the marketing functions within Lithuanian SMEs, in the first research stage, the qualitative empirical research design was used. This research aimed to identify the most universal and niche technologies of Industry 4.0 suitable for the adoption in the marketing-related functions within SMEs. After the research instrument was set up and the clear requirements for the participation in the semi-structured interviews were defined, in total, 50 C-level Executives were contacted, and 11 informants agreed to participate in the study.

All of the C-Level Executives met the 3 raised criteria: all of them were holding management positions or were in charge of company operations (of them, 2 CEOs, 7 heads of departments, 1 Industry 4.0 researcher and consultant, 1 Industry 4.0 investor and consultant). All of them worked in Lithuania-based SMEs (2 in micro-sized SMEs, 3 in small-sized SMEs, 6 in medium-sized SMEs), and all of them were closely involved in or responsible for Industry 4.0 implementation projects. The study assured that the respondents' identity, such as the respondents' names or company titles would be kept anonymous, and that the collected data would be used only for academic purposes. This study coded the informants' responses, found similarities and differences in the answers, and attempted to make relations for a further proposition of the Industry 4.0 technologies application suitability. A summary of the respondents' profiles who participated in the study is listed in Table No. 26.

Table 26. Interviewee profiles of the qualitative research

ID	Current Title	Industry	NACE code of industry	Company size
C-LEVEL EXECUTIVE 1.	Industry 4.0 Researcher, PhD and business consultant	Social science	M72 – Scientific research and development	Micro enterprise working locally only
C-LEVEL EXECUTIVE 2.	Director and digital transformation leader of consulting firm	Finance	M69 – Legal and accounting activities, M70 – Activities of head offices; management consultancy activities	Medium-sized enterprise working locally, part of a large enterprise operating globally
C-LEVEL EXECUTIVE 3.	Leading Manager of the Industrial and Automation Business area	Management and Automation	G46.5 – Wholesale of information and communication equipment	Small enterprise working locally only
C-LEVEL EXECUTIVE 4.	CEO of a digital advertising agency	Advertising	M73 – Advertising and market research	Small enterprise working locally, part of a large enterprise working globally
C-LEVEL EXECUTIVE 5.	Business Development Executive and Digitalisation leader	Information and Technology	J62 – Computer programming, consultancy and related activities	Medium-sized enterprise working locally only
C-LEVEL EXECUTIVE 6.	CEO of a Fintech company	Fintech	J62 – Computer programming, consultancy and related activities, K64 – Financial service activities, except insurance and pension funding	Medium-sized enterprise working locally only
C-LEVEL EXECUTIVE 7.	Marketing Channel Program Manager	Consumer Electronics	G47.5 – Retail sale of other household equipment in specialised stores	Micro enterprise working locally, part of a large enterprise working globally

ID	Current Title	Industry	NACE code of industry	Company size
C-LEVEL EXECUTIVE 8.	Venture capital Investor and Industry 4.0 consultant	Information and Technology, Fintech	K64.3 – Trusts, funds and similar financial entities	Medium-sized enterprise working locally only
C-LEVEL EXECUTIVE 9.	Business Analytics and digitalisation Team Lead	Fintech	J62 – Computer programming, consultancy and related activities, K64 – Financial service activities, except insurance and pension funding	Medium-sized enterprise working locally only
C-LEVEL EXECUTIVE 10.	E-commerce Growth and digitalisation Strategist	Fast Moving Consumer Goods	G47.91 – Retail sale via mail order houses or via Internet	Small enterprise working locally, part of a large enterprise working globally
C-LEVEL EXECUTIVE 11.	Head of Finance of e-commerce marketplace and digitalisation	E-commerce	G47.91 – Retail sale via mail order houses or via Internet	Medium-sized enterprise working locally only

Source: *created by the author based on* (European Commission, 2024)

Through the semi-structured online interviews, this study found that all eleven informants are familiar with the Industry 4.0 technologies as all C-Level Executives were asked to list at least 5 technologies which, in their opinion, can be linked to Industry 4.0 and briefly explain how and why.

All the respondents in the study highlighted *Artificial Intelligence* (AI) as one of the key Industry 4.0 technologies. The C-level Executive 1 mentioned that: "AI enables autonomous decision-making and process optimisation in Industry 4.0. It empowers machines to learn from data, adapt and improve efficiency, leading to increased productivity and reduced operational costs." These thoughts were supported by C-level Executive 5, who stated that the employment of AI "results in increased efficiency and reduced human intervention," whereas C-level Executive 6, stated that AI has "almost unlimited applicability." However, C-level Executive 9 highlighted the importance of correct data usage, by stating that "for AI to be effective, we need to be sure that we do not fill AI with incorrect data, for that, everything has to start from the basics." The respondents' answers confirmed that AI can be defined as one of the major Industry 4.0 technologies, as the C-level Executive 4 described AI as "probably the biggest and largest change since the invention of the personal computer." The C-level Executive 11 confirmed it by stating that "AI development is currently ongoing and still needs a lot of work to be done, but this would be a very groundbreaking change for everyone."

Nine out of the eleven respondents mentioned *IoT* and *Big Data* as the key Industry 4.0 technologies. C-level Executive 1 stated that "IoT connects physical devices and sensors to the Internet, facilitating real-time data collection and analysis. In Industry 4.0, IoT enables smart manufacturing, remote monitoring and seamless communication between machines, enhancing efficiency and data-driven decision-making." This idea was supported by a number of other C-level Executives: C-level Executive 7 described IoT as "technology allowing to access real time data from a variety of sensors," C-level Executive 5: "IoT involves connecting devices, sensors and machines to the internet to gather and share data," C-level Executive 11: "IoT is having all those small devices connected to the internet, providing some data points and helping everyday life," C-level Executive 6: "IoT can be used to get digital data to systems," C-level Executive 4: "IoT – almost everything is connected, almost everything could be controlled."

Based on C-level Executive 6: "Big data is food for AI, optimisation and data-driven decisions." C-level Executive 5 added that Big Data technology applications can "help in identifying patterns, trends and anomalies, leading to informed decision-making, process optimisation and

enhanced product quality." C-level Executive 7 mentioned that Big Data is also important for "creating extremely personalised offers or products for consumers." C-level Executive 1 also suggested that Big Data usage can "enhance customer experiences and identify new business opportunities." However, C-level Executive 9 stated that "for the Big Data to be efficient and have a really strong impact on the economy, we need to look for more efficient ways to gather all the needed information."

Another key Industry 4.0 technology mentioned by the respondents was *Robotics*. C-level Executive 7 identified robotics as "machines with the ability to perform tasks without human interaction." C-level Executive 5 suggested that "advanced robotics and automation systems play a pivotal role in Industry 4.0. They improve manufacturing efficiency by performing repetitive tasks accurately and quickly, leading to increased productivity, reduced errors and safer working conditions." Such statements were supported by other respondents: C-level Executive 4 stated: "with robotics, everything becomes easier, faster and cheaper from a long-term perspective," C-level Executive 8 stated: "Robotics helps any industry line reap efficiencies in terms of costs and time," C-level Executive 6 added: "due to Robotics – humans are free to do creative work as it increases productivity and quality," C-level Executive 10 stated: "no need for human intervention, a broader spectre of data and more optimized processes."

Cloud computing technology was mentioned by five out of the eleven respondents. C-level Executive 1 described Cloud computing as a technology that "provides scalable and flexible computing resources for storing and processing data." Three respondents – C-level Executive 1, C-level Executive 5, and C-level Executive 7 – highlighted that Cloud computing "supports real-time data sharing, remote monitoring and collaborative efforts across geographically distributed teams." *Augmented Reality* and *Digital Twin technologies* were mentioned by four out of the eleven respondents. C-level Executive 9 and C-level Executive 11 described the importance of Augmented Reality. According to C-level Executive 9, "future technologies, such as *Apple Vision Pro*, are the proof we are in the right direction." Meanwhile, C-level Executive 11 shared the personal job experience, where "augmented reality glasses were developed for maintenance: to see all the instructions on how to repair or use something in your glasses in the real time." Meanwhile, C-level Executive 1, C-level Executive 2, and C-level Executive 5 stated the importance of the Digital Twin: "Digital twin technology creates virtual replicas of physical assets and processes. It allows for real-time monitoring, simulation and analysis, enabling predictive maintenance and optimisation,

making it an integral part of Industry 4.0's smart manufacturing and service delivery."

Industry 4.0 technologies, such as *Chat GPT*, *Blockchain*, *5G*, *Machine learning*, *Cyber Security*, *Internet*, *Quantum Computing* and *Chatbots*, were mentioned by three or a fewer number of the respondents. It indicates that such technologies are not 'top-of-mind technologies' related to Industry 4.0 mentioned by the C-level Executives. However, such technologies still play an important role. For example, according to C-level Executive 11: "Chat GPT boomed into the everyday lives of lots of specialists, and the speed at which it took off is rather unprecedented." However, C-level Executive 9 raised data accuracy questions: "Latest reports about ChatGPT refer to the fact that it is getting less precise. Why? Because it is fed with low-quality data. How do we solve this?" According to C-level Executive 1: "Blockchain technology enhances trust and security in Industry 4.0 by providing an immutable and transparent record of transactions and data exchanges." However, C-level Executive 4 stated that "the Blockchain technology itself is great, but we are not ready yet. Anyway, it will be coming soon." According to C-level Executive 3 and C-level Executive 6: "5G ensures less delay and wider data channels for real time applications." Based on C-level Executive 5, "Machine Learning enable machines to learn from data and make intelligent decisions." According to C-level Executive 9: "Machine learning is being applied in our everyday interactions (all the targeted advertising, forecasting of sales or revenue, etc.). This is where we can make better decisions based on data but we need infrastructure and retrospective data to be able to use it." C-level Executive 11 also mentioned quantum computing as an important Industry 4.0 technology: "it will be millions of times faster than current super computers." Figure No. 11 shows the distribution of the respondents' answers.

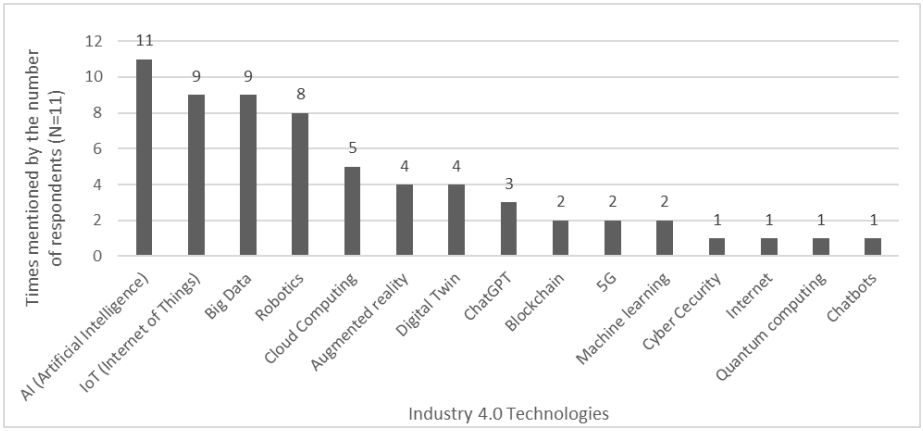

Figure 11. Number of times mentioning Industry 4.0 technologies by C-Level Executives (max: 11)
Source: created by the author

The qualitative study results confirm the C-level Executives' knowledge of the Industry 4.0 principles, as the majority of the technologies mentioned by the respondents coincide with the Industry 4.0 technologies named in the scholarly articles (Brkljac & Sudarevic, 2018; Calabrese et al., 2020; Cimini et al., 2017; Ćoćkalo, et al., 2019; Da Silva et al., 2019; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Ungerman & Dědková, 2019; Sima et al., 2020). The only technology mentioned by the C-level Executive, specifically, the Internet, is not considered to be related to Industry 4.0. This technology was established in 1983, and, in the context of Industry 4.0, the Internet rather serves as the base technology platform for the establishment of the more modern Industry 4.0 technologies, such as IoT (Zhou et al., 2015). The further study concentrates on the above-mentioned Industry 4.0 technologies and their suitability to be applied in the SMEs business functions.

3.2. Application Possibilities of Industry 4.0 Technologies in Business Functions of SMEs

To identify business functions in which the Industry 4.0 technologies can be applied, C-level Executives were asked to list them and explain how it can be done. After the result analysis, nine key business functions were identified: Manufacturing and Production, Marketing, Supply Chain & Logistics, Research & Development, Business Administration, Sales, Accountancy & Finances, Human Resources, and Customer service and support. Figure No. 12 shows the distribution of the respondents' answers.

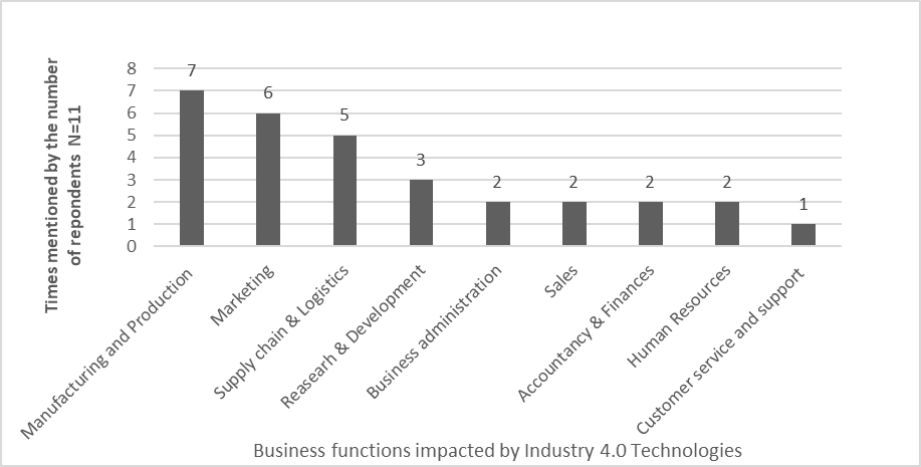

Figure 12. The most suitable business functions for Industry 4.0 technology applications
Source: created by the author

The Manufacturing and Production function was identified as the most suitable business function for the application of the Industry 4.0 technologies, as seven C-level Executives out of eleven mentioned it. Also, six technologies were highlighted as the key ones for this business function, such as: Robotics, IoT, AI, Big Data, 5G, and Automation. C-level Executive 4, C-level Executive 6, and C-level Executive 8 stated that: "robots with IoT learning can help in assembly line and improve using AI technology (fed with insights from Big Data) connected via 5G." Meanwhile, C-level Executive 3, C-level Executive 5, C-level Executive 9, and C-level Executive 11 added that: "AI enables predictive maintenance and precision automation. Data-driven insights optimise workflows, minimise downtime, and improve resource utilisation, ensuring sustainability." Such insights from the C-level Executives coincide with the scientific literature insights. According to Brkljac and Sudarevic (2018), many technological breakthroughs, such as the Internet of Things (IoT), Artificial Intelligence (AI), etc. are the main enablers of Industry 4.0, and their strong influence is especially notable in the manufacturing industry.

The second most suitable business function for the application of the Industry 4.0 technologies was found to be the Marketing function (mentioned by 6 out of 11 respondents). According to the C-level Executive 1, C-level Executive 9, C-level Executive 5, and C-level Executive 11: "AI, Big Data, and Digital Twin will revolutionise marketing strategies." According to the C-

level Executive 1: "AI-powered analytics provide valuable insights into customer behaviour and preferences, allowing businesses to deliver targeted and personalised marketing campaigns." These respondents also highlighted the benefits of the application of the Big Data and Digital Twin technologies in the marketing function: "Big Data analysis helps understand market trends and customer sentiments, enabling data-driven marketing decisions. Digital Twin technology can create virtual simulations of marketing campaigns, facilitating testing and optimisation before implementation." The importance of Virtual Reality for the marketing function was highlighted by the C-level Executive 3 and C-level Executive 9 who stated that: "products and services can be digitalised while applying virtual reality solutions, also AI will help to enhance customer centricity and business to be more innovative." Meanwhile, C-level Executive 2 suggested that cloud computing technologies are of a high importance for the marketing department: "cloud computing connects various tools that automate and deliver interactive insights into data for marketing department." In total, six Industry 4.0 technologies were mentioned by the C-level Executives as the most suitable to be applied in the marketing function, such as: Big Data, AI, Digital Twin, Cloud computing, Virtual Reality, and Chatbots. These respondents' observations align with the findings in the scholarly literature. For instance, according to Pranjić and Rekettye (2019), technological changes enable an absolute breakthrough in the marketing philosophy – to identify, predict, and even influence the behaviour of the consumer.

The Supply chain & Logistics was the number three identified business function, suitable for the application of the Industry 4.0 technologies (mentioned by 5 out of 11 respondents). C-level Executive 1, C-level Executive 6, C-level Executive 5, and C-level Executive 7 stated that: "Industry 4.0 technologies, such as IoT, Blockchain, and AI play a pivotal role in revolutionising supply chain management and logistics processes." According to C-level Executive 5: "AI analytics streamline operations, enhancing route planning, warehouse efficiency, and resource allocation." C-level Executive 6 supported this idea by enhancing the role of Big Data: "demand forecasting and inventory optimisation can improve efficiency and minimise inventory costs while employing Big data analytics." C-level Executive 1 also highlighted the role of IoT, by stating that: "IoT devices enable real-time tracking of goods, enhancing visibility and traceability throughout the supply chain," and highlighted the role of the Blockchain: "this technology ensures secure and transparent transactions, reducing the risk of fraud and enhancing trust among stakeholders." C-level Executive 8 also added that drones can be particularly important for the more efficient logistics

processes and faster delivery of goods: “logistics are more efficient due to last mile delivery, incorporating drones and timetable planning to deliver faster and save on fuel as estimating fastest route.”

The fourth most suitable business function for the application of the Industry 4.0 technologies was found to be the Research & development business function, and it was commented upon by four out of the eleven respondents. According to the C-level Executives, five Industry 4.0 technologies can be applied to this business function, such as: Digital twin, Cloud Computing, 3D printing, AI, and Big Data. C-level Executive 7 highlighted the importance of Big Data by stating that: “enabling this technology, highly personalised products can be created to address different target audience groups.” Meanwhile, C-level Executive 5, and C-level Executive 11 summarised the importance of Digital Twins, Cloud computing, AI, and 3D printing: “Industry 4.0 fuels rapid product evolution with digital twin prototypes, cloud-enabled global collaboration, AI and 3D printing for swift prototyping.”

The four remaining business functions, namely, Business administration, Sales, Accountancy & finances, and Human Resources were mentioned by two respondents. The Customer service and support business function was highlighted only by one C-level Executive. The respondents especially enhanced the AI and Big Data application possibilities in such business functions. For example, according to C-level Executive 9 and C-level Executive 11, Big Data can be applied in the sales business function: “for customer behaviour analysis and applying insights for improved sales offers to the clients (commercialising data).” C-level Executive 2 and C-level Executive 4 also suggested that Big Data can be applied to Accountancy & finances: “Big Data analytics tools are applicable for accountancy & finances, where Big Data, analytics and numbers could be managed. There are so many use cases in finance – from fully automating complete or parts of finance control, accounting, tax, etc.” According to C-level Executive 1 and C-level Executive 2, the Industry 4.0 technologies’ are highly important for the Human Resource business function: “AI can be used for talent acquisition and recruitment efficiency, Digital Twin for virtual training, IoT and Big Data for real-time performance monitoring and employee engagement and data-driven decision-making, ultimately fostering a more productive and engaged workforce while optimising HR processes.” C-level Executive 6 also mentioned Industry 4.0 related technology – Chatbots, and grounded the suitability of such a technology for application in the Customer service and support business functions: “AI-driven chatbots that have access to big data analytics can provide personalised fast service”.

Table No. 27 summarises the above-mentioned study results, while demonstrating Industry 4.0 technologies, mentioned by the C-level Executives, and their suitability in various business functions. It can be seen that, based on the respondents' answers, the most suitable Industry 4.0 technologies to be applied in the widest range of business area are: Big Data and AI. Therefore, it can be assumed that such technologies can be titled as *universal* Industry 4.0 technologies. Meanwhile, other Industry 4.0 technologies mentioned by the respondents were identified as having relation to only a few business functions. For instance, Virtual Reality was identified to be applicable only in the marketing-related business function. The business functions in which the widest range of the Industry 4.0 technologies could be applied were identified such as: Manufacturing & Production, Marketing, Supply chain & Logistics, Research & Development, and Human Resources.

Table 27. Application of Industry 4.0 technologies in business functions

Business Function / Industry 4.0 technology	Manufact. & Production	Marketing	Supply chain & Logistics	Research & Development	Human Resources	Customer service and support	Business administration	Accountancy & Finances	Sales
Big Data	X	X	X	X	X	X	X	X	X
AI	X	X	X	X	X	X	X	X	
Digital Twin		X		X	X				
IoT	X		X		X				
Cloud Computing		X		X					
5G	X								
Automation	X								
Robotics	X								
Virtual Reality		X							
Blockchain			X						
Drones			X						
3D printing				X					
Chatbots		X				X			

Source: created by the author

Further analysis will consist of the Industry 4.0 technologies' adoption suitability in the marketing-related functions of SMEs.

3.3. Industry 4.0 Technologies' Application Possibilities in the Marketing Functions of SMEs

To identify which Industry 4.0 technologies can be considered as the most suitable to be applied in the marketing functions of SMEs, the respondents were asked to list at least three technologies and explain how they can be applied in the marketing functions. In total, the C-level Executives mentioned nine suitable technologies, such as: Big Data, Artificial Intelligence, Augmented Reality, Cloud Computing, Automation, IoT, Digital Twin, Machine Learning, and Chatbots.

It is worth noting that the Industry 4.0 technology Big Data was mentioned by all the eleven respondents as an applicable technology in the marketing-related functions of SMEs. Most of the C-level Executives (C-level Executive 1, C-level Executive 4, C-level Executive 5, C-level Executive 6, C-level Executive 9, C-level Executive 11) mentioned that Big Data is specifically applicable in the marketing function for the consumer behaviour prediction and the forecasting of future trends. Also, C-level Executive 1, C-level Executive 2, C-level Executive 5, C-level Executive 8, and C-level Executive 10 highlighted that Big Data enhances the overall marketing performance, and it is very suitable for improving the customer targeting mechanisms. Also, this technology is helpful for data enablement and usage for creating more personalised offers, products and services (C-level Executive 3, and C-level Executive 7). Another Industry 4.0 technology mentioned by the respondents as one of the most suitable to be applied in the marketing functions of SMEs was Artificial Intelligence (mentioned by 10 out of 11 respondents). Six out of the eleven C-level Executives mentioned that this technology is beneficial for the creation of the marketing materials, such as the branding elements and promotional content. Meanwhile, three respondents (C-level Executive 1, C-level Executive 5, C-level Executive 6) identified that Artificial Intelligence, similarly to Big Data, enables consumer behaviour data insights to be applied for more optimised and personalised displayed content for the consumers. In addition to this, C-level Executive 1 and C-level Executive 7 highlighted that such Artificial Intelligence enablement can reduce the need and spending for the creative marketing agencies, as well as optimise the resources of the internal marketing teams.

Meanwhile, according to four respondents out of eleven (C-level Executive 3, C-level Executive 6, C-level Executive 7, C-level Executive 11), Augmented reality is a suitable Industry 4.0 technology to be applied for the marketing function of SMEs regarding its ability to demonstrate the benefits of the products and services, while enabling virtual trying out tools, which, in this way, helps to enhance the entire customer experience. Cloud computing was also mentioned as

one of the key Industry 4.0 technologies suitable for marketing-related activities within SMEs. According to C-level Executive 1, C-level Executive 2, and C-level Executive 3, this technology enables SMEs to store and access marketing data securely. C-level Executive 1 also highlighted that: "this technology can be beneficial if a particular company has branches or divisions in separate geographical areas, as it helps facilitate seamless collaboration among marketing teams across different locations." C-level Executive 2 also added that: "Cloud computing helps SMEs reach a great variety of marketing platforms for reasonable fees and in this way, leverage the existing tools instead of creating new ones." C-level Executive 2, C-level Executive 4, and C-level Executive 8 also enhanced the benefits of automation technologies in the promotion function of marketing. Based on the respondents' answers, such technologies can be widely used for automating marketing campaigns, as they are capable of creating hundreds or thousands of ads in a minute, and are effective while targeting the potential customers.

It is worth mentioning that the Industry 4.0 technologies, such as IoT, Digital Twin, Machine Learning and Chatbots, were referred to only by a few C-level Executives, and the possible application suitability in the marketing-related functions was very specific. For example, based on C-level Executive 5, while utilising the IoT technology, it is possible to "enable location-based services and geotargeting, and, in this way, SMEs can promote offers, discounts and events to potential customers near their business locations." C-level Executive 7 also mentioned that IoT "allows businesses to create their unique selling propositions while providing combined Smart solutions," and it is particularly important in the consumer electronics industry: "products with biometrical sensors and functionality enable people to call for medical assistance when needed, etc." C-level Executive 1 suggested that Digital Twin can be utilised within SMEs while creating virtual models of their target audience and simulating customer behaviours and responses to marketing strategies. According to C-level Executive 1, while analysing and testing different marketing initiatives in a risk-free virtual environment, SMEs can identify the most effective approaches before implementing them in the real world. Meanwhile, C-level Executive 9 highlighted the importance of machine learning for an enhanced marketing performance in the future: "machine learning models help to analyse the information and integrate patterns of consumer behaviour." Also, four C-level Executives mentioned that the customer service support area can be more automated by introducing Chatbots, and that can help to nurture relationships with customers, which is an important part of the marketing strategy. Table No. 28 summarises the study results and highlights the potential of each Industry 4.0 technology application in the marketing-related functions of SMEs.

Table 28. Application of Industry 4.0 Technologies in Marketing

Industry 4.0 Technology	Application suitability of Industry 4.0 Technologies for SMEs in marketing functions	Mentioned by C-level Executives
Big Data	• Leverages historical data to forecast future trends in consumer behaviour.	*C-level Executive 1, C-level Executive 4, C-level Executive 5, C-level Executive 6, C-level Executive 9, C-level Executive 11.*
	• Helps to improve customer targeting and enhance the overall marketing performance.	*C-level Executive 1, C-level Executive 2, C-level Executive 5, C-level Executive 8, C-level Executive 10.*
	• Allows the creation of highly personalised offers, products, or services.	*C-level Executive 3, C-level Executive 7.*
Artificial Intelligence	• Helps to create marketing materials: slogans, ads, campaigns, branding for different target audiences.	*C-level Executive 2, C-level Executive 4, C-level Executive 7, C-level Executive 9, C-level Executive 10, C-level Executive 11.*
	• Helps to identify patterns and preferences in customer data and enables content optimisation and personalisation.	*C-level Executive 1, C-level Executive 5, C-level Executive 6.*
	• Optimises the resources of the marketing team and reduces spending for creative agencies.	*C-level Executive 1, C-level Executive 7.*
Augmented Reality	• Helps to demonstrate the benefits of the products and services, and enhances the customer experience.	*C-level Executive 3, C-level Executive 6, C-level Executive 7, C-level Executive 11.*
Cloud Computing	• Enables scalable infrastructure for marketing data storage and processing.	*C-level Executive 1, C-level Executive 2, C-level Executive 3.*
	• Facilitates collaboration among marketing teams across different locations.	*C-level Executive 1.*
Automation (Robotics)	• Helps to automate marketing campaigns and more effectively target customers.	*C-level Executive 2, C-level Executive 4, C-level Executive 8.*

Industry 4.0 Technology	Application suitability of Industry 4.0 Technologies for SMEs in marketing functions	Mentioned by C-level Executives
IoT	• Enables geotargeting to deliver targeted marketing messages to the customers' devices based on their physical location.	*C-level Executive 5.*
	• Allows businesses to create their unique selling propositions (USP) while providing combined Smart solutions.	*C-level Executive 7.*
Digital Twin	• Enables testing different marketing initiatives in a risk-free virtual environment, helps SMEs identify the most effective approaches for implementation in the real world.	*C-level Executive 1.*
Machine Learning	• Helps to analyse the information and integrate patterns of consumer behaviour.	*C-level Executive 9.*
Chatbots	• Helps to automate and enhance customer support, nurtures the relation with the clients.	*C-level Executive 1, C-level Executive 3, C-level Executive 5, C-level Executive 11.*

Source: created by the author

To summarise, according to the study respondents, nine Industry 4.0-related technologies, mentioned by the C-level Executives, were found to be suitable to be applied in the marketing functions of SMEs. Also, it was found that Big Data has the most varied application possibilities and benefits for SMEs marketing-related functions. Meanwhile, according to the respondents, the Industry 4.0 technology, such as Chatbots, has only limited adoption possibilities within the marketing functions, and its effect is mostly noticeable in the customer service-related matters and the promotional marketing function. The main application possibilities and benefits of Big Data in the marketing functions are listed in Table No. 29, whereas, in Table No. 30, the main application possibilities and benefits of Chatbots in the marketing functions are stated.

Table 29. Big Data application possibilities and benefits in SMEs marketing functions

Big Data application in marketing	Benefits	Mentioned by C-level Executives
Operational efficiency	• SMEs can optimise marketing campaigns in real time and refine strategies to boost sales, engagement, efficiency and build brand loyalty.	*C-level Executive 1, C-level Executive 2, C-level Executive 4, C-level Executive 5, C-level Executive 6, C-level Executive 8, C-level Executive 9.*
	• Enables businesses to segment their audience more effectively.	*C-level Executive 1, C-level Executive 5, C-level Executive 6, C-level Executive 11.*
	• Gathering data through sources like site visits, social media and purchases allows for targeted campaigns.	*C-level Executive 1, C-level Executive 4, C-level Executive 5, C-level Executive 8.*
	• Can help forecast trends by using historical patterns, aid inventory planning, and allocate resources more efficiently.	*C-level Executive 5, C-level Executive 6, C-level Executive 10.*
	• Helps automate the marketing data processing by creating the right tools for such solutions.	*C-level Executive 2, C-level Executive 3.*
SMEs' Competitiveness	• Can help monitor rivals' strategies, by spotting trends and differentiation opportunities.	*C-level Executive 5, C-level Executive 6.*

Big Data application in marketing	Benefits	Mentioned by C-level Executives
	• Aids SMEs in identifying the market opportunities, refining value propositions, and gaining a competitive edge.	*C-level Executive 1.*
	• Can help to create a similarly high quality of a marketing material, irrespective of the company size.	*C-level Executive 9.*
Customer Centricity	• Helps to create personalised products, services or offers based on the consumers' needs, demand, historical purchases or interest data and preferences.	*C-level Executive 1, C-level Executive 3, C-level Executive 4, C-level Executive 5, C-level Executive 7, C-level Executive 8, C-level Executive 11.*
	• Analyses customers' feedback for improved customer satisfaction and products/services alignment.	*C-level Executive 1, C-level Executive 5.*

Source: created by the author

Table 30. Application possibilities of Chatbots and their benefits in SMEs marketing functions

Chatbots application in marketing	Benefits	Mentioned by C-level Executives
Operational efficiency	• Chatbots can handle routine inquiries, such as frequently asked questions, thereby freeing up human agents to focus on more complex tasks and save their time and the company's financial resources.	*C-level Executive 1, C-level Executive 3, C-level Executive 4, C-level Executive 5, C-level Executive 6, C-level Executive 8, C-level Executive 11.*
	• Chatbots can collect valuable customer data during interactions, thus helping SMEs gather insights on customer preferences which can be leveraged for targeted marketing campaigns.	*C-level Executive 1, C-level Executive 5, C-level Executive 6, C-level Executive 8, C-level Executive 9.*
	• Chatbots helps to upgrade the website look and feel, while eliminating the addition of pages with extensive information.	*C-level Executive 7.*

Chatbots application in marketing	Benefits	Mentioned by C-level Executives
SMEs competitiveness	• Chatbots can revolutionise customer engagement and support. This leads to improved response times, enhanced customer satisfaction and engagement, ultimately contributing to the overall business growth and success.	*C-level Executive 1, C-level Executive 4, C-level Executive 5, C-level Executive 6, C-level Executive 7, C-level Executive 8, C-level Executive 10.*
Customer centricity	• By integrating chatbots into the websites, social media pages, or messaging platforms, SMEs can provide instant and personalised customer service support 24/7.	*C-level Executive 1, C-level Executive 4, C-level Executive 5, C-level Executive 7, C-level Executive 8, C-level Executive 10.*
	• Chatbots can be programmed to use *Natural Language Processing* (NLP) and sentiment analysis, which allows the enhanced personalised interaction. Also, reinforcement learning allows chatbots to become more sophisticated over time and adapt to the changing customer demands, which enhances the overall customer experience and fosters brand loyalty.	*C-level Executive 1, C-level Executive 2, C-level Executive 5.*
	• Chatbots can be used as sales assistants helping customers to pick and choose products (e.g., the best size, colour and fit apparel based on the customer preferences or figure).	*C-level Executive 6, C-level Executive 7, C-level Executive.*

Source: created by the author

3.4. Ratings of the Suitability of Industry 4.0 Technologies for Adoption in Marketing Functions Provided by C-level Executives

The qualitative study also aimed to rate the Industry 4.0 technologies based on their suitability to be applied in all the four marketing functions. It was done by the C-level Executives rating the suitability of fourteen (14) pre-selected Industry 4.0 technologies for adoption in four (4) marketing functions of SMEs, while using the Likert scale from 1 to 5 (from very not suitable to very suitable).

The study results revealed that the widest group of the Industry 4.0 technologies can be applied in the product marketing function. The summarised results are presented in Table No. 31. In total, six out of the fourteen rated technologies were found to be very suitable in the product function, led by Artificial intelligence (mean 4.727), Simulation/Digital Twin (mean 4.636), IoT (mean 4.545), 3D printing (mean 4.545), Augmented Reality (mean 4.545), and 5G network (mean 4.455). The other seven technologies were rated as suitable ones to be applied in this particular marketing function, such as: Big Data, Mobile Apps/technologies, Virtual Reality, Autonomous Robots, Chatbots, Cloud Computing, and Virtual Assistants. The Industry 4.0 technology Blockchain was rated as a 'neutral' technology (i.e., neither not suitable, nor suitable) to be applied in the product function (mean 3.273). Such rating results coincide with the scientific literature results, as, according to scientists (Brkljac & Sudarevic, 2018; Caliskan et al., 2020; Cimini et al., 2017; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Sima et al., 2020; Ungerman & Dědková, 2019), Industry 4.0 technologies, such as Internet of Things, 3D printing, Simulation, Cloud computing, and Augmented Reality are considered the most suitable ones to be applied in the product marketing function. Based on Caliskan et al. (2020), this Industry provides a unique opportunity for the customer to be the co-creator of the product, while enabling different types of technologies, and it expands the range of the product personalisation offerings as well as enables the maximum level of customisation possible.

Table 31. Application suitability of Industry 4.0 technologies in the product marketing function

PRODUCT MARKETING FUNCTION/ Industry 4.0 Technologies	**x̄**	**n**	**SD**	95% Confidence Interval		**Median**	**Suitability rating**
				Min.	**Max.**		
ARTIFICIAL INTELLIGENCE	4.727	11	0.467	4	5	5	**Very suitable**
SIMULATION/DIGITAL TWIN	4.636	11	0.505	4	5	5	**Very suitable**
INTERNET OF THINGS (IoT)	4.545	11	0.522	4	5	5	**Very suitable**
3D PRINTING	4.545	11	0.688	3	5	5	**Very suitable**
AUGMENTED REALITY (AM)	4.545	11	0.522	4	5	5	**Very suitable**

PRODUCT MARKETING FUNCTION/ Industry 4.0 Technologies	x̄	n	SD	95% Confidence Interval		Median	Suitability rating
				Min.	Max.		
5G NETWORK	4.455	11	0.820	3	5	5	**Very suitable**
BIG DATA	4.364	11	0.674	3	5	4	Suitable
MOBILE APPS/TECHNOLOGIES	4.364	11	0.809	3	5	5	Suitable
VIRTUAL REALITY (VR)	4.182	11	0.751	3	5	4	Suitable
AUTONOMOUS ROBOTS	4.182	11	0.874	3	5	4	Suitable
CHATBOTS	4.091	11	0.944	2	5	4	Suitable
CLOUD COMPUTING	3.909	11	1.044	2	5	4	Suitable
VIRTUAL ASSISTANTS	3.909	11	1.221	2	5	4	Suitable
BLOCKCHAIN	3.273	11	1.104	1	5	3	Neutral

Source: created by the author

The other marketing function in which a wide range of Industry 4.0 technologies are found to be suitable to be applied was found to be the promotion function. Technologies, such as Big Data (mean 4.818), Artificial Intelligence (mean 4.727), Augment Reality (mean 4.636), Mobile Apps/Technologies (mean 4.636), and Chatbots (mean 4.455) were rated as the most suitable for the application. Meanwhile, technologies such as Blockchain and 3D printing were found to be neutral for the application in the promotion function. The importance of Artificial Intelligence and Chatbots application in the promotional function is frequently mentioned by scientists as well. For instance, Ungerman and Dědková (2019) state that digital marketing trends are being widely used in the promotion element, such as Artificial Intelligence, which analyses the behaviour of social network members automatically, and conversational marketing, which engages people in genuine communication by using chatbots to discover everything a customer desires. Also, Sima et al. (2020) suggests that, for the promotional function, the IoT technology is key. According to the authors, IoT enables the establishment of huge networks that will connect all the members of the value chain and influence the purchasing and consumption patterns. This idea is also proved by the study results as IoT is rated as the suitable technology (mean 4.000) to be applied in the promotional function. The summarised results are presented in Table No. 32.

Table 32. Application suitability of Industry 4.0 technologies in the promotion marketing function

PROMOTION MARKETING FUNCTION/ Industry 4.0 Technologies	x̄	n	SD	95% Confidence Interval		Median	Suitability rating
				Min.	Max.		
BIG DATA	4.818	11	0.405	4	5	5	**Very suitable**
ARTIFICIAL INTELLIGENCE	4.727	11	0.467	4	5	5	**Very suitable**
AUGMENTED REALITY (AM)	4.636	11	0.674	3	5	5	**Very suitable**
MOBILE APPS/TECHNOLOGIES	4.636	11	0.505	4	5	5	**Very suitable**
CHATBOTS	4.455	11	0.522	4	5	4	**Very suitable**
VIRTUAL REALITY (VR)	4.273	11	0.786	3	5	4	Suitable
VIRTUAL ASSISTANTS	4.091	11	0.831	2	5	4	Suitable
INTERNET OF THINGS (IoT)	4.000	11	1.095	2	5	4	Suitable
CLOUD COMPUTING	3.727	11	0.647	3	5	4	Suitable
SIMULATION/DIGITAL TWIN	3.636	11	0.674	2	4	4	Suitable
AUTONOMOUS ROBOTS	3.455	11	0.934	2	5	4	Suitable
5G NETWORK	3.455	11	1.128	2	5	4	Suitable
BLOCKCHAIN	3.091	11	0.701	2	4	3	Neutral
3D PRINTING	2.727	11	1.348	1	5	2	Neutral

Source: created by the author

While analysing the suitability of the Industry 4.0 technologies to be applied in the place marketing function, it was noticed that only one Industry 4.0 technology – Big Data – was rated as a very suitable technology to be adopted in the place function (mean 4.455). Industry 4.0 technologies, such as Artificial Intelligence, Mobile Apps/technologies, IoT, Cloud computing, 5G network, Augmented Reality, Chatbots, Virtual Assistants and Virtual Reality were rated as the suitable technologies to be adopted within the place marketing function. This partially coincides with the scientific literature, as, according to the Industry 4.0 researchers, the element of place can be the most influenced by Augmented Reality or mobile app marketing, as such technologies not only enable shopping online, but they also fulfil the delivery preferences of the consumers. Moreover, omnichannel allows customers to receive their desired items at their preferred time and location (Caliskan et al., 2020). Consequently, location-based services enable customers to obtain integrated information based on time, place and context, thus improving the shopping experience (Sima et al., 2020). Nonetheless, the lowest-rated

Industry 4.0 technologies in terms of suitability for adoption in the place marketing function by the C-level Executives were: 3D printing, Simulation/Digital Twin, Blockchain, and autonomous robots. This coincides with the scientific literature sources, as none of these technologies were mentioned as particularly suitable for application in the place marketing function within the investigated literature sources (Brkljac & Sudarevic, 2018; Caliskan et al., 2020; Cimini et al., 2017; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Sima et al., 2020; Ungerman & Dědková, 2019). The summarised results are placed in Table No. 33.

Table 33. Application suitability of Industry 4.0 technologies in the place marketing function

PLACE MARKETING FUNCTION/ Industry 4.0 Technologies	**x̄**	**n**	**SD**	95% Confidence Interval		**Median**	**Suitability rating**
				Min.	**Max.**		
BIG DATA	4.455	11	0.688	3	5	5	**Very suitable**
ARTIFICIAL INTELLIGENCE	4.182	11	0.603	3	5	4	Suitable
MOBILE APPS/TECHNOLOGIES	4.182	11	0.874	3	5	4	Suitable
INTERNET OF THINGS (IoT)	3.909	11	0.701	3	5	4	Suitable
CLOUD COMPUTING	3.818	11	1.168	2	5	4	Suitable
5G NETWORK	3.818	11	1.168	2	5	4	Suitable
AUGMENTED REALITY (AM)	3.636	11	0.924	2	5	4	Suitable
CHATBOTS	3.545	11	0.820	2	5	4	Suitable
VIRTUAL ASSISTANTS	3.545	11	0.820	2	5	4	Suitable
VIRTUAL REALITY (VR)	3.455	11	0.934	2	5	4	Suitable
3D PRINTING	3.364	11	1.502	1	5	3	Neutral
SIMULATION/DIGITAL TWIN	3.273	11	0.786	2	4	3	Neutral
BLOCKCHAIN	3.182	11	1.168	1	5	3	Neutral
AUTONOMOUS ROBOTS	2.909	11	0.831	1	4	3	Neutral

Source: created by the author

Based on the study results, it is noticeable that the smallest number of the Industry 4.0 technologies are considered to be suitable for application in the price marketing function. The summarised results are placed in Table No. 34.

Table 34. Application suitability of Industry 4.0 technologies in the price marketing function

PRICE MARKETING FUNCTION/ Industry 4.0 Technologies	x̄	n	SD	95% Confidence Interval		Median	Suitability rating
				Min.	Max.		
BIG DATA	4.455	11	0.934	2	5	5	**Very suitable**
ARTIFICIAL INTELLIGENCE	4.364	11	0.924	2	5	5	Suitable
SIMULATION/DIGITAL TWIN	3.909	11	0.831	3	5	4	Suitable
MOBILE APPS/TECHNOLOGIES	3.909	11	0.831	2	5	4	Suitable
INTERNET OF THINGS (IoT)	3.727	11	0.905	2	5	4	Suitable
CHATBOTS	3.727	11	0.647	3	5	4	Suitable
BLOCKCHAIN	3.727	11	0.647	3	5	4	Suitable
CLOUD COMPUTING	3.636	11	0.505	3	4	4	Suitable
VIRTUAL ASSISTANTS	3.364	11	0.924	2	5	3	Neutral
AUGMENTED REALITY (AM)	3.273	11	0.905	2	5	3	Neutral
3D PRINTING	3.091	11	1.044	1	4	3	Neutral
AUTONOMOUS ROBOTS	3.091	11	1.136	2	5	3	Neutral
5G NETWORK	3.091	11	1.044	2	5	3	Neutral
VIRTUAL REALITY (VR)	3.000	11	0.775	2	4	3	Neutral

Source: created by the author

Big Data was rated as the most suitable technology (mean 4.455), and seven other technologies were rated as suitable ones, namely, Artificial Intelligence, Simulation/Digital Twin, Mobile Apps/Technologies, IoT, Chatbots, Blockchain and Cloud computing. This coincides with the output of the scientific literature, as scientists (Brkljac & Sudarevic, 2018; Caliskan et al., 2020; Cimini et al., 2017; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Sima et al., 2020; Ungerman & Dědková, 2019) especially highlight Artificial Intelligence and Big Data implementation opportunities within the pricing marketing function. According to the Caliskan et al. (2020), due to the use of advanced analytics, fuelled by Artificial Intelligence and Big data, dynamic pricing focuses on the product and, more importantly, on the customer – to create the optimal revenue and develop a successful relationship with the customer. The summarised results of the suitability of the Industry 4.0 technologies to be applied in all four marketing functions are presented in Table No. 35 and Table No. 36.

Table 35. Application suitability of Industry 4.0 technologies in all four marketing functions combined

ALL FOUR MARKETING FUNCTIONS (product, price, place, promotion)/ Industry 4.0 Technologies	$\bar{x}$	n	SD	95% Confidence Interval		Median	Suitability rating
				Min.	Max.		
BIG DATA	4.523	11	0.698	2	5	5	**Very suitable**
ARTIFICIAL INTELLIGENCE	4.500	11	0.665	2	5	5	**Very suitable**
MOBILE APPS/TECHNOLOGIES	4.273	11	0.788	2	5	4	Suitable
INTERNET OF THINGS (IoT)	4.045	11	0.861	2	5	4	Suitable
AUGMENTED REALITY (AM)	4.023	11	0.952	2	5	4	Suitable
CHATBOTS	3.955	11	0.806	2	5	4	Suitable
SIMULATION/DIGITAL TWIN	3.864	11	0.852	2	5	4	Suitable
CLOUD COMPUTING	3.773	11	0.859	2	5	4	Suitable
VIRTUAL REALITY (VR)	3.727	11	0.949	2	5	4	Suitable
VIRTUAL ASSISTANTS	3.727	11	0.973	2	5	4	Suitable
5G NETWORK	3.705	11	1.133	2	5	4	Suitable
3D PRINTING	3.432	11	1.336	1	5	4	Neutral
AUTONOMOUS ROBOTS	3.409	11	1.041	1	5	3	Neutral
BLOCKCHAIN	3.318	11	0.934	1	5	3	Neutral

Source: created by the author

The qualitative study results reveal that Big Data (mean 4.523) can be considered as the most suitable Industry 4.0 technology to be applied in all the four marketing functions. Big Data was found to be the most suitable technology to be applied in the price, place and promotion marketing functions; it was also rated as a suitable one in the product marketing function.

Meanwhile Artificial Intelligence was found to be the second most suitable Industry 4.0 technology to be applied in all the four marketing functions. Such a technology was rated as number one technology to be applied in the product marketing function and number two Industry 4.0 technology for the application in the three remaining marketing functions (price, promotion, and place). Mobile apps/technologies were found to be number three Industry 4.0 technology suitable for application in the marketing functions (very suitable in the promotion function, and suitable in the remaining three functions), number four suitable technology was found to be IoT, and number five was Augmented Reality. Such results coincide with the

scientific literature sources, as, based on the results of other studies (Brkljac & Sudarevic, 2018; Caliskan et al., 2020; Cimini et al., 2017; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Sima et al., 2020; Ungerman & Dědková, 2019), the most universal technologies of Industry 4.0 having relation to the marketing functions were found to be the network technologies, for instance, Internet of Things, Artificial Intelligence, and Augmented Reality.

Also, technologies such as 3D printing were found to be very suitable for application only in one marketing function – product (in the other three functions, it was rated as neither not suitable, nor suitable), Autonomous robots were found to be suitable to be applied in product and promotion marketing functions but rated as the neutral Industry 4.0 technology in price and place marketing functions. The lowest rated technology to be suitable for application in the marketing-related functions was found to be Blockchain and was considered as suitable only in price marketing function. Such results coincide with literature sources, as based on the (Brkljac & Sudarevic, 2018; Caliskan et al., 2020; Cimini et al., 2017; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Sima et al., 2020; Ungerman & Dědková, 2019).

Table 36. Application suitability of Industry 4.0 technologies in all four marketing functions separately

ALL FOUR MAKRETING FUNCTIONS / Industry 4.0 Technologies	ALL RATING	ALL ANKING	PRODUCT RATING	PRODUCT RANK	PICE RATING	PRICE RANK	PLACE RATING	PLACE RANK	ROMO RATING	PROMO RANK
BIG DATA	**Very suitable**	1	Suitable	7	**Very suitable**	1	**Very suitable**	1	**Very suitable**	1
ARTIFICIAL INTELLIGENCE	**Very suitable**	2	**Very suitable**	1	Suitable	2	Suitable	2	**Very suitable**	2
MOBILE APPS/TECHNOLOGIES	Suitable	3	Suitable	8	Suitable	4	Suitable	3	**Very suitable**	4
INTERNET OF THINGS (IoT)	Suitable	4	**Very suitable**	3	Suitable	5	Suitable	4	Suitable	8
AUGMENTED REALITY (AM)	Suitable	5	**Very suitable**	5	neutral	10	Suitable	7	**Very suitable**	3
CHATBOTS	Suitable	6	Suitable	11	Suitable	6	Suitable	8	**Very suitable**	5
SIMULATION/DIGITAL TWIN	Suitable	7	**Very suitable**	2	Suitable	3	Neutral	12	Suitable	10
CLOUD COMPUTING	Suitable	8	Suitable	12	Suitable	8	Suitable	5	Suitable	9
VIRTUAL REALITY (VR)	Suitable	9	Suitable	9	Neutral	14	Suitable	10	Suitable	6
VIRTUAL ASSISTANTS	Suitable	10	Suitable	13	Neutral	9	Suitable	9	Suitable	7
5G NETWORK	Suitable	11	**Very suitable**	6	Neutral	13	Suitable	6	Suitable	12
3D PRINTING	Neutral	12	**Very suitable**	4	Neutral	11	Neutral	11	Neutral	14
AUTONOMOUS ROBOTS	Neutral	13	Suitable	10	Neutral	12	Neutral	14	Suitable	11
BLOCKCHAIN	Neutral	14	Neutral	14	Suitable	7	Neutral	13	Neutral	13
Meanings:	**ALL RATING*** – Suitability rating for all 4 marketing functions (product, price, place, promotion) **ALL RANKING*** – Suitability ranking for all the 4 marketing functions (product, price, place, promotion) **PRODUCT RATING*** – Suitability rating for the product marketing function **PRODUCT RANK*** – Suitability ranking for the product marketing function **PRICE RATING*** – Suitability rating for the price marketing function **PRICE RANK*** – Suitability ranking for the price marketing function **PLACE RATING*** – Suitability rating for the place marketing function **PLACE RANK*** – Suitability ranking for the place marketing function **PROMO RATING*** – Suitability rating for the promotion marketing function **PROMO RANK*** – Suitability ranking for the promotion marketing function									

Source: created by the author

3.5. Discussion of Qualitative Research Analysis Results on the Suitability of Industry 4.0 Technologies for Adoption in Marketing Functions within Lithuanian SMEs

The results obtained in the course of this study provide a new, original aspect to the existing information regarding the enablement of the Industry 4.0 technologies in the marketing functions of SMEs. Based on the qualitative research results and the discussion described above, it can be concluded that the selected C-level Executives are familiar with the Industry 4.0 technologies' as the majority of the technologies mentioned by the respondents coincide with the Industry 4.0 technologies mentioned in the scholarly articles. Also, according to the C-level Executives, marketing was identified as one of the key business functions in which the wide range of the Industry 4.0 technologies could be applied. According to the C-level Executives, six Industry 4.0-related technologies mentioned by the C-level Executives were identified to be suitable to be applied in the marketing-related functions of SMEs. Such technologies are: Big Data, Artificial Intelligence, Digital Twin (Simulation), Cloud Computing, Virtual Reality, and Chatbots.

The obtained results of the suitability ratings of the fourteen selected Industry 4.0 technologies to be applied to separate marketing functions within SMEs, as rated by the C-level Executives of SMEs, coincide with the respondents' open answers. The study results revealed that the widest group of the Industry 4.0 technologies can be applied in the marketing product function. Also, this study's main theoretical implication is that the qualitative study revealed that Big Data is considered to be the most applicable and universal Industry 4.0 technology for the marketing-related functions. Big Data was found to be the most suitable technology to be applied in the price, place, and promotion marketing functions, as well as rated as a suitable one in the product marketing function. According to the C-level Executives, Big Data provides many benefits for SMEs. It enhances the operational efficiency, as the gathered data helps optimise marketing campaigns, enables more efficient segmentation and targeting, and helps forecast the future trends. It also enhances SMEs competitiveness as it helps to monitor rivals' strategies and create high-quality marketing materials. Last but not least, it provides the opportunity to enable the customer-centricity element while improving the customer satisfaction and creating more personalised offerings. In addition to it, Artificial Intelligence was found to be the second most suitable Industry 4.0 technology to be applied in all the four marketing functions. Such a technology was rated as number one technology to be applied in the product

marketing function and number two Industry 4.0 technology for the application in the three remaining marketing functions (price, promotion, and place). Mobile apps/technologies were found to be number three Industry 4.0 technology suitable for application in the marketing functions (very suitable in the promotion marketing function, and suitable in the remaining three functions), number four suitable technology was found to be IoT, and number five was Augmented Reality. Such results coincide with the scientific literature sources, as, based on the results of other studies (Brkljac & Sudarevic, 2018; Caliskan et al., 2020; Cimini et al., 2017; Młody, 2018; Saniuk et al., 2020; Saucedo-Martínez et al., 2018; Sima et al., 2020; Ungerman & Dědková, 2019), the most universal technologies of Industry 4.0 having relation to the marketing functions were found to be network technologies, for instance, Internet of Things, Artificial Intelligence, and Augmented Reality. According to Caliskan et al., (2020), Augmented Reality enables shopping online, and Ungerman and Dědková (2019) state that digital marketing trends are being widely used in the promotion marketing function, while employing artificial intelligence, which analyses the behaviour of the social network members automatically. Sima et al. (2020) suggest that, for marketing, and especially for the marketing promotional function, the IoT technology is key, as IoT enables the establishment of huge networks which will connect all the members of the value chain and influence the purchasing and consumption patterns. Caliskan et al. (2020) also highlighted the importance of Big Data for the pricing marketing function, as dynamic pricing focuses on the product and on the customer to create the optimal revenue. Therefore, five Industry 4.0 technologies, namely, Big Data, Artificial Intelligence, Mobile Apps Technologies, IoT, and Augmented Reality can be considered as universal Industry 4.0 technologies suitable for adoption in various marketing-related functions.

However, the other remaining Industry 4.0 technologies, namely, Chatbots, Simulation/Digital Twin, Cloud Computing, Virtual Reality, Virtual Assistants, 5G Network, 3D Printing, Autonomous Robots, and Blockchain can be identified as niche Industry 4.0 technologies which are suitable for adoption only in the specific marketing-related functions. This is due to the fact that such technologies were mentioned fewer times, or were not mentioned at all by the C-level Executives as the suitable technologies to be applied in the SMEs marketing functions (i.e., 5G Network, Blockchain, Virtual Assistants were not commonly mentioned by the C-level Executives with regard to the marketing-related functions). Also, such technologies were rated as suitable for adoption only in several marketing functions. For instance, technologies such as 3D printing were found to be very suitable for

application only in one marketing function – product (in the other three functions, 3D printing was rated as neither not suitable, nor suitable), Autonomous robots were found suitable to be applied in the product and promotion marketing functions, but rated as neutral Industry 4.0 technologies in the price and place marketing functions. The lowest-rated technology to be suitable for application in the marketing-related functions was found to be Blockchain, and it was considered as suitable only in the price marketing function.

Further analysis will concentrate on the quantitative research methods. During this stage, the gathered information from the semi-structured interviews about universal (Big Data) and niche (Chatbots) technologies of the Industry 4.0 suitability for adoption in the marketing functions within Lithuanian SMEs will be used to test the raised hypotheses of the research model (Part A, Part B, Part C).

These two specific technologies were selected for further research due to the reason that the open questions and rating results provided by the C-level Executives revealed the contrasting application possibilities of the technologies in the marketing functions within SMEs. The Big Data technology, for instance, was rated as the most suitable Industry 4.0 technology across the four key marketing functions: price, place, promotion, and product. Specifically, it was deemed highly suitable for the price, place, and promotion functions, and suitable for the product function. This widespread applicability underscores the universal utility of the Big Data technology in various marketing contexts. Conversely, Chatbots were identified as a niche Industry 4.0 technology. This technology was considered suitable for adoption across the four marketing functions, with the C-level executives particularly noting its high applicability within the promotion marketing function. Here, Chatbots were rated as very suitable, whereas, in the remaining three functions, the adoption of Chatbots was rated as suitable. This indicates a more targeted application potential for Chatbots in one specific marketing function. Therefore, the selection of Big Data and Chatbots for the further investigation aims to elucidate distinct facets of the technology adoption process in the marketing functions within SMEs. Big Data's broad applicability contrasts with the targeted utility of Chatbots providing a comprehensive understanding of the varying adoption dynamics of the Industry 4.0 technologies in the SMEs marketing strategies.

4. RESULTS OF THE QUANTITATIVE RESEARCH ON FACTORS INFLUENCING THE SUITABILITY OF INDUSTRY 4.0 TECHNOLOGIES FOR ADOPTION IN MARKETING FUNCTIONS WITHIN LITHUANIAN SMEs

4.1. Demographic Characteristics of the Participants of the Survey

The second part of the research involved the use of the quantitative research methods aiming to identify the factors influencing the suitability of the selected niche and universal Industry 4.0 technologies for adoption in the four marketing functions within Lithuanian SMEs. To reach the aim of the study, eight surveys were prepared to investigate the suitability of the selected Industry 4.0 technologies (universal – *Big Data*, and niche – *Chatbots*) for adoption in the four marketing functions (*product, price, place, promotion*) within SMEs.

A team of twelve researchers from *Rinkos Tyrimų Centras* were reaching out to potential participants in the study in February and March 2024. A total of 7,474 enterprises were contacted through telephone. The remaining sample size consisted of 3,785 respondents who consented to engage in the study going forward, thereby accounting for 50.64% of the initially contacted firms, as 3,689 respondents rejected to participate. The 3,785 respondents who agreed to participate were asked four screening questions to determine their eligibility for further investigation. These questions assessed whether the respondents were employed by small or medium-sized enterprises (SMEs), were responsible for marketing decisions and were knowledgeable about the potential applications of Big Data and Chatbots in the marketing functions within SMEs. Additionally, it was confirmed that these respondents had not yet implemented these Industry 4.0 technologies in their current workplaces. Following the screening process and the removal of 1,376 respondents due to ineligibility, 2,313 respondents constituted the remaining sample size. Moreover, following a thorough review of the respondents' answers, 2,072 responses were eliminated due to inconsistencies. Consequently, the final sample size deemed suitable for the study consisted of 241 respondents, resulting in a response ratio of 10.42%. Each survey included responses from between thirty and thirty-one respondents. Table No. 37 lists the surveys in sequence.

It must be mentioned that the achieved response ratio aligns with recent trends in telephone survey response rates. For instance, Pew Research Center (2012), as cited in Dutwin & Buskirk (2021), documented a significant decline in response rates from 35 percent in 1997 to 9 percent in 2012. Additionally,

Pew Research Center (2019) observed that response rates continued to decline post – 2016. Consequently, the achieved response ratio of 10.42% in this study is consistent with current industry standards, thereby validating its appropriateness for subsequent analysis.

Table 37. The sequence and number of respondents in quantitative research surveys

Industry 4.0 related Technology	Marketing related function	Survey sequence	Number of respondents
Universal: Big Data	Product marketing function	First group of respondents	30
Universal: Big Data	Price marketing function	Second group of respondents	30
Universal: Big Data	Promotion marketing function	Third group of respondents	31
Universal: Big Data	Place marketing function	Fourth group of respondents	30
Niche: Chatbots	Product marketing function	Fifth group of respondents	30
Niche: Chatbots	Price marketing function	Sixth group of respondents	30
Niche: Chatbots	Promotion marketing function	Seventh group of respondents	30
Niche: Chatbots	Place marketing function	Eighth group of respondents	30

Source: created by the author

After the primary data was gathered, it was prepared for the analysis by using *Microsoft Excel*. The data was coded and then transferred to *SPSS*. Afterwards, regression, mediation, moderation, and correlation analyses were performed.

An examination of the diverse demographic attributes related to the examined SMEs is crucial for the analysis. According to the survey results, three quarters of the respondents were currently working at SMEs which had between 10 and 49 employees (74.27%) and the annual turnover (in euros) consisted of between 2.01 million EUR and 10 million EUR (82.16%). Meanwhile, only one quarter of the survey participants indicated that the enterprise where they were currently working had more than 50 employees (25.73%), and the annual turnover exceeded 50 million EUR (17.84%). These results indicate that the majority of the survey respondents were working in small enterprises, based on the official definition of SMEs. Table No. 38 reflects these results.

Table 38. Enterprise demographics in terms of the number of employees and the annual turnover in EUR in quantitative research surveys

Number of employees of the enterprise	QT	Share %	Annual Turnover (in euros) of the enterprise	QT	Share %
Between 10 and 49 employees	179	74.27%	Between 2.01 million EUR and 10 million EUR	198	82.16%
Between 50 and 250 employees	62	25.73%	Between 10.01 million EUR and 50 million EUR	43	17.84%
N (Sample size)	**241**	**100%**	**N (Sample size)**	**241**	**100%**

Source: created by the author

Table No. 39 reveals the dominant business sector of the examined enterprises. The majority of the participants were working in SMEs whose primary business sectors were services (43.15%), followed by production-focused SMEs (31.12%), and trade-focused SMEs (25.73%).

Table 39. Enterprise demographics in terms of the dominant Industry sector

The dominant Industry sector in the enterprise	QT	Share %
Services	104	43.15%
Production	75	31.12%
Trade	62	25.73%
N (Sample size)	**241**	**100%**

Source: created by the author

Table No. 40 summarises the main economic activities of the SMEs that participated in the study based on the NACE 2.0 criteria (European Commission, 2024). The table outlines the quantitative distribution of the enterprises across various economic sectors, along with their respective shares. The data reveals that the majority of the surveyed SMEs (14.52%) primarily engage in Professional, Scientific, and Technical Activities, encompassing services such as Advertising and Engineering. Following closely behind, 14.11% of the SMEs are involved in Manufacturing, while 11.62% are engaged in Wholesale and Retail Trade, including the Repair of Motor Vehicles and Motorcycles.

Among other notable sectors, Construction and Transportation and Storage each account for 10.37% of the surveyed SMEs. Accommodation and Food Service Activities represent 7.47%, followed by Electricity, Gas, Steam, and Air Conditioning Supply at 5.81%. Less prevalent among the surveyed SMEs are Agriculture, Forestry, and Fishing (4.98%), Information and Communication (4,56%), and Other Service Activities (4.15%). Sectors with the smallest representation include Mining and Quarrying (3.73%), Human

Health and Social Work Activities (2.49%), and Water Supply, Sewerage, Waste Management and Remediation Activities (2.49%). Furthermore, Financial and Insurance Activities make up 2.07% of the surveyed SMEs, while Real Estate Activities and Administrative and Support Service Activities have the smallest share at 0.83% and 0.41%, respectively.

Table 40. Enterprise demographics in terms of the Economic activities of the enterprises based on NACE 2.0

Economic activities of the enterprises based on NACE 2.0	**QT**	**Share %**
Professional, Scientific and Technical Activities	35	14.52%
Manufacturing	34	14.11%
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	28	11.62%
Construction	25	10.37%
Transportation and Storage	25	10.37%
Accommodation and Food Service Activities	18	7.47%
Electricity, Gas, Steam and Air Conditioning Supply	14	5.81%
Agriculture, Forestry and Fishing	12	4.98%
Information and Communication	11	4.56%
Other Service Activities	10	4.15%
Mining and Quarrying	9	3.73%
Human Health and Social Work Activities	6	2.49%
Water Supply, Sewerage, Waste Management and Remediation Activities	6	2.49%
Financial and Insurance Activities	5	2.07%
Real Estate Activities	2	0.83%
Administrative and Support Service Activities	1	0.41%
N (sample size)	**241**	**100%**

Source: created by the author

Table No. 41 provides a scientific breakdown of the geographical distribution of Small and Medium Enterprises (SMEs) based on the location of their headquarters. It presents both the quantitative count (QT) and the share of each geographical Region in the overall sample size.

Based on the data, it is evident that the majority of SMEs are headquartered in Vilnius Region, constituting 36.51% of the total sample size. Following Vilnius Region, Kaunas Region emerges as the next most prevalent location, representing 29.05% of the sample.

Further analysis reveals that Panevėžys Region comprises 7.47% of the sample, while Klaipėda Region and Šiauliai Region each make up 7.05% and

6.22%, respectively. Utena Region accounts for 3.73%, followed by Telšiai Region (2.90%). Alytus Region and Tauragė Region each have a share of 2.49% in the sample. Marijampolė Region has the smallest share (2.07%) in the sample size.

Table 41. Enterprise demographics in terms of the geographical locations of their Headquarters

Geographical locations of enterprises' Headquarters	**QT**	**Share %**
Vilnius Region	88	36.51%
Kaunas Region	70	29.05%
Panevėžys Region	18	7.47%
Klaipėda Region	17	7.05%
Šiauliai Region	15	6.22%
Utena Region	9	3.73%
Telšiai Region	7	2.90%
Alytus Region	6	2.49%
Tauragė Region	6	2.49%
Marijampolė Region	5	2.07%
N (sample size)	**241**	**100%**

Source: created by the author

For further analysis, it is crucial to investigate the respondents' work experience related to the marketing decision-making in their current role within SMEs. Table No. 42 presents the data breakdown. Upon examination, the most prevalent respondents' segment within the surveyed population, comprising 82.16% of the sample, have accumulated work experience in their current role related to marketing decision-making for longer than 5 years.

Table 42. Respondents demographics in terms of their work experience related to marketing-decision making in the current role within SMEs

Respondents work experience related to marketing decision making in the current role within SMEs	**QT**	**Share %**
up to 1 year	4	1.66%
between 1 and 3 years	16	6.64%
between 3 and 5 years	23	9.54%
longer than 5 years	198	82.16%
N (sample size)	**241**	**100%**

Source: created by the author

Additionally, the analysis indicates that a smaller proportion of the respondents had varying degrees of experience. Specifically, 9.54% had between 3 and 5 years of experience, and 6.64% of respondents had between 1 and 3 years of experience. The smallest segment consisted of the respondents with up to 1 year of experience, constituting only 1.66% of the sample size.

Demographic analysis revealed that one quarter of the respondents (25.73%) indicated that, in the SME where they were currently working, they were only responsible for marketing-related decision-making. Meanwhile, 74.27% of the respondents stated that they were responsible for marketing-related decision-making as well as other areas of the business, such as finance, human resources, manufacturing, logistics, investments, and so on.

This information also correlates with the indicated job titles of the respondents shown in Table No. 43, as 152 out of 241 respondents referred to their current job title as the Chief Executive Officer. Assistant Managers and Chief Sales Officers each had a share of 7.05% in the sample, followed by Chief Marketing Officers with 6.64% of the sample size. Other indicated job titles constitute the remaining 16.18% of the total sample size and refer to such positions as Chief Operations Officer, Marketing Specialist, Project Manager, Sales Specialist, SME Owner, and others.

Table 43. Respondent demographics in terms of their job titles

Job Title of respondents	**QT**	**Share %**
Chief executive officer	152	63.07%
Assistant Manager	17	7.05%
Chief sales officer	17	7.05%
Chief marketing officer	16	6.64%
Chief operations officer	9	3.73%
Marketing specialist	8	3.32%
Project Manager	7	2.90%
Sales specialist	4	1.66%
SME Owner	4	1.66%
Others	7	2.90%
N (sample size)	**241**	**100%**

Source: created by the author

The distribution of the demographic findings shows that the survey participants met the selection criteria, thus making the collected data suitable for further analysis.

4.2. Exploratory Factor Analysis, Sample Size and Reliability of the Constructs

The current study employed exploratory factor analysis to understand the structure of a set of variables and address the multicollinearity problem (Field, 2013). Tables No. 44. and No. 45 show the summarised results of the exploratory factor analysis conducted. In Appendix No. 6, comprehensive exploratory factor analysis results are shown.

This study used the principal component analysis method with a varimax rotation to extract factors from the 13 statements used in the questionnaire, which reflects part of No. 5 question in the survey. The results of Bartlett's test of sphericity indicated that the correlation matrix was not random, $\chi^2(78) = 1460.3$, $p<0.001$, and the KMO statistic was 0.809, which is well above the minimum standard for conducting factor analysis. Therefore, it was determined that the correlation matrix was appropriate for factor analysis. The analysis yielded a four-factor solution. Table No. 44 presents the factor loadings, communalities and variances explained. Loadings which were <0.4 were not included in the table, as they were found to be statistically insignificant.

Based on the analysis results, Item No. Q5.7 could be explained by the first and the fourth factors, nonetheless, it was assigned to the first factor as it has a higher weight (0.539>0.413) and corresponds better according to meaning. Consequently, four items loaded onto the first factor (0.539–0.855). These items were related to the perceived compatibility of the Big Data/Chatbots technology (1)*. Three items loaded onto the second factor (0.850–0.891), which referred to the perceived trialability of the Big Data/Chatbots technology (2)*. Three items loaded onto the third factor (0.766–0.898). These items were related to the perceived complexity of the Big Data/Chatbots technology (3)*. The final three statements belonged to the fourth factor (0.613–0.829) which represented the perceived observability of the Big Data/Chatbots technology (4)*. These four factors explained 72% of the total variance. According to Hair et al. (2018), factors that account for 60% of the total variance are satisfactory.

Table 44. Exploratory factor analysis (Q5)

Variable No.	1*	2*	3*	4*	h^2
Q5.4	**0.827**				**0.737**
Q5.5	**0.855**				**0.834**
Q5.6	**0.838**				**0.825**

Variable No.	1*	2*	3*	4*	h^2
Q5.7	**0.539**			0.413	**0.600**
Q5.8			**0.803**		**0.656**
Q5.9			**0.898**		**0.820**
Q5.10			**0.766**		**0.604**
Q5.12				**0.613**	**0.413**
Q5.13				**0.829**	**0.715**
Q5.14				**0.763**	**0.673**
Q5.15		**0.891**			**0.834**
Q5.16		**0.887**			**0.830**
Q5.17		**0.850**			**0.794**
% of Variance	**20.38**	**19.65**	**16.52**	**15.26**	
Meanings:	**1*** – perceived compatibility of the Big Data/Chatbots technology **2*** – perceived trialability of the Big Data/Chatbots technology **3*** – perceived complexity of the Big Data/Chatbots technology **4*** – perceived observability of the Big Data/Chatbots technology				

Source: created by the author

Table No. 45 presents the factor loadings, communalities and variances explained for the remaining items used in the survey (Q5–Q12). Loadings that were <0.4 were not included in the table, as they were found to be statistically insignificant. This study used the principal component analysis method with a varimax rotation to extract factors from the 27 statements used in the questionnaire. The results of Bartlett's test of sphericity indicated that the correlation matrix was not random, $\chi^2(351) = 6443.7$, $p<0.001$, and the KMO statistic was 0.930, which is well above the minimum standard for conducting factor analysis. Therefore, it was determined that the correlation matrix was appropriate for factor analysis.

Table 45. Exploratory factor analysis (Q5–Q12)

Variable No.	1*	2*	3*	4*	5*	6*	7*	8*	h^2
Q5.1					**0.794**				**0.884**
Q5.2					**0.809**				**0.901**
Q5.3					**0.655**				**0.774**
Q6.1	**0.701**								**0.908**
Q6.2	**0.762**								**0.946**
Q6.3	**0.719**								**0.935**
Q6.4	**0.694**								**0.911**
Q7.1			**0.840**						**0.794**
Q7.2			**0.748**						**0.759**
Q7.3			**0.858**						**0.785**

Variable No.	1*	2*	3*	4*	5*	6*	7*	8*	h^2
Q7.4			**0.768**						**0.740**
Q8.1				**0.774**					**0.875**
Q8.2				**0.715**					**0.844**
Q8.3				**0.771**					**0.882**
Q9.1		**0.625**		0.448					**0.772**
Q9.2		**0.721**							**0.826**
Q9.3		**0.772**							**0.867**
Q9.4		**0.795**							**0.809**
Q10.1						**0.630**			**0.795**
Q10.2						**0.846**			**0.872**
Q10.3						**0.851**			**0.862**
Q11.1							**0.720**		**0.844**
Q11.2							**0.734**		**0.888**
Q11.3							**0.625**		**0.872**
Q12.1								**0.907**	**0.842**
Q12.2								**0.875**	**0.819**
Q12.3								**0.772**	**0.662**
% of Variance	**11,46**	**11.14**	**11.05**	**10.75**	**10.67**	**10.44**	**9.90**	**8.55**	
Meanings:	**1*** – perceived usefulness of the Big Data/Chatbots technology adoption within SMEs **2*** – top management support of the Big Data/Chatbots technology adoption in selected marketing function within SMEs **3*** – perceived easiness of use of the Big Data/Chatbots technology for the employees within SMEs **4*** – attitude of the Big Data/Chatbots technology suitability for adoption in the selected marketing function (product, price, promotion, place) within SMEs **5*** – perceived relative advantage of the Big Data/Chatbots technology **6*** – competitive environment of the Big Data/Chatbots technology adoption in the selected marketing function within SMEs **7*** – the intention to adopt the Big Data/Chatbots technology in the selected marketing function within SMEs **8*** – SME size								

Source: created by the author

The analysis yielded an eight-factor solution. Four items loaded onto the first factor (0.694–0.762). These items were related to the perceived usefulness of the Big Data/Chatbots technology adoption within SMEs (1)*. Four items loaded onto the second factor (0.625–0.795), which referred to the top management support of the Big Data/Chatbots technology adoption in the selected marketing function within SMEs (2)*. Four items loaded onto the third factor (0.748–0.858). These items were related to the perceived easiness of use of the Big Data/Chatbots technology for the employees within SMEs (3)*. Three items loaded onto the fourth factor (0.715–0.774). These items were related to the attitude of the Big Data/Chatbots technology suitability for the adoption in the selected marketing function (product, price, promotion, place) within SMEs (4)*. Three items loaded onto the fifth factor (0.655–

0.809), which referred to the perceived relative advantage of the Big Data/Chatbots technology (5)*. Three items loaded onto the sixth factor (0.630–0.851). These items were related to the competitive environment of the Big Data/Chatbots technology adoption in the selected marketing function within SMEs (6)*. Three items loaded onto the seventh factor (0.625–0.734). These items were related to the intention to adopt the Big Data/Chatbots technology in the selected marketing function within SMEs (7)*. The final three statements belonged to the eight factor (0.772–0.907), which represented the SME size (8)*.

These eight factors explained 84% of the total variance. According to Hair et al. (2018), factors that account for 60% of the total variance are satisfactory.

It is worth noting that the total sample size consisted of 241 respondents' answers; therefore, exploratory factor analysis was divided into two parts. According to Guadagnoli and Velicer (1988), cited in Field (2013), if a factor has four or more loadings greater than 0.6, then it is reliable regardless of the sample size. In this study, only Q5.7 loading was slightly lower than 0.6 (0.539). Also, according to MacCallum et al. (1999), cited in Field (2013), with communalities in the 0.5 range, samples between 100 and 200 can be good enough, provided there are relatively few factors, each with only a small number of indicator variables. According to this study, only Q5.12 communality was slightly lower than 0.5 (specifically, 0.413), while all the remaining values were higher than 0.6. Consequently, the sample size of 241 is considered to be statistically meaningful.

To analyse the factors which influence the intention to adopt the Industry 4.0 technology within SMEs marketing-related functions, 12 constructs were used. The reliability of each construct was tested by using the Cronbach's alpha reliability test. In Table No. 46, Cronbach's alphas coefficients are provided. As it can be seen, the Cronbach's alpha coefficients of each construct are higher than 0.6, thus demonstrating the reliability of all the constructs.

Table 46. Cronbach's alpha coefficients of each tested construct

CONSTRUCTS	NUMBER OF ITEMS	Cronbach Alfa in the SMEs research
Relative advantage, (AlBar & Hoque, 2019), based on Premkumar and Roberts, 1999	3	0.910
Compatibility, (Kumar et al., 2017), based Wang et al., 2010	4	0.868

CONSTRUCTS	NUMBER OF ITEMS	Cronbach Alfa in the SMEs research
Complexity, (AlBar & Hoque, 2019), based on Premkumar and Roberts, 1999	3	0.771
Observability, (Duan et al., 2010), based on Moore and Benbasat (1991)	3	0.646
Trialability, (Yuen et al., 2021), based on Yuen et al., 2018	3	0.889
Perceived usefulness, (Rahman et al., 2021), based on Belanche et al., 2019	4	0.975
Perceived ease of use, (Rahman et al., 2021), based on Belanche et al., 2019	4	0.870
Attitude toward technology suitability for adoption, (Rahman et al., 2021), based on Belanche et al., 2019	3	0.924
Top management support, (Kumar et al., 2017), based on Ifinedo, 2011	4	0.910
Competitive environment, (AlBar & Hoque, 2019), based on Al-Qirim and Corbitt, 2002	3	0.885
Intention to adopt, (Kumar et al., 2017), based on Gangwar et al., 2015	3	0.936
SME Size, (Sun et al, 2020), based on Wang et al., 2010	3	0.820

Source: created by the author

Three of the twelve tested constructs exhibited a higher Cronbach's alpha compared to the original sources. For instance, the relative advantage construct Cronbach's alpha (0.910>0.733), the trialability construct Cronbach's alpha (0.889>0.855), and the competitive environment construct Cronbach's alpha (0.885>0.799). Meanwhile, the compatibility construct Cronbach's alpha (0.868) closely matched the original source value of 0.869. Besides, the intention to adopt construct Cronbach's alpha perfectly matched the original source value (0.936).

Moreover, the Cronbach's alpha for five out of twelve constructs was slightly lower than the values of the original sources. For example, the complexity construct Cronbach's alpha (0.771<0.848), as well as the perceived ease of use construct Cronbach's alpha (0.870<0.932). The same was applicable for the attitude towards the technology suitability for adoption

construct Cronbach's alpha (0.924<0.948) as well as for the top management support construct Cronbach's alpha (0.910<0.915). Also, the Cronbach's alpha for the SME size construct was slightly lower than that of the original source (0.820<0.895). However, all five of them are still considered reliable.

The construct of 'observability' had the lowest Cronbach's alpha coefficient (0.646), while, in the original source, this construct Cronbach's alpha was (0.771). It is worth noting that, in the survey, the adjusted observability construct was used, which consisted of four items instead of five (without Item OB2). Moreover, one item of this construct (OB1) was removed during exploratory factor analysis. Nonetheless, observability construct Cronbach's alpha coefficient in this study (0.646) was accepted as reliable but close to the lower limit of the acceptable range. Additionally, Cronbach's alpha of 'perceived usefulness' was 0.975, which implies that the items of the construct might be too similar. However, it almost perfectly matches the Cronbach's alpha from the original source (0.972) and is considered to be acceptable.

Thus, with Cronbach's alphas ranging from 0.646 to 0.975, all the twelve constructs were confirmed to be reliable and could have been used for the analysis.

4.3. Normality Analysis

Given the sample size of 241 respondents, the Kolmogorov-Smirnov and Shapiro-Wilk tests were employed for assessing normality. The outcomes of this test are shown in Table No. 47, with most of the p-values being notably under the limit of 0.05, thereby indicating that the assumption of normality is not justifiable.

Table 47. Analysis of normality by employing Kolmogorov-Smirnov and Shapiro-Wilk tests

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Perceived usefulness	0.109	241	<.001	0.941	241	<.001
Perceived ease of use	0.120	241	<.001	0.974	241	<.001
Attitude toward technology suitability for adoption	0.108	241	<.001	0.949	241	<.001
Top management support	0.114	241	<.001	0.958	241	<.001
Competitive environment	0.113	241	<.001	0.928	241	<.001

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Intention to adopt technology	0.091	241	<.001	0.948	241	<.001
SME Size	0.091	241	<.001	0.982	241	.004
Relative advantage	0.111	241	<.001	0.941	241	<.001
Compatibility	0.068	241	.009	0.967	241	<.001
Complexity	0.071	241	.005	0.969	241	<.001
Observability	0.080	241	<.001	0.985	241	.012
Trialability	0.178	241	<.001	0.848	241	<.001

Source: created by the author

Therefore, a comprehensive examination of Skewness and Kurtosis, which are vital components in reinforcing the regression analysis robustness, will also be used. Table No. 48 represents the descriptive statistics of the twelve constructs that were used for the analysis. All the constructs' means are lined up with the middle values (since a seven-point Likert scale was used for all constructs). Additionally, the Skewness and Kurtosis values of the constructs are presented.

The construct of competitive environment in the survey has the lowest mean (2.909), getting very close to the negative side. This result could be explained by the assumption that most of the respondents did not consider the competitive environment pressure as an important factor while taking the decision to adopt Industry 4.0 technologies within SMEs. On the other hand, the construct of trialability has the highest mean of all constructs (5.230). This means that most of the respondents believe that it is important to try out Industry 4.0 technologies before adopting them in their current company. All other survey means fall within the range of 3.476–4.570, indicating that the respondents' opinions were generally more in the middle and slightly more positive than negative regarding the variables.

Table 48. Comparison of means and Skewness and Kurtosis

	Mean	**Std. Deviation**	**Skewness**	**Kurtosis**
Perceived usefulness	3.5861	1.82192	0.082	-0.980
Perceived ease of use	3.6203	1.41312	-0.013	-0.366
Attitude toward technology suitability for adoption	4.1411	1.79129	-0.188	-0.857

	Mean	Std. Deviation	Skewness	Kurtosis
Top management support	3.6680	1.66482	-0.064	-0.872
Competitive environment	2.9087	1.57173	0.482	-0.585
Intention to adopt technology	3.4758	1.73912	0.162	-0.862
SME Size	3.6542	1.34348	-0.028	-0.470
Relative advantage	4.1079	1.80903	-0.298	-0.892
Compatibility	3.5633	1.57747	0.032	-0.683
Complexity	4.5698	1.51041	-0.269	-0.390
Observability	4.1203	1.26760	-0.260	-0.323
Trialability	5.2296	1.87128	-0.923	-0.226

Source: created by the author

Moving to the distribution shape of the responses, Skewness and Kurtosis were measured for all the constructs. The Skewness values, falling within the normality range (-1 to +1) for all the constructs, indicate that the distributions are reasonably symmetric, which means that the respondents' ratings are fairly evenly distributed around the mean.

Moreover, the Kurtosis values all falling within the range of (-1 to +1), which suggests that the shapes of these distributions are close to a normal distribution, with neither excessively peaked nor flat patterns. Therefore, the data from the table implies that the survey responses not only have means indicating positive ratings but also exhibit relatively balanced and normal distribution shapes, thereby providing valuable insights into the respondent preferences.

In conclusion, the analysis of the distribution characteristics justifies the normality of the data distribution, and the research will move forward with the hypotheses testing.

4.4. Examination of Factors Influencing the suitability of Industry 4.0 Technologies for Adoption in Marketing Functions within Lithuanian SMEs

4.4.1. The influence of perceived characteristics of Industry 4.0 technologies on perceived usefulness and ease of use

In this part of the study, the relationship between the perceived characteristics of the Industry 4.0 technology impact on the Industry 4.0 technology perceived usefulness and the perceived ease of use will be explored. Also, this model investigates the possible moderating effect of the type of the Industry 4.0 technology (*Research Model Part A, shown in Figure No. 8*).

Firstly, to investigate the strength of the relationship between the perceived characteristics and the perceived usefulness of the Industry 4.0 technology, a correlation analysis was performed. The results are shown in Table No. 49.

Table 49. Correlation between perceived characteristics of Industry 4.0 technology and perceived usefulness

Pearson correlation	**Perceived usefulness**	**Relative Advantage**	**Compatibility**	**Complexity**	**Observability**	**Trialability**
Perceived usefulness	1.000	**0.775****	**0.755****	-0.048	0.489**	0.554**
Relative Advantage	**0.775****	1.000	0.806**	-0.109*	0.540**	0.478**
Compatibility	**0.755****	0.806**	1.000	-0.171*	0.616**	0.479**
Complexity	-0.048	-0.109*	-0.171*	1.000	-0.038	-0.002
Observability	0.489**	0.540**	0.616**	-0.038	1.000	0.340**
Trialability	0.554**	0.478**	0.479**	-0.002	0.340**	1.000
Meanings:	** p<0.001 *p<0.05					

Source: created by the author

Based on the Pearson correlation analysis results, it can be stated that the perceived usefulness is highly positively correlated with the perceived relative advantage ($r=0.775$, $p<0.001$) and the perceived compatibility ($r=0.755$, $p<0.001$). Meanwhile, the perceived trialability exhibits a moderate positive correlation with the perceived usefulness ($r=0.554$, $p<0.001$) as well as the perceived observability ($r=0.489$, $p<0.001$) with the perceived usefulness. The perceived complexity shows a very weak negative correlation

with the perceived usefulness and is insignificant (r=-0.048, p=0.231). Also, the correlation analysis indicates that there is a strongly positive correlation between the perceived compatibility and the perceived relative advantage (r=0.806, p<0.001). As the correlation analysis confirms that there is a significant link between four out of the five perceived characteristics of Industry 4.0 and the perceived usefulness, further analysis will concentrate on the multiple regression analysis for testing hypotheses H1, H3, H5, H7, and H9:

H1: *The perceived relative advantage of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

H3: *The perceived compatibility of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

H5: *The perceived complexity of the Industry 4.0 technology negatively affects the perceived usefulness of the Industry 4.0 technology.*

H7: *The perceived observability of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

H9: *The perceived trialability of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*

The regression model validity assumptions were validated. The normality and linearity can be assumed to be present because the sample of the data exceeds 200 respondents. Homoscedasticity is valid, there are no patterns clearly visible, but there are some outliers in the scatterplot, which could have a small impact on the overall results. The scatterplot is presented in Appendix No. 7. There are no multicollinearity problems in this regression as all the VIF collinearity statistics are below 3.5, and the tolerance values are lower than 1. The multiple regression results are shown in Table No. 50.

Table 50. Impact of perceived characteristics of Industry 4.0 technology on perceived usefulness

Construct	Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-0.783	0.334		-2.348	0.020		
Relative advantage	0.423	0.064	0.420	6.619	**<.001**	0.337	2.968
Compatibility	0.392	0.079	0.339	4.948	**<.001**	0.289	3.459
Complexity	0.067	0.045	0.056	1.484	0.139	0.956	1.046
Observability	-0.015	0.068	-0.010	-0.216	0.829	0.610	1.639
Trialability	0.189	0.042	0.194	4.529	**<.001**	0.740	1.352

Source: created by the author

The regression analysis model shows that five factors (perceived relative advantage, perceived compatibility, perceived complexity, perceived observability, and perceived trialability) explain 68.1% of the variance of the perceived usefulness of the Industry 4.0 technology (R2=0.681, F=100.349, p <0.001). It was found that the perceived relative advantage has a positive impact on the perceived usefulness of the Industry 4.0 technology (p-value<0.001, β=0.423); therefore, H1 was accepted. H3 was also confirmed as perceived compatibility has a positive impact on the perceived usefulness of the Industry 4.0 technology, (p-value<0.001, β=0.392). Nonetheless, Hypothesis 5 and Hypothesis 7 were rejected as the p values of the perceived complexity and the perceived observability were found to be non-significant (p=0.139) and (p=0.829). Finally, Hypothesis 9 was confirmed, as it was found that the perceived trialability has a positive impact on the perceived usefulness of the Industry 4.0 technology (p-value<0.001, β =0.189).

To sum up, **hypotheses (H1, H3, H9) were accepted**, as it was found that the perceived relative advantage, the perceived compatibility, and the perceived trialability has a significant positive impact on the perceived usefulness of Industry 4.0 technology. **Hypotheses (H5, H7) were rejected**, meaning that the perceived complexity and the perceived observability do not have any impact towards the perceived usefulness of the Industry 4.0 technology.

Also, to investigate the strength of the relationship between the perceived characteristics and the perceived ease of use of the Industry 4.0 technology, a correlation analysis was performed. The results are shown in Table No. 51.

Table 51. Correlation between perceived characteristics of Industry 4.0 technology and perceived ease of use

Pearson correlation	Perceived ease of use	Relative advantage	Compatibility	Complexity	Observability	Trialability
Perceived ease of use	1.000	**0.431****	**0.503****	-0.203**	**0.514****	0.263**
Relative advantage	**0.431****	1.000	0.806**	-0.109*	0.540**	0.478**
Compatibility	**0.503****	0.806**	1.000	-0.171*	0.616**	0.479**
Complexity	-0.203**	-0.109*	-0.171*	1.000	-0.038	-0.002
Observability	**0.514****	0.540**	0.616**	-0.038	1.000	0.340**
Trialability	0.263**	0.478**	0.479**	-0.002	0.340**	1.000
Meanings:	** p<0.001 *p<0.05					

Source: created by the author

Pearson correlation analysis results revealed that the perceived ease of use has a moderately positive correlation with the perceived observability ($r=0.514$, $p<0.001$), the perceived compatibility ($r=0.503$, $p<0.001$), and the perceived relative advantage ($r=0.431$, $p<0.001$). Also, the perceived ease of use has a weakly positive relationship with the perceived trialability ($r=0.263$, $p<0.001$) and a weakly negative relationship with the perceived complexity ($r=-0.203$, $p=0.001$).

As correlation analysis confirms that there is a significant relation between all the five perceived characteristics of Industry 4.0 and the perceived ease of use, further analysis will concentrate on the multiple regression analysis for testing hypotheses H2, H4, H6, H8, and H10:

H2: *The perceived relative advantage of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

H4: *The perceived compatibility of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

H6: *The perceived complexity of the Industry 4.0 technology negatively affects the perceived ease of use of the Industry 4.0 technology.*

H8: *The perceived observability of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

H10: *The perceived trialability of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*

The regression model validity assumptions were validated. The normality and linearity can be assumed to exist because the sample of the data is over 200 respondents. The scatterplot is presented in Appendix No. 7. Homoscedasticity is valid, there are no patterns clearly visible, but there are some outliers in the scatterplot, which could have a small impact on the overall results. There are no multicollinearity problems in this regression as all the VIF collinearity statistics are below 3.5, and the tolerance values are lower than 1. The multiple regression results are shown in Table No. 52.

Table 52. Impact of perceived characteristics of Industry 4.0 technology on perceived ease of use

Construct	Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.752	0.372		4.713	<.001		
Relative advantage	0.029	0.071	0.037	0.410	0.682	0.337	2.968

Construct	Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
Compatibility	0.204	0.088	0.228	2.315	**0.021**	0.289	3.459
Complexity	-0.137	0.051	-0.147	-2.707	**0.007**	0.956	1.046
Observability	0.381	0.076	0.341	5.038	**<.001**	0.610	1.639
Trialability	0.015	0.046	0.020	0.323	0.747	0.740	1.352

Source: created by the author

Regression analysis model shows that five factors (the perceived relative advantage, the perceived compatibility, the perceived complexity, the perceived observability, and the perceived trialability) explain 34.1% of the variance of the perceived ease of use of the Industry 4.0 technology ($R2=0.341$, $F=24.357$, $p <0.001$). It was found that the perceived relative advantage has no significant impact on the perceived ease of use of the Industry 4.0 technology ($p=0.682$), also, the perceived trialability has no significant impact on the perceived ease of use of the Industry 4.0 technology ($p=0.747$), thus H2 and H10 were rejected. On the other hand, the perceived compatibility (p-value<0.05, $\beta=0.204$), the perceived complexity (p-value<0.05, $\beta=-0.137$) and the perceived observability (p-value<0.001, $\beta=0.381$) were found to have an impact on the perceived ease of use of the Industry 4.0 technology, and thus hypotheses H4, H6, and H8 were accepted.

Summarising the points stated above, it was confirmed that the perceived compatibility and the perceived observability have a positive impact towards the perceived ease of use of the Industry 4.0 technology, thus **hypotheses (H4, H8) were accepted.** Also, it was confirmed that the perceived complexity exerts a negative impact towards the perceived ease of use of the Industry 4.0 technology. Thus, **hypothesis (H6) was accepted. Hypotheses (H2, H10) were rejected**, which means that the perceived relative advantage and the perceived trialability do not have an impact towards the perceived ease of use of the Industry 4.0 technology.

For testing of hypotheses H11, H11a, H11b, H11c, H11d, H11e, moderation analysis was used:

H11: *The impact of the perceived characteristics of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H11a**: The impact of the perceived relative advantage of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H11b**: The impact of the perceived compatibility of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H11c**: The impact of the perceived complexity of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H11d**: The impact of the perceived observability of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H11e**: The impact of the perceived trialability of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

The *SPSS Process Macro* procedure was utilised to assess the moderating role of the type of the Industry 4.0 technology on the interaction between the perceived characteristics of the Industry 4.0 technology and the perceived usefulness of the Industry 4.0 technology. It is worth mentioning that, as previously it had already been confirmed that the perceived complexity and the perceived observability do not have an impact towards the perceived usefulness of the Industry 4.0 technology, **Hypothesis H11c and Hypothesis H11d were rejected.** Thus, moderation analysis was executed only to test H11a, H11b, and H11e. Moderation analysis results of the H11a testing are presented in Table No. 53.

The regression results indicated that the perceived relative advantage significantly predicted the perceived usefulness of the Industry 4.0 technology ($R2=0.6012$, $F(3;237)=119.1$, $p<0.001$). However, the type of the Industry 4.0 technology did not impact the perceived usefulness of the Industry 4.0 technology ($p=0.889$). Furthermore, the moderation effect of the type of the Industry 4.0 technology on the interaction between a perceived relative advantage and the perceived usefulness of the Industry 4.0 technology was insignificant ($p=0.394$); therefore, H11a was rejected.

Table 53. Moderating role of the type of the Industry 4.0 technology on interaction between perceived relative advantage and perceived usefulness

	Coeff	se	t	p	LLCI	ULCI
Constant	3.6230	0.1134	31.9363	<.001	3.3995	3.8464
Relative Advantage	0.7397	0.0630	11.7437	**<.001**	0.6156	0.8638
Industry 4.0 technology	-0.0225	0.1608	-0.1400	0.8887	-0.3393	0.2943
Int_1 (Industry 4.0 technology moderation effect)	0.0760	0.0891	0.8536	0.3942	-0.0995	0.2515

Source: created by the author

Table No. 54 presents that the perceived compatibility significantly predicted the perceived usefulness of the Industry 4.0 technology ($R2=0.5767$, $F(3;237)=107.6$, $p<0.001$). Also, the type of the Industry 4.0 technology impacts the perceived usefulness of the Industry 4.0 technology (p-value=0.045, $\beta=-0.323$). This means that the selected universal Industry 4.0 technology – Big Data – has no impact towards the perceived usefulness, however, the selected niche Industry 4.0 technology – Chatbots – has a negative impact towards the perceived usefulness.

Furthermore, the moderation effect of the type of the Industry 4.0 technology on interaction between the perceived compatibility and the perceived usefulness of the Industry 4.0 technology was insignificant ($p=0.898$); therefore, H11b was rejected.

Table 54. Moderating role of the type of the Industry 4.0 technology on interaction between perceived compatibility and perceived usefulness

	Coeff	se	t	p	LLCI	ULCI
Constant	3.7438	0.1130	33.1354	<.001	3.5212	3.9664
Compatibility	0.8490	0.0716	11.8582	**<.001**	0.7080	0.9901
Industry 4.0 technology	-0.3225	0.1602	-2.0129	**0.0453**	-0.6381	-0.0069
Int_1 (Industry 4.0 technology moderation effect)	-0.0130	0.1018	-0.1280	0.8983	-0.2135	0.1875

Source: created by the author

Meanwhile, Table No. 55 presents that the perceived trialability significantly predicted the perceived usefulness of the Industry 4.0 technology

(R2=0.3757, F(3;237)=47.5, p<0.001). Also, the type of the Industry 4.0 technology impacts the perceived usefulness of the Industry 4.0 technology (p-value<0.001, β=-0.944). Same as in the analysis above, Big Data does not exert any negative influence towards the perceived usefulness, meanwhile, Chatbots have a negative impact towards the perceived usefulness. Furthermore, the moderation effect of the type of the Industry 4.0 technology on the interaction between the perceived trialability and the perceived usefulness of the Industry 4.0 technology was insignificant (p=0.415). Therefore, H11e was rejected.

Table 55. Moderating role of the type of the Industry 4.0 technology on interaction between perceived trialability and perceived usefulness

	Coeff	**se**	**t**	**p**	**LLCI**	**ULCI**
Constant	4.0511	0.1320	30.6846	<.001	3.7910	4.3112
Trialability	0.5714	0.0778	7.3456	**<.001**	0.4181	0.7246
Industry 4.0 technology	-0.9440	0.1870	-5.0472	**<.001**	-1.3124	-0.5755
Int_1 (Industry 4.0 technology moderation effect)	-0.0830	0.1016	-0.8169	0.4148	-0.2833	0.1172

Source: created by the author

To sum up, this analysis revealed that the Industry 4.0 technology has a direct impact on the perceived usefulness in the context of the perceived compatibility and the perceived trialability. In both cases, it was indicated that Big Data does not have a negative influence towards the perceived usefulness, meanwhile, Chatbots have a negative impact towards the perceived usefulness. In addition to this, based on the moderation analysis results, the interaction between the perceived characteristics of the Industry 4.0 technology and the perceived usefulness of the Industry 4.0 technology were not moderated by the type of the Industry 4.0 technology, therefore, **H11a, H11b, H11c, H11d, H11e, and H11 were rejected**.

For the testing of hypotheses H12, H12a, H12b, H12c, H12d, H12e, moderation analysis was used:

H12: *The impact of the perceived characteristics of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

H12a*: The impact of the perceived relative advantage of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H12b**: The impact of the perceived compatibility of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H12c**: The impact of the perceived complexity of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H12d**: The impact of the perceived observability of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

***H12e**: The impact of the perceived trialability of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*

The SPSS Process Macro procedure was also utilised to assess the moderating role of the type of the Industry 4.0 technology on the interaction between the perceived characteristics of the Industry 4.0 technology and the perceived ease of use of the Industry 4.0 technology. It is worth highlighting that, as it had already been previously confirmed that the perceived relative advantage and the perceived trialability do not have an impact towards the perceived usefulness of the Industry 4.0 technology, **Hypothesis H12a and Hypothesis H12e were rejected**. Thus, moderation analysis was executed only to test H12b, H12c, and H12d. Moderation analysis results of the H12b testing are presented in Table No. 56.

Table 56. Moderating role of the type of the Industry 4.0 technology on interaction between perceived compatibility and perceived ease of use

	Coeff	se	t	p	LLCI	ULCI
Constant	3.5632	0.1159	30.7517	<.001	3.3349	3.7914
Compatibility	0.4078	0.0734	5.5539	**<.001**	0.2632	0.5525
Industry 4.0 technology	0.1667	0.1643	1.0149	0.3112	-0.1569	0.4904
Int_1 (Industry 4.0 technology moderation effect)	0.1163	0.1044	1.1144	0.2662	-0.0893	0.3219

Source: created by the author

The regression results indicated that the perceived compatibility predicted the perceived ease of use of the Industry 4.0 technology ($R2=0.2600$, $F(3;237)=27.8$, $p<0.001$). However, the type of the Industry 4.0 technology did not impact the perceived ease of use of the Industry 4.0 technology

(p=0.311). Furthermore, the moderation effect of the type of the Industry 4.0 technology on the interaction between the perceived compatibility and the perceived ease of use of the Industry 4.0 technology was insignificant (p=0.266); therefore, H12b was rejected.

Table No. 57 presents that the perceived complexity predicted the perceived ease of use of the Industry 4.0 technology (R2=0.0519, F(3;237)=4.3, p=0.0054). However, the type of the Industry 4.0 technology did not impact the perceived ease of use of the Industry 4.0 technology (p=0.147). Furthermore, the moderation effect of the type of the Industry 4.0 technology on the interaction between the perceived complexity and the perceived ease of use of the Industry 4.0 technology was insignificant (p=0.435). Accordingly, H12c was rejected.

Table 57. Moderating role of the type of the Industry 4.0 technology on interaction between perceived complexity and perceived ease of use

	Coeff	**se**	**t**	**p**	**LLCI**	**ULCI**
Constant	3.7508	0.1259	29.7906	<.001	3.5028	3.9988
Complexity	-0.2508	0.0966	-2.5969	**<.001**	-0.4411	-0.0605
Industry 4.0 technology	-0.2594	0.1784	-1.4536	0.1474	-0.6108	0.0921
Int_1 (Industry 4.0 technology moderation effect)	0.0956	0.1222	0.7819	0.4350	-0.1452	0.3363

Source: created by the author

Meanwhile, Table No. 58 presents that the perceived observability predicted the perceived ease of use of the Industry 4.0 technology (R2=0.2666, F(3;237) =28.7, p<0.001).

Table 58. Moderating role of the type of the Industry 4.0 technology on interaction between perceived observability and perceived ease of use

	Coeff	**se**	**t**	**p**	**LLCI**	**ULCI**
Constant	3.6820	0.1112	33.1152	<.001	3.4630	3.9011
Observability	0.5776	0.0963	5.9997	**<.001**	0.3880	0.7673
Industry 4.0 technology	-0.1255	0.1575	-0.7967	0.4264	-0.4357	0.1848
Int_1 (Industry 4.0 technology moderation effect)	-0.0145	0.1262	-0.1146	0.9089	-0.2631	0.2341

Source: created by the author

However, the type of the Industry 4.0 technology did not impact the perceived ease of use of the Industry 4.0 technology (p=0.426). Furthermore, the moderation effect of the type of the Industry 4.0 technology on the interaction between the perceived observability and the perceived ease of use of the Industry 4.0 technology was insignificant (p=0.909); thus, H12d was rejected.

To sum up, this analysis revealed that, in contrast to the perceived usefulness, the Industry 4.0 technology does not have a direct impact on the perceived ease of use. Based on the moderation analysis results, the interaction between the perceived characteristics of the Industry 4.0 technology and the perceived ease of use of the Industry 4.0 technology were not moderated by the type of the Industry 4.0 technology; therefore, **H12a, H12b, H12c, H12d, H12e, and H12 were rejected**.

In the next sub-section, the Research Model Part B hypotheses will be tested.

4.4.2. The influence of perceived usefulness and ease of use on attitude towards the suitability of Industry 4.0 technologies for adoption in marketing functions within SMEs

In this part of the study, the relationship between the perceived usefulness and the perceived ease of use of the Industry 4.0 technology and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs will be explored. Also, the relationship between the perceived ease of use of the Industry 4.0 technology and the perceived usefulness of the Industry 4.0 technology will be investigated. As in the research model Part A, in this section, the possible moderating effect of the type of the Industry 4.0 technology will be investigated; also, the possible moderating effect of the type of the marketing function will be researched (*Research Model Part B, shown in Figure No. 9*).

Firstly, to investigate the strength of the relationship between the perceived usefulness, the perceived ease of use and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, a correlation analysis was performed. The results are shown in Table No. 59.

Based on the Pearson correlation analysis results, it can be stated that the perceived usefulness is highly positively correlated with the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs ($r=0.724$, $p<0.001$). Meanwhile, the perceived ease of use exhibits a moderate positive correlation with the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function

within SMEs (r=0.394, p<0.001). Also, correlation analysis indicates that there is a moderate positive correlation between the perceived usefulness and the perceived ease of use (r=0.473, p<0.001).

Table 59. Correlation between perceived usefulness, perceived ease of use, and attitude towards Industry 4.0 technology suitability for adoption in marketing function within SMEs

Pearson correlation	Suitability attitude	Perceived usefulness	Perceived ease of use
Suitability attitude	1.000	0.724**	0.394**
Perceived usefulness	0.724**	1.000	0.473**
Perceived ease of use	0.394**	0.473**	1.000
Meanings:	** p<0.001 *p<0.05		

Source: created by the author

As the correlation analysis confirms that there is a significant relation between the perceived usefulness, the perceived ease of use, and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, further analysis will concentrate on the multiple regression analysis for testing hypotheses H13 and H14:

H13: *The perceived usefulness of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

H14: *The perceived ease of use of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

The regression model validity assumptions were validated. The normality and linearity can be assumed to be manifested because the sample of the data is over 200 respondents. The scatterplot is presented in Appendix No. 7. Homoscedasticity is valid, there are no patterns clearly visible, but there are some outliers in the scatterplot, which could have a small impact on the overall results. There are no multicollinearity problems in this regression as all the VIF collinearity statistics are below 1.3, and the tolerance values are lower than 1. The multiple regression results are shown in Table No. 60.

The regression analysis model shows that the perceived usefulness and the perceived ease of use explain 52.8% of the variance of the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs (R2=0.528, F=133.057, p <0.001). It was established that the

perceived usefulness has a positive impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs (p-value<0.001, β=0.681); therefore, **H13 was accepted**. Meanwhile, the perceived ease of use does not have an impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs (p=0.191), **thus, H14 was rejected.**

Table 60. Impact of perceived usefulness and perceived ease of use on attitude towards Industry 4.0 technology suitability for adoption in marketing function within SMEs

	Unstandardised Coefficients		**Standardised Coefficients**	**t**	**Sig.**	**Collinearity Statistics**	
	B	**Std. Error**	**Beta**			**Tolerance**	**VIF**
(Constant)	1.394	0.230		6.066	<.001		
Perceived usefulness	0.681	0.050	0.693	13.707	**<.001**	0.776	1.288
Perceived ease of use	0.084	0.064	0.066	1.312	0.191	0.776	1.288

Source: created by the author

To test H15, mediation analysis was used.

H15*: The perceived ease of use of the Industry 4.0 technology mediates the impact of the perceived usefulness on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*

The mediation analysis results are shown in Table No. 61. The mediation analysis confirms that the perceived ease of use mediates the impact of the perceived usefulness on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs (BootLLCI=0.2939, BootULCI=0.5455). This means that a higher perceived ease of use leads to the higher perceived usefulness of the Industry 4.0 technology, which, in turn, increases the positive attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. Therefore, **H15 was accepted.**

Table 61. Mediation effect of perceived ease of use on the impact of perceived usefulness on the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs

Direct effect of perceived ease of use on the attitude towards Industry 4.0 technology suitability for adoption in marketing function within SMEs						
	Effect	se	t	p	LLCI	ULCI
Suitability attitude	0.0841	0.0641	1.3119	0.1908	-0.422	0.2103
Indirect effect of perceived ease of use on the attitude towards Industry 4.0 technology suitability for adoption in marketing function within SMEs						
	Effect	BootSE	BootLLCI	BootULCI		
Perceived usefulness	0.4153	0.0656	**0.2939**	**0.5455**		

Source: created by the author

For the testing of hypotheses H16 and H17, moderation analysis was used:

H16: *The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.*

H17: *The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.*

The *SPSS Process Macro* procedure was employed to assess the moderating role of the type of the Industry 4.0 technology on the interaction between the perceived usefulness of the Industry 4.0 technology and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. The analysis results are presented in Table No. 62.

Table 62. Moderating role of the type of the Industry 4.0 technology on interaction between perceived usefulness and the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs

	Coeff	**se**	**t**	**p**	**LLCI**	**ULCI**
Constant	4.2921	0.1177	36.4781	<.001	4.0603	4.5329
Perceived ease of use	0.0382	0.1017	0.3754	0.7077	-0.1621	0.2384

	Coeff	se	t	p	LLCI	ULCI
Perceived usefulness	0.6259	0.0748	8.3732	**<.001**	0.4786	0.7732
Industry 4.0 technology	-0.2536	0.1666	-1.5379	0.1254	-0.5846	0.0720
Int_1 (Industry 4.0 technology moderation effect on PEOU)	0.0821	0.1310	0.6267	0.5314	-0.1760	0.3402
Int_1 (Industry 4.0 technology moderation effect on PU)	0.0683	0.1038	0.6576	0.5114	-0.1363	0.2728

Source: created by the author

The regression results indicated that the perceived usefulness significantly predicted the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs ($R2=0.5356$, $F(5;235)=54.2$, $p<0.001$). The perceived usefulness has a positive impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs (p-value<0.001, $\beta=0.626$). However, neither the perceived ease of use ($p=0.708$), nor the Industry 4.0 technology ($p=0.125$) exert a direct impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.

Furthermore, the moderation effect of the Industry 4.0 technology on the interaction between the perceived usefulness and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs was found to be insignificant ($p=0.511$); thus, H16 was rejected. Also, this moderation effect of the Industry 4.0 technology on the interaction between the perceived usefulness and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs while being mediated by the perceived ease of use was found to be insignificant ($p=0.531$).

To sum up, this analysis revealed that the Industry 4.0 technology does not moderate the interaction between the perceived usefulness and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, and **H16 was rejected**.

As it had been previously confirmed that the perceived ease of use of the Industry 4.0 technology does not directly impact the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function

within SMEs, **H17 was also rejected**, thereby denying the moderation effect of the Industry 4.0 technology on this interaction.

For the testing of hypotheses H18 and H19, moderation analysis was used:

H18*: The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the marketing function.*

H19*: The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the marketing function.*

The *SPSS Process Macro* procedure was also employed to assess the moderating role of the type of the marketing function on the interaction between the perceived usefulness of the Industry 4.0 technology and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. The analysis results are presented in Table No. 63.

The regression results indicated that the perceived usefulness significantly predicted the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs ($R2=0.5556$, $F(11;229)=26.0$, $p<0.001$). The perceived usefulness has a positive impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs (p-value<0.001, $\beta=0.755$). However, neither the perceived ease of use ($p=0.379$), nor the marketing functions ($p=0.410$, $p=0.190$, $p=0.150$) had any direct impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. Furthermore, the very weak moderation effect of the type of the marketing function on the interaction between the perceived usefulness and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs was identified only in the case of the place marketing function. Nonetheless, as the *p* value was very close to the >0.05 value ($p=0.048$), and, with other marketing functions, the moderation effect was identified as being insignificant ($p=0.372$, $p=0.945$), H18 was rejected. As well as this moderation effect of the marketing function on the interaction between the perceived usefulness and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs while being mediated by the perceived ease of use was found to be insignificant ($p=0.300$, $p=0.626$, $p=0.135$).

Table 63. Moderating role of the type of the marketing function on interaction between perceived usefulness on the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs

	Coeff	se	t	p	LLCI	ULCI
Constant	4.3367	0.1616	26.8437	<.001	4.0184	4.6550
Perceived ease of use	0.1135	0.1288	0.8819	0.3788	-0.1402	0.3672
Perceived usefulness	0.7551	0.1007	7.4982	**<.001**	0.5567	0.9536
Price	-0.1878	0.2277	-0.8249	0.4103	-0.6364	0.2608
Place	-0.3015	0.2294	-1.3146	0.1900	-0.7535	0.1505
Promotion	-0.3253	0.2252	-1.4441	0.1501	-0.7690	0.1185
Int_1 (Price moderation effect on PEOU)	0.2050	0.1976	1.0374	0.3006	-.01843	0.5943
Int_2 (Place moderation effect on PEOU)	0.884	0.1808	0.4887	0.6255	-0.2679	0.4446
Int_3 (Promotion moderation effect on PEOU)	-0.2602	0.1733	-1.5012	0.1347	-0.6017	0.0813
Int_1 (Price moderation effect on PU)	-0.1337	0.1493	-0.8952	0.3716	-0.4278	0.1605
Int_2 (Place moderation effect on PU)	-0.2883	0.1450	-1.9884	**0.0480**	-0.5739	-0.0026
Int_3 (Promotion moderation effect on PU)	0.0093	0.1343	0.0689	0.9451	-0.2554	0.2739

Source: created by the author

To sum up, this analysis revealed that the marketing function does not moderate the interaction between the perceived usefulness and the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs, and **H18 was rejected**.

As it had been previously confirmed that the perceived ease of use of the Industry 4.0 technology does not impact the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs,

H19 was also rejected, denying the moderation effect of the marketing function on this interaction.

In the next sub-section, Research Model Part C hypotheses will be tested.

4.4.3. The influence of the attitude on the behavioural intention to adopt Industry 4.0 technologies in marketing functions within SMEs

In this part of the study, the impact of the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be explored. Also, the possible moderation effects on this relationship by the elements of the TOE framework (*SME size, top management support, competitive environment*) and some additional elements, such as the type of the Industry 4.0 technology and the type of the marketing function, will be tested (*Research Model Part C, shown in Figure No. 10*).

Firstly, to investigate the strength of the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, the SME size, the competitive environment, the top management support, and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs, a correlation analysis was performed. The results are shown in Table No. 64.

Based on the Pearson correlation analysis results, it can be stated that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs has a moderately positive correlation with the behavioural intention to adopt Industry 4.0 technology in the marketing function within SMEs ($r=0.711$, $p<0.001$). A positive moderate correlation was also noticed between the competitive environment and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs ($r=0.686$, $p<0.001$), as well as between the top management support and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs ($r=0.750$, $p<0.001$). Nonetheless, the relationship between the SME size and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was found to be very weak ($r=0.085$) and insignificant ($p=0.095$).

Table 64. Correlation between the attitude, SME size, competitive environment, top management support and the behavioural intention to adopt Industry 4.0 technology in the marketing function within SMEs

Pearson correlation	Intention to adopt	Suitability Attitude	SME size	Competitive environment	Top management support
Intention to adopt	1.000	**0.711****	0.085	**0.686****	**0.750****
Suitability Attitude	**0.711****	1.000	0.156*	0.575**	0.663**
SME size	0.085	0.156*	1.000	0.053	0.189*
Competitive environment	**0.686****	0.575**	0.053	1.000	0.596**
Top management support	**0.750****	0.663**	0.189*	0.596**	1.000
Meanings:	** p<0.001 *p<0.05				

Source: created by the author

As the correlation analysis confirms that there is a significant relation between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs, as well as between the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs and the competitive environment and the top management support, further analysis will concentrate on the multiple regression analysis for testing hypotheses H20, H21, H23, and H25.

For the testing of hypotheses H20, H21, H23, and H25, multiple regression analysis was also used:

H20: *The attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H21: *The SME size positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H23: *The top management support positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

H25: *The competitive environment positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*

The regression model validity assumptions were validated. The normality and linearity can be assumed to exist because the sample of the data is over 200 respondents. The scatterplot is presented in Appendix No. 7. Homoscedasticity is valid, there are no patterns clearly visible, but there are some outliers in the scatterplot, which could have a small impact on the overall results. There are no multicollinearity problems in this regression as all the VIF collinearity statistics are below 2, and the tolerance values are lower than 1. The multiple regression results are shown in Table No. 65.

Table 65. Impact of the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs, SME size, competitive environment and top management support on the behavioural intention

	Unstandardised Coefficients		**Standardised Coefficients**	**t**	**Sig.**	**Collinearity Statistics**	
	B	**Std. Error**	**Beta**			**Tolerance**	**VIF**
(Constant)	0.107	0.223		0.480	0.632		
Suitability Attitude	0.284	0.049	0.292	5.807	**<.001**	0.508	1.967
SME size	-0.066	0.048	-0.051	-1.383	0.168	0.954	1.048
Competitive environment	0.314	0.052	0.284	6.036	**<.001**	0.582	1.719
Top management support	0.414	0.054	0.396	7.663	**<.001**	0.482	2.076

Source: created by the author

The regression analysis model shows that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, the SME size, the competitive environment and the top management support explain 69.6% of the variance of the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs ($R2=0.696$, $F=134.928$, $p<0.001$). It was found that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs has a positive impact on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (p-value<0.001, $\beta=0.284$); therefore, H20 was accepted. Also, it was found that

both the competitive environment (p-value<0.001, β=0.314) and the top management support (p-value<0.001, β=0.414) have a positive impact towards the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs; thus, H23 and H25 were accepted. Nonetheless, the regression analysis showed that the SME size does not impact the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (p=0.168); thus, H21 was rejected.

To sum up, **hypotheses (H20, H23, H25) were accepted** as it was found that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, the competitive environment, and the top management support positively impact the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. **Hypothesis H21 was rejected**, which means that the SME size does not impact the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.

For the testing of hypothesis H22, moderation analysis was used:

H22: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger in the case of a bigger size of the SME.*

The *SPSS Process Macro* procedure was employed to assess the moderating role of the SME size on the interaction between the attitude towards the Industry 4.0 technology suitability for the adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. The analysis results are presented in Table No. 66.

Table 66. Moderating role of the SME size on the interaction between attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention

	Coeff	se	t	p	LLCI	ULCI
Constant	3.4807	0.0800	43.4922	<0.001	3.32320	3.6383
Suitability attitude	0.6927	0.0450	15.4046	**<.001**	0.6041	0.7813
SME size	-0.0363	0.0599	-0.6060	0.5451	-0.1544	0.0817
Int_1 (SME size moderation effect)	-0.0130	0.0300	-0.4318	0.6663	-0.721	0.0462

Source: created by the author

The regression results indicated that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs significantly predicted the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (R2=0.5060, F(3;237)=80.9, p<0.001). However, the SME size did not impact the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (p=0.545). Furthermore, the moderation effect of the SME size on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was insignificant (p=0.666), **therefore, H22 was rejected.**

For the testing of hypothesis H24, moderation analysis was used:

H24: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger for a higher level of the SME top management support.*

Table No. 67 suggests that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs significantly predicted the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (R2=0.6508, F(3;237)=147.2, p<0.001). Also, the top management support positively impacts the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (p-value<0.001, β=0.516). Furthermore, the moderation effect of the top management support on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was confirmed (p-value=0.031, β=0.048).

Table 67. Moderating role of the top management support on the interaction between the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention

	Coeff	se	t	p	LLCI	ULCI
Constant	3.3813	0.0796	42.4365	<0.001	3.2244	3.5381
Suitability attitude	0.3911	0.0508	7.7056	**<.001**	0.2911	0.4910

	Coeff	se	t	p	LLCI	ULCI
Top management support	0.5164	0.0536	9.6384	**<.001**	0.4108	0.6219
Int_1 (Top management support moderation effect)	0.0480	0.0222	2.1672	**0.0312**	0.0044	0.0917

Source: created by the author

Table No. 68 and Figure No. 13 present the conditional effects of the top management moderating the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.

It can be stated that, with the lower level of the top management support when the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is better, then, the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will also be better. With the medium level of the top management support, if the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs increases, then, the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will also increase. It is worth noting that the strongest moderation effect on this interaction is noticeable when the level of top management support is the highest. Thus, **H24 was accepted**.

Table 68. Conditional effects of the focal predictor at values of the moderator (top management support on the interaction between attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention)

Top management support	Effect	Se	t	p	LLCI	ULCI
-1.6648	0.3111	0.0566	5.4968	**<.001**	0.1996	0.4226
0.0000	0.3911	0.0508	7.7056	**<.001**	0.2911	0.4910
1.6648	0.4710	0.0683	6.8924	**<.001**	0.3364	0.6057

Source: created by the author

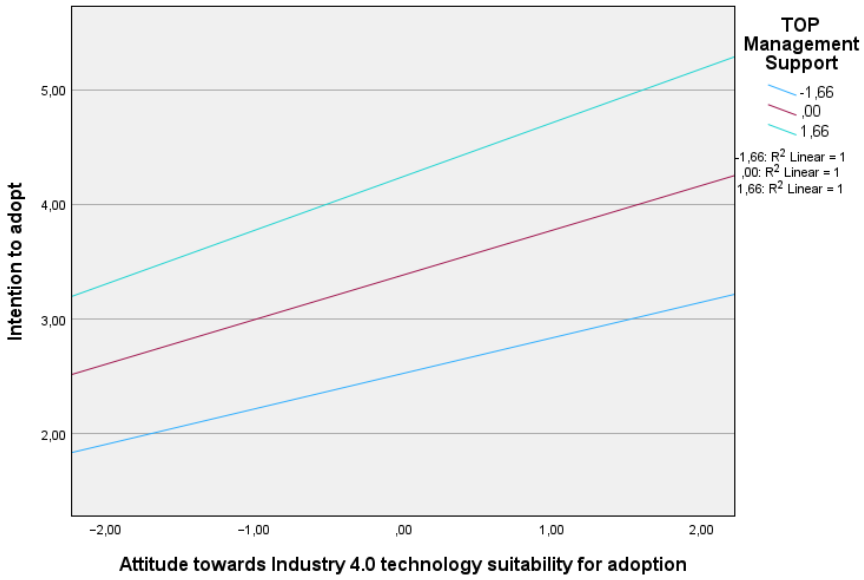

Figure 13. Conditional effects of the focal predictor on the values of the moderator
Source: created by the author

For the testing of hypothesis H26, moderation analysis was used.

H26: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger for a higher level of the competitive environment.*

Hypothesis No. 26 regression analysis results indicated that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs significantly predicted the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs ($R2=0.6226$, $F(3;237)=130.4$, $p<0.001$).

Also, the competitive environment positively impacts the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (p-value<0.001, $\beta=0.442$). Nonetheless, the moderation effect of the competitive environment on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was insignificant

(p=0.190); therefore**, H26 was rejected**. The results are presented in Table No. 69.

Table 69. Moderating role of the competitive environment on the interaction between the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention

	Coeff	Se	t	p	LLCI	ULCI
Constant	3.4239	0.0797	42.9495	<0.001	3.2668	3.5809
Suitability attitude	0.4711	0.0483	9.7539	**<0.001**	0.3760	0.5663
Competitive environment	0.4424	0.0554	7.9913	**<0.001**	0.3333	0.5514
Int_1 (Competitive environment moderation effect)	0.0322	0.0245	1.3144	0.1900	-0.0161	0.0805

Source: created by the author

For the testing of hypothesis H27, moderation analysis was used.

H27: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger in the case of the universal Industry 4.0 technology adoption.*

Table No. 70 suggests that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs significantly predicted the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (R2=0.5082, F(3;237)=81.6, p<0.001). Also, it was established that the Industry 4.0 technology does not impact the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (p=0.222). In addition, the moderation effect of the Industry 4.0 technology on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was found to be insignificant (p=0.753); **therefore, H27 was rejected**.

Table 70. Moderating role of the Industry 4.0 technology on the interaction between the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention

	Coeff	se	t	p	LLCI	ULCI
Constant	3.5832	0.1161	30.8657	<0.001	3.3545	3.8119
Suitability attitude	0.6597	0.0655	10.0714	**<0.001**	0.5306	0.7887
Industry 4.0 technology	-0.2015	0.1645	-1.2250	0.2218	-0.5255	0.1225
Int_1 (Industry 4.0 technology moderation effect)	0.0290	0.0920	0.3152	0.7529	-0.1523	0.2103

Source: created by the author

For the testing of hypothesis H28, moderation analysis was used.

H28: *The impact of the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is moderated by the type of the marketing function.*

Table No. 71 presents the regression results which indicate that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs significantly predicted the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs ($R2=0.5101$, $F(7;233)=34.7$, $p<0.001$).

However, the type of the marketing function did not impact the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs ($p=0.468$, $p=0.184$, $p=0.196$). Also, the moderation effect of the marketing function on interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was found to be insignificant ($p=0.784$, $p=0.895$, $p=0.777$); therefore, **H28 was rejected**.

Table 71. Moderating role of the type of the marketing function on interaction between the attitude towards Industry 4.0 technology suitability for adoption in marketing function within SMEs and the behavioural intention

	Coeff	se	t	p	LLCI	ULCI
Constant	3.2858	0.1598	20.5611	<0.001	2.9710	3.6007
Suitability attitude	0.6736	0.0842	7.9980	**<0.001**	0.5077	0.8396
Price	0.1647	0.2265	0.7270	0.4680	-0.2816	0.6110
Place	0.3022	0.2267	1.3327	0.1839	-0.1445	0.7489
Promotion	0.2919	0.2251	1.2972	0.1958	-0.1515	0.7353
Int_1 (Price moderation effect)	0.0342	0.1242	0.2751	0.7835	-0.2106	0.2789
Int_2 (Place moderation effect)	0.0173	0.1312	0.1317	0.8953	-0.2412	0.2758
Int_3 (Promotion moderation effect)	0.0339	0.1192	0.2842	0.7765	-0.2010	0.2688

Source: created by the author

Summarising the points stated above, it is noticeable that only the top management support is moderating the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs (**H24 accepted**). This means that, with a higher level of the top management support, if the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs increases, then, the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will also increase. Nonetheless, **Hypotheses (H22, H26, H27, H28) were rejected**, indicating that the SME size, the competitive environment, the Industry 4.0 technology, and the type of the marketing function do not moderate the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.

The results of the quantitative research analysis are discussed in the next sub-section.

4.4.4. Quantitative research analysis discussion on the factors influencing the suitability of Industry 4.0 technologies for adoption in the marketing functions within Lithuanian SMEs

Quantitative research analysis aimed to test the raised hypotheses about the suitability of the niche and universal Industry 4.0 technologies for adoption in the four marketing functions within Lithuanian SMEs. To achieve the study aim, a quantitative research study was conducted within Q1 of 2024, and the data was collected by the market research company *Rinkos tyrimų centras*. In total, 241 respondents were participating in the study, who were working in small-sized companies. The majority of the respondents had accumulated work experience in their current role related to marketing decision-making for longer than 5 years; thus, the provided answers were considered to be valid for further analysis.

The current study employed exploratory factor analysis, and 12 constructs were used. Thus, all the twelve constructs were confirmed to be reliable. Besides, the analysis of the distribution characteristics justified the normality of the data distribution. Therefore, by conducting correlation, regression, mediation and moderation analyses about the suitability of the niche and universal Industry 4.0 technologies for adoption in the four marketing functions within Lithuanian SMEs, in total, twenty-eight hypotheses were tested, twelve of them were accepted, and sixteen of them were rejected. The quantitative research results are discussed below.

Firstly, the hypotheses of the research model Part A, concerning the relationship between the five perceived characteristics of the Industry 4.0 technology impact on the Industry 4.0 technology perceived usefulness and the perceived ease of use were tested.

The regression analysis results confirmed that the perceived relative advantage has a significant positive impact on the perceived usefulness of the Industry 4.0 technology; therefore, **H1 was accepted**. Such results are in line with the previous research results (Tripopsakul, 2018; Al-Rahmi et al., 2019; Yuen et al., 2021). This indicates that the increased perception of the relative advantage of the Industry 4.0 technology positively impacts the perceived usefulness of the technology. However, **H2 was rejected** as it was found that the perceived relative advantage has no significant positive impact towards the perceived ease of use of the Industry 4.0 technology. This study result contradicts some previous research findings (Al-Rahmi et al., 2019; Tripopsakul, 2018).

Also, it was found that the perceived compatibility of the Industry 4.0 technology has a positive impact on both the perceived usefulness of the

Industry 4.0 technology as well as on the perceived ease of use of the Industry 4.0 technology; therefore, **H3** and **H4 were accepted**. Such results coincide with the previous studies conducted by Al-Jabri and Sohail (2012), Tripopsakul (2018), Al-Rahmi et al. (2019), and Yuen et al. (2021). This means that the more the Industry 4.0 technology is perceived as consistent with the existing values and the needs of the potential adopters, the more the perceived usefulness and perceived ease of use of such technology will increase.

The study results reveal that the perceived complexity of the Industry 4.0 technology does not have an impact towards the perceived usefulness of the Industry 4.0 technology; thus, **H5 was rejected.** This coincides with the literature results; yet, no studies were found to confirm such a relationship. However, **H6 was accepted** as it was found that the perceived complexity of the Industry 4.0 technology has a negative impact towards the perceived ease of use of the Industry 4.0 technology. Such an impact was also proven in a study carried out by Al-Rahmi et al. (2019). This result proves that if the Industry 4.0 technology is perceived as relatively difficult to be understood, then, the perceived ease of use of the technology will be smaller.

Moreover, this study proves a different effect of the perceived observability towards the perceived usefulness and the perceived ease of use of the Industry 4.0 technology. It was found that the perceived observability of the Industry 4.0 technology does not impact the perceived usefulness; therefore, **H7 was rejected**. That means that, despite the observed positive effects of the Industry 4.0 technology, its perceived usefulness will not improve. Such results contradict the findings of some previous studies where this impact was proven (Al-Rahmi et al., 2019; Yuen et al., 2021). However, it was proven that the perceived observability of the Industry 4.0 technology positively impacts the perceived ease of use; thus, **H8 was accepted**. Such results coincided with the research carried out by Yuen et al. (2021).

Additionally, **H9 was accepted** because the positive impact of the perceived trialability of the Industry 4.0 technology on the perceived usefulness was confirmed. Such results coincide with the previous studies conducted by Tripopsakul (2018) and Al-Rahmi et al. (2019). This means that if a potential adopter of the Industry 4.0 technology could try this technology out before fully adopting it, its perceived usefulness would increase. Nonetheless, this study did not confirm the positive impact of the perceived trialability of the Industry 4.0 technology on the perceived ease of use; thus, **H10 was rejected.** Such a finding partially correlates with the previous studies as, in some of them, such an impact was confirmed (Tripopsakul, 2018; Yuen

et al., 2021); meanwhile, the study conducted by Al-Rahmi et al. (2019) also denied this impact.

To sum up, it can be stated that the five selected perceived characteristics of the Industry 4.0 technology have different impacts towards the perceived usefulness and the perceived ease of use. The perceived compatibility positively impacts both the perceived usefulness and the perceived ease of use of the Industry 4.0 technology. Meanwhile, the perceived usefulness of the Industry 4.0 technology is also positively impacted by the perceived relative advantage as well as by the perceived trialability. Meanwhile, the perceived observability exerts a positive impact towards the perceived ease of use of the Industry 4.0 technology, and the perceived complexity has a negative impact on the perceived ease of use of the Industry 4.0 technology.

Additionally, research model Part A also investigated the moderating effect of the type of the Industry 4.0 technology towards the perceived usefulness and the perceived ease of use. Analysis results revealed that the Industry 4.0 technology has a direct impact on the perceived usefulness in the context of the perceived compatibility and the perceived trialability. In both cases it was indicated that Big Data does not have a negative influence towards the perceived usefulness, meanwhile, Chatbots have a negative impact towards the perceived usefulness. Nonetheless, none of the interactions between the perceived characteristics of the Industry 4.0 technology and the perceived usefulness of the Industry 4.0 technology were moderated by the type of the Industry 4.0 technology; thus, **H11a, H11b, H11c, H11d, H11e, and H11 were rejected**.

Also, this analysis revealed that, differently than in the case with the perceived usefulness, the Industry 4.0 technology does not have a direct impact on the perceived ease of use. However, same as in the case with perceived usefulness of the Industry 4.0 technology, no moderation effect on the interaction between the perceived characteristics of the Industry 4.0 technology and the perceived ease of use of the Industry 4.0 technology were found; therefore, **H12a, H12b, H12c, H12d, H12e, and H12 were rejected**. It is of importance to note that, to the best of the knowledge of the author of this thesis, no previous studies exist which would have proven this moderation effect. However, most scientific studies focus on the results of the accepted hypotheses, leading to the assumption that previous researchers may have investigated this moderation effect but also found it as being insignificant. The summarised results of the hypothesis testing of research model Part A are listed in Table No. 72.

Table 72. Hypotheses testing results of Research Model Part A

HYPOTHESES	Research model part (A, B, C)	TEST RESULT
H1: *The perceived relative advantage of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*	**(A)**	**Accepted**
H2: *The perceived relative advantage of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*	**(A)**	**Rejected**
H3: *The perceived compatibility of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*	**(A)**	**Accepted**
H4: *The perceived compatibility of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*	**(A)**	**Accepted**
H5: *The perceived complexity of the Industry 4.0 technology negatively affects the perceived usefulness of the Industry 4.0 technology.*	**(A)**	**Rejected**
H6: *The perceived complexity of the Industry 4.0 technology negatively affects the perceived ease of use of the Industry 4.0 technology.*	**(A)**	**Accepted**
H7: *The perceived observability of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*	**(A)**	**Rejected**
H8: *The perceived observability of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*	**(A)**	**Accepted**
H9: *The perceived trialability of the Industry 4.0 technology positively affects the perceived usefulness of the Industry 4.0 technology.*	**(A)**	**Accepted**
H10: *The perceived trialability of the Industry 4.0 technology positively affects the perceived ease of use of the Industry 4.0 technology.*	**(A)**	**Rejected**
H11: *The impact of the perceived characteristics of Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H11a**: The impact of the perceived relative advantage of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**

HYPOTHESES	Research model part (A, B, C)	TEST RESULT
***H11b**: The impact of the perceived compatibility of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H11c**: The impact of the perceived complexity of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H11d**: The impact of the perceived observability of the Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H11e**: The impact of the perceived trialability of Industry 4.0 technology on the perceived usefulness of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
H12: *The impact of the perceived characteristics of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H12a**: The impact of the perceived relative advantage of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H12b**: The impact of the perceived compatibility of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H12c**: The impact of the perceived complexity of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H12d**: The impact of the perceived observability of the Industry 4.0 technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.*	**(A)**	**Rejected**
***H12e**: The impact of the perceived trialability of the Industry 4.0*	**(A)**	**Rejected**

HYPOTHESES	Research model part (A, B, C)	TEST RESULT
technology on the perceived ease of use of the Industry 4.0 technology is moderated by the type of the Industry 4.0 technology.		

Source: created by the author

Furthermore, research model Part B explored the relationship between the perceived usefulness and the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. The study results revealed that the perceived usefulness has a positive impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs; therefore, **H13 was accepted**. This result supports the findings of the previous studies (Matikiti et al., 2018; Alhashmi et al., 2019; Rahman et al., 2021). The literature research indicates that, in the context of Industry 4.0, the perceived usefulness refers to the extent to which a potential Industry 4.0 technology is believed to enhance the job productivity, performance, and effectiveness. Therefore, the greater is the perceived usefulness of Industry 4.0 technology, the more positive the attitude towards adopting it will be.

Moreover, this study found that the perceived ease of use does not have the direct positive impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs; thus, **H14 was rejected.** However, such findings contradict the results of other currently available studies (Matikiti et al., 2018; Alhashmi et al., 2019). This means that the study indicates that even if the manager or owner of an SME finds an Industry 4.0 technology easy to use, it will not have a positive impact on their attitude towards its suitability for adoption in the marketing functions within SMEs.

In addition to this, it was confirmed that the perceived ease of use mediates the impact of the perceived usefulness on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs; therefore, **H15 was accepted.** This means that a higher perceived ease of use leads to the higher perceived usefulness of the Industry 4.0 technology, which, in turn, increases the positive attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. Such a relationship was also confirmed by numerous previous studies (Herzallah & Mukhtar, 2016; Tripopsakul, 2018; Al-Rahmi et al., 2019; Alhashmi et al., 2019; Yuen et al., 2021).

Additionally, research model Part B investigated the moderating effect of the type of the Industry 4.0 technology on the interaction between the

perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs and between the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs. However, the study results confirm that the Industry 4.0 technology did not have a direct impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. On top of that, in both cases, the moderation effect of the Industry 4.0 technology was not confirmed, and **H16 and H17 were rejected**.

Also, it was confirmed that the marketing function does not have a direct impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. Also, it was found that the marketing function does not moderate the interaction between the perceived usefulness and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, and also, the marketing function does not moderate the interaction between the perceived ease of use and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs; thus, **H18 and H19 were rejected**.

To sum up, the moderation analysis of the model Part B revealed that, despite a different Industry 4.0 technology or a different marketing function, the perceived usefulness impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs remain the same. The same outcome is applicable towards the interaction between the perceived ease of use and the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. The summarised results of the hypothesis testing of the research model Part B are stated in Table No. 73.

Table 73. Hypotheses testing results of Research Model Part B

HYPOTHESES	Research model part (A, B, C)	TEST RESULT
H13: *The perceived usefulness of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*	**(B)**	**Accepted**
H14: *The perceived ease of use of the Industry 4.0 technology positively influences the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*	**(B)**	**Rejected**

HYPOTHESES	Research model part (A, B, C)	TEST RESULT
H15*: The perceived ease of use of the Industry 4.0 technology mediates the impact of the perceived usefulness on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs.*	**(B)**	**Accepted**
H16: *The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.*	**(B)**	**Rejected**
H17: *The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the Industry 4.0 technology.*	**(B)**	**Rejected**
H18: *The impact of the perceived usefulness of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the marketing function.*	**(B)**	**Rejected**
H19: *The impact of the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs is moderated by the type of the marketing function.*	**(B)**	**Rejected**

Source: created by the author

Moreover, the research model Part C explored the impact of the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. It was found that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs has a positive impact on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs; thus, **H20 was accepted**. This indicates that if the owner or manager of an SME has a positive outlook towards the Industry 4.0 technology, they will not hesitate to adopt and implement the new technology. This relationship was also confirmed by previous studies (Alhashmi et al., 2019; Rahman et al., 2021).

Additionally, the direct impact of the SME size on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was explored. However, this study did not confirm such an impact of the SME size; thus, **H21 was rejected**. This study results contradict previous

researches (Nguyen & Waring, 2013; Kumar et al., 2017; Usman et al., 2019; Nair et al., 2019; Skafi et al., 2020). This means that the current study indicates that the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is not impacted by the SME size. Also, the moderation effect of the SME size on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was found to be insignificant; therefore, **H22 was rejected.**

Moreover, this study proved that the top management support has a positive impact towards the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs; thus, **H23 was accepted.** This coincides with the results of previous research studies (Kumar et al., 2017; Matikiti et al., 2018; AlBar & Hoque, 2019; Prause, 2019; Usman et al., 2019; Skafi et al., 2020). This indicates that if the top management perceives the Industry 4.0 technology as beneficial for the firm, then, there is a high chance that it will be adopted. Also, the moderation effect of the top management support on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was confirmed, so, **H24 was accepted.** It means that, with a higher level of the top management support, the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs increases, and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs also increases.

Furthermore, it was revealed that the competitive environment positively impacts the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs; thus, **H25 was accepted**. This impact was also proven in previous studies (Kumar et al., 2017; Matikiti et al., 2018; AlBar & Hoque, 2019; Usman et al., 2019). Nonetheless, the moderation effect of the competitive environment on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was not confirmed; therefore, **H26 was rejected.**

Additionally, the research model Part C investigated the moderating effect of the type of the Industry 4.0 technology on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the

Industry 4.0 technology in the marketing function within SMEs. However, the study results confirm that the Industry 4.0 technology did not have a direct impact on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. As well as the moderation effect of the Industry 4.0 technology on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was found to be insignificant; therefore, **H27 was rejected**.

Also, it was confirmed that the marketing function do not have a direct impact on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. In addition to this, the moderation effect of the marketing function on the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs was found to be insignificant; therefore, **H28 was rejected**.

Summarising the points stated above, the moderation analysis of the model Part C revealed that the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is only moderated by the top management support. This means that, despite a different type of the Industry 4.0 technology, a different marketing function, a different size of an SME, and a different competitive environment, the impact of the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs remains the same. Summarised results of hypothesis testing of the research model Part C are presented in Table No. 74.

Table 74. Hypotheses testing results of Research Model Part C

HYPOTHESES	Research model part (A, B, C)	TEST RESULT
H20: *Attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*	**(C)**	**Accepted**
H21: *The SME size positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*	**(C)**	**Rejected**
H22: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger in the case of a bigger size of the SME.*	**(C)**	**Rejected**
H23: *The top management support positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*	**(C)**	**Accepted**
H24: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger for a higher level of the SME top management support.*	**(C)**	**Accepted**
H25: *Competitive environment positively affects the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs.*	**(C)**	**Accepted**
H26: *The positive relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger for a higher level of the competitive environment.*	**(C)**	**Rejected**
H27: *The positive relationship between the attitude towards Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs will be stronger in the case of the universal Industry 4.0 technology adoption.*	**(C)**	**Rejected**
H28: *The impact of the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs is moderated by the type of the marketing function.*	**(C)**	**Rejected**

Source: created by the author

The findings from both qualitative and quantitative research analyses are discussed in the subsequent subsection. These results are critically compared with the previous authors' findings, and the novel aspects of the current research shall be highlighted.

4.5. Scientific Research Discussion on the Factors Influencing the Suitability of Industry 4.0 technologies for Adoption in the Marketing Functions within Lithuanian SMEs

This study concentrated on analysing the suitability of adopting the Industry 4.0 technologies in the marketing functions within SMEs. Given the unique characteristics of these companies, which often lack substantial financial and managerial resources, the application of next-generation technologies in the marketing functions emerges as a particularly pertinent issue. Furthermore, the adoption of various technologies in these companies is predominantly influenced by the personal attitudes of the SMEs owners/managers. Thus, this study aimed to explore the behavioural dimensions of an individual SMEs owner/manager to address the currently existing literature gaps and uncover novel insights into the adoption process of the Industry 4.0 technologies within the marketing functions of SMEs. To achieve this goal, the study employed both qualitative and quantitative research methodologies.

The qualitative research revealed that the marketing function is a pivotal business area where a wide array of the Industry 4.0 technologies can be effectively utilised. This finding is consistent with the extant literature which underscores the potential of these technologies in enhancing the marketing processes (Pranjić & Rekettye, 2019; Ungerman & Dědková, 2019; Guven, 2020). The data suggests that marketing is not only integral to the business, but also a prime candidate for technological enhancement, by virtue of offering significant opportunities for competitive advantage. Moreover, the results of this study verify previous research results (Balmer & Yen, 2017; Brkljac & Sudarevic, 2018; Młody, 2018; Ungerman & Dědková, 2019; Caliskan et al., 2020) by demonstrating that the product marketing function within SMEs exhibits the highest potential for the adoption of a diverse array of the Industry 4.0 technologies. Among the four primary marketing functions, such as the product, price, place, and promotion, the product marketing function stands out as the most suitable to technological integration within SMEs.

One of the key contributions of this research is the proposed categorisation of the Industry 4.0 technologies based on their suitability for adoption in the marketing functions within SMEs. The qualitative study evaluated fourteen pre-selected Industry 4.0 technologies, identified from the scientific literature, through ratings provided by C-level Executives of SMEs. The findings indicate that these technologies can be categorised into two distinct groups: *universal* Industry 4.0 technologies, and *niche* Industry 4.0

technologies. The first category includes technologies such as *Artificial Intelligence (*AI) and *Big Data*, which are suitable for adoption across a wide range of the marketing functions. These technologies are characterised by their broad applicability and versatility, making them essential for SMEs aiming to enhance multiple aspects of their marketing strategies. The second category comprises technologies such as *3D Printing* and *Chatbots*, which are more specialised and suitable for the specific marketing function as these technologies offer targeted solutions addressing particular needs within the marketing domain.

Quantitative research analysis results revealed a novel aspect of the perceived characteristics of the Industry 4.0 technology impact on the perceived usefulness and the perceived ease of use. The study confirmed the significant positive influence of the perceived relative advantage on the perceived usefulness, coinciding with the results of some previous studies (Tripopsakul, 2018; Al-Rahmi et al., 2019; Yuen et al., 2021). This indicates that an increased perception of the relative advantage of the Industry 4.0 technology positively impacts its perceived usefulness. However, contrary to the previous findings, it was observed that the perceived relative advantage did not significantly affect the perceived ease of use, thereby highlighting a novel insight into the adoption process of new technologies within SMEs.

Furthermore, consistent with the prior body of research (Al-Jabri & Sohail, 2012; Tripopsakul, 2018; Al-Rahmi et al., 2019; Yuen et al., 2021), this study confirmed that the perceived compatibility positively impacts both the perceived usefulness and the ease of use. This implies that the Industry 4.0 technologies, which are perceived as consistent with the existing values and needs of the SMEs managers/owners, are regarded as more useful and easier to use. Moreover, coinciding with the previous research results (Al-Rahmi et al., 2019), this study found that the perceived complexity negatively impacts the perceived ease of use; however, this study did not confirm that the perceived complexity has a negative impact towards the perceived usefulness.

Moreover, this study highlights the contrasting impacts of the perceived observability on the perceived usefulness and the ease of use. While the perceived observability does not impact the perceived usefulness, it positively influences the ease of use. These results contradict the previous findings where the perceived observability was shown to impact the perceived usefulness (Al-Rahmi et al., 2019; Yuen et al., 2021). Thus, the study provides new knowledge that, despite the positive observed effects of the Industry 4.0 technologies, their perceived usefulness does not improve, but the perceived ease of use does ultimately benefit. Finally, the study confirmed the positive impact of the perceived trialability on the perceived usefulness, which is

consistent with the findings of Tripopsakul (2018) and Al-Rahmi et al. (2019). This suggests that if SMEs managers/owners can trial the Industry 4.0 technologies before their full adoption, their perceived usefulness would increase. However, the study did not confirm the positive impact of the perceived trialability on the perceived ease of use.

Additionally, the study results revealed that the perceived usefulness has a positive impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs, thus supporting the findings of previous studies (Matikiti et al., 2018; Alhashmi et al., 2019; Rahman et al., 2021). This indicates that the greater is the perceived usefulness of the Industry 4.0 technology, the more positive the attitude towards adopting it will be by the SMEs manager/owner. Moreover, this study found that the perceived ease of use does not have an impact on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs. However, it was confirmed that the perceived ease of use mediates the impact of the perceived usefulness on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs. This means that a higher perceived ease of use leads to a higher perceived usefulness of the Industry 4.0 technology, which, in turn, increases the positive attitude towards its adoption in the marketing functions within SMEs. Such a relationship was also confirmed by numerous previous studies (Herzallah & Mukhtar, 2016; Tripopsakul, 2018; Al-Rahmi et al., 2019; Alhashmi et al., 2019; Yuen et al., 2021).

In addition to this, the research results revealed that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs have a positive impact on the behavioural intention to adopt these technologies. This finding indicates that if the owner or manager of an SME has a positive outlook towards the Industry 4.0 technology, they are more likely to adopt and implement it. This relationship was also confirmed by previous studies (Alhashmi et al., 2019; Rahman et al., 2021), thus proving that this behavioural variable is crucial in the decision-making to adopt the latest technologies within the company.

Moreover, the study proved the direct impact of the top management support and the competitive environment towards the behavioural intention to adopt the Industry 4.0 technology in the marketing functions within SMEs. However, it diverged from the existing literature by denying the direct impact of the SME size on the behavioural intentions (Nguyen & Waring, 2013; Kumar et al., 2017; Usman et al., 2019; Nair et al., 2019; Skafi et al., 2020). Additionally, the study revealed an important novel aspect of the top management support moderating effect. The study results revealed that the top

management support positively moderates the interaction between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing functions within SMEs and the behavioural intention to adopt these technologies. This implies that the improved attitude regarding the Industry 4.0 technology's suitability, combined with higher levels of the top management support, enhance the behavioural intention to adopt the Industry 4.0 technologies in the marketing functions of SMEs.

The study also explored the direct and moderating role of the type of the Industry 4.0 technology and the marketing functions, but found no direct impact towards the behavioural intention, nor did it establish any moderation effect on the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. Such findings indicate that, regardless of the type of the Industry 4.0 technology or the specific marketing function, the impact of the attitude towards the suitability of these technologies for adoption remains consistent in influencing behavioural intentions within SMEs.

To sum up, the analysis results significantly advance the understanding of the suitability of the Industry 4.0 technologies for adoption within the marketing functions of SMEs. The categorisation framework introduced in this study provides a foundational basis for future research to explore the impact of specific categories of the Industry 4.0 technologies on distinct marketing functions. By focusing on these categories, subsequent studies can generate deeper insights into the strategic implementation of these technologies in SMEs, thereby contributing to a more nuanced understanding of the digital transformation in the marketing context.

Moreover, the novelty of this study lies in the integration of four theoretical frameworks — the *Technology Acceptance Model* (TAM), the *Diffusion of Innovations Theory* (DOI), the *Theory of Planned Behaviour* (TPB), and the *Technology-Organisation-Environment* (TOE) – with an emphasis on the behavioural aspects of the SMEs managers/owners. This integration has led to the identification of the previously unexplored relationships and has contributed to existing knowledge on the adoption of the Industry 4.0 technologies within SMEs. The study challenges the previously held assumptions that the perceived relative advantage significantly affects the perceived ease of use, and that the perceived observability impacts the perceived usefulness, thus providing a new perspective on the Industry 4.0 technology adoption process.

Additionally, the study's findings on the mediating role of the perceived ease of use between the perceived usefulness and the attitude

towards technology adoption offer a more nuanced understanding of this relationship. Also, the study results prove that the SMEs managers'/owners' attitude towards the adoption suitability of the Industry 4.0 technologies in the marketing functions within SMEs plays the crucial role. Study confirms that if the owner or manager of an SME has a positive outlook towards the Industry 4.0 technology, they are more likely to adopt and implement it in the marketing functions within SMEs. In addition, the identification of the moderating role of the top management support on the interaction between attitude towards the technology suitability and the behavioural intentions highlights an essential factor that can enhance the Industry 4.0 technology adoption rates.

Consequently, the study's findings support the consistent influence of the attitude towards the behavioural intention to adopt the newest technologies despite a different range of the Industry 4.0 technologies and marketing functions. However, the study results also imply that, in contrast to large corporations, certain features of SMEs, such as a lack of financial resources and technological expertise, continue to be obstacles to the full integration of the Industry 4.0 technologies in the marketing functions of SMEs.

CONCLUSIONS

1. The analysis of the scientific literature reveals that the current advancement of the 4th Industrial Revolution is widely recognised as the integration of the latest digital technologies within companies. In recent years, there has been a growing interest among scholars in studying the impact of Industry 4.0 on the business functions in SMEs, with a particular emphasis on the importance of the marketing functions. However, the decision-making in small and medium-sized enterprises (SMEs) is typically dominated by owners/managers (Gilmore et al., 2001; Walsh & Lipinski, 2009; Resnick et al., 2016), which has led to a research gap in understanding the factors that influence the adoption process of the Industry 4.0 technologies in the marketing functions within SMEs from the perspective of the SMEs owners/managers. Therefore, this study aimed to address this gap in the literature by investigating the factors influencing the suitability of the Industry 4.0 technologies for adoption in the marketing functions within Lithuanian SMEs.
2. The examination of the fundamental principles underlying the Industry 4.0 phenomenon and its relationship to the SMEs business functions has demonstrated that the ongoing digitisation in its various forms has a positive impact on the small business growth, performance, and competitiveness. Scientific literature confirms that the implementation of Industry 4.0 within SMEs is often associated with a reassessment of established organisational structures and business models. While some researchers advocate for implementing Industry 4.0 through the Lean Manufacturing principles, others argue that digital transformation will profoundly alter all elements of business models through radical innovation. Despite the benefits of adopting novel Industry 4.0 technologies in various business functions, such as manufacturing, marketing, operations and logistics, many scientific studies underscore the challenges that SMEs are facing in adopting the Industry 4.0 technologies compared to larger organisations. These challenges include constraints related to the technological knowledge, budgetary limitations, and managerial capacities.
3. The descriptive analysis of the Industry 4.0-derived technologies applicability across various marketing functions in SMEs has revealed that technologies such as the Internet of Things, Artificial Intelligence, Big Data, Chatbots, Virtual Reality, Cloud Computing and others can be utilised in all the researched marketing functions including the product,

price, place, promotion, process, physical evidence, and people marketing functions. Furthermore, this analysis underscored the varying applicability levels of the different Industry 4.0 technologies across the marketing functions. While some technologies have broad application possibilities across multiple marketing functions, others have more limited and specific utilisation possibilities. Consequently, the examination of the SMEs marketing functions in the context of Industry 4.0 has highlighted that the adoption of new technologies enables novel forms of production within firms and creates new relationships between firms and their markets. As the boundaries between the producers and consumers, and between innovation and market adoption are becoming increasingly blurred, the importance of the customer alignment and individualisation is growing. Therefore, marketers are encouraged to take the initiative by proactively understanding how various data can be collected and used to gain valuable consumer insights and effectively target audiences. This proactive approach leverages the adoption possibilities of the Industry 4.0-related technologies in the marketing functions within SMEs.

4. The analysis of the theoretical frameworks used by scientists to explore factors influencing the intention to adopt the Industry 4.0 technologies within SMEs has revealed that well-established frameworks, such as the *Technology Acceptance Model* (TAM), the *Diffusion of Innovations Theory* (DOI), and the *Technology-Organisation-Environment* (TOE) framework are most suitable for this type of research. Additionally, the examination of the management-related theoretical frameworks including the *Agency Theory* (Berle & Means, 1932; Ross, 1973; Jensen & Meckling, 1976), the *Stewardship Theory* (Davis et al., 1997), and the *Upper Echelons Theory* (Hambrick & Mason, 1984) indicated that these frameworks predominantly focus on managerial decision-making processes within large organisations. Given the primary role of the manager/owner within SMEs, this study concentrated on the behavioural aspects of the individual SME owner/manager through the lens of the *Theory of Planned Behaviour* (Ajzen, 1985). Literature analysis highlighted that the attitude of SMEs manager/owners towards the suitability and adoption of new technologies in the marketing functions is influenced by several groups of factors. These include technology-specific factors (the perceived characteristics, usefulness, and the ease of use of the technologies), firm-specific factors (the top management support for adopting new technologies), resource-based factors (the SME size), and external factors (the competitive environment).

5. Based on the findings from the theoretical part, a research model was constructed to investigate the factors influencing the adoption of the Industry 4.0 technologies in marketing functions within SMEs. The central figure of the research model is the SME manager's/owner's attitude towards the suitability of the Industry 4.0 technologies for adoption in the marketing functions within SMEs. This research model integrates elements from the four aforementioned theoretical frameworks (TPB, TAM, DOI, and TOE), as this combination provides a more holistic approach and better explains the factors influencing the suitability of the Industry 4.0 technologies for adoption in the SMEs marketing functions. The research model in this study was divided into three main parts. The research model Part A explores the perceived characteristics of the Industry 4.0 technology impact on the perceived usefulness and the perceived ease of use. The research model Part B examines the relationship between the perceived usefulness and the perceived ease of use of the Industry 4.0 technology on the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs. The research model Part C examines the impact of the attitude towards the Industry 4.0 technology suitability for the adoption in the marketing function within SMEs on the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. Relationships within the model are moderated by the type of the Industry 4.0 technology, the marketing function, the SME size, the top management support, and the competitive environment. To test the noted relationship in the research model, hypotheses and the research design were developed.
6. The first part of the research employed a qualitative empirical research design aimed at identifying the most universal and niche Industry 4.0 technologies suitable for adoption in the marketing functions within SMEs. This was achieved through rating the suitability of fourteen pre-selected Industry 4.0 technologies across the four marketing functions within SMEs by C-level Executives. The C-level Executives selected for the semi-structured interviews possessed practical experience with Industry 4.0 projects, which was necessary since the research aimed to validate the applicability of these technologies as documented in the currently existing scientific literature and to generate new insights. In July and August 2023, eleven semi-structured interviews were conducted with C-level Executives of SMEs. Qualitative content analysis was applied to analyse the answers from each interview.

7. The qualitative study results corroborated the findings from previous scientific studies and confirmed that C-level Executives possess a solid understanding of the Industry 4.0 principles since the majority of the technologies mentioned by the respondents aligned with those documented in scholarly articles. Additionally, the C-level executives identified the key business functions where a broad spectrum of the Industry 4.0 technologies can be applied, including the Manufacturing and Production, Marketing, Supply Chain & Logistics, and Research & Development business functions. Furthermore, the qualitative research underscored that marketing is a crucial area where a wide array of the Industry 4.0 technologies can be effectively utilised within SMEs as well as that the product marketing function out of the four marketing functions (product, price, place, and promotion) within SMEs exhibits the highest potential for adopting a diverse array of the Industry 4.0 technologies.
8. The qualitative study has revealed that Artificial Intelligence and Big Data are the most suitable Industry 4.0 technologies for adoption in the marketing functions within SMEs due to their varied application possibilities and significant benefits. Consequently, a categorisation system for the Industry 4.0 technologies based on their utilisation suitability in the marketing functions within SMEs was proposed. According to this, the Industry 4.0 technologies can be categorised as either universal or niche. The universal technologies, such as Artificial Intelligence and Big Data, are suitable for adoption across multiple marketing functions within SMEs. In contrast, niche technologies, like 3D Printing or Chatbots, are suitable for a more limited range of the marketing functions. This categorisation provides a framework for SMEs to strategically select and implement the Industry 4.0 technologies that best align with their marketing needs, thus enhancing their ability to innovate and compete in the digital age.
9. The second part of the research involved the use of the quantitative research method. In this stage, the information gathered from the semi-structured interviews was used to test the raised hypotheses of the research model. The selected technologies for the further research were: Big Data as a universal technology, and Chatbots as a niche technology. Also, the four marketing functions for the analysis were selected: product, price, place, promotion. The instrument of the research consisted of eight surveys distributed to target population by the market research company *Rinkos Tyrimų Centras*. The response options for the factor-related questions were created by using a seven-point Likert scale. A quantitative research study was conducted within the period of February–March 2024.

In total, 241 respondents were participating in the study, who were working in small-sized companies, and the majority of the respondents had accumulated work experience in their current role related to the marketing decision-making for longer than 5 years. The target population for the quantitative research stage was intentionally selected to include SMEs that have not yet adopted the Industry 4.0 technologies, thus contributing to researching the factors which exert influence on the initial intention to adopt the newest technologies in the marketing functions within SMEs. The current study employed exploratory factor analysis. Thus, all the twelve constructs were confirmed to be reliable, whereas the analysis of the distribution characteristics justified the normality of the data distribution. Correlation, regression, mediation, and moderation analyses were used to test twenty-eight hypotheses. Twelve of them were accepted, and sixteen of them were rejected.

10. The results of the quantitative research analysis model Part A unveiled a new perspective on how the perceived characteristics of the Industry 4.0 technology influence its perceived usefulness and ease of use. The study confirmed a significant positive impact of the perceived relative advantage on the perceived usefulness. However, contrary to previous findings, the perceived relative advantage did not significantly affect the perceived ease of use. These results provide a novel insight into the adoption process of the Industry 4.0 technologies within SMEs, by emphasising that while technologies perceived by SMEs managers/owners as superior and beneficial alternatives are deemed more useful, this perception does not affect their ease of use. Moreover, the study results underscored the significance of the perceived compatibility, by revealing that it positively influenced both the perceived usefulness and the ease of use. This finding implies that the Industry 4.0 technologies, which are perceived as consistent with the existing values and the needs of SMEs managers/owners, are regarded as more useful and easier to use. This highlights the importance of aligning new technologies with the existing frameworks and the expectations within SMEs to facilitate their adoption.
11. Interestingly, the results of the research analysis model Part A have revealed that the perceived complexity did not affect the perceived usefulness, but had a negative impact on the perceived ease of use. This indicates that, while the Industry 4.0 technologies perceived as challenging to comprehend or implement do not diminish their perceived usefulness, they do negatively influence the perceived ease of use among SMEs managers/owners. Therefore, even if these technologies are seen as

beneficial, their complexity may hinder their adoption due to the increased difficulty in understanding and implementing them. This study also highlights contrasting impacts of the perceived observability on the perceived usefulness and the ease of use of the Industry 4.0 technologies. While the perceived observability does not affect the perceived usefulness, it positively influences the perceived ease of use. Thus, the study provides new insights indicating that, despite the positive observed effects of the Industry 4.0 technologies, their perceived usefulness does not increase, but their perceived ease of use is enhanced. Furthermore, the positive impact of the perceived trialability on the perceived usefulness aligns with previous studies, indicating potential benefits if the adopters can trial the Industry 4.0 technology beforehand. However, the positive impact of the perceived trialability on the perceived ease of use in this study was not confirmed.

12. Moreover, the research model Part A explored the moderating effect of the Industry 4.0 technology on the interaction between the perceived characteristics of the Industry 4.0 technology and the perceived usefulness and the ease of use. Despite the fact that the moderation effect was not confirmed in both cases, it was found that the Industry 4.0 technology has a direct impact on the perceived usefulness in the context of the perceived compatibility and the perceived trialability. In both cases, the universal Industry 4.0 technology – Big Data – has no impact towards the perceived usefulness, however, the niche Industry 4.0 technology – Chatbots – has a negative impact towards the perceived usefulness.
13. The research model Part A results question prior assumptions that the perceived relative advantage has a significant impact on the perceived ease of use, and that the perceived observability affects the perceived usefulness, thereby presenting a fresh outlook on the adoption of the Industry 4.0 technologies. Moreover, the study results have revealed that the type of the Industry 4.0 technology does not moderate the interaction between the perceived characteristics of the Industry 4.0 technology and the perceived usefulness and the ease of use, thus indicating that these relationships hold consistent across different types of technologies within the Industry 4.0 spectrum.
14. The research model Part B investigated how the perceived usefulness and the ease of use of the Industry 4.0 technology influences the attitude towards its adoption in the SMEs marketing functions. The study found that the perceived usefulness positively impacts this attitude, which is consistent with prior research, whereas the perceived ease of use alone does not influence it, contrary to the existing studies. This indicates that

the higher is the perceived usefulness of the Industry 4.0 technology, the more positive the attitude towards its adoption will be among the SMEs managers/owners. However, the perceived ease of use was found to mediate the relationship between the perceived usefulness and the attitude towards the Industry 4.0 technology adoption suitability, aligning with previous research. This means that a higher perceived ease of use leads to a greater perceived usefulness of the Industry 4.0 technology, thereby increasing the positive attitude towards its adoption in the marketing functions within SMEs. Furthermore, the study explored whether the type of the Industry 4.0 technology moderates these relationships, but found no direct impact or moderation effects. Additionally, the marketing function itself was not found to directly impact the attitude or moderate the relationship between the perceived usefulness or the ease of use and the attitude towards the Industry 4.0 technology adoption within SMEs.

15. The research model Part B findings contribute to the understanding of the factors influencing the attitude towards the suitability of the Industry 4.0 technologies for adoption in the SMEs marketing functions, thus emphasising the critical role of the perceived usefulness and the mediating role of the perceived ease of use. The results also highlight the uniformity of these relationships across different types of the Industry 4.0 technologies and the lack of a direct influence or a moderating role from the marketing function itself.
16. In Part C of the research model, the study explored how the attitude towards the suitability of the Industry 4.0 technology adoption in the SMEs marketing functions influence the behavioural intentions. The study has confirmed previous scientific findings that the perceptions of SMEs managers/owners towards the adoption of the Industry 4.0 technologies in the marketing functions play a major role. It was found that SMEs owners or managers with a positive outlook towards the Industry 4.0 technology are more likely to adopt and implement it in the marketing functions. Additionally, the study revealed that the top management support has a direct positive impact on the behavioural intentions. Moreover, it was confirmed to have a moderating effect on the relationship between the attitude and intentions towards the adoption of the Industry 4.0 technology. This suggests that higher levels of the top management support enhance the attitude towards the suitability of the Industry 4.0 technology adoption in the SMEs marketing functions, thereby increasing the behavioural intention of SMEs to adopt the Industry 4.0 technology in the marketing functions. These findings underscore the critical role of the managerial perceptions and the top

management support in shaping the adoption of the Industry 4.0 technologies in SMEs.

17. Furthermore, the research model Part C identified that the competitive environment has a direct positive impact on the behavioural intentions. However, it does not moderate the relationship between the attitude and the behavioural intention to adopt the Industry 4.0 technology in the marketing functions within SMEs. Additionally, the study did not find evidence for a direct impact of the SME size on the behavioural intentions, which diverges from existing literature. These findings provide new insights into the factors influencing the behavioural intentions towards the adoption of the Industry 4.0 technology in the SMEs marketing functions. The direct positive impact of the competitive environment suggests that SMEs may be motivated to adopt these technologies to enhance their competitive position. Meanwhile, the lack of a moderating effect from the competitive environment and the SME size on the relationship between the attitude and intentions indicates that other factors, such as the managerial perceptions and the top management support, play a more significant role in shaping the adoption decisions.
18. The research model Part C also explored the role of the type of Industry 4.0 technology and the marketing functions, but found no direct impact towards the behavioural intention, nor did it find any moderation effect on the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. These findings suggest that, irrespective of the specific type of the Industry 4.0 technology or the marketing function, the attitudes of SMEs managers/owners towards technology adoption are crucial determinants of their behavioural intentions. The lack of a direct impact or a moderation effect indicates that other factors, such as managerial perceptions, the top management support, and the competitive environment, exert a more significant influence on the adoption decisions of the Industry 4.0 technologies in SMEs.
19. The research model Part C findings provide a comprehensive understanding of the complex factors influencing the adoption of the Industry 4.0 technologies in the SMEs marketing functions. It highlights the critical roles of the managerial perceptions, the top management support, and the competitive environment in shaping the behavioural intentions towards technology adoption. These insights contribute to both the theoretical development and the practical implications for promoting the successful adoption of the Industry 4.0 technologies in SMEs, while

offering guidance for the policymakers and practitioners seeking to facilitate technological innovation in small and medium-sized enterprises.

20. The main contribution of this thesis lies in the comprehensive investigation of the factors influencing the adoption suitability of the Industry 4.0 technologies in the marketing functions within SMEs. This study provides a nuanced understanding of the interplay between the perceived characteristics of the Industry 4.0 technology, the attitudes towards the adoption and the behavioural intentions to adopt the technologies within SMEs marketing functions through the lenses of the SMEs managers/owners. By integrating four theoretical frameworks and employing both qualitative and quantitative research methods, this research offers a holistic view of the complex dynamics involved in the adoption of the Industry 4.0 technologies in the marketing functions within SMEs. Additionally, the proposed categorisation of the suitability of the Industry 4.0 technologies for the adoption in different marketing functions of SMEs and the examination of the moderating factors contribute to a deeper understanding of the adoption process of the Industry 4.0 technologies within SMEs.
21. The study's findings reveal the consistent impact of the attitudes towards the technology suitability adoption across the different types of the Industry 4.0 technologies and the marketing functions, which underscores the generalisability of these findings, thereby paving the way for more targeted and effective adoption strategies within SMEs. However, the study results also imply that, compared to large companies, certain SMEs characteristics, such as budgetary constraints, or the lack of technological and managerial expertise, continue to hinder the full potential of the Industry 4.0 technologies adoption in the marketing functions within SMEs.

Recommendations for future research. The results of the dissertation research make it possible to highlight the limitations of the study and provide recommendations for the future research:

1. The study results show that the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs, the SME size, the competitive environment, and the top management support explain 69.6% of the variance in the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs ($R2=0.696$, $F=134.928$, $p<0.001$). While these factors provide significant insights into the adoption decisions, the study acknowledges several limitations that warrant further investigation. The *first limitation* is that the study focused primarily on the managerial and organisational factors, such as the attitudes and the top management support, while neglecting potentially influential manager/owner characteristics, such as their age, educational level, and the knowledge of the technology. Inclusion of these individual-level characteristics could provide a more nuanced understanding of the Industry 4.0 technology adoption process. The *second limitation* is that the analysis did not encompass external factors beyond the competitive environment, such as the regulatory environment. Exploring regulatory frameworks and other external influences could enhance the comprehensiveness of the study and provide a broader perspective on the adoption of the Industry 4.0 technologies in the SMEs marketing functions.
2. The *third limitation* of this study is that the explored marketing functions were selected based on the 4Ps Marketing Mix model and included the functions of the product, price, promotion, and place. However, the research results revealed that these selected marketing functions do not moderate the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. For future studies, it is recommended to narrow down the selected marketing functions to more specific marketing activities, such as assortment-related activities, branding-related activities, discount-related activities, distribution channel-related activities, etc., and explore their potential moderation effects on the adoption of the

Industry 4.0 technologies. This approach would provide a more granular understanding of how different aspects of marketing activities actually influence the adoption of the Industry 4.0 technologies in SMEs.

3. The *fourth limitation* of this study is that, for the quantitative research, only two Industry 4.0 technologies were selected, namely, Big Data and Chatbots, and these technologies did not exhibit a moderating effect on the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the Industry 4.0 technology in the marketing function within SMEs. To address this limitation, future research should incorporate a more extensive range of the Industry 4.0 technologies. Moreover, subsequent studies should investigate the direct and moderating impact of these technologies across a wider array of the SMEs business functions and perform comparative analyses to assess their differential effects. This comprehensive approach would provide a deeper understanding of how various Industry 4.0 technologies can be effectively adopted in marketing and other business functions within SMEs.
4. The *fifth limitation* of this thesis is that the majority of the respondents in this study were working in small-sized companies (three-quarters), whereas only one-quarter were working in medium-sized companies. For future studies, it is advised to ensure a greater diversity and representation across the different sizes of SMEs. Specifically, efforts should be made to guarantee an equal distribution of the respondents from micro, small, and medium-sized companies. This approach would allow for a more comprehensive analysis of how the SME size influences the behavioural intentions towards the adoption of the Industry 4.0 technologies. Furthermore, it is recommended to conduct comparative research between large enterprises and SMEs to analyse the differential factors influencing the suitability of the Industry 4.0 technologies for adoption in the marketing functions.
5. In this study, twelve constructs were explored. The *sixth limitation* of the study is that the Cronbach's alfa of the observability construct (0.646) was close to the lower limit of the acceptable reliability range. Also, the Cronbach's alfa of the perceived usefulness construct (0.975) symbolised that the items of the construct might be too similar. Therefore, for the future studies, it is advisable to carefully examine the existing constructs and select those that are most appropriate for further research. This would strengthen the reliability

and validity of the future research findings, allowing for more accurate assessments of the factors influencing the adoption of the Industry 4.0 technologies in the marketing functions within SMEs.

6. SMEs can be categorised in various ways, such as by the type of ownership, the predominant business activities, and other characteristics. The *seventh limitation* of this study is that, in this study, these categorisations were not explored in relation to their influence on the suitability of adopting the Industry 4.0 technologies in the marketing functions within SMEs. For future studies, it is recommended to investigate how these characteristics influence and differ in their impact on the adoption of the Industry 4.0 technologies in the SMEs' marketing functions. Exploring factors such as the ownership type (e.g., family-owned, a public company), the predominant business activities (e.g., manufacturing, services), and other relevant categorisations could provide valuable insights into the specific conditions under which SMEs are more likely to adopt these technologies.

Recommendations for practicians. The results of the dissertation research make it possible to provide recommendations for the practicians:

1. Managers of small and medium-sized enterprises (SMEs) in Lithuania can leverage the research model developed in this study as a strategic tool to assess the adoption suitability of the Industry 4.0 technologies in the marketing functions. The model integrates elements from the TPB, TAM, DOI and TOE frameworks, thus providing a holistic approach to understanding the factors influencing the adoption of the Industry 4.0 technologies in the SMEs marketing functions. Implementing this model can not only assist SMEs in strategically assessing and selecting the appropriate Industry 4.0 technologies for the marketing functions, but also to enhance the managerial understanding of the factors influencing technology adoption. By adopting these recommendations, SMEs can enhance their competitiveness, efficiency, and innovation through the effective adoption of the Industry 4.0 technologies in the marketing functions.
2. This thesis has managerial practice implications, while proposing a new way of the categorisation of the Industry 4.0 technologies (niche vs. universal Industry 4.0 technologies) with regard to their adoption suitability in the marketing functions within SMEs. Based on this categorisation, practicians can ground their decision to adopt the selected Industry 4.0 technology in the marketing functions. For the Lithuanian SMEs, it is recommended to prioritise the adoption of the

universal Industry 4.0 technologies, such as Artificial Intelligence (AI) and Big Data, in the marketing functions, as the study results suggest that these technologies offer extensive application possibilities and substantial benefits, while facilitating enhanced data-driven decision-making, customer insights and the overall marketing performance. However, if an SME is particularly interested into improving one selected marketing function, then it might be advisable to adopt the niche Industry 4.0 technology due its more narrow but specific application benefits, for example: Chatbots adoption can improve customer service interactions, while 3D Printing can enable product customisation.

3. The results of the quantitative research analysis offer a new perspective on how the perceived characteristics of the Industry 4.0 technology influence its perceived usefulness and the ease of use and provide practical guidance for SMEs managers and owners to navigate the adoption of the Industry 4.0 technologies in the marketing functions. Based on the study results, for the SMEs, it is recommended to focus on the technology's relative advantage as well as on its compatibility, while emphasising the alignment of the new technologies with the existing values and needs of SMEs to facilitate their adoption. Also, it is recommended to consider the technology complexity and observability. It is of importance to note that while complex Industry 4.0 technologies may offer substantial benefits, their perceived ease of use can hinder their adoption. Therefore, highlighting observable benefits can enhance the ease-of-use perception among the SMEs managers/owners. Moreover, it is recommended to prioritise the trials of the Industry 4.0 technologies to demonstrate their potential benefits and increase the perceived usefulness. These recommendations are designed to assist SMEs managers and owners in effectively adopting the Industry 4.0 technologies within the marketing functions. By focusing on a technology's relative advantage, compatibility, managing complexity, highlighting observable benefits and prioritising trials, SMEs can leverage the transformative potential of the Industry 4.0 technologies.
4. Furthermore, for SMEs, it is recommended to emphasise the perceived usefulness of the Industry 4.0 technologies in the marketing functions to foster positive attitudes among the SMEs managers and owners. Highlighting the benefits and advantages of these technologies can strengthen their perceived usefulness, thereby

increasing the likelihood of the positive attitude towards technology adoption. Additionally, due to the mediating role of the perceived ease of use in the technology adoption process, SMEs are recommended to implement strategies aimed at simplifying the understanding and usage of the Industry 4.0 technologies. This includes the provision of training, support and resources to facilitate a smoother adoption process. Moreover, as the relationships between the perceived usefulness, the ease of use, and the adoption attitudes are consistent across different types of the Industry 4.0 technologies, it is suggested that the Industry 4.0 technology adoption strategies should be tailored to highlight the perceived usefulness and ease of use features relevant to each technology. Furthermore, as the marketing function itself does not directly influence the attitudes towards the adoption of the Industry 4.0 technologies, nor does it moderate the relationship between the perceived usefulness and the perceived ease of use, SMEs are encouraged to focus on enhancing the perceived usefulness and the ease of use, instead of relying on specific marketing function characteristics to drive the adoption decisions.

5. The study findings emphasise the crucial role of the managerial perceptions in the adoption of the Industry 4.0 technologies within the SMEs marketing functions. The study confirms that a positive attitude of the SMEs managers/owners towards the adoption of the Industry 4.0 technologies significantly influence their behavioural intentions to adopt these technologies. Therefore, to foster the adoption and implementation of the Industry 4.0 technologies in the marketing functions within SMEs, it is recommended to focus on creating and maintaining a positive outlook among the managers and owners towards the Industry 4.0 technologies. This can be achieved by showcasing successful case studies, demonstrating tangible benefits, and providing clear evidence of the advantages these technologies bring to the marketing functions. Also, for SMEs, it is recommended to encourage the SMEs leaders to develop a strategic vision which would include the integration of the Industry 4.0 technologies. A clear roadmap and a long-term plan can help align the organisation's goals with the benefits of these technologies, thereby fostering a positive attitude towards their adoption.
6. Additionally, the findings regarding the top management support's moderating effect on the relationship between the attitude towards the Industry 4.0 technology suitability for adoption in the marketing function within SMEs and the behavioural intention to adopt the

Industry 4.0 technology in the marketing function within SMEs, offer practical implications for the SMEs navigating the digital transformation landscape. While striving for the successful Industry 4.0 technology adoption in the marketing functions, for SMEs, it is recommended to ensure the high top management involvement and the commitment towards the adoption of the new technologies. This could be achieved by demonstrating a clear vision and leadership in integrating these technologies into the marketing functions. Also, it is recommended to cultivate a company culture that encourages innovation and technological adoption. The top management should lead by example, by showing enthusiasm and support for the new technologies, as well as to prioritise and support initiatives that promote continuous learning. Finally, it is important for the top management to be actively involved in assessing the progress, identifying challenges, and making the necessary adjustments to ensure the successful Industry 4.0 implementation. By emphasising the high top management involvement and commitment, SMEs can effectively navigate the digital transformation landscape and achieve successful adoption of the Industry 4.0 technologies in the marketing functions.

7. The study results highlight that the adoption of the Industry 4.0 technologies in the marketing functions has many potential benefits for the SMEs growth and competitiveness. Nonetheless, due to the specificalities of the SMEs and constraints related to technological knowledge, budgetary limitations and managerial capacities, the adoption of the most recent technologies for SMEs is usually more challenging than for the larger companies. Therefore, for the policy makers in Lithuania, it is recommended to develop tailored support mechanisms which would address the unique challenges faced by SMEs in adopting the Industry 4.0 technologies. This could include targeted funding programs, knowledge-sharing platforms, and capacity-building initiatives aimed at enhancing technological literacy among SMEs owners and managers. Moreover, it is recommended to encourage collaboration between SMEs, research institutions, and larger enterprises to facilitate the technology transfer and knowledge diffusion. Establishing networks and partnerships can help SMEs access resources and expertise needed for the successful Industry 4.0 adoption. By addressing these recommendations, stakeholders can foster a supportive environment for SMEs to harness the benefits of the Industry 4.0 technologies, thereby enhancing their

growth, performance, and competitiveness in the context of Industry 4.0.

8. This study also extends the current knowledge about the benefits of the adoption of the Industry 4.0 technologies in the marketing functions, particularly for SMEs. By leveraging these insights, SMEs can improve their competitive edge, while offering more precise and tailored products and services. Furthermore, the adoption of these technologies not only benefits SMEs, but also positively impacts society. As SMEs become more efficient and customer-focused, they contribute to a more dynamic and responsive market environment.

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APPENDICES

Appendix 1. Literature Review on Industry 4.0 Roadmaps

Table 1. Documented Industry 4.0 Roadmaps and identified research gaps

#	Method	Authors	Focus	Research Gaps
1	Manufacturing Readiness Index (Four Dimensions)	Jung et al. (2016)	Evaluating smart manufacturing readiness index for small and MNEs. Four dimensions for assessing manufacturing readiness stated: (1) organisational maturity, (2) information technology (IT) maturity, (3) performance management maturity, and (4) information connectivity maturity.	Steps to achieve Industry 4.0 are missing.
2	Framework	Qin et al. (2016)	A set of technologies that can help an SME achieving the Industry 4.0 paradigm. Considered automation and intelligence capabilities as the enabler for Industry 4.0.	The gap analysis does not present a concrete index or level to determine an SME's present state and how to lead it towards the Industry 4.0 paradigm.
3	Maturity Model (Considering Diversification as Enabler)	Ganzarain & Errasti (2016)	Company (SME)-specific vision leads to Industry 4.0. A three-stage maturity model: (1) initial, (2) managed, and (3) defined to transform and detail a business model.	Only a diversification corporate strategy is being considered as the enabler for Industry 4.0. A readiness assessment tool for Industry 4.0 is missing.
4	Analytic Network Process (Four Dimensions)	Lee et al. (2017)	Considers dimensions (or building blocks) for Multiple-Criteria Decision-Making. A five-level maturity model considered for achieving Industry 4.0: (1) checking, (2)	Steps to evaluate the Industry 4.0 readiness and to proceed towards Industry 4.0 are missing.

#	Method	Authors	Focus	Research Gaps
			monitoring, (3) control, (4) optimisation, and (5) autonomy.	
5	Development of an Assessment Model for Industry 4.0: Industry 4.0-MM	Gökalp et al. (2017)	Mentions a six level (0–5) maturity model: (0) incomplete, (1) performed, (2) managed, (3) established, (4) predictable, and (5) optimising.	Steps to evaluate the Industry 4.0 readiness are missing. An SME perspective for Industry 4.0 is not considered.

Source: *Aggregated by the author according to* Mittal et al. (2018). A Critical Review of Smart Manufacturing & Industry 4.0 Maturity Models: Implications for Small and Medium-sized Enterprises (SMEs)

Appendix 2. Qualitative Research Semi-Structured Interview Guideline

Part (I) Introduction:

1. Please indicate your: Name and Surname.
2. Please indicate your: Current Job Title and the Industry Field you are currently working in.

Part (II) Open questions related to Industry 4.0 technologies application in SMEs:

1. Please list at least 5 technologies which, in your opinion, can be linked to Industry 4.0. Briefly explain how and why.
2. Based on your opinion and expertise, please list at least 3 business functions in which Industry 4.0 technologies can be applied. Briefly explain how and why.
3. In your opinion, which Industry 4.0 technologies can be applied in the marketing function of Small and Midsize enterprises (SMEs)? List at least 3 technologies and briefly describe their possible application.
4. Please describe how, in your opinion, the Industry 4.0 technology BIG DATA could be applied to the marketing function of Small and Midsize enterprises (SMEs).
5. Please describe how, in your opinion, the Industry 4.0 technology CHATBOTS could be applied to the marketing function of Small and Midsize enterprises (SMEs).

Part (III) Rating the suitability of fourteen (14) selected Industry 4.0 technologies for adoption in four (4) marketing functions of SMEs:

For your convenience, below you will find a brief explanation of each marketing function.

- **PRODUCT FUNCTION:** Refers to the item or service. Includes such aspects of the item/service as: benefits and features, assortment/variety, quality, design, sizes, branding, packaging, services, warranties.
- **PRICE FUNCTION:** Includes the price of the item/service. Includes such aspects of the item/service as: list price, discounts, allowances, payment methods, credit terms.
- **PLACE FUNCTION:** Refers to the location where the product or service is available to the customer. Include such aspects of the item/service as: channels, coverage, locations, inventory, transport.
- **PROMOTION FUNCTION:** Refers the market communication of the item or service. Include such aspects of the item/service as: sales promotion, advertising, public relations, direct marketing, personal selling, sponsorship.

1. Please rate the suitability of the Industry 4.0 technology INTERNET OF THINGS (IoT)* to be adopted in the selected marketing functions: *(It is a technology that allows adding a device to an inert object (for example: vehicles, lighting, etc.) that can measure environmental parameters, generate associated data, and transmit the data through a communications network).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

2. Please rate the suitability of the Industry 4.0 technology ARTIFICIAL INTELLIGENCE (AI)* to be adopted in the selected marketing functions: *(It is a set of technologies that enable computers to perform a variety of advanced functions, including the ability to see, understand and translate spoken and written language, analyse data, make recommendations, and more).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

3. Please rate the suitability of the Industry 4.0 technology BIG DATA* to be adopted in the selected marketing functions: *(It is data containing great variety, arriving in increasing volumes, and with more velocity. Big data is larger, more complex data sets, especially from new data sources).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

4. Please rate the suitability of the Industry 4.0 technology CLOUD COMPUTING* to be adopted in the selected marketing functions:*(It is on-demand access, via the internet, to computing resources – applications, servers (physical servers and virtual servers), data storage, and more – hosted at a remote data centre managed by a cloud services provider (or CSP)).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

5. Please rate the suitability of the Industry 4.0 technology 3D PRINTING* to be adopted in the selected marketing functions:*(It uses computer-aided design to create three-dimensional objects through a layering method. It is sometimes referred to as additive manufacturing).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

6. Please rate the suitability of the Industry 4.0 technology SIMULATION/DIGITAL TWIN* to be adopted in the selected marketing functions:*(It is the use of computer modelling to virtually test manufacturing methods and procedures, including processes such as production, assembly, inventory, and transportation).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

7. Please rate the suitability of the Industry 4.0 technology AUGMENTED REALITY (AM)* to be adopted in the selected marketing functions:*(It as an enhanced, interactive version of a real-world environment achieved through digital visual elements, sounds, and other sensory stimuli via holographic technology).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

8. Please rate the suitability of the Industry 4.0 technology VIRTUAL REALITY (VR)* to be adopted in the selected marketing functions:*(It as a computer-generated environment with scenes and objects that appear to be real, making the user feel they are immersed in their surroundings. This environment is perceived through a device known as a Virtual Reality headset or helmet).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

9. Please rate the suitability of the Industry 4.0 technology MOBILE APPS/TECHNOLOGIES* to be adopted in the selected marketing functions:*(It as a software application developed specifically for use on small, wireless computing devices, such as smartphones and tablets, rather than desktop or laptop computers).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

10. Please rate the suitability of the Industry 4.0 technology CHATBOTS* to be adopted in the selected marketing functions:*(It as a computer program designed to simulate conversation with human users, especially over the Internet).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

11. Please rate the suitability of the Industry 4.0 technology VIRTUAL ASSISTANTS* to be adopted in the selected marketing functions:*(It is an application program that understands natural language voice commands and completes tasks for the user).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

12. Please rate the suitability of the Industry 4.0 technology AUTONOMOUS ROBOTS* to be adopted in the selected marketing functions:*(It is a type of an automated machine that can execute specific tasks with little or no human intervention, and with speed and precision).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

13. Please rate the suitability of the Industry 4.0 technology 5G NETWORK* to be adopted in the selected marketing functions:*(It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together, including machines, objects, and devices).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

14. Please rate the suitability of the Industry 4.0 technology BLOCKCHAIN* to be adopted in the selected marketing functions:*(It is "a distributed database that maintains a continuously growing list of ordered records, called blocks." These blocks "are linked [by] using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data).

	Very not suitable	Not suitable	Neutral	Suitable	Very suitable
PRODUCT FUNTION					
PRICE FUNCTION					
PLACE FUNCTION					
PROMOTION FUNCTION					

15. Please indicate additional Industry 4.0 technologies that, in your opinion, could be suitable for adoption in the marketing functions, but were not mentioned above.

If there are any, please also indicate the suitability of such technologies for adoption (highly unsuitable, not suitable, neutral, suitable, very suitable) in separate marketing functions (product, price, place, promotion), i.e., (drones could be very suitable in the promotion function and neutral in the pricing function)

Source: created by the author.

Appendix 3. Original and Adjusted Constructs Used for the Quantitative Research

Table 2. Original constructs for quantitative research

ORIGINAL CONSTRUCTS	ITEMS
Relative Advantage, (AlBar & Hoque, 2019), based on Premkumar and Roberts, 1999	RA1: Cloud ERP will enhance the efficiency of organization
	RA2: Cloud ERP will improve the performance of organization
	RA3: Cloud ERP will provide timely information for decision making
Compatibility, (Kumar et al., 2017), based Wang et al., 2010	CO1: Using cloud service is compatible with all aspect of our work
	CO2: Usage of cloud computing service fits well with the way we like to work
	CO3: Cloud computing-created changes are compatible with our business
	CO4: Cloud computing is compatible with our existing technology infrastructure
Complexity, (AlBar & Hoque, 2019), based on Premkumar and Roberts, 1999	CX1: We believe that cloud ERP is difficult to use
	CX2: Integrating cloud ERP in our work practises will be difficult
	CX3: Our organization may encounter some difficulties in maintaining the cloud ERP platform
Observability, (Duan et al., 2010), based on Moore and Benbasat, 1991	OB1: The benefits of e-learning can be demonstrated
	OB2: There are plenty of chances to know about e-learning
	OB3: There are plenty of chances to know about benefits of e-learning
	OB4: The benefits of taking an e-learning course are apparent to me
	OB5: I have no difficulty to tell other about benefits of e-learning
Trialability, (Yuen et al., 2021), based on: Yuen et al., 2018	TR1: Before I decide to use Chatbots, I would like to view a demonstration of using Chatbots
	TR2: Before I decide to use Chatbots, I would like to receive an introduction using Chatbots
	TR3: Before I decide to use Chatbots, I would like to try it
Perceived usefulness, (Rahman et al., 2021), based on Belanche et al., 2019	PU1: It would improve my performance in managing banking investments by using AI enable technology in banking (e.g. *chatbots: chat based virtual assistant*)
	PU2: It would improve my productivity in managing banking investments by using AI enable technology in banking (e.g. *chatbots: chat based virtual assistant*)

ORIGINAL CONSTRUCTS	ITEMS
	PU3: It would enhance my effectiveness in managing banking investments by using AI enable technology in banking (e.g. *chatbots: chat based virtual assistant*)
	PU4: I would find AI enable technology in banking useful in managing banking investments (e.g., *chatbots: chat-based virtual assistant*)
Perceived ease of use, (Rahman et al., 2021), based on Belanche et al., 2019	PEOU1: Learning to use AI enable technology in banking is easy to me (*e.g. chatbots: chat based virtual assistant*)
	PEOU2: I would find it easy to manage banking investments using AI enable technology in banking (*e.g. chatbots: chat based virtual assistant*)
	PEOU3: I would find it easy for me become skilful at using AI enable technology in banking (*e.g. chatbots: chat based virtual assistant*)
	PEOU4: I would find it easy to interact with AI in banking as it does not require a lot of my mental effort (*e.g. chatbots: chat based virtual assistant*)
Attitude toward technology, (Rahman et al., 2021), based on Belanche et al., 2019	AT1: Using AI banking enable technology for managing banking investments seems like a good idea
	AT2: I like the idea of using AI banking enable technology for managing personal banking investments
	AT3: Using AI banking enable technology for implementing my banking investments seems like a wise idea
Top management support, (Kumar et al., 2017), based on Ifinedo, 2011	MAN1: Top management's attitude is positive towards using cloud computing
	MAN2: Top management supports the implementation of cloud services
	MAN3: Top management is ready to provide necessary resources for the introduction of cloud computing
	MAN4: Top management accepts possible risks, which may result from introducing cloud computing
Competitive environment, (AlBar & Hoque, 2019), based on Al-Qirim & Corbitt, 2002	ENV1: It is a strategic requirement to use cloud ERP to compete in the market
	ENV2: Our organization will be affected by competitive disadvantages if cloud ERP had not been adopted
	ENV3: We believe we will lose our market share if we do not adopt cloud ERP
Intention to adopt, (Kumar et al., 2017), based on Gangwar et al., 2015	INT1:Assuming we have access to cloud computing, we intend to use it
	INT2:Given that we have access to cloud computing, we predict that we would use it

ORIGINAL CONSTRUCTS	ITEMS
	INT3: Given easy access to cloud computing, I will recommend cloud computing implementation in my company
SME Size, (Sun et al, 2020), based on Wang et al., 2010	SIZ1: The capital of my company is high compared to the industry
	SIZ2: The revenue of my company is high compared to the industry
	SIZ3: The number of employees at my company is high compared to the industry

Source: created by the author

Table 3. Adjusted constructs used for the quantitative research

ADJUSTED CONSTRUCTS	ITEMS
Perceived Relative Advantage, based on (AlBar & Hoque, 2019), original: Premkumar and Roberts, 1999	RA1: Big Data/Chatbots technology adoption would enhance the efficiency of the SME
	RA2: Big Data/Chatbots technology adoption would improve the performance of the SME
	RA3: Big Data/Chatbots technology adoption would provide timely information for the decision making at the SME
Perceived Compatibility, based on (Kumar et al., 2017), original: Wang et al., 2010	CO1: Using Big Data/Chatbots technology would be compatible with all aspect of the work of the SME
	CO2: Using Big Data/Chatbots technology would fit well with the way SME like to work
	CO3: Big Data/Chatbots technology adoption created changes would be compatible with SME's business
	CO4: Big Data/Chatbots technology adoption would be compatible with the existing technology infrastructure of the SMEs
Perceived Complexity, based on (AlBar & Hoque, 2019), original: Premkumar and Roberts, 1999	CX1: Big Data/Chatbots technology would be difficult to use for the SME
	CX2: Integrating Big Data/Chatbots technology in work practices of the SME's would be difficult
	CX3: SME would encounter some difficulties in maintaining the Big Data/Chatbots technology
Perceived Observability, based on (Duan et al., 2010), original: Moore and Benbasat, 1991	OB1: The benefits of adopting Big Data/Chatbots technology can be demonstrated
	OB2: There are plenty of chances to know about the benefits of adopting the Big Data/Chatbots technology
	OB3: The benefits of adopting the Big Data/Chatbots technology are apparent to me
	OB4: I have no difficulty to tell others about Big Data/Chatbots technology adoption benefits
Perceived Trialability,	TR1: Before I decide to adopt Big Data/Chatbots technology in the organisation I am currently working, I

ADJUSTED CONSTRUCTS	ITEMS
based on (Yuen et al., 2021), original: Yuen et al., 2018	would like to view a demonstration of using this technology
	TR2: Before I decide to adopt Big Data/Chatbots technology in the organization I am currently working, I would like to receive an introduction using technology
	TR3: Before I decide to adopt Big Data/Chatbots technology in the organisation I am currently working, I would like to try it
Perceived usefulness, based on (Rahman et al., 2021), original: Belanche et al., 2019	PU1: It would improve my performance in managing daily business operations by adopting the Big Data/Chatbots technology at the organisation where I am currently working
	PU2: It would improve my productivity in managing daily business operations by adopting the Big Data/Chatbots technology at the organisation where I am currently working
	PU3: It would enhance my effectiveness in managing daily business operations by adopting the Big Data/Chatbots technology at the organisation where I am currently working
	PU4: I would find the Big Data/Chatbots technology adoption useful in managing daily business operations at the organisation where I am currently working
Perceived ease of use, based on (Rahman et al., 2021), original: Belanche et al., 2019	PEOU1: Learning to use the Big Data/Chatbots technology in managing daily business operations would be easy for the company employees at the organisation where I am currently working
	PEOU2: The company employees of the organization where I am currently working would find it easy to manage daily business operations by using the Big Data/Chatbots technology
	PEOU3: The company employees where I am currently working would find it easy to become skilful at using the Big Data/Chatbots technology
	PEOU4: The company employees where I am currently working would find it easy to interact with the Big Data/Chatbots technology in managing daily business operations as it does not require a lot of mental effort
Attitude toward technology, based on (Rahman et al., 2021), original: Belanche et al., 2019	AT1: At the organization where I am currently working, using the Big Data/Chatbots technology enabled in marketing for managing the selected marketing function seems like a good idea
	AT2: I like the idea of using the Big Data/Chatbots technology enabled in marketing for managing selected marketing function at the organisation where I am currently working

ADJUSTED CONSTRUCTS	ITEMS
	AT3: At the organisation where I am currently working, using the Big Data/Chatbots technology enabled in marketing for implementing selected marketing function seems like a wise idea
Top management support, based on (Kumar et al., 2017), original: Ifinedo, 2011	MAN1: At the organisation where I am currently working, the Top management's attitude is positive towards adopting the Big Data/Chatbots technology in a selected marketing function
	MAN2: At the organisation where I am currently working, the Top management supports the implementation of the Big Data/Chatbots technology in a selected marketing function
	MAN3: At the organisation where I am currently working, the Top management is ready to provide necessary resources for the introduction of the Big Data/Chatbots technology in a selected marketing function
	MAN4: At the organisation where I am currently working, the Top management accepts possible risks, which may result from introducing the Big Data/Chatbots technology in a selected marketing function
Competitive environment, based on (AlBar & Hoque, 2019), original: Al-Qirim & Corbitt, 2002	ENV1: At the organisation where I am currently working, it is a strategic requirement to adopt the Big Data/Chatbots technology in a selected marketing function to compete in the market
	ENV2: The organization where I am currently working will be affected by competitive disadvantages if the Big Data/Chatbots technology will not be adopted in a selected marketing function
	ENV3: I believe that the organisation where I am currently working, will lose market share if the Big Data/Chatbots technology will not be adopted in a selected marketing function
Intention to adopt, based on (Kumar et al., 2017), original: Gangwar et al., 2015	INT1: Assuming that the organisation where I am currently working has an access to Big data/Chatbots technology, I would intend to adopt it in the selected marketing function
	INT2: Given that the organisation where I am currently working has an access to the Big Data/Chatbots technology, I predict that I would adopt it in the selected marketing function
	INT3: Given easy access to the Big Data/Chatbots technology, I will recommend the implementation of such a technology at the organisation where I am currently working in a selected marketing function

ADJUSTED CONSTRUCTS	ITEMS
SME Size, based on (Sun et al, 2020), original: Wang et al., 2010	SIZ1: At the organisation where I am currently working, the capital of the company is high compared to the industry
	SIZ2: At the organisation where I am currently working, the revenue of the company is high compared to the industry
	SIZ3: At the organisation where I am currently working, the number of employees of the company is high compared to the industry

Source: created by the author

Appendix 4. Quantitative research survey (Lithuanian)

Survey example for the first group of respondents – Big Data technology suitability to be adopted in the product marketing function within SMEs (in Lithuanian)

Gerbiamasis Pone/Ponia,

Esu (*vardas, pavardė*) iš Rinkos tyrimų centro. Šiuo metu atliekame tyrimą apie 4.0 Industrinės revoliucijos technologijų tinkamumą naudoti su rinkodara susijusiose funkcijose mažose ir vidutinėse įmonėse (MVĮ).

Šia apklausa siekiama išanalizuoti **Didžiųjų duomenų/Big Data** technologijos įdiegimo tinkamumą naudoti **rinkodaros funkcijoje susijusioje su prekės/paslaugos valdymu** mažose ir vidutinėse įmonėse (MVĮ).

Šiai apklausai atsakyti užtruksite apie 15 minučių, o surinkti duomenys bus naudojami tik tyrimo tikslais.

1. Ar šiuo metu dirbate mažoje ir vidutinėje įmonėje (MVĮ)? (Organizacijoje dirba nuo 10 iki 250 darbuotojų ir metinė įmonės apyvarta siekia nuo 2 iki 50 mln. EUR) (atsakant galimas tik vienas variantas)

1.1. Taip
1.2. Ne (pasirinkę šį atsakymą negalėsite tęsti klausimyno).

2. Kurioje srityje (srityse) esate atsakingas už sprendimų priėmimą MVĮ, kurioje šiuo metu dirbate? (atsakant galima pasirinkti kelis atsakymų variantus)

2.1. Finansų sritis
2.2. Žmogiškųjų išteklių sritis
2.3. Gamybos sritis
2.4. Rinkodaros sritis
2.5. Logistikos sritis
2.6. Investicijų sritis
2.7. Kita

(jeigu respondentas nepasirinko „Rinkodaros srities“, jis toliau negali tęsti klausimyno).

3. Ar žinote/teko girdėti, kad yra galimybių Didžiųjų duomenų/Big Data technologiją taikyti MVĮ rinkodaros srityse? (Big Data/Didieji Duomenys yra Pramonės 4.0 technologija. Didžiųjų duomenų įvairovė yra didesnė, gaunama vis didesniu kiekiu ir didesniu greičiu. Ši technologija suteikia galimybę efektyviau analizuoti informaciją ir greičiau priimti naudingus sprendimus.) **(atsakant galimas tik vienas variantas)**

3.1. Taip
3.2. Ne (pasirinkę šį atsakymą negalėsite tęsti klausimyno).

4. Ar šiuo metu taikote Big Data/Didžiųjų duomenų technologiją su rinkodara susijusiose funkcijose (prekės/paslaugos valdymo veikloje; kainodaros veikloje; reklamos, pardavimų skatinimo ir pardavimų veikloje; paskirstymo ir logistikos veikloje) MVĮ, kurioje šiuo metu dirbate? (atsakant galimas tik vienas variantas)

4.1. Taip (pasirinkę šį atsakymą negalėsite tęsti klausimyno)
4.2. Ne

5. Šioje apklausos dalyje prašome įvertinti Big Data/Didžiųjų duomenų technologijos charakteristikas ir galimą šių technologijų pritaikymo įtaką Mažųjų ir vidutinių įmonių veikloje. Teiginius įvertinkite balais nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Big Data/Didžiųjų duomenų technologijos įdiegimas MVĮ pagerintų įmonės efektyvumą							
Big Data/Didžiųjų duomenų technologijos įdiegimas MVĮ pagerintų įmonės veiklos rezultatus							
Big Data/Didžiųjų duomenų technologijos įdiegimas MVĮ suteiktų savalaikės informacijos priimant sprendimus įmonėje							
Big Data/Didžiųjų duomenų technologijos naudojimas MVĮ atitiktų visus įmonės veiklos aspektus							
Big Data/Didžiųjų duomenų technologijos naudojimas MVĮ puikiai derėtų su esamais įmonės veiklos procesais							
Big Data/Didžiųjų duomenų technologijos įdiegimo MVĮ nulemti pokyčiai atitiktų įmonės verslo poreikius							
Big Data/Didžiųjų duomenų technologijos įdiegimas MVĮ būtų suderinamas su esama įmonės technologijų infrastruktūra							
MVĮ būtų sudėtinga naudotis Big Data/Didžiųjų duomenų technologija							
Integruoti Big Data/Didžiųjų duomenų technologiją į MVĮ veiklos procesus būtų sudėtinga							
MVĮ susidurtų su tam tikrais sunkumais, užtikrinant Big Data/Didžiųjų duomenų technologijos priežiūrą							
Big Data/Didžiųjų duomenų technologijos įdiegimo MVĮ nauda gali būti pademonstruojama							
Yra daug galimybių sužinoti apie Big Data/Didžiųjų duomenų technologijos įdiegimo MVĮ naudą							
Big Data/Didžiųjų duomenų technologijos įdiegimo MVĮ nauda man yra aiškiai suprantama							
Man yra lengva papasakoti kitiems apie Big Data/Didžiųjų duomenų technologijos įdiegimo MVĮ naudos aspektus							
Prieš nusprendžiant įdiegti Big Data/Didžiųjų duomenų technologiją įmonėje, kurioje šiuo metu dirbu, norėčiau pamatyti technologijos naudojimo demonstraciją							
Prieš nusprendžiant įdiegti Big Data/Didžiųjų duomenų technologiją įmonėje, kurioje šiuo metu dirbu, norėčiau susipažinti su technologijos naudojimo instrukcija							
Prieš nusprendžiant įdiegti Big Data/Didžiųjų duomenų technologiją įmonėje, kurioje šiuo metu dirbu, norėčiau šią technologiją išbandyti							

6. Šioje apklausos dalyje prašome įvertinti Big Data/Didžiųjų duomenų technologijos įdiegimo naudingumą organizacijoje, kurioje šiuo metu dirbate. Įvertinkite teiginius skalėje nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Koordinuojant kasdienes verslo operacijas, įmonėje, kurioje šiuo metu dirbu, mano veiklos rezultatai pagerėtų įdiegus Big Data/Didžiųjų duomenų technologiją							
Koordinuojant kasdienes verslo operacijas, įmonėje, kurioje šiuo metu dirbu, mano našumas pagerėtų įdiegus Big Data/Didžiųjų duomenų technologiją							
Koordinuojant kasdienes verslo operacijas, įmonėje, kurioje šiuo metu dirbu, mano efektyvumas pagerėtų įdiegus Big Data/Didžiųjų duomenų technologiją							
Manau, kad Big Data/Didžiųjų duomenų technologijos įdiegimas įmonėje, kurioje šiuo metu dirbu, būtų naudingas koordinuojant kasdienes verslo operacijas organizacijoje							

7. Šioje apklausos dalyje prašome įvertinti Big Data/Didžiųjų duomenų technologijos įdiegimo lengvumą organizacijos, kurioje šiuo metu dirbate, darbuotojams. Įvertinkite teiginius skalėje nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Įmonės, kurioje šiuo metu dirbu, darbuotojams būtų lengva išmokti atlikti kasdienes verslo operacijas naudojant Big Data/Didžiųjų duomenų technologiją							
Įmonės, kurioje šiuo metu dirbu, darbuotojams būtų paprasta atlikti kasdienes verslo operacijas naudojant Big Data/Didžiųjų duomenų technologiją							
Įmonės, kurioje šiuo metu dirbu, darbuotojams būtų lengva įgauti įgūdžius, reikalingus naudotis Big Data/Didžiųjų duomenų technologija							
Įmonės, kurioje šiuo metu dirbu, darbuotojams būtų paprasta naudotis Big Data/Didžiųjų duomenų technologija atliekant kasdienes verslo operacijas organizacijoje, nes tai nereikalauja didelių protinių pastangų							

8. **Šioje apklausos dalyje prašome įvertinti Big Data/Didžiųjų duomenų technologijos įdiegimo tinkamumą rinkodaros funkcijoje susijusioje su prekės/paslaugos valdymu, įmonėje, kur šiuo metu dirbate.** Ši funkcija apima tokius prekės/paslaugos aspektus kaip: privalumai ir savybės, asortimentas/įvairovė, kokybė, dizainas, dydžiai, prekės ženklas, pakuotė, paslaugos, garantijos. Įvertinkite šiuos teiginius balais nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Big Data/Didžiųjų duomenų technologijos naudojimas įmonėje, kurioje šiuo metu dirbu, siekiant koordinuoti rinkodaros funkciją, susijusią su prekės/paslaugos valdymu, atrodo kaip gera idėja							
Man patinka idėja naudoti Big Data/Didžiųjų duomenų technologiją, siekiant koordinuoti rinkodaros funkciją, susijusią su prekės/paslaugos valdymu, įmonėje, kurioje šiuo metu dirbu							
Big Data/Didžiųjų duomenų technologijos naudojimas įmonėje, kurioje šiuo metu dirbu, siekiant įgyvendinti rinkodaros funkciją, susijusią su prekės/paslaugos valdymu, atrodo kaip išmintinga idėja							

9. **Šioje apklausos dalyje prašome įvertinti pagrindinių įmonės vadovų/valdybos narių paramą svarstant Big Data/Didžiųjų duomenų technologijos įdiegimo tinkamumą rinkodaros funkcijoje susijusioje su prekės/paslaugos valdymu, įmonėje, kur šiuo metu dirbate.** Įvertinkite teiginius balais nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Įmonėje, kurioje šiuo metu dirbu, Aukščiausios vadovybės požiūris į Big Data/Didžiųjų duomenų technologijos įdiegimą rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu, yra teigiamas							
Įmonėje, kurioje šiuo metu dirbu, Aukščiausia vadovybė pritaria Big Data/Didžiųjų duomenų technologijos įdiegimui rinkodaros funkcijoje, susijusioje prekės/paslaugos valdymu							
Įmonėje, kurioje šiuo metu dirbu, Aukščiausia vadovybė yra pasirengusi suteikti reikiamus išteklius Big Data/Didžiųjų duomenų technologijos įdiegimui rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu							
Įmonėje, kurioje šiuo metu dirbu, Aukščiausia vadovybė prisiima galimą riziką, kuri gali kilti diegiant Big Data/Didžiųjų duomenų technologiją rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu							

10. **Šioje apklausos dalyje prašome įvertinti konkurencinę aplinką ir spaudimą įdiegti Big Data/Didžiųjų duomenų technologiją rinkodaros funkcijoje susijusioje su prekės/paslaugos valdymu, įmonėje, kur šiuo metu dirbate.** Įvertinkite teiginius balais nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Siekiant būti konkurencingiems rinkoje, Big Data/Didžiųjų duomenų technologijos įdiegimas rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu, įmonėje, kurioje šiuo metu dirbu yra strategiškai reikalingas							
Jeigu Big Data/Didžiųjų duomenų technologija nebus įdiegta rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu, įmonė, kurioje šiuo metu dirbu, susidurs su nepalankiomis konkurencinėmis sąlygomis							
Manau, kad įmonė, kurioje šiuo metu dirbu, praras turimą rinkos dalį jeigu, Big Data/Didžiųjų duomenų technologija nebus įdiegta rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu							

11. **Šioje apklausos dalyje prašome įvertinti teiginius, susijusius su ketinimu įdiegti Big Data/Didžiųjų duomenų technologiją rinkodaros funkcijoje susijusioje su prekės/paslaugos valdymu, įmonėje, kur šiuo metu dirbate.** Įvertinkite teiginius balais nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Darant prielaidą, kad įmonė, kurioje šiuo metu dirbu turi prieigą prie Big Data/Didžiųjų duomenų technologijos, ketinčiau šią technologiją įdiegti rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu							
Atsižvelgiant į tai, kad įmonė, kurioje šiuo metu dirbu turi prieigą prie Big Data/Didžiųjų duomenų technologijos, prognozuoju, kad įdiegsiu šią technologiją rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu							
Turint lengvą prieigą prie Big Data/Didžiųjų duomenų technologijos, rekomenduočiau šią technologiją įdiegti rinkodaros funkcijoje, susijusioje su prekės/paslaugos valdymu, įmonėje, kurioje šiuo metu dirbu							

12. Šioje apklausos dalyje prašome įvertinti teiginius, susijusius su įmonės dydžiu, kurioje šiuo metu dirbate. Įvertinkite teiginius balais nuo 1 (visiškai nesutinku) iki 7 (visiškai sutinku).

	1	2	3	4	5	6	7
Įmonės, kurioje šiuo metu dirbu, kapitalas yra didelis palyginus su sektoriaus konkurentais							
Įmonės, kurioje šiuo metu dirbu, pajamos yra didelės palyginus su sektoriaus konkurentais							
Įmonėje, kurioje šiuo metu dirbu, darbuotojų skaičius yra didelis palyginus su sektoriaus konkurentais							

13. Prašome pasirinkti tinkamą variantą, kuris atspindi organizacijos, kurioje šiuo metu dirbate, darbuotojų skaičių? (atsakant galimas tik vienas variantas)

13.1. nuo 10 iki 49 darbuotojų
13.2. nuo 50 iki 250 darbuotojų

14. Prašome pasirinkti tinkamą variantą, kuris atspindi organizacijos, kurioje šiuo metu dirbate, metinę apyvartą (eurais)? (atsakant galimas tik vienas variantas)

14.1. nuo 2,01 mln. eurų iki 10 mln. eurų
14.2. nuo 10,01 mln. eurų iki 50 mln. Eurų

15. Prašome pasirinkti tinkamą variantą, kuris atspindi pramonės sektorių, kuris yra dominuojantis/pagrindinis organizacijoje, kurioje šiuo metu dirbate? (atsakant galimas tik vienas variantas)

15.1. Gamyba
15.2. Paslaugos
15.3. Prekyba

16. Nurodykite, koks yra pagrindinis produktas ar paslauga organizacijoje, kurioje šiuo metu dirbate? (įterpti atsakymą.....)

17. Nurodykite, kuriame mieste yra jūsų organizacijos, kurioje šiuo metu dirbate, pagrindinė buveinė? (įterpti atsakymą.....)

18. Prašome pasirinkti tinkamą variantą, kuris atspindėtų, kiek laiko dirbate dabartinėje MVĮ ir esate atsakingas už sprendimų, susijusių su rinkodaros funkcijomis, priėmimą? (atsakant galimas tik vienas variantas)

18.1. iki 1 metų
18.2. nuo 1 iki 3 metų
18.3. nuo 3 iki 5 metų
18.4. ilgiau nei 5 metus

19. Nurodykite savo dabartinių pareigų pavadinimą? (įterpti atsakymą.....)

Ačiū už dalyvavimą apklausoje.

Table 4. Survey sequence and manipulated variables (in Lithuanian)

Apklausos seka	4-tosios Pramonės revoliucijos funkcija	Rinkodaros funkcija
Pirmoji respondentų grupė	Didžiųjų duomenų technologija	Prekės/paslaugos valdymas
Antroji respondentų grupė	Didžiųjų duomenų technologija	Kainodaros valdymas
Trečioji respondentų grupė	Didžiųjų duomenų technologija	Reklamos, pardavimų skatinimo ir pardavimų veiklos valdymas
Ketvirtoji respondentų grupė	Didžiųjų duomenų technologija	Paskirstymo ir logistikos veiklos valdymas
Penktoji respondentų grupė	Pokalbių robotų technologija	Prekės/paslaugos valdymas
Šeštoji respondentų grupė	Pokalbių robotų technologija	Kainodaros valdymas
Septintoji respondentų grupė	Pokalbių robotų technologija	Reklamos, pardavimų skatinimo ir pardavimų veiklos valdymas
Aštuntoji respondentų grupė	Pokalbių robotų technologija	Paskirstymo ir logistikos veiklos valdymas

Source: created by the author.

Appendix 5. Quantitative Research Survey (English)

Survey example for the first group of respondents – Big Data technology suitability to be adopted in the product marketing function within SMEs (in English)

Dear Sir/Madam,

I am (*name, surname*) from the *Market Research Center*. We are currently conducting a study on the adoption of the suitability of the 4.0 Industrial Revolution technologies within marketing-related functions in small and medium-sized enterprises (SMEs).

This survey aims to analyse the suitability of the Big Data technology adoption in the product marketing function in small and medium-sized enterprises (SMEs).

This survey will take approximately 15 minutes to complete, and the data collected will be used for research purposes only.

1. Are you currently working in a Small and Medium Sized company (SME)? (Between 10 and 250 employees in the organisation + annual turnover between 2 and 50 million EUR). **(please select only one answer)**

1.1. Yes
1.2. No (by choosing this answer, you will not be able to proceed with the questionnaire).

2. In which area/areas are you responsible for the decision making at the SME you are currently working in? (multiple choice question)

2.1. Finance area
2.2. Human Resources area
2.3. Manufacturing area
2.4. Marketing area
2.5. Logistics area
2.6. Investment area
2.7. Other

(if the respondent did not choose 'Marketing area', they will not be able to proceed with the questionnaire)

3. Are you familiar with the Big Data technology application possibilities in the SME marketing related functions? (Big Data is a technology of Industry 4.0. The variety of big data is greater, it is obtained in an ever-increasing amount and at a greater speed. This technology provides an opportunity to analyse information more efficiently and make useful decisions faster). **(please select only one answer)**

3.1. Yes
3.2. No (by choosing this answer, you will not be able to proceed with the questionnaire).

4. Are you currently applying the Big Data technology in the marketing-related functions (product, promotion, place, and product) within SME where you are currently working at? (please select only one answer)

4.1. Yes (by choosing this answer, you will not be able to proceed with the questionnaire)

4.2. No

5. In this section, please evaluate the characteristics of the Big Data technology and its possible adoption influence on the activities within SMEs business. Evaluate the following statements on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
Big Data technology adoption would enhance the efficiency of the SME							
Big Data technology adoption would improve the performance of the SME							
Big Data technology adoption would provide timely information for the decision-making at the SME							
Using Big Data technology would be compatible with all aspects of the work of the SME							
Using Big Data technology would fit well with the way the SME likes to work							
Big Data technology adoption-created changes would be compatible with the SME business							
Big Data technology adoption would be compatible with the existing technology infrastructure of the SME							
Big Data technology would be difficult to use for the SME							
Integrating Big Data technology in the work practices of the SME would be difficult							
SME would encounter some difficulties in maintaining the Big Data technology							
The benefits of adopting the Big Data technology can be demonstrated							
There are plenty of opportunities to find out about the benefits of adopting the Big Data technology							
The benefits of adopting the Big Data technology are apparent to me							
I have no difficulty to tell others about the Big Data technology adoption benefits							
Before I decide to adopt the Big Data technology at the organisation I am currently working, I would like to view a demonstration of using this technology							
Before I decide to adopt the Big Data technology at the organization I am currently working, I would like to receive an introduction to using this technology							
Before I decide to adopt a Big Data technology at the organisation I am currently working, I would like to try it							

6. In this section, please evaluate the Big Data technology adoption usefulness for the organisation you are currently working in. Read the following statements and evaluate them on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
It would improve my performance in managing daily business operations by adopting the Big Data technology at the organisation where I am currently working							
It would improve my productivity in managing daily business operations by adopting the Big Data technology at the organisation where I am currently working							
It would enhance my effectiveness in managing daily business operations by adopting the Big Data technology at the organisation where I am currently working							
I would find the Big Data technology adoption useful in managing daily business operations at the organisation where I am currently working							

7. In this section, please evaluate the easiness of the adoption of a Big Data technology for the employees of the organisation you are currently working in. Read the following statements and evaluate them on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
Learning to use the Big Data technology in managing daily business operations would be easy for the company employees at the organisation where I am currently working							
The company employees of the organisation where I am currently working would find it easy to manage daily business operations by using the Big Data technology							
The company employees where I am currently working would find it easy to become skilful at using the Big Data technology							
The company employees where I am currently working would find it easy to interact with the Big Data technology in managing daily business operations as it does not require a lot of mental effort							

8. In this section, please evaluate the suitability of the Big Data technology adoption in the product marketing function within the organisation you are currently working. The **product marketing function** refers to an item or service. Include such aspects of the item/service as: benefits and features, assortment/variety, quality, design, sizes, branding, packaging, services, warranties. Read the following statements and evaluate them on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
At the organisation where I am currently working, using the Big Data technology enabled in marketing for managing the product marketing function seems to be a good idea							
I like the idea of using the Big Data technology enabled in marketing for managing the product marketing function at the organisation where I am currently working							
At the organisation where I am currently working, using the Big Data technology enabled in marketing for implementing the product marketing function seems like a wise idea							

9. In this section, please evaluate the statements regarding the Top management support of the Big Data technology adoption in the product marketing function within the organisation you are currently working in. Read the following statements and evaluate them on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
At the organisation where I am currently working, the Top management's attitude is positive towards adopting the Big Data technology in the product marketing function							
At the organisation where I am currently working, the Top management supports the implementation of the Big Data technology in the product marketing function							
At the organisation where I am currently working, the Top management is ready to provide the necessary resources for the introduction of the Big Data technology in the product marketing function							
At the organisation where I am currently working, the Top management accepts possible risks, which may result from introducing a Big Data technology in the product marketing function							

10. In this section, please evaluate statements regarding competitor pressure of the Big Data technology adoption in the product marketing function within the

organisation you are currently working in. Read the following statements and evaluate them on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
At the organisation where I am currently working, it is a strategic requirement to adopt the Big Data technology in the product marketing function to compete in the market							
The organisation where I am currently working will be affected by competitive disadvantages if the Big Data technology will not be adopted in the product marketing function							
I believe the organisation where I am currently working will lose market share if the Big Data technology will not be adopted in the product marketing function							

11. In this section, please evaluate the statements regarding the intention to adopt the Big Data technology in the product marketing function within the organisation you are currently working in. Read the following statements and evaluate them on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
Assuming that the organisation where I am currently working has an access to the Big Data technology, I would intend to adopt it in the product marketing function							
Given that the organisation where I am currently working has an access to the Big Data technology, I predict that I would adopt it in the product marketing function							
Given an easy access to the Big Data technology, I will recommend the implementation of such a technology at the organisation where I am currently working in the product marketing function							

12. In this section, please evaluate statements regarding the firm size of the organisation you are currently working in. Read the following statements and evaluate them on a scale from 1 (strongly disagree) to 7 (strongly agree).

	1	2	3	4	5	6	7
At the organisation where I am currently working, the capital of the company is high compared to the industry							
At the organisation where I am currently working, the revenue of the company is high compared to the industry							
At the organisation where I am currently working, the number of employees of the company is high compared to the industry							

13. Please choose the suitable option which reflects the number of employees of the organisation you are currently working in (please select only one answer)

13.1. between 10 and 49 employees

13.2. between 50 and 250 employees

14. Please choose the suitable option which reflects the Annual Turnover (in euros) of the organisation you are currently working in (please select only one answer)

14.1. between 2.01 million EUR and 10 million EUR

14.2. between 10.01 million EUR and 50 million EUR

15. Please choose the suitable option which reflects the Industry sector which is the dominant/primary in the organisation you are currently working in (please select only one answer)

15.1. Production

15.2. Services

15.3. Trade

16. Please indicate what it is the principal product or service in the organisation you are currently working in (insert your answer….……...……...)

17. Please indicate in which city the Headquarters of your organisation you are currently working in are located (insert answer.....)

18. Please choose the suitable option which reflects how long you are working in the current SME and are responsible for the decision-making related to the Marketing functions (please select only one answer)

18.1. up to 1 year

18.2. between 1 and 3 years

18.3. between 3 and 5 years

18.4. longer than 5 years

19. Please indicate your current job title: (insert the job title.....)

Thank you for participating in the survey.

Table 5. Survey sequence and manipulated variables (in English)

Survey sequence	Industry 4.0-related Technology	Marketing-related function
First group of respondents	Big Data Technology	Product marketing function
Second group of respondents	Big Data Technology	Price marketing function
Third group of respondents	Big Data Technology	Promotion marketing function
Fourth group of respondents	Big Data Technology	Place marketing function
Fifth group of respondents	Chatbots Technology	Product marketing function
Sixth group of respondents	Chatbots Technology	Price marketing function
Seventh group of respondents	Chatbots Technology	Promotion marketing function
Eighth group of respondents	Chatbots Technology	Place marketing function

Source: created by the author

Appendix 6. Exploratory Factor Analysis (Rotated Component Matrix)

Table 6. Exploratory factor analysis (Q5)

Variable No.	Variable	1*	2*	3*	4*	h^2
Q5.4	Using the Big Data/Chatbots technology would be compatible with all aspects of the work of the SME	**0.827**				**0.737**
Q5.5	Using the Big Data/Chatbots technology would fit well with the way the SME like to work	**0.855**				**0.834**
Q5.6	Big Data/Chatbots technology adoption-created changes would be compatible with the SME business	**0.838**				**0.825**
Q5.7	Big Data/Chatbots technology adoption would be compatible with the existing technology infrastructure of the SME	**0.539**			0.413	**0.600**
Q5.8	Big Data/Chatbots technology would be difficult to use for the SME			**0.803**		**0.656**
Q5.9	Integrating the Big Data/Chatbots technology in the work practices of the SME would be difficult			**0.898**		**0.820**
Q5.10	SME would encounter some difficulties in maintaining the Big Data/Chatbots technology			**0.766**		**0.604**
Q5.12	There are plenty of opportunities to know about the benefits of adopting the Big Data/Chatbots technology				**0.613**	**0.413**
Q5.13	The benefits of adopting the Big Data/Chatbots technology are apparent to me				**0.829**	**0.715**
Q5.14	I have no difficulty to tell other about the Big Data/Chatbots technology adoption benefits				**0.763**	**0.673**
Q5.15	Before I decide to adopt the Big Data/Chatbots technology at the organisation I am currently		**0.891**			**0.834**

Variable No.	Variable	1*	2*	3*	4*	h^2
	working, I would like to view a demonstration of using this technology					
Q5.16	Before I decide to adopt the Big Data/Chatbots technology at the organisation I am currently working, I would like to receive an introduction to using this technology		**0.887**			**0.830**
Q5.17	Before I decide to adopt the Big Data/Chatbots technology at the organization I am currently working, I would like to try it		**0.850**			**0.794**
	% of Variance	**20.38**	**19.65**	**16.52**	**15.26**	
Meanings	**1*** – perceived compatibility of Big Data/Chatbots **2*** – perceived trialability of Big Data/Chatbots **3*** – perceived complexity of Big Data/Chatbots **4*** – perceived observability of Big Data/Chatbots					

Source: created by the author

Table 7. Exploratory factor analysis (Q5–Q12)

Variable No.	Variable	1	2	3	4	5	6	7	8	h^2
Q5.1	Big Data/Chatbots technology adoption would enhance the efficiency of the SME					**0.794**				**0.884**
Q5.2	Big Data/Chatbots technology adoption would improve the performance of the SME					**0.809**				**0.901**
Q5.3	Big Data/Chatbots technology adoption would provide timely information for the decision making at the SME					**0.655**				**0.774**
Q6.1	It would improve my performance in managing the daily business operations by adopting the Big Data/Chatbots technology at the organisation where I am currently working	**0.701**								**0.908**
Q6.2	It would improve my productivity in managing daily business operations by adopting the Big Data/Chatbots technology at the organisation where I am currently working	**0.762**								**0.946**
Q6.3	It would enhance my effectiveness in managing the daily business operations by adopting the Big Data/Chatbots technology at the organisation where I am currently working	**0.719**								**0.935**
Q6.4	I would find the Big Data/Chatbots technology adoption useful in managing the daily business operations at the organisation where I am currently working	**0.694**								**0.911**
Q7.1	Learning to use the Big Data/Chatbots technology in managing the daily business operations would be easy for the company employees at the organisation where I am currently working			**0.840**						**0.794**

Variable No.	Variable	1	2	3	4	5	6	7	8	h^2
Q7.2	The company employees of the organisation where I am currently working would find it easy to manage the daily business operations by using the Big Data/Chatbots technology			**0.748**						**0.759**
Q7.3	The company employees where I am currently working would find it easy to become skilful at using the Big Data/Chatbots technology			**0.858**						**0.785**
Q7.4	The company employees where I am currently working would find it easy to interact with the Big Data/Chatbots technology in managing the daily business operations as it does not require a lot of mental effort			**0.768**						**0.740**
Q8.1	At the organisation where I am currently working, using the Big Data/Chatbots technology enabled in marketing for managing a selected marketing function seems like a good idea				**0.774**					**0.875**
Q8.2	I like the idea of using the Big Data/Chatbots technology enabled in marketing for managing a selected marketing function at the organization where I am currently working				**0.715**					**0.844**
Q8.3	At the organisation where I am currently working, using the Big Data/Chatbots technology enabled in marketing for implementing a selected marketing function seems like a wise idea				**0.771**					**0.882**
Q9.1	At the organisation where I am currently working, the Top management's attitude is positive towards adopting the Big Data/Chatbots technology in a selected marketing function		**0.625**		0.448					**0.772**

Variable No.	Variable	1	2	3	4	5	6	7	8	h2
Q9.2	At the organisation where I am currently working, the Top management supports the implementation of the Big Data/Chatbots technology in a selected marketing function		**0.721**							**0.826**
Q9.3	At the organisation where I am currently working, the Top management is ready to provide the necessary resources for the introduction of the Big Data/Chatbots technology in s selected marketing function		**0.772**							**0.867**
Q9.4	At the organisation where I am currently working, the Top management accepts possible risks which may result from introducing the Big Data/Chatbots technology in a selected marketing function		**0.795**							**0.809**
Q10.1	At the organisation where I am currently working, it is a strategic requirement to adopt the Big Data/Chatbots technology in s selected marketing function to compete in the market						0.630			**0.795**
Q10.2	The organisation where I am currently working will be affected by competitive disadvantages if the Big Data/Chatbots technology will not be adopted in a selected marketing function						0.846			**0.872**
Q10.3	I believe the organisation where I am currently working will lose market share if the Big Data/Chatbots technology will not be adopted in a selected marketing function						0.851			**0.862**

Variable No.	Variable	1	2	3	4	5	6	7	8	h^2
Q11.1	Assuming that the organization where I am currently working has an access to the Big Data/Chatbots technology, I would intend to adopt it in a selected marketing function							**0.720**		**0.844**
Q11.2	Given that the organisation where I am currently working has an access to the Big Data/Chatbots technology, I predict that I would adopt it in a selected marketing function							**0.734**		**0.888**
Q11.3	Given an easy access to the Big Data/Chatbots technology, I will recommend the implementation of such a technology at the organization where I am currently working in a selected marketing function							**0.625**		**0.872**
Q12.1	At the organisation where I am currently working, the capital of the company is high compared to the industry								**0.907**	**0.842**
Q12.2	At the organisation where I am currently working, the revenue of the company is high compared to the industry								**0.875**	**0.819**
Q12.3	At the organisation where I am currently working, the number of employees of the company is high compared to the industry								**0.772**	**0.662**
	% of variance	**11.46**	**11.14**	**11.05**	**10.75**	**10.67**	**10.44**	**9.90**	**8.55**	
Meanings	**1*** – perceived usefulness of the Big Data/Chatbots adoption within SMEs **2*** – Top management support of the Big Data/Chatbots adoption in a selected marketing function within SMEs **3*** – perceived easiness of the use of the Big Data/Chatbots for the employees within SMEs **4*** – suitability of the Big Data/Chatbots adoption in a selected marketing function within SMEs **5*** – perceived relative advantage of Big Data/Chatbots **6*** – competitive environment of the Big Data/Chatbots adoption in a selected marketing function within SMEs **7*** – the intention to adopt Big Data/Chatbots in a selected marketing function within SMEs **8*** – SME size									

Source: created by the author

Appendix 7. Scatterplots of Quantitative Research

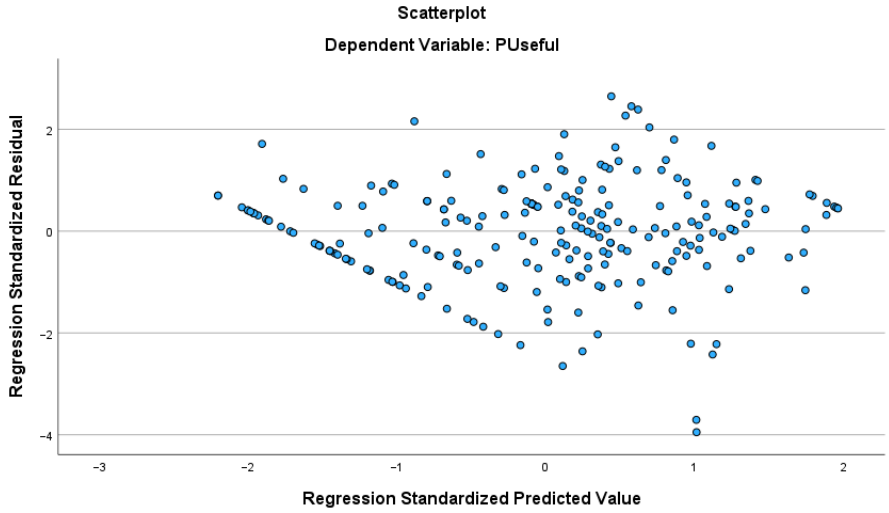


Figure 1. Scatterplot of Perceived usefulness (Research model Part A)
Source: created by the author

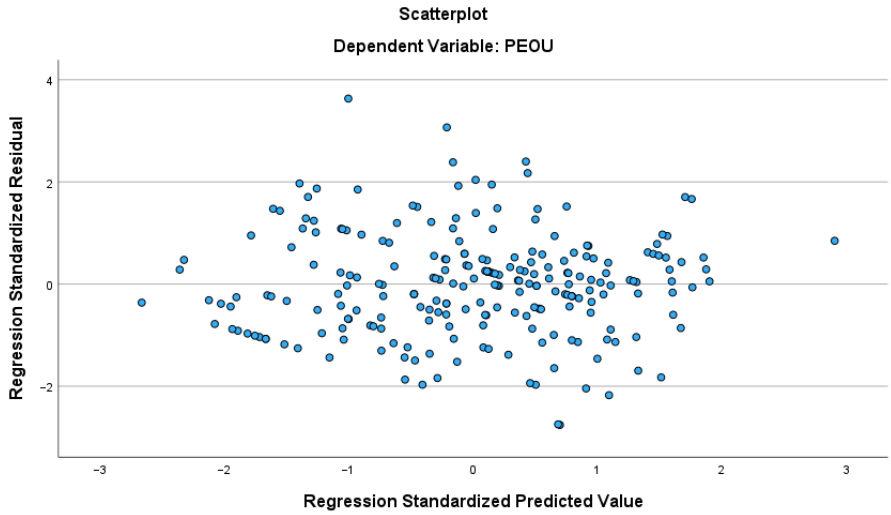


Figure 2. Scatterplot of Perceived ease of use (Research model Part A)
Source: created by the author

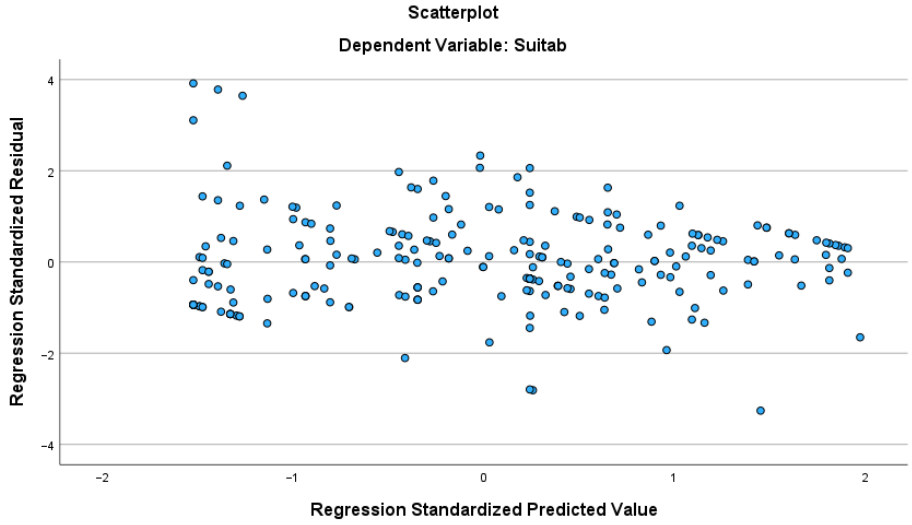


Figure 3. Scatterplot of Attitude towards the suitability of the Industry 4.0 technologies adoption (Research model Part B)
Source: created by author

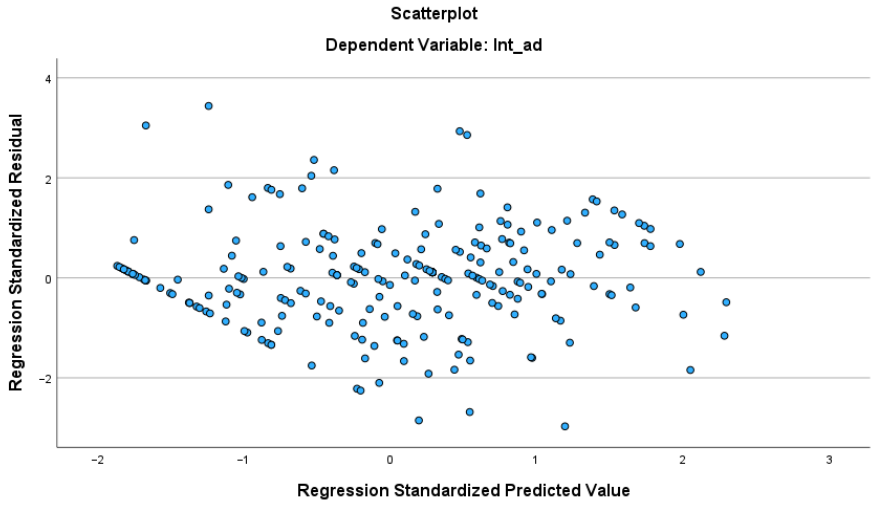


Figure 4. Scatterplot of Behavioural intention towards the adoption of the Industry 4.0 technologies (Research model Part C)
Source: created by the author

SUMMARY IN LITHUANIAN

ĮVADAS

Disertacijos tyrimo aktualumas. Mažosios ir vidutinės įmonės (MVĮ) yra gyvybiškai svarbios pasaulinei ekonomikai. Jos sudaro 99% įmonių skaičiaus bei daugiau nei 50% sukuriamos įmonių vertės, taip pat įdarbina daugiau nei 60% Europos Sąjungos (ES) darbo jėgos (European Commission, 2023). Šiuolaikinė aplinka, kurioje veikia MVĮ, yra itin dinamiška. Vienas iš pagrindinių tai lemiančių veiksnių yra šiuo metu pastebimas skaitmeninimo progresas, siejamas su Pramone 4.0. Pramonė 4.0, kaip buvo akcentuota 2011-ųjų Hanoverio technologijų mugėje, žengia pirmyn dėka tokių naujausių technologijų kaip Dirbtinis intelektas, kuris turi įtakos tiek gamybos, tiek ir verslo modelių transformacijai (Brkljac & Sudarevic, 2018; Młody, 2018). Pramonė 4.0 technologijos sukuria inovacijų bei klientų įtraukimo galimybes, tačiau tam, kad MVĮ galėtų sėkmingai įdiegti naujausias technologijas, neretai prireikia konsultacijų bei papildomų išteklių. Šiuolaikiniame kontekste neretai manoma, kad dėl aukšto lygio resursų reikalingumo Pramonės 4.0 įgyvendinimui, MVĮ skaitmeninimo progresas gali tapti netolygus (Ibarra ir kt., 2018; Mittal ir kt., 2018; Da Silva ir kt., 2019). Į tai ima reaguoti vyriausybės, iškeldamos tokias iniciatyvas kaip *Industry 4.0* (Vokietija), *Industry of the Future* (Prancūzija), bei Europos Sąjungos iniciatyva *DigitaliseSME* (Moeuf et al., 2017). Lietuvoje paskelbtos gairės *Lietuvos pramonės skaitmeninimo kelrodis 2019–2030* siekia sustiprinti MVĮ konkurencingumą, tačiau daugelis mažų įmonių vis dar išlieka skeptiškos dėl kaštų, reikalingų Pramonės 4.0 įgyvendinimui, bei galimos grįžtamosios naudos santykio (European Commission, 2021).

Disertacijos tyrimo mokslinis naujumas. Pasak akademinės literatūros, McCarthy sukurtas rinkodaros komplekso 4P modelis (1960) yra esminės svarbos MVĮ rinkodaros funkcijų tyrimo paradigma, kuria remiantis galima analizuoti rinkodaros funkcijas. Autoriai, Ungerman ir Dědková (2019), pabrėžė, jog Pramonės 4.0 technologijų įdiegimas MVĮ įmonėms suteikia aukštesniojo lygmens rinkodaros įrankių bei strategijų prieinamumą, kuriais anksčiau galimybes naudotis turėjo tik didžiosios įmonės. Tuo tarpu, Pranjić ir Rekettye (2019) pabrėžė esminius Pramonės 4.0 nulemtus pokyčius rinkodaros funkcijoms. Pavyzdžiui, dėka Pramonės 4.0 technologijų įdiegimo, MVĮ gali tiksliau prognozuoti bei paveikti kliento elgseną.

Atsižvelgiant į besikeičiantį Pramonės 4.0 vaidmenį, itin svarbu suvokti, kaip MVĮ galėtų įgalinti Pramonės 4.0 technologijas rinkodaros

funkcijose. Tačiau dauguma naujausių tyrimų koncentruojasi į gamybos gairių atitiktį Pramonės 4.0 kontekste (Erol ir kt., 2016; Ibarra ir kt., 2018), ar Pramonės 4.0 poveikio įmonių verslo modeliams tyrimus (Prause, 2015). Todėl tyrimų tematikoje apie tai, kaip šios technologijos atitinka MVĮ rinkodaros poreikius, pastebimos ryškios tyrimų spragos. Šiame kontekste Pramonės 4.0 poveikiui tirti įprastai naudojami tokie teoriniai modeliai kaip Inovacijų difuzijos teorija (angliškai *Diffusion of Innovations Theory*, DOI) (Rogers, 1962), Technologijų priėmimo modelis (angliškai *Technology Acceptance Model*, TAM) (Davis et al., 1989) bei Technologinio, organizacinio ir aplinkos kontekstų visumos modelis (angliškai *Technology-Organization-Environment*, TOE) (Tornatzky & Fleischer, 1990). Tačiau kadangi MVĮ įmonėse sprendimų priėmimą dažniausiai paveikia įmonės savininkas ir/ar vadovas, į šį tyrimą taip pat įtraukiama Planuotos elgsenos teorija (angliškai *Theory of Planned Behaviour*, TPB; Ajzen, 1985).
Remiantis minėtomis mokslinėmis teorijomis, ši disertacija nagrinėja MVĮ vadovų ir savininkų elgesio aspektus bei pateikia įžvalgas apie Pramonės 4.0 technologijų įgalinimo tinkamumą rinkodaros funkcijose.

Dabartinis disertacijos tematikos mokslinio ištirtumo lygis. Literatūros apžvalga atskleidžia, kad tyrimų apie tai, kaip Pramonės 4.0 technologijos gali būti įgalintos MVĮ rinkodaros funkcijose, yra mažai. Be to, kad Pramonė 4.0 būtų efektyviai integruota, MVĮ įmonėms būtina spręsti technologijų, strategijos, lyderystės, kultūros, produktų, veiklos bei žmogiškųjų išteklių klausimus (Da Silva ir kt., 2019). Taigi, pasireiškia akivaizdi žinių stoka, kadangi vis dar yra nežinoma, kas yra pagrindinė varomoji jėga, skatinanti MVĮ įgalinti Pramonės 4.0 technologijas rinkodaros funkcijose. Todėl **tyrimo problema**, kurios buvo imtasi šioje disertacijoje, yra tokia: Kokie yra pagrindiniai veiksniai, turintys įtakos Pramonės 4.0 technologijų įgalinimo tinkamumui rinkodaros funkcijose MVĮ įmonėse?

Disertacijos objektas. Ši disertacija tyrinėja, kokie veiksniai paveikia Pramonės 4.0 technologijų įgalinimo tinkamumą rinkodaros funkcijose MVĮ įmonėse. Šis tyrimas dėmesį sutelkia į MVĮ vadovų ir/ar savininkų suvokimą ir nuostatas – tai yra, koks yra MVĮ vadovų ir/ar savininkų požiūris į šių technologijų priėmimą ir įgalinimą rinkodaros funkcijose MVĮ. Tyrime pritaikoma *Planuotos elgsenos teorija*, *Inovacijų difuzijos teorija* bei *Technologijų priėmimo modelis*. Šios tyrimų paradigmos leidžia ištirti, kaip suvokiamosios Pramonės 4.0 technologijų savybės (pvz., suvokiamas santykinis pranašumas), technologijų priimtinumo veiksniai (pvz., suvokiamas naudingumas), bei elgesio faktoriai (pvz., požiūris į technologijų tinkamumą) paveikia ketinimą įgalinti šias technologijas rinkodaros

funkcijose. Be to, šiame darbe tyrinėjami moderuojantys *TOE struktūros* faktorių efekto aspektai (pvz., MVĮ dydis) bei tiriamas technologijos tipo poveikis (*universalioji* arba *nišinė* technologija), bei marketingo funkcijų tipo poveikis (produktas, kainodara, reklama, vieta). Aptariant šiuos klausimus, šiuo tyrimu siekiama užpildyti šiuo metu esančias žinių spragas bei pateikti įžvalgų, kaip minėti veiksniai kolektyviai (t.y., kartu) turi įtakos MVĮ sprendimo priėmimui įgalinti Pramonės 4.0 technologijas rinkodaros funkcijose.

Šio tyrimo **tikslas** – ištirti veiksnius, turinčius įtakos Pramonės 4.0 technologijų įgalinimo tinkamumui rinkodaros funkcijose MVĮ įmonėse.

Šio tyrimo **uždaviniai** yra:

1. Ištirti svarbiausius Pramonės 4.0 reiškinio principus bei jų sąsajas su verslo funkcijomis MVĮ įmonėse.
2. Atlikti sisteminę literatūros analizę, apimančią Pramonės 4.0 technologijų įgalinimo tinkamumą įvairiose rinkodaros funkcijose MVĮ įmonėse.
3. Remiantis mokslinės literatūros šaltinių analize, nustatyti svarbiausius veiksnius, turinčius įtakos Pramonės 4.0 technologijų įgalinimo tinkamumui MVĮ rinkodaros funkcijose.
4. Ištirti teorinius technologijų taikymo modelius, remiantis jų aprašymu mokslinės literatūros šaltiniuose, bei sukurti tyrimo metodologiją.
5. Panaudoti kokybinius tyrimo metodus ir nustatyti universaliąsias bei nišines Pramonės 4.0 technologijas, tinkamas įgalinimui keturiose rinkodaros funkcijose Lietuvos MVĮ įmonėse.
6. Pritaikyti kiekybinio tyrimo metodus ir ištirti pasiriktų veiksnių poveikį nišinių bei universaliųjų Pramonės 4.0 technologijų įgalinimo tinkamumui keturiose rinkodaros funkcijose Lietuvos MVĮ įmonėse.
7. Pristatyti išvadas ir rekomendacijas mokslininkams ir praktikams.

Tyrimo metodologija bei duomenų analizės metodai. Sisteminė literatūros analizė, integruota su kokybiniu bei kiekybiniu tyrimu, buvo panaudota ieškant atsakymų į tyrime išsikeltus klausimus. Kokybinėje tyrimo dalyje buvo pritaikytas pusiau struktūrinis interviu. Buvo apklausti 11 C lygmens vadovų, atstovaujančių pasirinktas MVĮ įmones. Pusiau struktūriniai interviu buvo atlikti 2023-ųjų III ketvirtį. Šie interviu padėjo nustatyti svarbiausias Pramonės 4.0 technologijas, tinkamas taikyti rinkodaros funkcijose MVĮ įmonėse. Kiekybinis tyrimas buvo atliktas 2024-ųjų I ketvirtį. Respondentų tyrimo duomenis surinko rinkos tyrimų kompanija *Rinkos Tyrimų Centras*. Tyrimo apimtį sudarė 241 respondentai. Visi šie tyrimo dalyviai yra atsakingi už rinkodaros sprendimų priėmimą MVĮ įmonėse, o

dauguma jų turi daugiau nei penkerius metus patirties rinkodaros vadovavimo srityje. Šiuo kiekybiniu tyrimu buvo siekiama patikrinti hipotezes dėl pasirinktų Pramonės 4.0 technologijų įgalinimo tinkamumo keturiose rinkodaros funkcijose Lietuvos MVĮ įmonėse.

Tyrime ginami šie teiginiai:

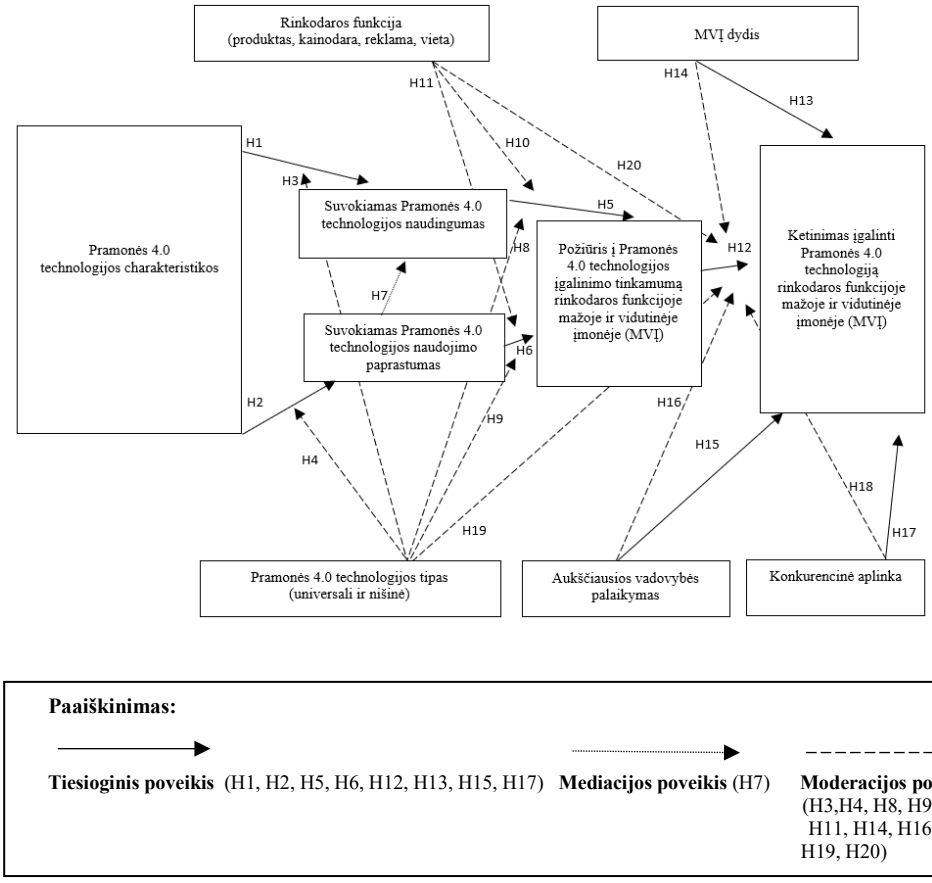
1. Pramonės 4.0 technologijas galima suskirstyti į dvi grupes pagal jų tinkamumą įgalinimui rinkodaros funkcijose MVĮ įmonėse. Tokios Pramonės 4.0 technologijos kaip *dirbtinis intelektas* ar *didieji duomenys* gali būti vadinamos universaliosiomis Pramonės 4.0 technologijomis (kurios yra tinkamos taikymui didelei grupei rinkodaros funkcijų), kai tuo tarpu tokios Pramonės 4.0 technologijos kaip 3D spausdinimas ar pokalbių robotas gali būti laikomos nišinėmis Pramonės 4.0 technologijomis.
2. Iš keturių rinkodaros funkcijų (produkto, kainos, vietos ir rėmimo), didžiausią Pramonės 4.0 technologijų įvairovę MVĮ įmonėse galima įgalinti *produkto* rinkodaros funkcijoje.
3. Suvokiamų Pramonės 4.0 technologijų savybės skirtingais būdais paveikia jų suvokiamą naudingumą bei naudojimo paprastumą. Suvokiamas technologijos suderinamumas teigiamai paveikia abu kintamuosius. Suvokiamą naudingumą taip pat teigiamai veikia suvokiamas santykinis pranašumas bei suvokiamas išbandomumas. Tuo tarpu suvokiamą naudojimo paprastumą teigiamai veikia suvokiamas pastebimumas, o neigiamai paveikia suvokiamas sudėtingumas.
4. Suvokiamas Pramonės 4.0 technologijos naudojimo paprastumas medijuoja suvokiamo naudingumo poveikį į požiūrį į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje.
5. Rinkodaros funkcijos (produktas, kainodara, reklama, vieta) bei Pramonės 4.0 technologijos (universaliosios ir nišinės) nemoderuoja poveikio tarp požiūrio į Pramonės 4.0 technologijų įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo įdiegti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje.
6. Aukščiausios vadovybės palaikymas teigiamai moderuoja poveikį tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo įdiegti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje.

Disertacijos struktūra. Šią disertaciją sudaro įvadas, teorinis tyrimas, tyrimo metodologijos aprašymas, kokybinio ir kiekybinio tyrimo skyriai bei išvados, tyrimo ribotumo pristatymas, rekomendacijos ir priedai.

TYRIMO METODOLOGIJA

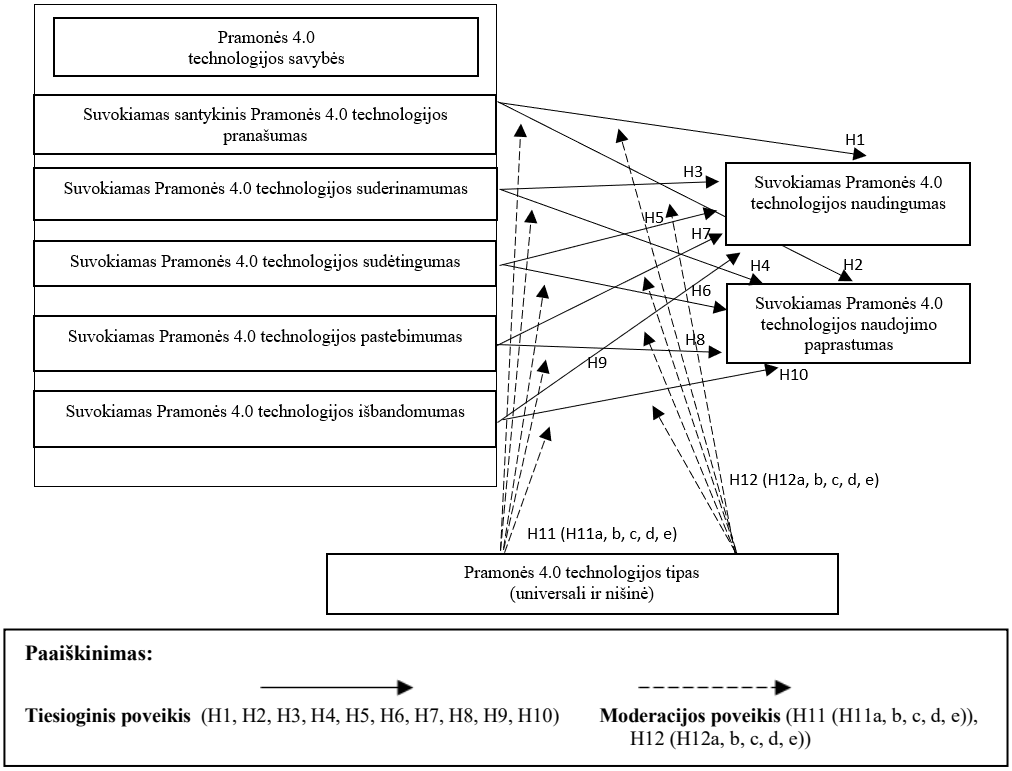
Tyrimo tikslas: ištirti veiksnius, lemiančius Pramonės 4.0 technologijų (*universaliųjų* ir *nišinių*) įgalinimo tinkamumą keturių rinkodaros funkcijų (produkto, kainos, vietos ir rėmimo) atžvilgiu Lietuvos MVĮ įmonėse.

Remiantis teorinės tyrimo dalies atradimais, centrinę vietą šio tyrimo modelyje užima MVĮ įmonės vadovo ir/ar savininko požiūris apie Pramonės 4.0 technologijų įgalinimo tinkamumą rinkodaros funkcijose MVĮ įmonėse. Šio tyrimo modelis integruoja elementus iš keturių aukščiau įvardintų teorinių paradigmų (TPB, TAM, DOI ir TOE). Pasiūlytas tyrimo modelis laikosi nuostatos, jog galima kelti hipotezę, kad reikšmingiausi modelio kintamieji turi tiesioginį poveikį. Be to, šiame modelyje yra ir papildomų medijuojančiųjų bei moderuojančiųjų kintamųjų, kuriems keliama hipotezė, kad jie paveikia santykius tarp pirminių kintamųjų. Šis tyrimo modelis pristatomas **Paveiksle 1**.



Paveikslas 1. Tyrimo modelis
Šaltinis: sudaryta autorės

Svarbu pažymėti, kad, tolesnio tyrimo tikslais, tyrimo modelis yra skeliamas į tris akivaizdžiai atskiriamas dalis: Dalį A, Dalį B ir Dalį C. Tyrimo modelio Dalis A tyrinėja Pramonės 4.0 technologijos suvokiamų savybių poveikį Pramonės 4.0 technologijos suvokiamam naudingumui bei suvokiamam naudojimo paprastumui. Taip pat šis modelis analizuoja galimą moderuojantį Pramonės 4.0 technologijos tipo poveikį. Tyrimo modelio Dalis A yra pristatoma **Paveiksle 2**.



Paveikslas 2. Tyrimo modelio Dalis A – Suvokiamos Pramonės 4.0 technologijos savybės ir suvokiamas naudingumas bei suvokiamas naudojimo paprastumas
Šaltinis: sudaryta autorės

Tyrimo modelio Dalis A: hipotezių iškėlimas

Rogers (1962) apibrėžia santykinį pranašumą pagal tai, kaip priimtiniau inovacija yra suvokiama, palyginus su anksčiau vietoj jos naudota technologija. Kuo didesnis yra santykinis Pramonės 4.0 technologijų pranašumas, tuo labiau tikėtina, kad jos bus įdiegtos MVĮ. Tyrimai nuosekliai atskleidžia, kad santykinis pranašumas yra gyvybiškai svarbus diegiant Pramonės 4.0 technologijas (Kumar ir kt., 2017; Usman ir kt., 2019; AlBar & Hoque, 2019). Tačiau ryšiai tarp suvokiamo santykinio pranašumo, suvokiamo naudojamo paprastumo (angliškai trumpinamo PEOU) bei suvokiamo naudingumo (angliškai trumpinamo PU) yra ištyrinėti menkiau. Visgi, kai kurie tyrimai nurodo, kad suvokiamas santykinis pranašumas teigiamai paveikia tiek PU, tiek ir PEOU (Al-Rahmi ir kt., 2019; Tripopsakul, 2018). Tad siūloma iškelti šias hipotezes:

H1: *Suvokiamas santykinis Pramonės 4.0 technologijos pranašumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudingumą.*

H2: *Suvokiamas santykinis Pramonės 4.0 technologijos pranašumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudojimo paprastumą.*

Kuomet kalbama apie suderinamumą, įprastai turima omenyje, kaip gerai inovacija dera su susiformavusiomis vertybėmis bei potencialių Pramonės 4.0 technologijų taikytojų poreikiais. Jei į inovaciją žvelgiama kaip į didžiausio lygio pokytį, tikimybė, kad ši inovacija bus įdiegta yra mažesnė (Rogers, 1962). Tyrimuose nurodoma, kad suvokiamas suderinamumas paveikia technologijų diegimą (Al-Jabri & Sohail, 2012; Usman ir kt., 2019). Ankstesni tyrimai nuosekliai atskleidžia, kad suvokiamas suderinamumas paveikia suvokiamą naudingumą (PU) bei suvokiamą naudojimo paprastumą (PEOU). Tokie tyrimai kaip Al-Rahmi ir kt. (2019), Yuen ir kt. (2021), Al-Jabri & Sohail (2012), bei Tripopsakul (2018) pritaria šiai prielaidai. Tad siūloma iškelti šias hipotezes:

H3: *Suvokiamas Pramonės 4.0 technologijos suderinamumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudingumą.*

H4: *Suvokiamas Pramonės 4.0 technologijos suderinamumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudojimo paprastumą.*

Anot Rogers (1962), sudėtingumas yra lygis, kuriuo inovacija yra suvokiama kaip sudėtinga suprasti ir naudoti praktiškai. Empiriniai tyrimai nuosekliai rodo, kad suvokiamas sudėtingumas neigiamai paveikia ketinimą diegti Pramonės 4.0 technologijas (Nazari ir kt., 2013; Usman ir kt., 2019; Skafi ir kt., 2020). Be to, Al-Rahmi ir kt. (2019) nustatė neigiamą santykį tarp suvokiamo sudėtingumo ir suvokiamo naudojimo paprastumo (PEOU). Tačiau kol kas stinga įrodymų dėl ryšio tarp suvokiamo sudėtingumo bei suvokiamo naudingumo. Tad siūloma iškelti šias hipotezes:

H5: *Suvokiamas Pramonės 4.0 technologijos sudėtingumas neigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudingumą.*

H6: *Suvokiamas Pramonės 4.0 technologijos sudėtingumas neigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudojimo paprastumą.*

Pastebimumas yra mastas, kuriuo inovacijos rezultatai yra matomi kitiems (Rogers, 1962). Tyrimais buvo nustatyta, kad suvokiamas pastebimumas teigiamai paveikia ketinimą diegti Pramonės 4.0 technologijas (Nazari ir kt., 2013; AlBar & Hoque, 2019). Yuen ir kt. (2021) taip pat nustatė

teigiamą santykį tarp suvokiamo pastebimumo ir suvokiamo naudingumo bei tarp suvokiamo pastebimumo ir suvokiamo naudojimo paprastumo. Tad siūloma iškelti šias hipotezes:

H7: *Suvokiamas Pramonės 4.0 technologijos pastebimumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudingumą.*

H8: *Suvokiamas Pramonės 4.0 technologijos pastebimumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudojimo paprastumą.*

Išbandomumas yra mastas, kuriuo inovaciją galima pabandyti panaudoti praktiškai ribotu lygiu. Rogers (1962) išsakė mintį, kad suvokiamas išbandomumas teigiamai siejasi su tikėtinumu, kad inovacija bus įdiegta. Šią mintį palaikė ir Nazari ir kt. (2013) Pramonės 4.0 technologijų atžvilgiu. Tyrimuose taip pat buvo nagrinėjamas suvokiamo išbandomumo santykis su suvokiamu naudingumu bei suvokiamu naudojimo paprastumu. Al-Rahmi ir kt. (2019) nustatė teigiamą suvokiamo išbandomumo poveikį suvokiamam naudingumui, tačiau nenustatė reikšmingo ryšio su suvokiamu naudojimo paprastumu. Priešingai, Yuen et al. (2021) nustatė teigiamą ryšį tarp suvokiamo išbandomumo ir suvokiamo naudojimo paprastumo. Tad siūloma iškelti šias hipotezes:

H9: *Suvokiamas Pramonės 4.0 technologijos išbandomumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudingumą.*

H10: *Suvokiamas Pramonės 4.0 technologijos išbandomumas teigiamai paveikia Pramonės 4.0 technologijos suvokiamą naudojimo paprastumą.*

Be to, šiuo tyrimu siekiama nustatyti moderuojantį Pramonės 4.0 technologijos tipo vaidmenį poveikiui tarp suvokiamos Pramonės 4.0 technologijos savybės bei suvokiamo naudingumo bei naudojimo paprastumo. Tad siūloma iškelti šias hipotezes:

H11: *Pramonės 4.0 technologijos suvokiamos savybės poveikis suvokiamam Pramonės 4.0 technologijos naudingumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H11a**: Pramonės 4.0 technologijos suvokiamo santykinio pranašumo poveikis suvokiamam Pramonės 4.0 technologijos naudingumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H11b**: Pramonės 4.0 technologijos suvokiamo suderinamumo poveikis suvokiamam Pramonės 4.0 technologijos naudingumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H11c**: Pramonės 4.0 technologijos suvokiamo sudėtingumo poveikis suvokiamam Pramonės 4.0 technologijos naudingumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H11d**: Pramonės 4.0 technologijos suvokiamo pastebimumo poveikis suvokiamam Pramonės 4.0 technologijos naudingumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H11e**: Pramonės 4.0 technologijos suvokiamo išbandomumo poveikis suvokiamam Pramonės 4.0 technologijos naudingumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

H12: *Pramonės 4.0 technologijos suvokiamos savybės poveikis suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H12a**: Pramonės 4.0 technologijos suvokiamo santykinio pranašumo poveikis suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

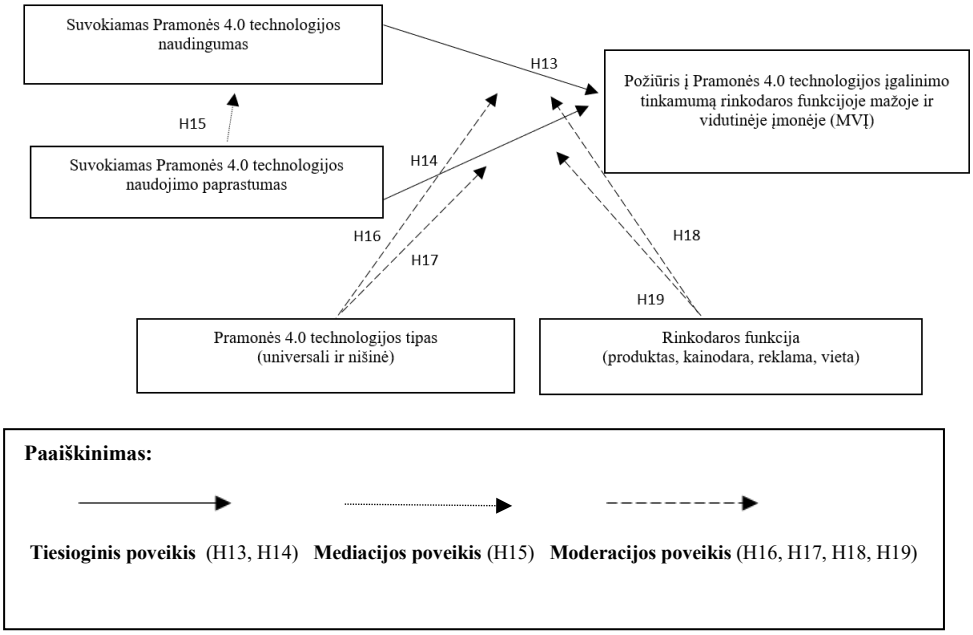
***H12b**: Pramonės 4.0 technologijos suvokiamo suderinamumo poveikis suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H12c**: Pramonės 4.0 technologijos suvokiamo sudėtingumo poveikis suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H12d**: Pramonės 4.0 technologijos suvokiamo pastebimumo poveikis suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

***H12e**: Pramonės 4.0 technologijos suvokiamo išbandomumo poveikis suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui yra moderuojamas Pramonės 4.0 technologijos tipo.*

Tyrimo modelio Dalis B nagrinėja ryšį tarp suvokiamo naudingumo bei suvokiamo Pramonės 4.0 technologijos naudojimo paprastumo bei kaip tai formuoja požiūrį į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje. Taip pat tiriamas ryšis tarp suvokiamo Pramonės 4.0 technologijos naudojimo paprastumo bei suvokiamo Pramonės 4.0 technologijos suvokiamo naudingumo. Kaip ir tyrimo modelio Dalyje A, taip ir čia tyrinėjamas galimas moderuojantis Pramonės 4.0 technologijos tipo poveikis. Taip pat tiriamas ir rinkodaros funkcijos tipo moderuojantis poveikis. Tyrimo modelis pristatomas **Paveiksle 3**.



Paveikslas 3. Tyrimo modelio Dalis B – suvokiamas naudingumas ir naudojimo paprastumas bei požiūris į Pramonės 4.0 technologijos įgalinimo tinkamumą MVĮ
Šaltinis: sudaryta autorės

Tyrimo modelio Dalis B: hipotezių iškėlimas

Suvokiamas naudingumas, kaip jį apibrėžia Davis ir kt. (1989), yra mastas, kuriuo yra tikima, kad tam tikra technologija įgalins (pagerins, sustiprins) jos naudotojo veiklos rezultatus. Tyrimais atskleidžiamas tiesioginis teigiamas ryšys tarp suvokiamo Pramonės 4.0 technologijos naudingumo bei ketinimo diegti šias technologijas (Camilleri, 2019; Ritz ir kt., 2019; Al-Rahmi ir kt., 2019; Nazir ir Khan, 2022). Kai kurie tyrimai teigia, kad požiūris į technologiją medijuoja šį santykį. Tai reiškia, kad didesnis suvokiamas naudingumas veda prie teigiamesnio požiūrio, o tai, savo ruožtu, paveikia sprendimą įdiegti technologiją (Matikiti ir kt., 2018; Rahman ir kt., 2021; Alhashmi ir kt., 2019). Tad siūloma iškelti šią hipotezę:

H13: *Suvokiamas Pramonės 4.0 technologijos naudingumas teigiamai paveikia požiūrį į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje.*

Suvokiamas naudojimo paprastumas nusako mastą, kuriuo žmogus yra įsitikinęs, kad technologijos panaudojimas pareikalaus minimalių pastangų

(Davis ir kt., 1989). Pramonės 4.0 kontekste jei MVĮ įmonės vadovui ar savininkui pasirodo, kad technologiją panaudoti lengva, jos diegimo tikimybės išauga. Šį teigiamą poveikį patvirtina ankstesni tyrimai (Camilleri, 2019; Ritz ir kt., 2019; Al-Rahmi ir kt., 2019; Vahdat ir kt., 2021; Nazir & Khan, 2022). Be to, kai kurie tyrėjai teigia, kad suvokiamas naudojimo paprastumas teigiamai paveikia požiūrį į Pramonės 4.0 technologijų diegimą (Matikiti ir kt., 2018; Alhashmi ir kt., 2019). Tad siūloma iškelti šią hipotezę:

H14: *Suvokiamas Pramonės 4.0 technologijos naudojimo paprastumas teigiamai paveikia požiūrį į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje.*

Pasak pradinės TAM modelio versijos, suvokiamas naudojimo paprastumas (angliškai trumpinamas PEOU) vartotojų ketinimą naudoti šią technologiją paveikia netiesiogiai, per suvokiamą naudingumą (angliškai trumpinamą PU) (Davis ir kt., 1989). Šį santykį jau yra patvirtinę keletas tyrimų (Tripopsakul, 2018; Herzallah & Mukhtar, 2016; Al-Rahmi ir kt., 2019; Alhashmi ir kt., 2019; Yuen ir kt., 2021). Tad siūloma iškelti šią hipotezę:

H15*: Suvokiamas Pramonės 4.0 technologijos naudojimo paprastumas medijuoja suvokiamo naudingumo poveikį į požiūrį į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje*.

Be to, šis tyrimas siekia patikrinti moderuojantį Pramonės 4.0 technologijos tipo vaidmenį poveikiui tarp suvokiamo Pramonės 4.0 technologijos naudingumo ir požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje, taip pat moderuojantį Pramonės 4.0 technologijos tipo vaidmenį poveikiui tarp suvokiamo Pramonės 4.0 technologijos naudojimo paprastumo ir požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje. Tad siūloma iškelti šias hipotezes:

H16: *Pramonės 4.0 technologijos suvokiamo naudingumo poveikis požiūriui į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje yra moderuojamas Pramonės 4.0 technologijos tipo.*

H17: *Pramonės 4.0 technologijos suvokiamo naudojimo paprastumo poveikis požiūriui į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje yra moderuojamas Pramonės 4.0 technologijos tipo.*

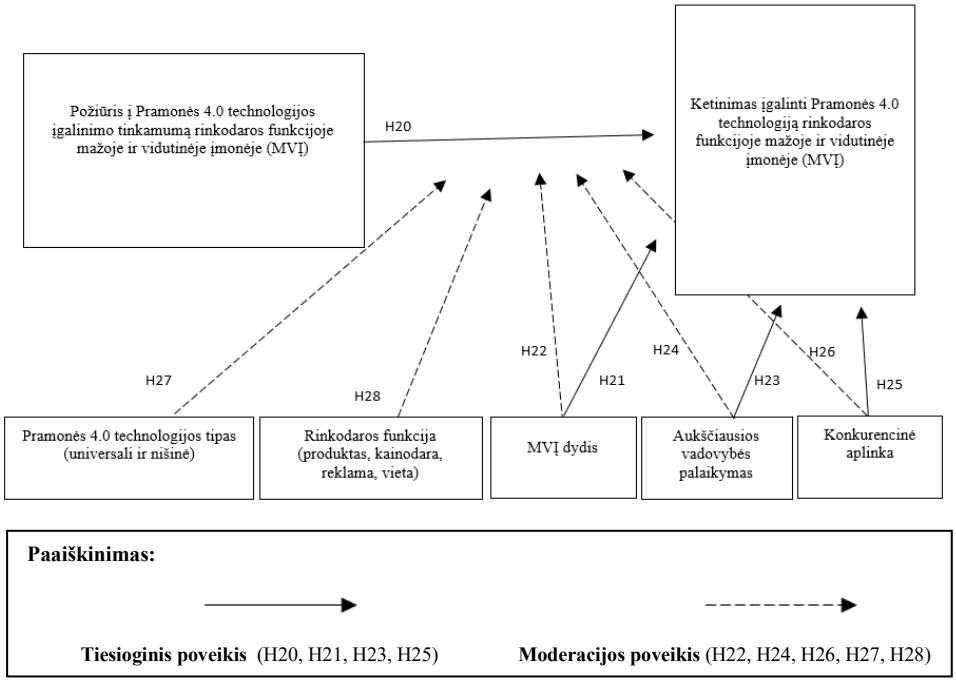
Be to, keliama hipotezė, kad rinkodaros funkcijos tipas moderuos poveikį tarp suvokiamo Pramonės 4.0 technologijos naudingumo ir požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ

įmonėje. Taip pat ir rinkodaros funkcijos tipas moderuos poveikį tarp suvokiamo Pramonės 4.0 technologijos naudojimo paprastumo ir požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje. Tad siūloma iškelti šias hipotezes:

H18: *Pramonės 4.0 technologijos suvokiamo naudingumo poveikis požiūriui į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje yra moderuojamas rinkodaros funkcijos tipo.*

H19: *Pramonės 4.0 technologijos suvokiamo naudojimo paprastumo poveikis požiūriui į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje yra moderuojamas rinkodaros funkcijos tipo.*

Tyrimo modelio Dalis C nagrinėja požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje poveikį elgsenos ketinimui diegti technologiją. Šis modelis taip pat analizuoja moderacijos poveikį šiam santykiui: pagal TOE struktūros elementus (*MVĮ dydis, aukščiausios vadovybės palaikymas, konkurencinė aplinka*) bei įtraukia papildomus elementus: Pramonės 4.0 technologijos ir rinkodaros funkcijos tipai. Tyrimo modelis pristatomas **Paveiksle 4**.



Paveikslas 4. Tyrimo modelio Dalis C – požiūris į Pramonės 4.0 technologijų įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimas
Šaltinis: sudaryta autorės

Tyrimo modelio Dalis C: hipotezių iškėlimas

Požiūriu nusakomas laipsnis, kuriuo žmogus turi teigiamą arba neigiamą nuostatą apie konkretų elgesį ir svarsto galimas tokio elgesio įgyvendinimo baigtis (Ajzen, 1985). Elgsenos ketinimas įdiegti naują technologiją yra paveikiamas požiūrio į šią technologiją (Davis ir kt., 1989). Taigi, jei įmonės savininkas ar vadovas turi teigiamą požiūrį į Pramonės 4.0 technologijas, yra labiau tikėtina, kad jie diegs naujas technologijas ir taikys jas praktikoje. Šį santykį jau patvirtino ankstesni tyrimai (Alhashmi ir kt., 2019; Rahman ir kt., 2021). Tad siūloma iškelti šią hipotezę:

H20: *Požiūris į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje teigiamai paveikia elgsenos ketinimą įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje.*

Tyrimai, kuriuos atliko Nguyen ir Waring (2013), Kumar ir kt. (2017), Nair ir kt. (2019), bei Usman ir kt. (2019), atskleidė, kad įmonės dydis pozityviai paveikia gebėjimą diegti Pramonės 4.0 technologijas, ir didesnės įmonės yra labiau pajėgios tai atlikti dėl to, kad disponuoja didesniais resursais bei yra labiau linkusios toleruoti riziką. Be to, manoma, kad MVĮ dydis moderuoja poveikį tarp Pramonės 4.0 technologijos įgalinimo tinkamumo rinkodaros funkcijoje bei elgsenos ketinimo diegti šias technologijas. Tad siūloma iškelti šias hipotezes:

H21: *MVĮ dydis teigiamai paveikia elgsenos ketinimą įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje.*

H22: *Teigiamas poveikis tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje bus tuo stipresnis, kuo didesnė yra MVĮ.*

Pasak Kumar ir kt. (2017), MVĮ įmonių kontekste, aukščiausioji vadovybė yra MVĮ savininkas/vadovas. Kadangi savininkas/vadovas vadovauja visoms/daugeliui verslo funkcijų MVĮ ir dažnu atveju yra galutinis sprendimų priėmėjas, tai reikšmingai paveikia Pramonės 4.0 technologijų diegimą. Jei savininkui/vadovui šios technologijos atrodo naudingos, jų diegimo tikimybė išauga (Usman ir kt., 2019). Šį ryšį jau patvirtino daugelis tyrimų (Matikiti ir kt., 2018; Prause, 2019; Skafi ir kt., 2020). Be to, manoma, kad aukščiausiosios vadovybės palaikymas moderuoja poveikį tarp Pramonės 4.0 technologijos įgalinimo tinkamumo rinkodaros funkcijoje bei elgsenos ketinimo diegti šias technologijas. Tad siūloma iškelti šias hipotezes:

H23: *Aukščiausiosios vadovybės palaikymas teigiamai paveikia elgsenos ketinimą įgalinti Pramonės 4.0 technologijas rinkodaros funkcijoje MVĮ įmonėje.*

H24: *Teigiamas poveikis tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje bus tuo stipresnis, kuo stipresnis yra MVĮ aukščiausios vadovybės palaikymas.*

Pasak autorių (Halse & Jaeger, 2019; Ungerman & Dědková, 2019) naujosios technologijos, atsiradusios Pramonės 4.0 kontekste, yra svarbus veiksnys, padedantis MVĮ įmonėms išlaikyti savo konkurencinį pranašumą. Natūralu, kad daugelis tyrimų patvirtina ryšį tarp konkurencinės aplinkos bei ketinimo diegti naująsias technologijas (Matikiti ir kt., 2018; AlBar & Hoque, 2019; Usman ir kt., 2019). Šis tyrimas taip pat siekia nustatyti, koks yra konkurencinės aplinkos moderuojantis poveikis tarp požiūrio į Pramonės 4.0 technologijų įgalinimą bei elgsenos ketinimo. Tad siūloma iškelti šias hipotezes:

H25: *Konkurencinė aplinka teigiamai paveikia elgsenos ketinimą įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje.*

H26: *Teigiamas poveikis tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje bus tuo stipresnis, kuo stipresnė yra konkurencinė aplinka.*

Be to, manoma, kad Pramonės 4.0 technologijos tipas moderuos poveikį tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumo rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo. Tad siūloma iškelti šią hipotezę:

H27: *Teigiamas poveikis tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje bus stipresnis universalios Pramonės 4.0 technologijos įgalinimo atveju.*

Taip pat iškeliama hipotezė, kad rinkodaros funkcijos tipas moderuos poveikį tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumo rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo. Tad siūloma iškelti šią hipotezę:

H28: *Teigiamas poveikis tarp požiūrio į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje bei elgsenos ketinimo įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje yra moderuojamas rinkodaros funkcijos tipo.*

TYRIMO REZULTATAI

Pirmojoje tyrimo dalyje buvo panaudotas kokybinis empirinio tyrimo modelis. Buvo siekiama išsiaiškinti, kurios universaliausios bei kurios nišinės Pramonės 4.0 technologijos yra tinkamos taikyti keturiose rinkodaros funkcijose Lietuvos MVĮ įmonėse. Antroji tyrimo dalis pasitelkė kiekybinius tyrimo metodus. Remiantis kokybinio tyrimo rezultatais, dvi Pramonės 4.0 technologijos (viena universalioji – *didieji duomenys*, ir viena nišinė – *pokalbių robotai*) buvo pasirinktos tolesniam tyrimui, taip pat nagrinėjant ir keturias rinkodaros funkcijas (produktas, kainodara, reklama, vieta).

Suvokiamų Pramonės 4.0 technologijų savybių poveikio suvokiamam naudingumui bei naudojimo paprastumui tyrimo rezultatai (Tyrimo modelio Dalis A)

Apibendrinti tyrimo modelio Dalies A rezultatai pateikiami **Lentelėje 1**. Iš 12 iškeltų hipotezių, 6 buvo patvirtintos, o 6 buvo atmestos.

Lentelė 1. Tyrimo modelio Dalies A rezultatų apibendrinimas

Hipotezė	Poveikis	B	p	Baigtis	Analizė
H1	*Suvokiamas santykinis pranašumas → Suvokiamas naudingumas*	β=0,423	**<0,001**	Patvirtinta	Regresijos
H2	*Suvokiamas santykinis pranašumas → Suvokiamas naudojimo paprastumas*	β=0,029	0,682	Atmesta	Regresijos
H3	*Suvokiamas suderinamumas → Suvokiamas naudingumas*	β=0,392	**<0,001**	Patvirtinta	Regresijos
H4	*Suvokiamas suderinamumas → Suvokiamas naudojimo paprastumas*	β=0,204	**<0,05**	Patvirtinta	Regresijos
H5	*Suvokiamas sudėtingumas → Suvokiamas naudingumas*	β=0,067	0,139	Atmesta	Regresijos
H6	*Suvokiamas sudėtingumas → Suvokiamas*	β=-0,137	**<0,05**	Patvirtinta	Regresijos

Hipotezė	Poveikis	B	p	Baigtis	Analizė
	naudojimo paprastumas				
H7	*Suvokiamas pastebimumas → Suvokiamas naudingumas*	β=-0,015	0,829	Atmesta	Regresijos
H8	*Suvokiamas pastebimumas → Suvokiamas naudojimo paprastumas*	β=0,381	**<0,001**	Patvirtinta	Regresijos
H9	*Suvokiamas išbandomumas → Suvokiamas naudingumas*	β=0,189	**<0,001**	Patvirtinta	Regresijos
H10	*Suvokiamas išbandomumas → Suvokiamas naudojimo paprastumas*	β=0,015	0,747	Atmesta	Regresijos
H11 (*H11a, H11b, H11c, H11d, H11e*)	*Suvokiamos Pramonės 4.0 technologijos savybės → Pramonės 4.0 technologijos tipas (moderatorius) → Suvokiamas naudingumas*		H11a p=0,394; H11b p=0,898;H11c p=N/A; H11d p=N/A; H11e p=0,415;	Atmesta	Moderacijos
H12 (*H12a, H12b, H12c, H12d, H12e*)	*Suvokiamos Pramonės 4.0 technologijos savybės → Pramonės 4.0 technologijos tipas (moderatorius) → Suvokiamas naudojimo paprastumas*		H12a p=N/A; H12 p=0,266; H12c p=0,435; H12d p=0,909; H12e p=N/A;	Atmesta	Moderacijos

Šaltinis: sukurta autorės

Apibendrinus, **Hipotezės (H1, H3, H9) buvo patvirtintos**, kadangi buvo nustatyta, kad suvokiamas santykinis pranašumas, suvokiamas suderinamumas bei suvokiamas išbandomumas turi reikšmingą teigiamą poveikį suvokiamam Pramonės 4.0 technologijos naudingumui. **Hipotezės (H5, H7) buvo atmestos**, o tai reiškia, kad suvokiamas sudėtingumas bei suvokiamas pastebimumas nedaro poveikio suvokiamam Pramonės 4.0 technologijos naudingumui.

Taip pat buvo patvirtinta, kad suvokiamas suderinamumas bei suvokiamas pastebimumas turi teigiamą poveikį suvokiamam Pramonės 4.0

technologijos naudojimo paprastumui. Todėl **hipotezės (H4, H8) buvo patvirtintos**. Be to, buvo atrasta, kad suvokiamas sudėtingumas daro neigiamą poveikį suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui, o todėl **hipotezė (H6) buvo patvirtinta**. **Hipotezės (H2, H10) buvo atmestos**, o tai reiškia, kad suvokiamas santykinis pranašumas bei suvokiamas išbandomumas neturi poveikio suvokiamam Pramonės 4.0 technologijos naudojimo paprastumui.

Tyrimo rezultatai atskleidė, kad Pramonės 4.0 technologija daro tiesioginį poveikį suvokiamam naudingumui suvokiamo suderinamumo bei suvokiamo išbandomumo kontekste. Tačiau, remiantis moderacijos analizės rezultatais, poveikis tarp suvokiamų Pramonės 4.0 technologijos savybių bei suvokiamo naudingumo nebuvo moderuojamas iš Pramonės 4.0 technologijos tipo pusės. Todėl **Hipotezės H11a, H11b, H11c, H11d, H11e ir H11 buvo atmestos**. Be to, poveikis tarp suvokiamų Pramonės 4.0 technologijos savybių bei suvokiamo naudojimo paprastumo nebuvo moderuojamas iš Pramonės 4.0 technologijos tipo pusės. Todėl **Hipotezės H12a, H12b, H12c, H12d, H12e ir H12 buvo atmestos**.

Suvokiamo naudingumo ir naudojimo paprastumo poveikio Pramonės 4.0 technologijų tinkamumui diegti rinkodaros funkcijoms MVĮ įmonėse tyrimo rezultatai (Tyrimo modelio Dalis B)

Apibendrinant tyrimo modelio Dalies B rezultatus, tyrimo rezultatai pristatomi **Lentelėje 2**. Iš 7 hipotezių, 2 buvo patvirtintos, o 5 buvo atmestos.

Lentelė 2. Tyrimo modelio Dalies B rezultatų apibendrinimas

Hipotezė	Poveikis	B	p/ (BootLLCI/ BootULCI)	Baigtis	Analizė
H13	*Suvokiamas naudingumas → Požiūris*	β=0,681	**<0,001**	Patvirtinta	Regresijos
H14	*Suvokiamas naudojimo paprastumas → Požiūris*	β=0,084	0,191	Atmesta	Regresijos
H15	*Suvokiamas naudingumas → Suvokiamas naudojimo paprastumas (mediatorius) → Požiūris*		**BootLLCI =0,294; BootULCI =0,546;**	Patvirtinta	Mediacijos

Hipotezė	Poveikis	B	p/ (BootLLCI/ BootULCI)	Baigtis	Analizė
H16	*Suvokiamas naudingumas → Pramonės 4.0 technologijos tipas (moderatorius) → Požiūris*		0,511	Atmesta	Moderacijos
H17	*Suvokiamas naudojimo paprastumas → Pramonės 4.0 technologijos tipas (moderatorius) → Požiūris*		0,531	Atmesta	Moderacijos
H18	*Suvokiamas naudingumas → Rinkodaros funkcijos tipas (moderatorius) → Požiūris*		p=0,372; p=0,048; p=0,945;	Atmesta	Moderacijos
H19	*Suvokiamas naudojimo paprastumas → Rinkodaros funkcijos tipas (moderatorius) → Požiūris*		p=0,301; p=0,626; p=0,135;	Atmesta	Moderacijos

Šaltinis: sukurta autorės

Tyrimo rezultatai atskleidžia, kad suvokiamas naudingumas turi teigiamą poveikį požiūriui į Pramonės 4.0 technologijų įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje, todėl **Hipotezė H13 buvo patvirtinta**. Tačiau suvokiamas naudojimo paprastumas neturėjo jokio poveikio požiūriui, tad **Hipotezė H14 buvo atmesta.** Mediacijos analizė patvirtino, kad suvokiamas naudojimo paprastumas medijuoja suvokiamo naudingumo poveikį požiūriui. Todėl **Hipotezė H15 buvo patvirtinta.**

Tikrinant hipotezes H16, H17, H18 ir H19, buvo naudojama moderacijos analizė. Tyrimas atskleidė, kad nei Pramonės 4.0 technologija, nei rinkodaros funkcija nemoderuoja poveikio tarp suvokiamo naudingumo ir požiūrio. Todėl **Hipotezės H16 ir H18 buvo atmestos**. Taip pat tyrimas atskleidė, kad nei Pramonės 4.0 technologija, nei rinkodaros funkcija nemoderuoja poveikio tarp suvokiamo naudojimo paprastumo ir požiūrio. Todėl **Hipotezės H17 ir H19 buvo atmestos**.

Požiūrio į elgsenos ketinimą įgalinti Pramonės 4.0 technologijas poveikio MVĮ įmonėse tyrimo rezultatai (Tyrimo modelio Dalis C)

Apibendrinant tyrimo modelio Dalies C rezultatus, pristatoma **Lentelė 3**. Iš 9 hipotezių, 4 buvo patvirtintos, o 5 – atmestos.

Lentelė 3. Tyrimo modelio Dalies C rezultatų apibendrinimas

Hipotezė	Poveikis	B	p	Baigtis	Analizė
H20	*Požiūris → Elgsenos ketinimas*	β=0,284	**<0,001**	Patvirtinta	Regresijos
H21	*MVĮ dydis → Elgsenos ketinimas*	β=-0,066	0,168	Atmesta	Regresijos
H22	*Požiūris → MVĮ dydis (moderatorius) → Elgsenos ketinimas*		0,666	Atmesta	Moderacijos
H23	*Aukščiausios vadovybės palaikymas → Elgsenos ketinimas*	β=0,414	**<0,001**	Patvirtinta	Regresijos
H24	*Požiūris → Aukščiausios vadovybės palaikymas (moderatorius) → Elgsenos ketinimas*	β=0,048	**0,031**	Patvirtinta	Moderacijos
H25	*Konkurencinė aplinka → Elgsenos ketinimas*	β=0.314	**<0,001**	Patvirtinta	Regresijos
H26	*Požiūris → Konkurencinė aplinka (moderatorius) → Elgsenos ketinimas*		0,190	Atmesta	Moderacijos
H27	*Požiūris → Pramonės 4.0 technologijos tipas (moderatorius) → Elgsenos ketinimas*		0,753	Atmesta	Moderacijos

Hipotezė	Poveikis	B	p	Baigtis	Analizė
H28	*Požiūris → Rinkodaros funkcijos tipas (moderatorius) → Elgsenos ketinimas*		p=0,784; p=0,895; p=0,777;	Atmesta	Moderacijos

Šaltinis: sukurta autorės

Hipotezės (H20, H23, H25) buvo patvirtintos, kadangi buvo nustatyta, kad požiūris į Pramonės 4.0 technologijų įgalinimo tinkamumą rinkodaros funkcijoje MVĮ įmonėje, konkurencinė aplinka bei aukščiausios vadovybės palaikymas teigiamai paveikia elgsenos ketinimą. **Hipotezė H21 buvo atmesta**, o tai reiškia, kad MVĮ įmonės dydis nedaro poveikio elgsenos ketinimui.

Tyrimo rezultatai atskleidė, kad aukščiausio lygio vadovybės palaikymas moderuoja poveikį tarp požiūrio ir elgsenos ketinimo (**Hipotezė H24 buvo patvirtinta**). Tai reiškia, kad kuomet aukščiausio lygio vadovybės parama yra stipresnė, požiūris į Pramonės 4.0 technologijos įgalinimo tinkamumą rinkodaros funkcijoje sustiprėja, o tuomet ir elgsenos ketinimas įgalinti Pramonės 4.0 technologiją rinkodaros funkcijoje MVĮ įmonėje taip pat išauga. Vis dėlto **Hipotezės (H22, H26, H27, H28) buvo atmestos**, o tai atskleidžia, kad MVĮ dydis, konkurencinė aplinka, Pramonės 4.0 technologija bei rinkodaros funkcijos tipas nemoderuoja poveikio tarp požiūrio ir elgsenos ketinimo.

Apibendrinus, tyrimo rezultatai atskleidė, kad, iš 28 nagrinėtų hipotezių, 12 buvo patvirtinta, o 16 – atmesta.

Išvados

1. Tyrimo rezultatai atskleidžia, kad Pramonė 4.0 teigiamai prisideda prie MVĮ augimo, veiklos rezultatų gerinimo bei konkurencingumo didinimo. Mokslinės literatūros analizė rodo, jog Pramonės 4.0 diegimas dažnai verčia iš naujo įvertinti organizacijos struktūrą ir verslo modelį. Nepaisant Pramonės 4.0 technologijų taikymo naudingumo tokioms verslo funkcijoms kaip gamyba, rinkodara ar logistika, MVĮ įmonės susiduria su tokiais iššūkiais kaip ribotos žinios technologijų srityje, biudžeto ribotumas ar vadybiniai resursai, lyginant su didesnėmis įmonėmis.
2. Sisteminė analizė atskleidė, kad tokios technologijos kaip IoT, AI, didieji duomenys, pokalbių robotai, virtuali realybė ar debesų kompiuterija gali būti įgalintos įvairiose MVĮ įmonių rinkodaros

funkcijose. Šių technologijų pritaikomumas yra įvairus – dalis jų naudojamos plačiai, o kitos yra labiau nišinės. Jų įdiegimas MVĮ skatina atsirasti naujus gamybos metodus ir santykius tarp įmonių bei rinkų.

3. Tokie teoriniai modeliai kaip: Technologijų priėmimo modelis (TAM), Inovacijų difuzijos teorija (DOI) ar Technologinio, organizacinio ir aplinkos kontekstų visumos modelis (TOE) yra tinkami nagrinėti Pramonės 4.0 diegimą MVĮ įmonėse. Greta šių teorijų, į šį tyrimą taip pat įtraukiama Planuotos elgsenos teorija (Ajzen, 1985), kuri leidžia sutelkti dėmesį į MVĮ savininkų/vadovų elgsenos aspektus. Veiksniai, lemiantys MVĮ savininkų/vadovų požiūrį į Pramonės 4.0 technologijos diegimą rinkodaros funkcijose, šiame tyrime apima technologijoms būdingus veiksnius (suvokiamos technologijų savybės, naudingumas bei naudojimo paprastumas), MVĮ būdingus faktorius (aukščiausios vadovybės palaikymas, MVĮ dydis) bei išorinius faktorius (konkurencinė aplinka).
4. Kokybinio tyrimo rezultatai atskleidė, kad produkto rinkodaros funkcija yra gyvybiškai svarbi sritis įdiegiant įvairias Pramonės 4.0 technologijas MVĮ įmonėse. Kokybinis tyrimas taip pat atskleidė, kad dirbtinis intelektas ir didieji duomenys yra dvi tinkamiausios Pramonės 4.0 technologijos MVĮ rinkodarai dėl jų plataus pritaikomumo bei teikiamos naudos. Remiantis kokybinio tyrimo rezultatais, buvo pasiūlyta skirstymo į kategorijas sistema, kuria atskiriamos universaliosios Pramonės 4.0 technologijos (tokios kaip AI ar didieji duomenys), kurios yra lanksčios ir dera su daugeliu rinkodaros funkcijų, bei nišinės technologijos (tokios kaip 3D spausdinimas ar pokalbių robotai), kurios atlieka labiau specializuotas funkcijas.
5. Tyrimo modelio Dalies A rezultatai atskleidė, kad suvokiamas santykinis pranašumas reikšmingai paveikia suvokiamą naudingumą, tačiau nepaveikia naudojimo paprastumo. Suvokiamas suderinamumas teigiamai paveikia tiek ir suvokiamą naudingumą, tiek ir suvokiamą naudojimo paprastumą, kas atskleidžia, kad technologijos, kurios dera su praktikuojamomis vertybėmis bei poreikiais MVĮ, gali būti lengviau pritaikomos. Be to, tyrimo rezultatai atskleidė, kad suvokiamas sudėtingumas neigiamai paveikia naudojimo paprastumą, tačiau ne naudingumą, iš ko seka, kad nors sudėtingos technologijos gali būti laikomos naudingomis, tačiau jas diegti kliudo įgyvendinimo iššūkiai. Suvokiamas pastebimumas

sustiprina naudojimo paprastumą, tačiau nepaveikia suvokiamo naudingumo. Suvokiamas išbandomumas teigiamai paveikia naudingumą, tačiau ne naudojimo paprastumą. Šiame tyrime nebuvo aptiktas Pramonės 4.0 technologijos tipo moderuojantis poveikis tarp suvokiamų Pramonės 4.0 technologijos savybių ir naudingumo ar naudojimo paprastumo.

6. Tyrimo modelio Dalies B rezultatai patvirtino, kad suvokiamas naudingumas teigiamai paveikia požiūrį į pramonės 4.0 technologijų įgalinimo tinkamumą MVĮ įmonių rinkodaros funkcijose. Tuo tarpu suvokiamas naudojimo paprastumas tiesiogiai šio požiūrio nepaveikia. Tačiau naudojimo paprastumas medijuoja šį santykį: didesnis suvokiamas naudojimo paprastumas sustiprina suvokiamą naudingumą, o tai veda prie labiau teigiamo požiūrio. Be to, nei Pramonės 4.0 technologijos tipas, nei rinkodaros funkcijos tipas tiesiogiai nepaveikia ir nemoderuoja šių sąveikų. Šie gauti rezultatai išryškina suvokiamo naudingumo vaidmenį bei medijuojantį naudojimo paprastumo vaidmenį formuojant požiūrį į Pramonės 4.0 technologijų diegimą MVĮ. Nuoseklios tendencijos pastebimos tiek įvairių Pramonės 4.0 technologijų, tiek ir rinkodaros funkcijų atžvilgiu.
7. Tyrimo modelio Dalies C rezultatai patvirtino, kad MVĮ savininkų ir/ar vadovų teigiamas požiūris į Pramonės 4.0 technologijas reikšmingai paveikia jų ketinimą įgalinti šias technologijas rinkodaros funkcijose. Aukščiausios vadovybės palaikymas sustiprina šiuos ketinimus bei moderuoja požiūrio ir ketinimų santykį, dėl ko padidėja technologijų įdiegimo tikimybė. Nors ir konkurencinė aplinka teigiamai paveikia ketinimą diegti technologijas, tačiau ji nemoderuoja požiūrio ir ketinimų santykio. Skirtingai nei ankstesniuose tyrimuose, šis tyrimas teigia, kad MVĮ įmonės dydis tiesiogiai nepaveikia elgesio ketinimų. Tyrimas taip pat nustatė, kad Pramonės 4.0 technologijos tipas ir konkrečios rinkodaros funkcijos tiesiogiai nepaveikia, ir nemoderuoja poveikio tarp požiūrio ir elgsenos ketinimo.
8. Šis tyrimas detaliai apžvelgia, kaip suvokiamos Pramonės 4.0 technologijos savybės, požiūris į įgalinimo tinkamumą bei elgsenos ketinimai sąveikauja, žvelgiant iš MVĮ vadovo/savininko perspektyvos. Tyrime atliktas Pramonės 4.0 technologijų suskirstymas bei moderuojančių faktorių ištyrimas suteikia naujų įžvalgų apie Pramonės 4.0 technologijų diegimo procesą rinkodaros

funkcijose. Tyrimas patvirtina, jog teigiamas požiūris į Pramonės 4.0 technologiją, turi teigiamą įtaką ketinimui diegti šią technologiją MVĮ, nepriklausant nuo Pramonės 4.0 technologijos bei rinkodaros funkcijos tipo, o tai atskleidžia platų tyrimo rezultatų pritaikomumą. Tačiau tokie iššūkiai kaip ribotas biudžetas ar ekspertinio lygmens žinių stoka ir toliau riboja pilną šių technologijų diegimo potencialą MVĮ rinkodaros funkcijose.

Rekomendacijos tolesniems tyrimams

1. Šis tyrimas paaiškino 69,6% variacijos, nagrinėjant MVĮ įmonių elgesio ketinimus įgalinti Pramonės 4.0 technologijas rinkodaros funkcijose. Tolesni tyrimai turėtų įtraukti daugiau veiksnių, tokių, kaip vadovo/savininko savybės (išsilavinimas, technologinė kompetencija) bei išorinių faktorių (pavyzdžiui, įstatyminė aplinka), kad būtų galima dar plačiau suvokti tiriamąjį reiškinį.
2. Tyrimas pritaikė rinkodaros 4P komplekso modelį, tačiau nepavyko aptikti rinkodaros funkcijų moderuojančio poveikio tarp požiūrio ir elgsenos ketinimo įgalinti Pramonės 4.0 technologijas. Tolesni tyrimai turėtų tyrinėti konkrečias rinkodaros veiklas (pvz., asortimentas, nuolaidos, paskirstymo kanalai), kad būtų galima įvertinti šių faktorių galimą moderuojantį poveikį.
3. Šiame tyrime buvo nagrinėtos dvi Pramonės 4.0 technologijos – didieji duomenys bei pokalbių robotai – tačiau nei viena iš jų nepademonstravo moderuojančio efekto tarp požiūrio ir elgesio ketinimo. Į tolesnius tyrimus būtų naudinga įtraukti didesnę Pramonės 4.0 technologijų įvairovę, ištirti jų poveikį įvairioms MVĮ verslo funkcijoms bei atlikti lyginamąją analizę.
4. Tyrimo respondentų dauguma buvo iš mažųjų kompanijų. Tolesni tyrimai turėtų užtikrinti, kad būtų subalansuota imtis tarp mikro, mažųjų ir vidutiniųjų kompanijų, taip padidinant rezultatų apibendrinamumą.
5. Šiame tyrime nebuvo nagrinėjama, kaip įvairios MVĮ klasifikacijos (pvz., nuosavybės tipas, verslo veikla) paveikia Pramonės 4.0 diegimą. Tolesni tyrimai turėtų nagrinėti šiuos veiksnius, siekiant suprasti sąlygas, nulemiančias technologijų diegimą.

Rekomendacijos praktikams

1. Šiame tyrime pristatoma nauja pramonės 4.0 technologijų kategorizacija, suskirstant jas į nišinį ir universalų tipus MVĮ rinkodaros funkcijų atžvilgiu. Lietuvos įmonės turėtų teikti pirmenybę universaliosioms technologijoms – tokioms kaip

dirbtinis intelektas ar didieji duomenys, dėl plačių jų pritaikymo galimybių bei teikiamos reikšmingos naudos, o tuo tarpu nišinės technologijos gali būti taikomos konkrečioms rinkodaros funkcijoms dėl jų tikslinių privalumų.

2. MVĮ turėtų sutelkti dėmesį į Pramonės 4.0 technologijas, teikiančias aiškų santykinį pranašumą bei derantį su jų dabartiniais poreikiais. Be to, išryškinant pastebimą naudą bei išbandymo galimybes, galima pagerinti suvokiamą Pramonės 4.0 technologijų naudingumą bei naudojimo paprastumą.
3. Siekiant sulaukti padidėjusio teigiamo MVĮ įmonių vadovų ir savininkų požiūrio link Pramonės 4.0 technologijų, būtina akcentuoti šių technologijų suvokiamą naudingumą. Taip pat labai svarbu supaprastinti technologijų naudojimo aspektus pasitelkiant apmokymus ir techninę paramą. Pramonės 4.0 technologijų įgalinimo strategijos stipriau akcentuoti turėtų Pramonės 4.0 technologijų suvokiamą naudingumą bei naudojimo paprastumą nei susitelkti į technologijos taikymo aspektus konkrečioje rinkodaros funkcijoje.
4. Šiame tyrime buvo nustatyta, kad aukščiausios vadovybės parama moderuoja poveikį tarp požiūrio ir Pramonės 4.0 technologijos diegimo ketinimų. MVĮ įmonės turėtų užtikrinti, kad aukščiausioji vadovybė intensyviai dalyvauja technologijų diegimo procese ir yra tvirtai į jį įsitraukusi tam, kad Pramonės 4.0 technologijas būtų galima efektyviai integruoti į rinkodaros funkcijas.
5. Nors Pramonės 4.0 technologijos ir suteikia ženklios naudos MVĮ augimui bei konkurencingumui, tačiau jų diegime iššūkius kelia technologiniai, finansiniai bei vadybiniai ribotumai. Valstybės politikos kūrėjai turėtų sukurti paramos mechanizmus, skatinančius bendradarbiavimą tarp MVĮ, tyrimų institucijų bei didesnių įmonių, siekiant palengvinti Pramonės 4.0 technologijų įgalinimą MVĮ bei dalinimąsi žiniomis.

Evelina Blažinauskytė, **šios disertacijos autorė**, tyrinėja naujausių technologijų įgalinimo tinkamumą rinkodaros funkcijose mažosiose ir vidutiniosiose įmonėse (MVĮ). Moksliniuose tyrimuose ji taiko daugiau nei dešimtmetį sukauptas žinias ir profesinę patirtį rinkodaros, pardavimų bei vadybos srityse. Jos ekspertinės žinios buvo išugdytos padedant puoselėti žinomų Lietuvos grožio ir sveikatos prekinių ženklų verslus Vakarų Europos rinkose – Jungtinėje Karalystėje, Nyderlanduose, Vokietijoje, Austrijoje,

Lenkijoje ir kitose šalyse bei vadovauti pasaulinių grožio ir sveikatos prekinių ženklų verslo plėtrai Lietuvos rinkoje.

Privačiame sektoriuje Evelina Blažinauskytė sėkmingai bendradarbiauja su pirmaujančiais grožio ir sveikatos pramonės mažmenininkais, vadovauja naujų produktų diegimui įvairiose rinkose, planuoja rinkodaros bei reklamines kampanijas, skatina įvairių kategorijų plėtrą bei skaitmeninimo projektus. Į jos vaidmenų ratą patenka ir išsami rinkos bei pirkėjų tendencijų duomenų analizė. Tai praturtina jos suvokimą apie besivystantį rinkodaros kontekstą bei gyvybiškai svarbų skaitmeninimo vaidmenį. Greta veiklos pramonės srityje, Evelinos Blažinauskytės moksliniai tyrimai nagrinėja, kokį poveikį naujausia technologijų pažanga turi rinkodaros praktikoms įmonėse. Disertacijos autorė turi daugiau nei penkerius metus akademinio dėstymo patirties, dėstydama bakalaurams ir magistrantams globaliosios rinkodaros vadybos srities disciplinas. Ji taip pat yra vadovavusi įvairaus lygio moksliniams darbams rinkodaros srityje.

Šis praktinės patirties ir mokslinių tyrimų derinys suteikia Evelinai Blažinauskytei galimybę tyrinėti, kaip inovatyvios technologijos gali atnešti perversmą į verslo srities rinkodaros erdves. Autorė savo darbu siekia užpildyti spragą tarp atsiradusių teorinių žinių ir praktinio jų taikymo, suteikdama reikšmingų įžvalgų tiek mokslininkams, tiek ir praktikams rinkodaros srityje.

PADĖKA

Ypatingą padėką skiriu disertacijos vadovui prof. dr. Vytautui Dikčiui už bendradarbiavimą pastaruosius šešerius metus, palaikymą, supratingumą ir neįkainojamą pagalbą rengiant disertaciją.

Nuoširdžiai dėkoju disertacijos recenzentams prof. dr. Sigitui Urbonavičiui ir doc. dr. Algiui Gaižučiui už skirtą laiką disertacijos teksto skaitymui ir pateiktas vertingas rekomendacijas.

Didelį ačiū skiriu šeimos nariams ir artimiesiems, draugams ir kolegoms, kurie domėjosi studijų eiga, kartu džiaugėsi pergalėmis ir padrąsino reikiamais momentais. Esu dėkinga už Jūsų rūpestį, meilę, palaikymą, tikėjimą manimi, supratingumą ir kantrybę laukiant dažnesnių mūsų susitikimų.

Dėkoju visiems Vilniaus universiteto Ekonomikos ir verslo administravimo fakulteto Rinkodaros katedros kolegoms. Esu dėkinga už vertingus patarimus, kurie prisidėjo prie disertacijos turinio tobulinimo, taip pat už suteiktą galimybę būti bendruomenės dalimi, kuri mane visapusiškai ugdė, formavo bei įkvėpė tobulėti.

Evelina Blažinauskytė, 2024 m. liepos mėn.

LIST OF PUBLICATIONS

The contribution of the author of the dissertation in the preparation of scientific publications and the participation in scientific conferences in the research on the suitability of the Industry 4.0 technologies for adoption in the marketing functions within SMEs.

Articles in peer-reviewed scientific publications:

1. Blažinauskytė, E. & Dikčius, V. (2023). Industry 4.0 technologies enablement in marketing activities of SMEs to fulfill customers' needs for personalization: systematic review. In *13th International scientific conference "Business and Management 2023," May 11–12, 2023, Vilnius, Lithuania. Vilnius: Vilnius Gediminas Technical University, 2023. art. No. bm.2023.1066, p. 377–386. ISSN 2029-4441. eISSN 2029-929X. ISBN 9786094763335. eISBN 9786094763342*
2. Blažinauskytė, E. & Dikčius, V. (2023). Conceptual research framework concerning industry 4.0 technologies' suitability for adoption in marketing functions within SMEs. In *16th Annual Conference of the EuroMed Academy of Business."Business Transformation in Uncertain Global Environments," September 27–29, 2023, Vilnius, Lithuania. EuroMed Press, 2023 October, p. 781–784. ISSN: 2547-8516, ISBN: 978-9963-711-98-7*
3. Blažinauskytė E. & Dikčius, V. (2023). Suitability of Industry 4.0 technologies' to be applied in SMEs marketing related functions. In *Global Research Review in Business and Economics*, *9*(5), p. 92–103. ISSN: 2454-3217.

Reports at international scientific conferences:

1. Blažinauskytė, E. & Dikčius, V. Industry 4.0 technologies enablement in marketing activities of SMEs to fulfill customers' needs for personalization: systematic review. 13th scientific International conference "Business and management 2023," Vilnius (Lithuania), 2023 May 11–12.
2. Blažinauskytė, E. & Dikčius, V. Conceptual research framework concerning industry 4.0 technologies' suitability for adoption in marketing functions within SMEs. 16th Annual Conference of the EuroMed Academy of Business, Vilnius (Lithuania), 2023 September 27–29.

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