The rise of Phygital Reality: insights from Structural Topic Modelling

DANIELE VIRGILLITO[1] FRANCESCO RUSSO[2] ALESSIA MUNNIA[3] MARCO ROMANO[4]

Abstract

Latest technological advancements enabled to go beyond digitalisation, offering opportunities to combine physical and digital realities in a hybrid phygital one, with the potential to disrupt several activities. The aim of this work is to conduct an explorative literature review on the emerging topic of phygital reality. We employed Structural Topic Modelling, a text mining methodology, to analyse data retrieved from Web of Science and Scopus databases. The analysis led to the identification of seven thematic areas that allow to gain a broad understanding of phygital applications in different contexts: (1) Metaverse, (2) Health Technology, cultural heritage and gaming, (3) Fashion & Luxury, (4) Customer experience, (5) Education, (6) Tourism, (7) Retail experience. The study provides some clarity on the exploitation opportunities of phygital reality and identifies a gap concerning the phygital applications to enhance social inclusion toward some disadvantaged and marginalised segments, thus providing insights on business opportunities to fill this gap.

Key words: *phygital, text mining, structural topic modelling, social inclusion*

Framing of the research. *Covid-19 pandemic led consumers worldwide engage in exercise, shopping and socialisation activities from their own homes, thus accelerating an already existing trend. These habits partially survived even after the acute phase of pandemic had passed, encouraging the development of a "phygital reality"(Schneider, 2021).*

The phygital combines two types of realities: the traditional physical one and the digital one (Mele et al., 2023). The term describes the social interactions taking place at the intersection between physical and digital contexts (Mele & Russo-Spena, 2022) based on the combination of physical and digital contents (Gelsomini et al., 2021). Phygital experience originally dealt with retail, but it was subsequently developed in fashion and banking industry (Ballina et al., 2019). Phygital is however an overarching phenomenon that leverages technological breakthroughs in the field of computing, artificial intelligence, augmented reality and virtual reality to transform many of our daily activities, from work and study to travel and entertainment, toward the integration of virtual environments in real life. Research on this topic is still in its infancy and embraces different fields. The aim of this work-in progress study is to review existing literature on phygital applications by applying structural topic modelling (STM) methodology, in order to make some clarity on the main research streams and identify some gaps to be filled by future research. The remaining of the manuscript is organised as follows: a methodology section represents the main steps taken collect data and conduct the STM analysis, a results section presents and discusses the main topics identified, and eventually we highlight the limitations, managerial implications and the originality of our work.

Methodology. *We retrieved all the papers pertaining to the subject of interest by searching for the term "phygital" in the Web of Science and Scopus databases. Both searches were limited to works published only in English, with no specific time frame. There were 324 records retrieved in total. We decided not to restrict the search to a specific publication type because, given the exploratory nature of the study and the novelty of the topic, it was deemed appropriate to be as inclusive as possible at this stage of the research.*

Next, we used KNIME Analytics to carry out the text mining procedures, implementing the standard stages of text pre-processing on the extracted abstracts (Tursi & Silipo, 2018). Initially, we removed the repeated entries, resulting in a final sample size of 196 observations. Next, we eliminated stop words and non-descriptive words based on their low word frequency, and then we used the Kuhlen Stemmer. Ultimately, we constructed the bag of words by taking into account all the individual words and the most occurring bi-grams.

[1] University of Catania
e-mail: daniele.virgillito@unict.it
[2] University of Catania
e-mail: francesco.russo@phd.unict.it
[3] University of Catania
e-mail: alessia.munnia@phd.unict.it
[4] University of Catania
e-mail: romanom@unict.it

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In order to get the main themes that may effectively summarise the content of the 196 abstracts, we used the Structural Topic Modelling (STM) approach developed by Roberts et al. (2019). STM, like the Latent Dirichlet Allocation (LDA) model introduced by Blei et al. (2003), enables the summarization of a collection of texts into a set of themes. Each topic is described by a list of terms, and each document is assigned a probability of belonging to each subject (Blei et al., 2003). In LDA, it is believed that all documents have the same distribution of themes (topic prevalence). On the other hand, in Structural Topic Modelling (STM), each document is estimated to have a unique distribution of topics, and the model also allows for correlation between topics. When determining the best number of topics, four factors may be taken into account: exclusivity, semantic coherence, held-out likelihood, and residual variance. In our scenario, exclusivity implies that the best answer is achieved by selecting between 6 and 11 topics. Semantic coherence is achieved with fewer than 7 topics. The held-out probability is achieved with between 6 and 11 topics. The residual variance is around 13 topics. Next, we assessed three potential options for subjects: 6, 7, and 8. Ultimately, we chose the second option since it was simpler to read and had less instances of overlapping themes in terms of their real significance.

Results. *The table below provides a concise summary of the subjects and keywords that have been identified.*

Table 1: Identified topics and keywords

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6	Topic 7
business	data	consumer	brand	development	approach	behavior
concept	design	customer	consumer	digital	art	customer
digital	digital	customer-experience	consumption	education	cultural	dimension
emerg	game	design	experience	educational	digital	experience
future	information	engagement	fashion	generation	experience	play
metaverse	interaction	experience	luxury	learn	innovation	positive
potential	physical	journey	online	proces	museum	retail
technology	robot	market	product	student	social	service
virtual	space	physical-digital	retail	support	tool	store
world	system	strategy	strategy	teacher	tourism	technology

The following subsections provide a discussion of the identified topics.

Topic 1: Metaverse

The convergence of physical and digital realms, commonly known as "phygital", has received significant scholarly attention in recent literature, particularly regarding its integration with the expanding concept of the metaverse (Omarali, 2023). As a result, new mechanisms of value creation and capture at the intersection of physical and virtual economies emerge in the metaverse (Mancuso et al., 2023). Technological developments are expected to introduce a new organization to physical and virtual socio-spatial relations, as well as new socio-technological groups (Hamurcu, 2022).

The new human dynamics will be a seamless integration of both physical and digital realms, known as phygital (Sui & Shaw, 2022). The pandemic has accelerated the shift towards phygital marketing, with social media and e-commerce playing a crucial role (Silvia et al., 2023). Scholars have explored various applications of this integration across different domains, including retail. Particularly, they have focused on an innovative approach to consumer behaviour (Johnson & Barlow, 2021; Silva & Cachinho, 2021). Existing literature emphasizes the transformative potential of using the metaverse to enhance user engagement and interaction by adding digital overlays to physical spaces (Chrétien-Ichikawa, 2022; Ioannidis & Kontis, 2023; Tse & Pun, 2024). It explores the hybridization of marketing tools, including phygital omnichannel promotion and contactless sales across new digital frontiers. Additionally, it examines the implementation of the empirical concept in world trade activities (Nozdreva et al., 2023); research has shown how retailers can use the metaverse to create immersive shopping experiences that combine digital product visualization with physical store environments, potentially transforming the retail industry (Mengalli et al., 2023). In addition to the need to measure how customers find, interact with, and consume content and images, the metaverse ecosystem has identified the need to optimize relationships with consumers in order to mitigate purchase difficulty gaps (Davies et al., 2024; Mengalli et al., 2023). Furthermore, the education sector has recognized the potential of the metaverse to facilitate immersive learning environments where students can engage with educational content in a dynamic and interactive manner, such as in a game (AydoÄŸdu et al., 2021; Guga, 2015). Likewise, the entertainment industry is at the leading edge of embracing digital metaverse experiences, allowing users to participate in interactive stories beyond the boundaries of traditional media (Del Vecchio et al., 2023; Giovannini & Bono, 2023; Russo et al., 2024). A number of studies highlight that these integrations are capable of transforming industries such as retail, entertainment, education, healthcare, etc (Terenzi & Vignati, 2021). While the literature acknowledges the myriad opportunities presented by phygital metaverse applications, it also highlights several challenges and considerations. Concerns about privacy, ethical implications, and technological limitations emerge as critical factors that warrant the attention of the scientific community.

Topic 2: Health Technology, cultural heritage and gaming

Researchers have investigated various applications of phygital technologies, including wearable devices, remote monitoring systems, augmented reality (AR) and virtual reality (VR) interventions (Bini et al., 2023) related to healthcare industry. These technologies have the potential to transform healthcare delivery by improving patient engagement, enabling personalized interventions, and optimizing clinical workflows. The convergence of virtual, augmented, mixed,

and extended reality, mobile tools, the Internet of Things, and artificial intelligence has enabled the growing symbiosis between human spaces and computers. This is leading to the emergence of mixed physical and digital ecosystems that will have a transformational impact on people's lives (Gaggioli et al., 2023).

The potential role that phygital systems could play in enhancing mental health and well-being is still under investigation (Spitale et al., 2019). By simulating realistic healthcare scenarios and providing immersive experiences, these technologies can enhance learning outcomes, improve patient comprehension of complex medical concepts, alleviate pain and anxiety during medical procedures, and support people with intellectual disabilities (Gelsomini et al., 2021). Wearable devices equipped with biometric sensors allow for real-time monitoring of vital signs and health parameters, which can facilitate early detection of health issues and empower individuals to proactively manage their well-being (Gennari et al., 2023; Sayem et al., 2023; Schiavi et al., 2023). The literature emphasizes the significance of human-centered design principles and interdisciplinary collaboration in developing effective phygital healthcare solutions (Barresi et al., 2023). By integrating insights from fields such as human-computer interaction and psychology, researchers can design intuitive and user-friendly interfaces that enhance usability and acceptance among healthcare providers and patients alike (Gelsomini et al., 2021).

Research in this topic has explored the potential of phygital gaming experiences to engage audiences with cultural heritage artifacts, sites, and narratives, linking health, heritage, and gaming, discovering the transformative effects of such experiences (Andrade & Dias, 2020; Cirafici et al., 2022). The integration of augmented reality, virtual reality, and mixed reality (MR) with gaming platforms allows users to explore virtual reconstructions of historical sites, interact with digitized artifacts, and participate in narrative-driven experiences that bring the past to life (Bollini, 2022; Borsotti, 2022; Marra et al., 2023; Turco & Giovannini, 2020), especially those that are inaccessible due to restoration work (Hallot et al., 2021). AR can provide additional layers of information to support physical exhibitions while also extending the knowledge produced beyond the art gallery's boundaries.

This highlights the immersive qualities of extended reality technologies and the phygital future that is emerging in the exhibition space (Brusaporci & Maiezza, 2021; Crossley et al., 2023). Researchers have explored the role of phygital gaming in fostering cultural understanding, empathy, and appreciation among diverse audiences. This transcends geographical and temporal boundaries, facilitating meaningful connections with heritage resources(Prajapati & Das, 2023). Moreover, the literature emphasizes the significance of collaborative and participatory approaches in developing phygital gaming experiences. This involves engaging stakeholders, such as cultural institutions, game developers, scholars, and community members, in the co-creation process (Lupetti et al., 2018; Piumatti et al., 2017; Pratticò et al., 2019).

Topic 3: Fashion & Luxury

Phygital retailing blends the physical and digital worlds to create unique customer experiences. Papers included in this topic have examined how luxury fashion brands are using phygital approaches to create immersive and cohesive brand experiences that seamlessly integrate physical and digital touch points. While the applications of phygital retailing are on the rise, there is still a lack of understanding of what factors can influence customer experience, particularly hedonic factors (Banik & Gao, 2023). Through initiatives such as virtual fashion shows and interactive digital installations, brands can extend their reach beyond traditional brick-and-mortar stores and engage global audiences in innovative ways. With the increase in consumers' online and offline interactions, there is a greater need for marketers to prompt integrated customer experiences. This can be achieved through online and offline interactions (Lee et al., 2023). Phygital marketing is characterized by its focus on the quality of consumer experiences, but few papers have explored how neuroscience can be used to study these experiences (Johnson & Barlow, 2023). Additionally, the literature emphasizes the importance of phygital technologies in enhancing the exclusivity and desirability of luxury fashion products. These technologies enable brands to provide personalized and customized experiences that appeal to affluent consumers (Jacob et al., 2023). Some research questions explore how human interactions with experienced salespeople contribute to the value of the phygital experience (Samy Soliman & Erakat, 2023). Omnichannel retailing has transformed retailers' strategies for engaging customers in making purchase decisions (Mikheev et al., 2021). Contemporary luxury marketing literature addresses the research gap by explaining the role of phygital functionality in enhancing relationship building, social engagement, and trust and commitment development, resulting in a seamless customer experience and enhanced loyalty and patronage(Pangarkar et al., 2022). Researchers have explored the implications of phygital strategies for brand storytelling. They emphasize the importance of authenticity and heritage in conveying the brand's values and identity across digital platforms (Banik, 2021). Moreover, recent literature emphasizes the importance of luxury fashion brands implementing an omnichannel strategy that seamlessly integrates both online and offline channels to provide a cohesive and uninterrupted shopping experience for consumers (Mele et al., 2021). Current research aims to explore innovative ways in which luxury fashion brands can leverage phygital approaches to enhance brand equity, foster consumer loyalty, and drive sustainable growth in an increasingly digitized marketplace.

Topic 4: Customer experience

Consumers are nowadays accustomed to shift from physical to digital settings and the availability of phygital spaces opens up to novel opportunities to further enrich customer experience (Ballina et al., 2019). The spread of phygital environments has contributed to fill the gap between online and offline along the entire customer journey to deliver an enhanced customer experience, relying on the use of smart technologies (Mele & Russo-Spena, 2022).

Part of the literature included in this topic is focused on luxury customer experience. The intrinsic characteristics of luxury industry (high quality of physical products emphasised by ideals of legacy and craftsmanship as well as the services provided) make it look as mismatched with anything linked to digitalisation (Black, 2022). However, it is actually hugely impacted by the implementation of phygital solutions for enhanced interactions with customers (Kumar, 2023; Pangarkar & Shukla, 2023).

In this topic, research has evidenced the underlying mechanisms of the impact of phygital on customer experience. A key factor is represented by the medium used to provide services and interact with customers during the purchase process, such as mobile applications (Lawry, 2023; Silva e Sousa et al., 2022). Some studies deal with experience-related characteristics that make it phygital, such as the sense of touch simulation in a dematerialised environment (Ornati & Kalbaska, 2022) and phygital connectedness, intended as the tendency of consumers to showcase their physical experience with the product on social media networks (Kumar, 2023). Another aspect highlighted by scholars is the impact of phygital on customer relationship management performance metrics such as customer satisfaction, loyalty and retention (Mishra et al., 2023).

Topic 5: Education

The phygital environment is playing a key role in the digitalisation process of education, significantly accelerated by covid-19 pandemic (Fazzin, 2022; Zaitseva et al., 2023), which raised the need for remote or distance learning (Distefano, 2023), at all levels, from primary and higher education to university and beyond (Fazzin, 2022). Phygital education is the integration of traditional classroom methods with digital learning, thus going beyond the digital education practices developed during pandemic and restructuring the educational process in such a way that the role of both students and teachers is transformed (Zaitseva et al., 2023). It particularly fits students belonging to Generation Z, also known as phygital generation (Tolstikova et al., 2021). Scholars in the education field have started to investigate whether teaching effectiveness can increase in a phygital mode (Chaturvedi et al., 2021).

Literature evidences that phygital environments can innovate the educational process in different ways. It introduces new educational practices, based on the use of smartphones to foster socialization and collaborative learning (Fonseca & Mealha, 2022) as well as on the adoption of phygital textbooks to support an immersive learning experience to enable collaborative active learning (Prajapati, 2023). As emerges from the literature, the implementation of phygital learning practices can also take place by including gaming technologies in the educational process, providing students with the opportunity to train and rehearse their skills in a simulation environment (Zaitseva et al., 2023), also with the support of augmented reality (Chaturvedi et al., 2021). Education gamification in phygital environments is also reported as an effective solution for students with special educational needs (especially those aged between 5 and 12 years, for whom the border between physical and digital disappears), delivering a playful learning experiences by means of specific Apps (Goretti et al., 2020).

Some studies shed light on possible benefits of phygital education. Phygital solutions can therefore guide education towards enhanced inclusiveness, addressing the risk of digital exclusion for students with special needs (Efthymiou, 2023; Hemdan et al., 2023). In addition to being more inclusive, another great potential of phygital education highlighted in literature which however requires further investigation, is personalisation (Chaturvedi et al., 2021).

Topic 6: Tourism

The potential of the phygital environment in tourism industry mainly concerns the delivery of enhanced tourist experience. Tourists can indeed benefit from a dual physical-virtual world in a new experiential model that allows them to explore in an immersive and interactive way (Clemente et al., 2024)

A stream of literature evidences that phygital solutions are becoming increasingly popular in cultural institutions. Many studies in this topic provide examples of phygital applications in museums (Baldi, 2022; Baratta et al., 2022; Debono, 2021; Zhuang & Zheng, 2023). The phygital formula in such contexts represents a means to co-create cultural value (Clemente et al., 2024). The need for museums to implement phygital strategies and deliver phygital experiences has increased during pandemic but even post-pandemic scenarios involve the possibility to rely on phygital experiences. These scenarios may consist in offering a digital version of the physical tour or complementing the physical tour with some digital contents (Debono, 2021). As evidence by Clemente et al. (2024), some internationally popular museums such as Louvre (France), British Museum (UK), National Gallery (UK), National Museum of China (China) and Metropolitan Museum of Art (USA) have already implemented augmented/virtual reality based exhibitions and immersive tours as well as digital environments. Such solutions improve accessibility, enrich the visit and visitors' engagement, also allowing to personalise the visit with specific human-like interactions. According to the authors, such solutions contribute to the four dimensions of phygital experience: extended socialisation, extended self, extended sensation and extended setting. In some contexts, such as wine tourism, the phygital mode can be exploited to deliver an enjoyable learning experience concerning specific aspects tourist may be curious about (e. g. learn how to prune the vines wearing a virtual reality helmet instead of listening to the traditional explanations by winemakers), without losing human contact and relationship with tourists (Lorey et al., 2023).

By implementing a moderate digital approach to guide the physical visit can enhance the tension of artworks and expand the space for public discourse and the creation of game mechanisms that assign missions and roles to the public in a phygital manner, generates excitement and better engages participants. However, an excessive use of sensory stimulation may cause cognitive difficulty and result in negative user experience. The right balance should be found in

establishing a multi-dimensional dialogue relationship between "Person-Content-Object-Field" (Zhuang & Zheng, 2023).

Research in this stream also highlights the impact of the hybridisation of physical and digital components on destination performance, in terms of experience co-creation (Sustacha et al., 2022), tourists satisfaction and the overall competitiveness of smart tourist destinations (Ballina et al., 2019), destination recovery and resilience (Muangasame & Tan, 2023).

Topic 7: Retail experience

Retailers can improve customer engagement, facilitate informed decision-making, and enhance the overall shopping experience through initiatives such as interactive fitting rooms, virtual product try-on experiences, and personalized digital signage (Kumar et al., 2024). Publications included in this topic have examined how phygital technologies, including interactive displays, can be leveraged to create immersive and engaging retail environments that seamlessly blend online and offline interactions (Roten & Vanheems, 2023). The literature also emphasizes the importance of phygital strategies in addressing key challenges facing the retail industry, including showrooming, omnichannel integration, and declining foot traffic in physical stores. Due to mass customization, retailers cannot present all possible configurations in-store for customers to experience. In addition, consumers are shifting to online shopping (Van Rheden et al., 2023). Retailers can bridge the gap between digital convenience and physical touch, offering consumers the best of both-while driving brand loyalty and advocacy. Phygital customers' needs and expectations that are satisfied through in store technologies and to detect the in store strategies that use these technologies to make the store attractive and experiential (Bonfanti et al., 2023). Furthermore, the impact of these technologies on consumer behaviour is explored, with emphasis on the role of sensory stimulation, emotional resonance, and social interaction in shaping purchase decisions and brand perception; to enhance the phygital customer journey and shopping experience, retailers aim to meet customers' needs for utilitarian, hedonic, social, and playful experiences. These approaches increase gratification and emotions towards the acceptance of phygital retail, using user-generated content (Ray et al., 2023).

The literature analysed also highlights the importance of retailers adopting a customer-centric approach to phygital retailing, prioritizing seamless integration, personalized experiences, and data-driven insights to meet the evolving needs and preferences of the modern consumer. The in-store experience for customers can be enhanced through the use of phygital devices that showcase the appeal of technology to consumers. Retailers can leverage these perceptions to improve the overall retail experience (Boudkouss & Djelassi, 2021).

Current research has focused on understanding the long-term impact of phygital retail experiences on consumer satisfaction, brand loyalty, customer satisfaction, and business performance, as well as innovative strategies to maximize the potential of phygital technologies in driving retail innovation and competitiveness (Guzzetti et al., 2024; Lecointre-Erickson et al., 2021).

Research limitations. *The study has some limitations. We conducted an extensive literature search to encompass all aspects of the topic, which resulted in the inclusion of some less scientifically rigorous document types in the sample (i.e. conference proceedings and book chapters). However, this was deemed appropriate at this explorative stage to conduct a broad investigation of such an innovative domain. Future developments of the research may address this limitation, applying additional filters to the research.*

Managerial implications. *The study provides some clarity on the exploitation opportunities of phygital reality and identifies a gap concerning the phygital applications to enhance social inclusion toward some disadvantaged and marginalised segments, thus providing insights on business opportunities to fill this gap.*

Originality of the paper. *The paper addresses a novel emerging topic for which research is still at its infancy, by applying a robust methodology to provide an overview of the state of the art. The findings show that a relevant outcome of phygital applications is represented by enhanced user and customer experience in different fields (luxury consumers, tourists, students). An overarching common thread that links some of the topics between each other is represented by the theme of inclusion. The phygital reality is indeed able to prevent some segments of students from being excluded as well as enables smart engagement strategies of various types of customers and tourists. However, phygital literature still lacks specific contributions able to unveil how the presence of phygital realities can enhance social inclusion, cultural participation and digitalization, by reducing marginalization and creating the conditions for better institutions, trust and social capital that in turn foster social cohesion and social sustainability. Future research may address this gap, investigating how phygital allows to enhance social inclusion toward some disadvantaged and marginalised segments (e.g. migrants, NEETs, the unemployed, older adults, cultural minorities, women, persons with disabilities, and those suffering from chronic disease and mental disorders).*

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