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Breaking Barriers: The Path to Immersive Technologies Adoption in Small and Medium-sized Enterprises

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Research Paper

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Abstract. Recent advancements in immersive technologies (ImTs) present various opportunities for small and medium-sized enterprises (SMEs) including the creation of virtual prototypes and the facilitation of employee training in extended reality settings. Integrating ImTs into their business models as part of the digitization process is increasingly viewed as essential for SMEs to maintain future competitiveness. However, despite the potential benefits, the adoption of ImTs by SMEs remains relatively low. This study analyses the affordances and constraints associated with the adoption of ImTs through a qualitative analysis of 10 semi-structured interviews with providers and users of ImTs in the context of SMEs. This research builds upon existing literature and provides valuable insights into the adoption of ImTs, including the hitherto underexposed facets of improved worker safety through ImTs as well as the lack of standardization, which are of particular interest in the context of SMEs.

Keywords: Immersive Technologies, Small and Medium-sized Enterprises, Technology Adoption, Digital Transformation, Qualitative Analysis.

1 Introduction

The era of digital transformation has brought about numerous technological innovations. Among these, immersive technologies (ImTs) such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) have had a significant impact on user experience and interaction with digital content (Suh & Prophet 2018, Tcha-Tokey et al. 2018). ImTs have the unique ability to blur the boundaries between the physical world and digital simulations, providing immersive experiences that were previously unattainable (Bowman & McMahan 2007, Winkler et al. 2020). ImTs have been applied in various sectors, including healthcare, education, and entertainment. Notably, the business sector has also embraced ImTs, with the promise of revolutionizing traditional operational and strategic approaches (Gutierrez et al. 2008, Steffen et al. 2019).

Small and medium-sized enterprises (SMEs) are a crucial component of the global economy, renowned for their agility, innovation, and significant contributions to employ-

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ment and GDP. However, despite the evident advantages of digital technologies, SMEs frequently face obstacles in adopting these innovations due to limited resources, lack of expertise, and resistance to change (Di Bella et al. 2023, OECD 2021). The potential of ImTs to enhance SMEs competitiveness through innovative product design, training, and customer engagement is substantial. However, their adoption in SMEs is relatively modest (Berg & Vance 2017, Gil-Cordero et al. 2023). This disparity emphasizes the necessity for a more profound comprehension of the affordances and constraints related to ImTs in SMEs, as well as the factors that motivate their adoption and integration into business practices. The first research question addressed by this study is:

RQ1: What are the key affordances and constraints affecting the adoption of immersive technologies in small and medium-sized enterprises?

This study is based on the framework proposed by Wendt, Kalgovas & Benlian (2022), which also reflects the previous literature well. The aim is to determine whether this framework can be expanded to encompass new aspects that are not currently represented. This leads to the second research question:

RQ2: Are there affordances and constraints affecting the adoption of immersive technologies in small and medium-sized enterprises that are not represented in the framework proposed by Wendt, Kalgovas & Benlian (2022)?

This study explores the adoption of ImTs in SMEs, focusing on the affordances and constraints that influence their integration into SME operations. The objective of this research is to validate and potentially expand the framework proposed by Wendt, Kalgovas & Benlian (2022). In doing so, the study aims to provide valuable insights for SMEs on how they can overcome challenges and take advantage of opportunities offered by ImTs to enhance their competitiveness and innovation capacity.

2 Theoretical Background

2.1 Immersive Technologies

The reality-virtuality continuum is a continuous scale that extends from the real environment to the virtual environment and thus covers all possible variations and compositions of real and virtual objects. This concept provides a comprehensive view of technologies that range from the augmentation of reality with virtual objects to full immersion in a virtual environment (Milgram et al. 1994). VR technology allows for complete immersion in digital environments and provides benefits for industries such as aviation, healthcare, and education through risk-free and cost-effective simulations (Slater & Sanchez-Vives 2016, Angelov et al. 2020, Radoeva et al. 2022). AR enhances the real world with digital overlays, providing an improved user experience in retail through product visualizations and interactive instructions for machine maintenance (Azuma 1997, Carmigniani & Furht 2011). MR merges AR and VR, creating environments where digital and physical entities interact. This promotes advancements in design, engineering, and collaborative work (Milgram et al. 1994, Suh & Prophet 2018). Extended reality (XR) is a broad category that includes virtual reality (VR), augmented reality (AR), and mixed reality (MR). These technologies facilitate transformative interactions in entertainment, professional development, and remote collaboration. As XR technologies

continue to evolve, they aim to create more inclusive and accessible digital environments, enhancing global connectivity (Jalo et al. 2022).

Immersive technologies, such as spatial audio and projection mapping, represent significant advancements in enhancing sensory experiences beyond the scope of XR. Spatial audio simulates three-dimensional sounds, enriching environments and improving immersion in both digital and physical spaces without the need for visual augmentation (Guastavino & Katz 2004). Projection mapping transforms physical spaces into interactive displays by projecting images onto varied surfaces, altering perceptions and interactions with the environment (Grundhöfer & Iwai 2018). These technologies expand the immersive experience by engaging other senses and modifying physical spaces. This illustrates the immense potential of immersive technologies to transcend traditional XR boundaries.

2.2 Leveraging Immersive Technologies in Small and Medium-sized Enterprises

ImTs offer significant opportunities and unique challenges for SMEs. ImTs enable SMEs to simulate complex processes, enhance training programs, and facilitate seamless collaboration across dispersed teams (Winkler 2018). By creating immersive and interactive environments, ImTs improve understanding and retention of complex information, providing SMEs with innovative platforms that transcend traditional barriers (Jalo et al. 2022, Wendt, Kalgovas & Benlian 2022, Wendt, Adam, Benlian & Kraus 2022).

However, integrating ImTs into SMEs operations presents significant challenges due to technological constraints, such as the need for specialized infrastructure and hardware, which can pose substantial cost barriers for SMEs. Additionally, unreliable internet connections and limited bandwidth can hinder the seamless deployment of ImT solutions. Organizational factors, including constrained financial resources, smaller IT departments, and resistance to change, further complicate adoption efforts. To effectively utilize ImTs, SMEs employees must receive comprehensive training and support (Leonardi 2011, Chan et al. 2020).

To tackle these challenges, a collaborative approach between ImT providers and SMEs is required. Providers must develop simplified, cost-effective solutions that are tailored to SMEs needs, ensuring data security and prioritizing user-friendly design. At the same time, SMEs should cultivate an innovative culture, allocate resources for employee training, and integrate ImT solutions into existing workflows to minimize resistance and maximize benefits (Alcácer & Cruz-Machado 2019, Jalo et al. 2022).

The adoption of ImTs in SMEs requires a nuanced understanding of their specific affordances and constraints. By addressing these challenges directly, SMEs can use ImTs to improve operational efficiency, competitiveness, and innovation capacity in the current digital landscape (Leonardi 2011, Wendt, Kalgovas & Benlian 2022).

2.3 Affordances and Constraints in Immersive Technologies Adoption

Conceptual frameworks that explain the inherent affordances and constraints of this process, such as the Technology Affordances and Constraints Theory, are critical to understanding how ImTs are adopted by SMEs (Majchrzak & Markus 2013).

Affordances, as initially conceptualized by Gibson (1979) within ecological psychology, refer to the potential actions enabled by an environment, highlighting the significance of human-environment interaction. This concept emphasizes the importance of utilizing environmental elements to derive benefits, as further elaborated by Steffen et al. (2019). Conversely, constraints act as counterforces to affordances, impeding potential actions or benefits. The Technology Affordances and Constraints Theory provides a refined perspective on these concepts within the realm of information systems. It emphasizes the dynamic interplay between technology and users, framing affordances and constraints in technological terms (Majchrzak & Markus 2013).

Steffen et al. (2019) categorize affordances into different groups that provide insights that are applicable across different organizations. These categories include affordances that introduce new features, mitigate negative realities, reinforce positive features, and replicate existing functionality. Wendt, Kalgovas & Benlian (2022) validate these affordances specifically in the context of SMEs, while also outlining the constraints—including technology, organization, environment, and actors—that significantly influence the adoption process.

Wendt, Kalgovas & Benlian (2022) have contributed a framework that serves as a foundational structure for understanding the affordances and constraints that impact the adoption of ImTs in SMEs (Figure 1).

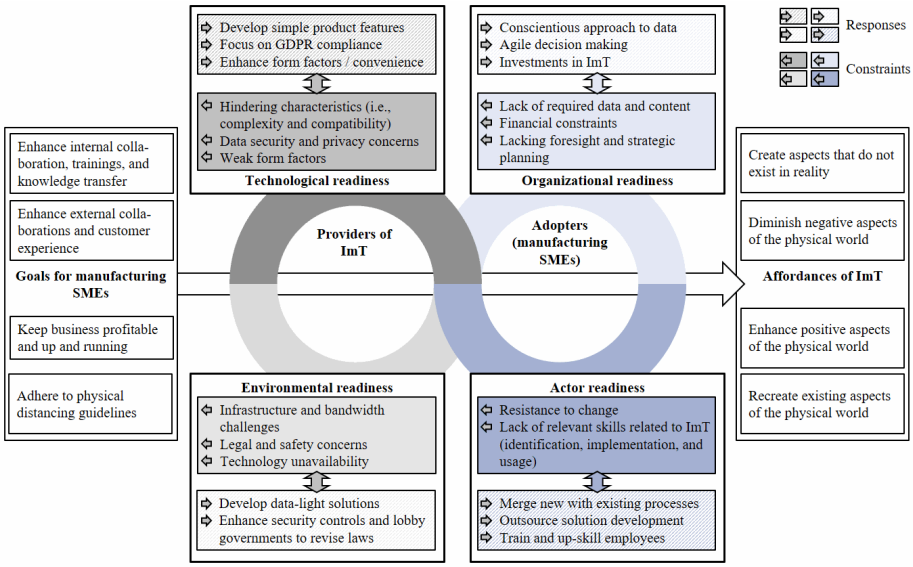

Figure 1. Affordances and constraints of ImTs adoption for SMEs (from Wendt, 2022).

In this study, the framework proposed by Wendt, Kalgovas & Benlian (2022) is employed to structure the coding of interviews, thereby facilitating the investigation of the initial research question (RQ1). Additionally, this study aims to potentially identify novel aspects pertaining to the adoption of ImTs in the context of SMEs that are not yet encompassed within this framework, thus addressing RQ2. Consequently, this study may validate this framework and potentially expand it by the inclusion of new aspects.

3 Methodology

In this study, our approach used semi-structured, focused interviews to gather insights from two key groups: professionals from companies that develop ImT solutions, hereafter referred to as ImT providers, and professionals from companies that currently use or have previously used ImT solutions, hereafter referred to as ImT users.

The adaptability of semi-structured interviews, which is underpinned by an interview guide yet open to impromptu queries and modifications, is well suited to eliciting detailed insights and unexpected discoveries from the participants. Furthermore, the emphasis on focused interviews on pre-defined topics that are familiar to both the interviewer and the interviewee fits seamlessly with our investigation into the unique affordances and constraints that SMEs face in using ImT solutions.

In order to conduct this study, two distinct interview guides were developed: one for ImT providers and one for ImT users. The first section of the interview guides comprised questions pertaining to the general aspects of the company and the role of the participant. The interview guide for ImT providers next includes inquiries concerning the available ImT products before focusing on the affordances and constraints of ImTs adoption from the perspective of their SME customers. This is then followed by a series of questions pertaining to the potential for the ImT industry in SMEs and the conclusion of the interview. The interview guide for ImT users focuses on questions pertaining to the affordances and constraints associated with the adoption of ImTs. This is then followed by a series of questions concerning the prospective implications of ImT use in SMEs and the conclusion of the interview.

To identify potential interviewees, we used a strategic combination of keyword searches on Google and LinkedIn. Recognizing the limitations of online visibility, especially among ImT users, we expanded our search to include case studies published by ImT providers, attendee lists from relevant ImT conferences, and various reports and interviews. The selection of SMEs for interviews was based on a comparison of company profiles against the SME criteria of the European Union, as outlined in Di Bella et al. (2023).

Table 1. Attributes of interviewees.

ID	Focus	Type of ImT	Position	Number of Employees
I01	Provider	VR tour	CEO	<20
I02	Provider	ImT solutions	CEO	<50
I03	User	VR showroom	Marketing manager	<100
I04	Provider	ImT software development	Head of marketing and sales	<250
I05	Provider	ImT applications	Founder and managing director	<20
I06	Provider	ImT consultancy	CEO	N/A
I07	Provider	VR display/simulation	Managing director	<250
I08	User	VR demonstration	Commercial manager	<250
I09	Provider	VR training	Consultant	<20
I10	Provider	VR visualization	Managing partner	<250

In the process of recruiting appropriate and interested interview partners, two factors presented particular difficulties. These were locating ImT users among SMEs and

engaging them for interview appointments. Despite these challenges, two interviews with ImT users and eight with ImT providers were conducted by reaching out directly to individual employees via business-focused social media platforms, most notably LinkedIn. All ten participants were based in Germany (see Table 1). The interviews were conducted from December 2021 to January 2022 via videoconferencing tools, namely Zoom and Microsoft Teams, in order to maintain security protocols in the context of the ongoing COVID-19 pandemic. The interviews with ImT providers lasted between 26 and 50 minutes, while those with ImT users lasted between 29 and 54 minutes. With the express consent of each participant, the sessions were recorded for transcription and subsequent analysis. No compensation was offered for participation in the study.

Following transcription, the interviews were subjected to a deductive process of coding based on a predefined list of categories and subcategories. In the initial coding cycle, we employ a descriptive coding approach, which summarizes the fundamental topic of a passage (Schmidt 2004). In a subsequent coding cycle, we align the topics with the list of affordances and constraints of the framework proposed by Wendt, Kalgovas & Benlian (2022) using the coding scheme shown in Table 2. Relevant aspects that could not be clearly coded were reported individually.

Table 2. Coding scheme.

Category	Subcategory
Affordances	Enhancing positive aspects of the physical world
	Diminishing negative aspects of the physical world
	Create aspects that don't exist in the physical world
	Recreating aspects of the physical reality
Constraints	Lacking foresight and strategic planning
	Financial constraints
	Lack of required data and content
	Lack of relevant skills related to ImTs
	Resistance to change
	Technology unavailability
	Legal and safety concerns
	Infrastructure and bandwidth
	Weak form factors
	Data security and privacy concerns
	Hindering characteristics

The following example is provided to illustrate the coding process. In response to the question "Which features of your product are most important to your customer?" posed by the interviewer, the participant stated the following: "Right now it's presentations that we do for clients. So these are 360 degree presentations where the goal is to present the company, to show the products of the company and of course to give a virtual impression of this location, what the company offers. And it's not just that with VR technology, I mean video has been around for ages and also cinema and movies, but with this 360-degree technology I have a completely different impression. It's really like being there." In the initial phase of the coding process, this passage has been allocated the topic of

"virtual presentation of existing products using virtual reality technology." Subsequently, in the second coding step, it was categorized as "affordance" and subcategorized as "recreating aspects of physical reality." The appearance of each subcategory was counted only once for each participant.

4 Results

The primary objective of this study was to systematically collect and analyze data to evaluate the affordances and constraints influencing the adoption of ImTs within small SMEs. Particular emphasis was placed on understanding the barriers to the adoption of ImTs, an area that remains underexplored in the existing scholarly discourse (Jalo et al. 2022). Through methodical thematic analysis and coding of interview transcripts, we identified a spectrum of affordances and constraints related to the adoption of ImTs in SMEs. These elements were systematically categorized, recognizing instances where certain findings spanned multiple categories due to interrelatedness.

Tables 3 and 4 present our comprehensive findings on the affordances and constraints associated with the adoption of ImTs in SMEs. It is imperative to note that the data presented does not reflect the frequency of affordances or constraints mentioned within each interview, but rather illustrates their presence within the collected empirical evidence.

4.1 Affordances Associated with the Adoption of ImTs in SMEs

In the present study, the affordance associated with the adoption of ImTs in SMEs mentioned by the largest number of participants was recreating aspects of the physical reality (Table 3).

Table 3. Affordances related to the adoption of ImTs in SMEs.

Affordance	Respondents	Users	Providers
Enhancing positive aspects of the physical world	I02–I04;I06–I09	2/2	5/8
Diminishing negative aspects of the physical world	I02–I09	2/2	6/8
Create aspects that don't exist in the physical world	I01;I03;I05–I07;I09–I10	1/2	6/8
Recreating aspects of the physical reality	I01–I10	2/2	8/8

The recreation of physical reality emerged as a dominant affordance, with two participants highly valuing the ability of ImTs to represent abstract information and virtually simulate locations [I01;I04]. This affordance extends to the re-imagining of product demonstrations and training methods. In addition, the potential to bypass the use of physical prototypes, thereby facilitating direct interaction with digital representations, has been particularly appreciated [I02;I05]. To illustrate, in the context of manufacturing SMEs, the use of ImTs has the potential to enhance efficiency in product development. This may be achieved by reducing the number of physical models or products in the initial stages, or even by eliminating them altogether [I02]. This approach has the potential to facilitate more rapid and cost-effective product development. However, this

is often overshadowed by the overarching goal of minimizing resource consumption and increasing operational efficiency [I02;I03;I05]. Given that the ImT industry is dominated by custom software, the implementation of ImT applications is prohibitively expensive for many SMEs. This can lead to a scenario where, even if an ImT solution offers significant efficiency benefits, it may not be cost-effective for SMEs in comparison to larger enterprises due to limited scalability [I02].

The second most frequently mentioned affordance, as evidenced by the study results, was diminishing negative aspects of the physical world (Table 3). The use of ImTs was praised for its role in enhancing workplace safety by effectively reducing physical hazards [I04]. This was further exemplified by an interviewee's comment on the use of ImTs to mitigate the challenges posed by the ongoing COVID-19 pandemic [I03]. In addition, a novel sub-affordance related to the prevention of intellectual property theft was identified, albeit requiring the integration of ImTs with additional technologies such as cloud computing [I05]. Another insightful observation highlighted the usefulness of ImTs in reducing the burden on SMEs' key knowledge holders, thereby streamlining the dissemination of information within organizations characterized by concentrated knowledge bases: "The operational dynamics of SMEs rely heavily on key knowledge holders. ImTs, in particular augmented reality, offer a novel means of reducing the burden on these individuals by augmenting the physical workspace with critical information" [I06].

The enhancement of the positive attributes of the physical domain was confirmed by the research, which recognized several sub-affordances such as enhanced collaboration, improved coordination, enhanced communication, and enriched information provision [I02;I03;I06;I07;I08;I09]. The concept of information filtering has been articulated as: "Virtual reality allows for the selective representation of reality, allowing for the emphasis of elements deemed crucial, thus tailoring the information content to specific needs" [I09].

In addition, the ability to conceptualize entities and scenarios beyond the constraints of physical reality received positive support. Four participants noted that ImTs enable representations that are not bound by current temporal and spatial limitations, thereby facilitating experiences and visualizations that extend beyond traditional boundaries [I03;I05;I09;I10]. This was succinctly summarized by one respondent: "ImTs enable us to transcend conventional perception, allowing us to explore and interact with phenomena on a scale previously unattainable by standard means" [I07].

4.2 Constraints Associated with the Adoption of ImTs in SMEs

Within the data collected, the constraints to the adoption of ImTs in SMEs mentioned by the largest number of participants included lacking foresight and strategic planning, resistance to change, and the hindering characteristics inherent in ImTs (Table 4).

Lacking foresight and strategic planning emerged as a critical factor leading to unsuccessful ImT investments among SMEs. Two participants reported that SMEs management often lacks a comprehensive understanding of the capabilities and limitations of the technology [I01;I08]. This knowledge gap has led to unrealistic expectations and goals, as one respondent highlighted the mismatch between their clients' aspirations and

Table 4. Constraints related to the adoption of ImTs in SMEs.

Constraint	Respondents	Users	Providers
Lacking foresight and strategic planning	I01–I09	2/2	7/8
Financial constraints	I01–I06;I08–I09	2/2	6/8
Lack of required data and content	I01–I03;I05–I06;I08–I09	2/2	5/8
Lack of relevant skills related to ImTs	I04;I06–I10	1/2	5/8
Resistance to change	I02–I10	2/2	7/8
Technology unavailability	I01–I02;I05–I07;I09-I10	0/2	7/8
Legal and safety concerns	I02;I04–I07;I09	0/2	6/8
Infrastructure and bandwidth	I02;I05–I07;I10	0/2	5/8
Weak form factors	I01;I03;I05–I06;I09	1/2	4/8
Data security and privacy concerns	I02;I05;I08–I09	1/2	3/8
Hindering characteristics	I01–I02;I04–I10	1/2	8/8

the practicalities of their business operations: “Many of our customers have a strong interest in exploring virtual reality technologies, envisioning ‘Star Trek’-like scenarios. However, such visions are often disconnected from their actual business processes and goals, indicating a lack of grounded business strategy” [I02]. This observation was further supported by additional feedback indicating that there is widespread uncertainty among SMEs management about the practical benefits of ImTs, which is dampening enthusiasm for their adoption [I03;I04;I08]. A common sentiment among SMEs is the prioritization of immediate financial returns over long-term strategic benefits, as exemplified by one respondent’s comment: “The focus tends to be on tangible results that can be achieved in the short term, often within the next year or two, rather than the wider potential that these technologies could offer in the longer term” [I09]. Furthermore, it has been suggested that the existing corporate culture within some SMEs may contribute to a lack of motivation to pursue technological investments, particularly where traditional methods continue to meet current needs without immediate pressure to innovate [I05]. These findings underscore the significant impact of strategic planning and cultural factors on the willingness and ability of SMEs to adopt ImTs. The findings suggest that for ImTs adoption to be successful, it is imperative for SME management to cultivate a deeper understanding of the technology and align its implementation with the organization’s strategic goals and cultural context.

Similarly, nine interviewees indicated that resistance to change constituted a significant constraint. Given the nascent stage of these technologies, a segment of the workforce, particularly those less inclined to adopt technology, showed apprehension about adopting ImTs [I02;I10]. This reluctance is exacerbated in SMEs, which are characterized by a conservative ethos, as articulated by one interviewee: “Conservative individuals are present in every organization, or the organizations themselves may embody a conservative culture” [I04]. Two participants highlighted an overarching lack of awareness and acceptance among employees as a key barrier to the exploration and application of ImTs [I08;I09]. The critical role of internal champions in advocating for ImTs was highlighted: “There is often a need for a visionary within the company. . . someone who is determined

to pioneer and integrate these technologies" [I07]. Concerns were also raised about the accessibility of ImTs for people with disabilities [I08].

Challenges specific to the practical application of ImTs include technical limitations such as resolution and frame rate issues [I01;I02], and the complexity of presenting information on XR devices [I06]. Interoperability issues between ImT software and hardware also emerged as a notable limitation [I05]. In addition, the lack of interfaces to facilitate seamless integration between ImT hardware and other critical systems was identified, leading to operational discontinuities [I07;I08].

A recurring theme was the lack of standardized, readily deployable solutions across the industry, as exemplified by one participant's observation: "There is a gap in industry-standard applications that SMEs can easily adopt... a universal standard that transcends sector boundaries is essential" [I02;I05]. This gap is reported to result in the proliferation of siloed systems that are difficult to integrate into the existing IT infrastructure of SMEs [I06]. Five respondents argued that there is a need for the standardization of ImT hardware and software among SMEs in order to facilitate the provision of cost-effective and adaptable ImT solutions [I02;I04;I05;I09;I10]. Consequently, it can be concluded that the lack of standardization represents a significant constraint on the adoption of ImTs by SMEs.

Financial constraints significantly limit the uptake of ImTs, with the limited budgets of SMEs unable to absorb the costs associated with these technologies [I05]. This financial barrier is exacerbated by the structural nature of SMEs, where the scalability of ImT solutions does not parallel that of larger enterprises, reducing their attractiveness [I05]. Financial constraints also lead to a lack of essential data and content, as well as a lack of relevant technological skills [I02;I09]. The reliance on external ImT providers to compensate for these shortcomings was highlighted, with one user noting the lack of in-house expertise in software development and interface design [I08].

While data security and privacy were acknowledged as considerations, they were not seen as a significant barrier to the adoption of ImTs in SMEs [I08]. The evolution of device ergonomics and user safety measures was noted, although concerns about motion sickness and hygiene practices remain, especially when hardware is shared [I09]. Finally, the need for a robust technical infrastructure was discussed, with a consensus that while essential for data streaming applications, it is not a universal barrier to the adoption of ImTs in SMEs [I04;I06]. However, streaming high-resolution data was identified as significant challenge, especially in bandwidth-constrained environments [I07;I02].

5 Discussion

This study explored the affordances and constraints of ImTs adoption in SMEs. It is based on the framework proposed by Wendt, Kalgovas & Benlian (2022). Through interviews with providers and users of ImTs, it aimes to enrich the understanding of the adoption of ImTs in the context of SMEs. The results of this study confirm the previously theorized affordances and constraints and thereby provides additional validation of this framework. In addition, this study identifies two aspects that are not explicitly reflected in this framework. One is the affordance of improved worker safety, which is particularly relevant in hazardous environments. The other is the lack of standardization as additional

constraint, which in turn imposes financial constraints on the adoption of ImTs in the context of SMEs.

5.1 Affordances

Our findings highlight several affordances associated with the adoption of ImTs in SMEs. First, ImTs enable the replication of physical reality, enabling SMEs to simulate environments, products, and processes. This simulation capability facilitates product development, training, and remote operations, which is consistent with previous research highlighting the role of ImTs in enhancing operational efficiency and resilience (Berg & Vance 2017, Suh & Prophet 2018).

In addition, ImTs can mitigate operational negatives by improving worker safety, particularly relevant in hazardous industries. However, the COVID-19 pandemic has revealed that worker safety is not exclusively a concern in hazardous industries. The implementation of ImTs can facilitate the continuity of business operations, as evidenced by the experience during the pandemic. The impact on the economy demonstrated that it can be of great importance to maintain operational capability.

5.2 Constraints

Despite the benefits, SMEs face several barriers to the adoption of ImTs. Strategic planning deficiencies, characterized by a lack of alignment between ImT investments and business objectives, hinder successful adoption. This is consistent with previous research highlighting the importance of strategic alignment for technology integration (Benlian 2013, Govender & Pretorius 2015, Markus & Silver 2008). Resistance to technological change, particularly within conservative organizational cultures, further complicates adoption efforts. Overcoming this resistance requires leadership advocacy and cultural shifts toward innovation (Leonardi 2011, Vossen 1998).

In addition, inherent technological hurdles, such as compatibility issues, present significant obstacles for SMEs in adoption of ImTs. The lack of standardization in ImT solutions was identified as a particular constraint of interest in the context of SMEs. Due to limited resources, the necessity of custom software for most ImT use cases might contravene cost-effectiveness for SMEs in contrast to large enterprises with higher scalability.

5.3 Theoretical and Practical Implications

This study contributes to the academic discourse on the adoption of ImTs in SMEs by highlighting both the affordances and constraints associated with their implementation. Firstly, it validates the framework on adoption of ImTs in the context of SMEs proposed by Wendt, Kalgovas & Benlian (2022). Secondly, this framework is enhanced by the addition of the affordance of “improved worker safety” and the constraint of “lack of standardization.” The current literature on the adoption of ImTs in SMEs does not address these novel aspects adequately.

The findings of this study highlight for practioneers that SMEs should prioritize strategic alignment, foster a culture of innovation, and invest in technological readiness to maximize the benefits of ImTs adoption. In addition, ImT providers need to develop user-friendly and standardized solutions that address the unique affordances and constraints of SMEs.

5.4 Limitations

The limitations of this study are primarily due to the relatively small number of participants, with only eight ImT providers and two ImT users among SMEs. The imbalanced proportion of participants introduces a bias in the results of this study, with a greater representation of the perspective of the ImT providers. The direct inquiries to the ImT providers concerning the desires and requirements of their customers may have somewhat diminished this phenomenon. The difficulties encountered in recruiting a greater number of participants, particularly among ImT users, may also be indicative of the limited uptake of these technologies in SMEs.

Besides, the study design and qualitative nature of the research restrict the possibility of generalizing the findings to SMEs in the aggregate. Additionally, the study did not examine the financial implications of ImT adoption for SMEs, which could be a significant factor influencing adoption decisions. Furthermore, the cross-sectional design of the study restricts the scope for investigating temporal trends and long-term impacts of ImT adoption.

6 Conclusion

In conclusion, this study provides valuable insights for practitioners and researchers on the adoption of ImTs in SMEs. It identifies both the affordances and constraints associated with the adoption of ImTs in the context of SMEs. Addressing the identified constraints and leveraging the affordances of ImTs adoption can empower SMEs to innovate, improve operational efficiency, and gain a competitive advantage in the digital marketplace.

It would be beneficial for future research to prioritize the user perspective, or even to concentrate on potential candidates for the utilization of ImTs. Moreover, larger sample sizes are required for qualitative research approaches in addition to quantitative studies in order to further study this phenomenon. Furthermore, the role of government policies, industry collaborations, and technological advances in facilitating the adoption of ImTs in SMEs should be investigated. Longitudinal studies could provide insights into the long-term impact of ImTs adoption on SMEs performance and competitiveness.

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