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ABOUT THE JOURNAL

Foresight and STI Governance is an international interdisciplinary peer-reviewed open-access journal. It publishes original research articles, offering new theoretical insights and practice-oriented knowledge in important areas of strategic planning and the creation of science, technology, and innovation (STI) policy, and it examines possible and alternative futures in all human endeavors in order to make such insights available to the right person at the right time to ensure the right decision.

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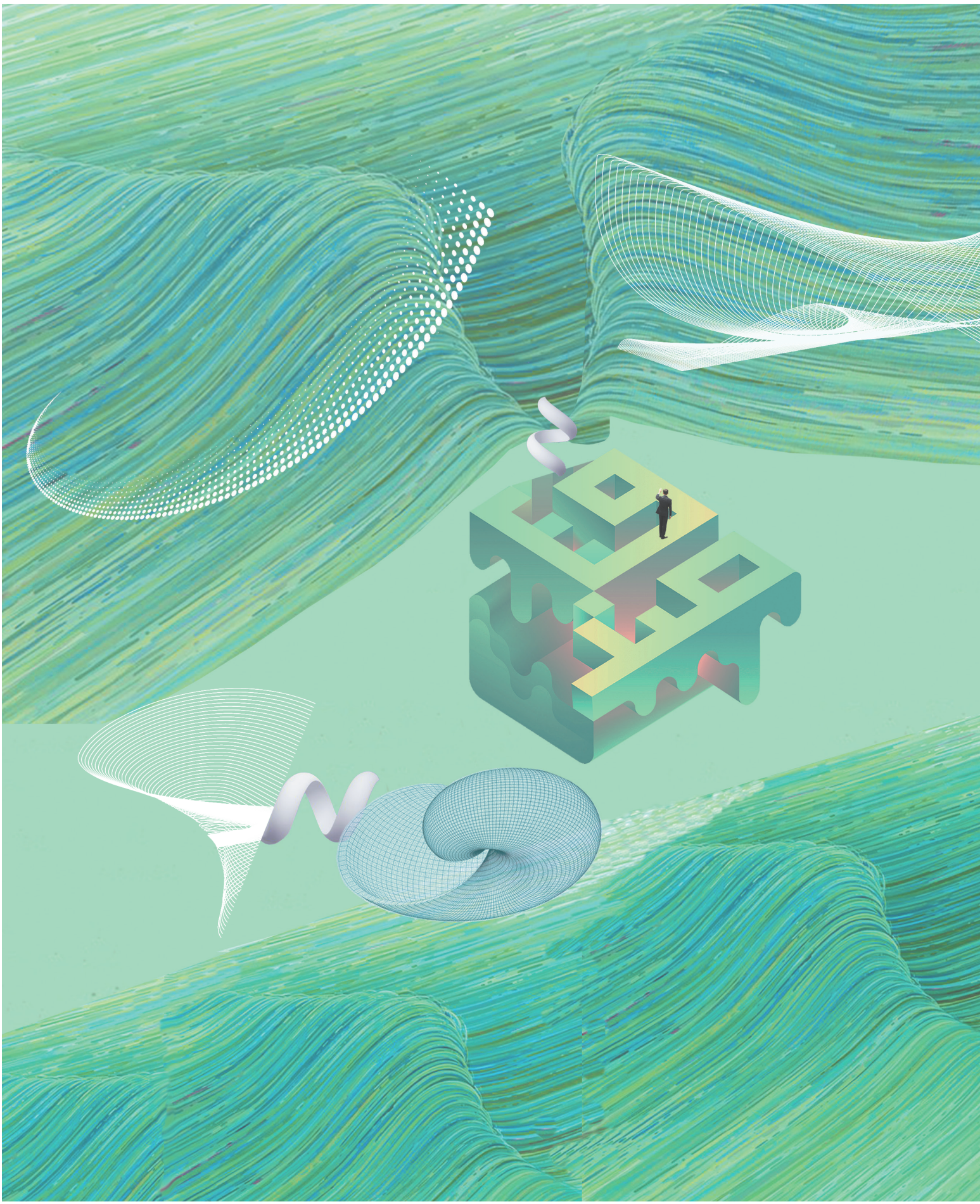

Preparing for the New Paradigm of Business: The Metaverse

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Abstract

The objective of this study is to explore the challenges and changing needs of companies in the age of the metaverse and its implications for business. It used a qualitative research methodology and is based on a review of the emerging academic discourse on metaverse and also on semi-structured interviews with corporate experts. The study found the various aspects of the metaverse that may affect business organizations, namely strategic aspects, technological aspects, human resource-related aspects, legal aspects, and ethical aspects. The study highlights the need for organizations to be flexible and adapt quickly to future unpredictable developments in the age of the metaverse. It accentuates the fact that the companies would be required to devise new marketing, e-commerce, and human resource strategies for taking advantage of the business opportunities presented by the metaverse. It also has important implications for policymakers as it highlights the legal and ethical aspects of the metaverse that may affect business and society in the future. The current study has laid the foundation for further research on the metaverse as a new paradigm of business.

Keywords: metaverse; augmented reality; virtual reality; legal aspects; learning; technology; ethics

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Introduction

Digitalization has been an important factor in transforming societies and businesses. Recent technological developments such as artificial intelligence (AI), virtual reality (VR), augmented reality (AR), machine learning, cloud computing, big data, and the Internet of Things (IoT) have transformed the goods and services that are on offer for the consumer, the way they are provided, and how the consumers access them. New technology has not only transformed the way companies do business but has also resulted in new competition, new markets, and new industries. The current type and pace of digital transformation has never before been witnessed.

Covid-19 has further enhanced the penetration of digital technologies in business and society. Online shopping, virtual meetings, e-learning, and so on were already in use before the advent of the pandemic. However, the restrictions on physical movement during the pandemic augmented the usage of digital technologies manifold in all spheres of human activity (Ivari et al., 2020; Nagel, 2020; Spurk, Straub, 2020). Businesses harnessed digitalization for building organizational resilience during the pandemic (Elgazzar et al., 2022). The businesses that did not have an online presence were also forced to change their business model to digital and had to find internet-based solutions. Before the pandemic, it was hard to imagine that businesses could run virtually and students could attend classes via Zoom meetings. The pandemic also had several negative repercussions for the global economy and industries (Kumar et al., 2020) in the form of increased unemployment, reduced industrial production, a slowdown in business activities, and a rise in poverty and income inequality. Despite these overwhelming challenges for businesses, it also encouraged business organizations to adopt new digital technologies and innovations (Baig et al., 2020; Vig, Agarwal, 2021). Business organizations that understood and adopted digital transformation during the pandemic would be able to boost their business resilience (Close et al., 2020; Keshky et al., 2020).

During and after the pandemic the world has witnessed unprecedented use of new technologies such as big data, social networking, online gaming, and AI, which has resulted in the convergence of the physical and digital worlds (Pellegrini et al., 2020; Secundo et al., 2021). The difference between the actual and virtual worlds will be further dissolved by the metaverse (Seok, 2021). It will provide a new dimension of human experience. The metaverse is creating new waves as 'the next big thing after the internet.' It will impact organizations and people in a greater way than the internet. The metaverse is a three-dimensional virtual world (Lee et al., 2021) in which users will interact through their 'avatars', which is a user's visual image that can be tailored to be anything that a user may imagine (Cheong, 2022; Davis et al., 2009).

The metaverse is likely to transform markets and many companies have commenced preparations to take advantage of the e-commerce market potential in the metaverse. The metaverse permits users to engage in interactions with other users in a digitally immersive environment where they can become a part of a physical environment virtually or they can be shown around an imagined environment. An immersive environment is created through the combination of various technologies like AR, VR, MR, AI, and so on. Consumers can try the products by running virtual product simulations, which will provide them with a more informative product experience. Consumers can become a part of various events like art exhibitions, product launches, trade shows, and concerts happening in any part of the world through an immersive experience. In recognition of the immense business opportunities presented by the metaverse, leading technology companies such as Google, Microsoft, Nvidia and others have invested in the metaverse.[1] The e-commerce, education, gaming, entertainment, and advertising industries will be most significantly affected by the introduction of the metaverse (Hollensen et al., 2023; Zhang et al., 2022; Gadalla et al., 2013; Hemp, 2006). However, no industry or company will remain unaffected once metaverse technology becomes more popular, available, and cheaper. Big brands such as Nike, Gucci, Warner Brothers, and McDonald's have already started to operate in the metaverse. The metaverse, like other paradigm shifts in the past, is expected to transform the quality of human experience.

"For some companies, the initial question of why a VW [Virtual World] presence might be needed for their organization has been answered by market pressures. Some organizations have a VW presence simply because their competitors are doing it, a phenomenon that mimics the early days of the Internet." (Davis et al., 2009, pp. 110–111).

Along with incredible opportunities, the metaverse also poses a gamut of challenges for business organizations, such as the need to adopt new strategies for increased competition, make decisions about the deployment of their financial, technological, and human resources, and also governance issues like cybersecurity and data privacy (Mackenzie, 2022). The metaverse offers immense economic prospects for businesses but it also requires organizations to prepare themselves for the upcoming transformation in terms of their strategy, specialized and skilled workforce, and governance policies. With this background, this study aims to explore the changing needs of companies in the age of the metaverse and its implications for employers and workplaces. It seeks to find answers to the following research questions:

[1] https://tech.co/news/metaverse-companies-whos-involved-whos-investing#giant, accessed 18.04.2023.

RQ1: What challenges and risks will the metaverse present for business organizations?

RQ2: What are the various aspects of the metaverse affecting business organizations?

What is the Metaverse?

The metaverse has attracted the attention of businesses and society the world over as the biggest technology companies have started investing in the metaverse and have declared it the "future of the internet" (Narin, 2021). As can be seen in the emerging academic literature and the industry discussions, there is no explicit definition of the metaverse (Lee, Kim, 2022; Peukert et al., 2022). However, researchers agree that it will be a combination of various technologies such as AI, AR, VR, mixed reality, blockchain technology, and non-fungible tokens (NFTs) (Lee et al., 2021). The metaverse was originally described by Neal Stephenson (1992) in his novel "Snow Crash" as a fictional idea. Now, this idea of the metaverse has transformed into a reality with the help of various technological advancements. The metaverse enables a fusion of the physical and the virtual worlds where the users can interact, collaborate, play, learn and work with each other in three-dimensional immersive virtual spaces. "Metaverse…is a network of interconnected experiences and applications, devices and products, tools and infrastructure" (Kevins, 2022). The metaverse will transform the way people socially interact. It uses visualization and the simulation of sensory experience to create a virtual world that allows the copresence of the users and their movement between virtual spaces. It minimizes the difference between physical and virtual reality (Lee et al., 2021). Users can be involved in shared social experiences such as shopping, attending, and participating in concerts, exhibitions, movie shows, and games together with other users in the metaverse through their digital avatars. The metaverse may be put to numerous uses in business, entertainment, education, learning, health, training, and development.

Methodology

This study used a qualitative research methodology. Data was collected from a review of the emerging academic body of knowledge on the metaverse and semi-structured interviews with 26 corporate experts working in the fields of information technology, marketing, human resources, and legal practice in India, who consented to participate in the study. The experts belonged to different areas of specialization which helped to capture the various dimensions and implications of the metaverse from multiple perspectives (Dwivedi et al., 2022). The desk research method was applied to collect data from articles in newspapers, research publications, and internet sources accessible in the public domain, related to the objective of the study. It was followed by semi-structured interviews of the respondents. The semi-structured interview technique was used as it helps the researcher to collect information without being constrained by fixed-response questions (Arksey, Knight, 1999). Ten respondents were initially identified based on purposive sampling. The participants were then requested to suggest further potential participants for the study (Silverman, Marvasti, 2008). During the interviews, the experts were asked questions such as what challenges or risks the metaverse may pose for business organizations in the future. Which aspects of the metaverse will impact business organizations and how? How can businesses prepare themselves for meeting these challenges? The interviews were held telephonically and in person and transcribed into writing simultaneously.

Data Analysis

This study used the thematic analysis method for analyzing the transcripts of interviews to identify the emerging themes. This method has been defined by Braun and Clarke (2006) as "a flexible and useful research tool, which can potentially provide a rich and detailed, yet complex account of data" (p. 5). Thematic analysis is a frequently used method of qualitative research wherein data is classified into units of analysis (Fereday, Muir-Cochrane, 2006). Thematic analysis "produces accounts of patterns across the dataset" (Terry et al., 2017). An analysis of responses obtained from the participants was made. This was followed by a comparison with other responses for the identification of similar themes (Ozcan, Eisenhardt, 2009). Common themes in the data were identified through codes, which were then reduced into categories.

Findings

Based on the interviews and reflections from the literature, five major themes emerged from the qualitative data analysis. These themes are discussed in this section. The conceptual model developed on the basis of analysis can be referred to in Figure 1. Illustrative excerpts from interviews with respondents on each topic are presented in Table 1. The findings revealed various aspects of the metaverse affecting business organizations. The major themes obtained from analysis were strategic, technological, human resource-related, legal, and ethical aspects.

Theme 1 – Strategic Aspects

According to an analysis made by Bloomberg, the metaverse carries a commercial potential of around $800 billion in 2024 against $500 billion in 2020. This revenue opportunity from the metaverse has attracted technology giants, the gaming industry, and social media platforms. In addition, the live entertainment industry comprising films, music, arts, and sports may also earn around $200 billion by becoming a part of the metaverse[2]. The metaverse will be used for facili-

[2] https://www.bloomberg.com/professional/blog/metaverse-may-be-800-billion-market-next-tech-platform/, accessed 12.04.2023

Figure 1. **Conceptual Model**

Source: author.

Table 1. **Excerpts from Interviews with Respondents on the Relevant Analyzed Aggregated Themes**

Theme 1 - Strategic aspects
"The metaverse is in a nascent stage but can offer many potential benefits and strategic opportunities for businesses."
"It will take many years before the metaverse will fully develop or be widely adopted, but companies are already investing in it."
"Enterprises have to understand - is the digital transformation necessary? If yes, they have to be flexible and adapt to the new paradigm quickly".
"Companies will have to make a metaverse strategy for adoption of new technology in their business…and make decisions about the utilization of various resources for the metaverse - financial, technological, human, etc."
"Companies are thinking about the metaverse in order to devise their future strategy. They have to decide which investments they should make today to be ready for tomorrow."
"Businesses will have to focus on how they can make a strategy for the metaverse and how their competitors are doing it."
"Ignoring the new trends could be fatal. They have to make the decision before it's too late."
"The era of the metaverse will demand a fundamental shift in the approach of the companies toward product development, service delivery, innovation, customer engagement and in a way, their complete business models".
"It will be challenging for the companies as the metaverse will increase competition and open up opportunities for new markets and new business models".
"Brands will have to rethink themselves in a virtual space."
"Brands are required to incur substantial expenses for advertising in the metaverse."
"For advertising in the metaverse, companies will have to understand what they want to achieve and what their customers will love."
"The metaverse will help brands to make better connections with their customers by providing a unique customer experience. It also allows companies to interact with their customers in virtual reality."
"What will the consumer get if he/she comes to your metaverse?"
"Try to understand how you can use the power of the metaverse to create a magical experience for your customers."
"The metaverse elevates customer experience."
"The metaverse will create new sales channels and establish newer kinds of customer relationships."
Theme 2 - Technological aspects
"It is not a single company or a single technology. Many companies are constructing it. It requires companies to work together"
"You have to find the right partners and make digital partnerships. Ensure that there is a good fit with your partner."
"A collaborative approach will help the companies achieve their goals in the future of the metaverse."
Theme 3 - Human-resource-related aspects
"Companies are trying to figure out which new skill sets will be required for the metaverse. How will it affect their talent management and talent acquisition policies?"
"The metaverse will come with its fair share of cybersecurity issues. Business organizations will have to thus look for specialized talent in cybersecurity and regulation."
"There will be a huge demand for skilled professionals for the metaverse."
"In the new scenario, organizations will have to make important decisions regarding investments in upskilling, reskilling, and learning functions."
"The metaverse will revolutionize the training and development programs by making them more interactive and real-life like."
"Companies can also use it for new employees' onboarding and training."
"The metaverse will open up new opportunities to rethink the work environments."
"It will lead to possibilities of virtual offices which are exciting and fun and located in distant and exotic places. A virtual workplace is not necessarily a dull space."
"Work teams will be able to discuss the ideas in a virtual environment while being located in different parts of the world."
Theme 4 - Legal aspects
"The metaverse will raise serious legal issues such as data privacy, financial fraud, etc."
"They will have to have to be really careful on how they protect their customers' personal data."
"Companies will have to check which and how data can be collected from the customers in a legal way."
"It will require policies at the organizational level for adequate data governance."
"Buyers get proof of ownership through NFTs but actually, it provides only partial property rights on such assets."
"We are faced with the question - what can be sold as digital assets or NFTs?"
"According to my understanding, the metaverse will create lots of issues relating to trademarks and copyrights."
"It will be challenging for the companies to protect their trademarks in the virtual world as the IPR legislations around the world were made for physical goods and real-world services. Nobody could think of virtual goods at that time."
"The metaverse is a new idea so there aren't clear legislations and judicial precedents to refer to."
"Companies need to rework their IPR policies, such as the terms of use for subscribers, licensing of IPRs, IPR protection, etc."
Theme 5 - Ethical aspects
"The metaverse can lead to both types of outcomes for humans - good or bad."
"Social media platforms have been associated with technology addiction in younger generations. The metaverse will provide a more immersive and engaging experience and may become the way people interact with each other. Thus, we will have to think about its impact on the mental health of the users."
"It will change the personal lives of users, it may be addictive and dangerous."
"Many people faced mental health issues during the Covid period. If the metaverse grows and people start interacting socially on the metaverse, it will reduce personal interactions and further increase the feeling of loneliness for some people."
"If the metaverse becomes a reality, we may see people developing dual personalities - one for the real world and another for the virtual world."
Source: compiled by the author based on survey results.

tating social and economic interactions in the virtual world and will be used for entertainment-related activities. For example, after the pandemic, companies were engaging their employees through virtual meetings but with the passage of time it became quite challenging to engage their attention in Zoom calls. NextMeet, a start-up based in India, worked on this idea and developed a business model based on the metaverse. NextMeet is an immersive platform that allows users to meet, interact, collaborate for work, and create networks based on avatars in a virtual three-dimensional space. This platform was created to reduce the feeling of isolation of employees who had been working remotely for a long time.3 In similar ways, the metaverse will drive a new wave of technology and offer new avenues for organizations.

Business organizations will have to devise a new strategy for making the most of opportunities in the short and long term. The change in strategy will depend on the size of the business, type of product or service offered, target audience, state of technology and digitization, innovation, finances, and the goal of the organization. For example, in the automobile sector, a large player like BMW has adopted a metaverse-based platform, created by Nvidia, for its virtual factory planning.[4] It is being used for planning very complex manufacturing systems, as it allows engineers to collaborate from different time zones and different parts of the world. They can efficiently work with virtual simulation anywhere and increase the speed and accuracy of their planning. It may also help them to identify errors before the commencement of the real production process.

Brands like Nike and Adidas have devised different strategies to ride the wave of the metaverse. Nike created Nikeland on a metaverse-based platform where its users can visit sports grounds, stadiums, and running tracks and buy various Nike products. In this way, Nike is using the metaverse to increase customer engagement. On the other hand, its competitor Adidas collaborated with NFT brands to sell its exclusive sportswear through online games.[5]

The metaverse will have a substantial impact on the business models of companies. The business model comprises nine components – "customer segments, key values, sales channels, customer relationships, revenue streams, key resources, activities, partners, and cost structure." (Osterwalder, Pigneur, 2010). The metaverse will bring changes to all these aspects. When existing businesses shift to the metaverse, some companies will change their business models and others will create new ones (Duwe et al., 2022). For instance, the metaverse was adopted by an Indian start-up that launched a university-like platform called 'Invact Metaversity' in 2022. This platform was created for providing quality education and improving the employment skills of students where they were provided immersive learning scenarios in practical skills like marketing, product management, and so on, while studying from their homes.[6] With such business ideas, the metaverse will lead to business model innovations as new kinds of products and services are introduced in the metaverse.

As the metaverse will create a virtual marketplace, it will be widely used by companies for marketing and advertising (Kim, 2021; Hemp, 2006; Castronova, 2005). The metaverse will offer increased levels of interaction and immersive experiences that will provide humungous opportunities for companies to market their products and services in innovative ways, which were not possible earlier. The users will get a three-dimensional e-commerce experience in the metaverse where consumers would be able to try on products like apparel or other fashion items and they can view the product's unique features such as in the case of automobiles through VR and AR. Consumers will also be able to view the products such as furniture or interior decoration items in 3-D virtual spaces, which will help them to make better purchase decisions. It may also be used in the real estate industry where the metaverse can be used to provide elaborate tours for buyers. The metaverse will enable companies to show photorealistic images of their products to consumers. Consumers will be able to virtually interact with the brands through their avatars on virtual markets which will help the advanced customization of products and services to fit their needs. Thus, organizations will have to change their marketing strategies to find new and innovative ways to promote their products and services by engaging with consumers in the virtual world. It will no longer be enough to spend marketing budgets on social media marketing. However, many companies are apprehensive to invest in digital transformation due to the high costs of new technologies for their financial, intellectual, and human capital (Pramanik et al., 2019).

Organizations will have to learn more about artificial intelligence to be able to create channels for personalized communication with their users and will have to evolve and adapt to the changing needs of customers. The metaverse will bring to life all brands in a three-dimensional interactive virtual space. This will have a revolutionary effect on the marketing function of the companies (Hollensen et al., 2023).

The Internet brought a substantial change to commerce and retail by introducing e-commerce, where

[3] https://nextmeet.live/, accessed 12.04.2023.

[4] https://www.press.bmwgroup.com/global/article/detail/T0329569EN/bmw-group-and-nvidia-take-virtual-factory-planning-to-the-next-level?language=en, accessed 12.04.2023.

[5] https://www.candidplatform.com/en/news/platform-news/all-platform-news/marketing/adidas-versus-nike-metaverse-experiences-for-a-gen-z-audience.html, accessed 23.02.2023

[6] https://yourstory.com/2022/08/invact-metaversity-relaunch, accessed 23.02.2023

the consumers had a different shopping experience as compared to physical commerce. In this situation, the companies had to focus on building information technology infrastructure and competencies, instead of their physical assets such as store locations. With the advent of e-commerce, businesses realized the importance of the collection, storage, and management of customers' data for customer relationship management (Bourlakis et al., 2009). Both the physical and the online spaces existed together. Now, with the development of the metaverse, commerce and retailing will take place in a three-dimensional virtual world. So, the companies will have to create a strategy for selling goods and services in physical, online, and metaverse spaces. The customer's preferences and expectations will also change as they would like to not only consume the products or services but also interact and experience the same products in the virtual world. This will pose challenges for several companies as was witnessed earlier when some traditional retailers had difficulty in moving to e-commerce.

Theme 2 - Technological Aspects

The metaverse requires multiple technologies to function. It is a combination of several innovative technologies such as VR, AR, AI, blockchain, IoT, and NFTs. It will also require technological capabilities in spatial technologies and 3D reconstruction (Anderson, Rainie, 2022; Lee et al., 2021), extended reality (XR), and Web3 tools. Apart from these technologies, the creation of a metaverse will require the support of software, apps, hardware, and content created by the users. AR will help in real-time interactions by the users in a virtual world and VR will provide a real-life-like sensory experience for the users. Blockchain technology will be used for making payments, value transfers, and for the storage of data. However, all the companies planning to operate in the metaverse may not have such advanced technological capabilities. Thus, they must forge partnerships with other companies, which would help them to identify collaborative business opportunities and potential risks in the metaverse. Also, the metaverse is expected to create interoperable economic offerings, which will require the companies to come together for the alignment of diverse technologies. The metaverse can be built up by collaboration between industry partners.

Another important consideration for companies in the metaverse is the cost involved in developing technological capabilities. Many further innovations will be required before the metaverse becomes widely used like the internet. It would be dependent on underlying technologies like 5G connectivity, chip technology, cloud computing, and edge computing. Business organizations have to carefully determine which investments will be viable for their business in the long run. The adoption of new technology is always related to risks (Dwivedi et al., 2022). The organizations will need to ensure that they possess adequate resources and infrastructure for handling computing power and connectivity. The metaverse has opened up new prospects for inventors and businesses producing AR technology-related devices such as eyeglasses, headsets, head-mounted devices, or tablets, and mobile devices or wearable devices like smartwatches. Companies will need to identify the gaps and develop new technologies to enhance the user experience in the metaverse and make it easy to use and accessible.

Theme 3 – Human Resource-Related Aspects

The emergence of the metaverse will have important implications for workplaces. With all the potential for growth in the metaverse, it will become mandatory for organizations to acquire a skilled and talented workforce equipped with the new skills required for the metaverse. The new paradigm calls for such skills as 3-D modeling, computer programming, software development, AR/VR development, VR engineering, VR designing, blockchain/ NFT engineering, and data skills (Marr, 2022). Skilled professionals can help organizations drive their metaverse strategy through an analysis of market opportunities, the recognition of technological possibilities, and innovation. Some companies have already appointed Chief Metaverse Officers for implementing new metaverse strategies. The adoption of the metaverse will also multiply cybersecurity risks such as identity theft and financial fraud caused by breaches of security. Thus, organizations would benefit from recruiting experts who are well-versed in the metaverse and can understand the security-related implications of relevant applications.

With the growth of the metaverse, many conventional professions such as content creators, designers, architects, professionals working in event management companies, and real estate companies will be transferred to the metaverse. These professionals will have to adapt and/or acquire new skills required for operating in the virtual world. In the new virtual world created by the metaverse, the focus of organizations will be to enhance the digital competence of their employees. Thus, human resource departments will be required to conduct skill-gap analyses for the existing employees and restructure their training strategies for the continuous learning needs of employees. Human capital is the most important factor for the adoption of new technologies in any organization. Thus, continuous training acquires significance in facing the challenges of digital transformation and increasing the competence of teams (Ferreira et al., 2020). The organizations will have to motivate and engage employees in learning and enhancing their digital capabilities, which will, in turn, aid in maintaining employee retention. In addition, organizations will have to conceptualize their digital transformation policies to ascertain the business uses of the metaverse within their organization and also ensure the involvement of employees in the new policy by communicating the organizational goals and values to them (Hwang et al., 2022).

It is interesting to note that the metaverse itself can be adopted as a training ecosystem and can be used for providing immersive training which may be beneficial for both the employees and organizations (Upadhyay, Khandelwal, 2022). It will also have cost advantages for organizations (Schwirn, 2022a). For example, companies can organize virtual training for their sales and marketing teams in the metaverse where they can experience the product of the company in three-dimensional virtual reality, irrespective of the time and place. Through the extensive use of AI-enabled trainers the metaverse can be used for training and skill development. It can also help train employees through virtual role playing, gamification, and simulation exercises. According to the US Metaverse Survey conducted by PWC in 2022, thirty-four of the responding companies agreed that the metaverse will be very beneficial in training their employees by offering real-life-like simulations.[7] The metaverse can be used by business schools to provide experiential learning for business executives and it can help to deliver more relevant content in a specific context. For example, the executives working in a multi-national FMCG company in the USA may not be aware of the consumer attitudes in India. In this scenario, the metaverse can be used to create a real-life simulation to provide experience and insights into Indian consumers' behaviors and attitudes. This will help the executives to appropriately target consumers on other markets.

The pandemic, by placing restrictions on physical interactions, has required organizations to accept remote and hybrid working as the new normal. In the post-covid world where several organizations are still continuing to use the practices of remote working or working from home, the metaverse can help by providing a more immersive environment (Peterson, 2022). The metaverse can make it possible for employees to work from any location but still be present in the office virtually, without sacrificing their personal time with family or friends. It can also help increase work efficiency by enabling information exchanges and collaboration between colleagues, leading to more effective knowledge sharing. By leveraging the power of technology, companies can also create an immersive metaverse environment within their organizations wherein the employees remain connected through human-like interactions through their digital avatars. The metaverse simulates real-world scenarios through digital twin technology. Thus, these avatars can participate in board meetings or company meetings from different parts of the world in the virtual environment. Thus, organizations may have to rethink the way they operate.

For creating this metaverse environment, it will be indispensable for organizations to put into place training programs for the employees to train them on how to use the metaverse and prepare them for the technological changes in the future.

Theme 4 - Legal Aspects

There can be several legal issues surrounding the metaverse. These issues may relate to data privacy and data protection; cybersecurity; payment systems; consumer protection; fraud; contractual relationships between the organizations, i.e., the platform owners and their users, or between platform users. For example, users can buy virtual land space in the metaverse through metaverse service providers. But if the metaverse service provider shuts down the business or becomes bankrupt, then the question arises about whether virtual land will cease to exist. What will the property rights of the owners of virtual land be in such a case? The legal framework surrounding such concerns is not yet clear as the right will exist only against the metaverse service provider as a personal claim.

The metaverse will also raise concerns relating to cybersecurity and cybercrimes which will not be straightforward to address as the identity of the criminals may be hidden behind several layers. Metaverse users can create their avatars and use them to harass other people's avatars. In such a case, what will be the liability of the harasser? Will it be considered a crime against a person? Will the intermediaries such as internet or telecom service providers, search engines, web hosts, or websites also be held liable? According to Indian legislation governing all cybercrimes[8], "an intermediary" has been provided protection from all liabilities arising out of information or content generated by third parties or users. This implies that metaverse platform providers shall not be held liable for any activity of their users. In such cases, law enforcement may become challenging and enforcement agencies will have to depend on the service providers' terms of use for metaverse platforms.

The metaverse will not only allow companies to interact with customers in more engaging ways in virtual worlds, but it will also enable them to collect more personal data of customers such as their activities, choices, preferences, and location for providing rich social experiences virtually. This type of data would be considered "sensitive personal data" under the aforementioned cyber legislation[9], and would thus, need protection. Indian law requires the maintenance of reasonable security systems and practices by companies that possess or handle such sensitive information as this data may be used in various harmful ways and may be shared for their business gains. Any non-compliance with these legal provisions may attract penalties and

[7] https://www.pwc.com/us/en/tech-effect/emerging-tech/metaverse-survey.html, accessed 19.04.2023.

[8] Information Technology Act of 2000 (https://eprocure.gov.in/cppp/rulesandprocs/kbadqkdlcswfjdelrquehwuxcfmijmuixngudufgbuubgubfugbububjxcgfvsbdihbgfGhdfgFHytyhRtMjk4NzY=, accessed 19.03.2023) and Information Technology Rules of 2011 (https://prsindia.org/billtrack/the-information-technology-rules-2011, accessed 19.03.2023).

punishment. Data theft of personal information may happen by targeting non-accessible systems (Indarta et al., 2022). Thus, it raises serious concerns for the data privacy of the customers (Bale et al., 2022).

Multinational companies are already facing a mire of stringent EU regulations governing social media, which are impacting the data privacy policies of these companies. A similar set of policy guidelines may apply to the metaverse in the future. Thus, organizations operating in the metaverse will have to strike a balance between innovation and regulation to create an open, creative, and trustworthy virtual world for their consumers. The legal teams of the companies will have to respect data protection and other laws without curbing the possibilities of innovation offered by the metaverse (Dwivedi et al., 2022).

Apart from the protection of the data of their customers, companies will also have to devise policies relating to the collection and use of data of their employees. If organizations use metaverse-based training or development programs for their employees, then they may collect data such as the time taken for employees to answer the questions, the time spent to complete a module, the pattern of their answers, and even their facial expressions or eye response to certain questions and so on. This data may be used for analytics without the trainees knowing about it. Thus, companies will have to build standards for maintaining the confidentiality of such data.

For assessing the potential impact of the metaverse on a company's business model, it will have to comprehend the legal aspects of the metaverse in terms of money, transactions, and payments, as consumption will become digital and virtual. It will become imperative to understand the application of the existing legal framework regarding movement and payment in the virtual world. Transactions in the metaverse will be facilitated by crypto-currencies and NFTs (Belk et al., 2022). The NFT market for unique digital objects such as music, artistic pieces, books, collectibles, software, photographic works, and other creative works is already thriving.

Virtual assets and NFTs relate to an area of law that is still ambiguous and emerging. The metaverse will potentially give rise to new kinds of property, thus, new property rights and legal claims. These rights and claims are currently subject to the existing regulations in various countries which have no clear legal provisions relating to the possession of virtual assets or property rights on virtual assets and currencies. Thus, companies will need to contemplate how they will sell or buy virtual assets and how they will operate according to the existing laws.

Countries across the world have taken different views on the legitimacy of cryptocurrencies. Where countries like China, Algeria, Egypt, Turkey, Morocco, and Iran have completely banned it, other countries like Singapore, Malaysia, Belarus, El Salvador, Germany, and Portugal have allowed transactions through cryptocurrencies. In India, the Reserve Bank of India (RBI), the central bank, and the apex regulatory body of the Indian banking system have prohibited the use of virtual currencies as legal tender for payment. It has also articulated its apprehensions regarding the use of cryptocurrencies for money laundering, creating financial instability, and other illegal activities. However, the Indian government, through the Finance Bill 2022,[10] recognized 'virtual digital assets' as a separate class of assets for taxation purposes. India does not have a legal framework for virtual digital assets[11]. Also due to the overall varying stances on the legality of virtual digital assets in India, their future still falls in a grey zone. Thus, in the absence of a legal framework, companies will need to take a comprehensive view of how they will mitigate the risk of financial fraud and cybersecurity scams in relation to virtual digital assets. Such ambiguities pose increasing risks for the companies, their board of directors, management, accountants, auditors, and regulatory bodies (Smaili, de Rancourt-Raymond, 2022)

Intellectual property rights (IPR) issues will assume great relevance in the metaverse as it incorporates a plethora of technologies such as hardware, software, designs, moving images, brand names and logos, and artistic creations and works covered under the IPR legislations in different jurisdictions (Vig, 2022). All types of IPR-related challenges that are common in the virtual world, such as infringement, unauthorized usage, and licensing of rights shall arise (Goossens et al., 2021). The metaverse will lead to an upsurge in some unique IPR-related issues in the context of copyrights, trademarks, patents, designs, and publicity rights. Thus, business organizations will have to deal with these issues to be able to extract a fair price for their virtual offerings in the virtual marketplace. Organizations will have to holistically consider the IPRs for brand enforcement because all kinds of IPRs will be interrelated in an unparalleled fashion in the metaverse.

There will be an increased threat of infringement of trademarks and copyrights in the metaverse as the digital experience will be interconnected with virtual and augmented reality. Several legal issues related to trademarks may arise such as trademarks for virtual goods/services, infringement of trademarks in a virtual form, and use of fictional trademarks. For example, a company may have a registered trademark for its physical product, but it may be used by another company on a fictional product in the metaverse. In such a scenario, the question may arise whether it will be considered an infringement or not because it was not used on actual goods.

[9] https://prsindia.org/billtrack/the-information-technology-rules-2011, accessed 19.03.2023.

[10] https://incometaxindia.gov.in/news/circular-23-2022.pdf, accessed 21.04.2023.

[11] https://www.tribuneindia.com/news/comment/digital-assets-await-enabling-legal-framework-369625, accessed 21.04.2023.

Companies may create fictional logos, names, or marks affixed to their virtual goods/services, which means that these trademarks will only be used in the virtual world. In such cases, there will be an issue of whether the fictional trademarks are registerable under trademark law or copyright law, as such a name or logo is a creative work. Some companies may create non-traditional trademarks for digital goods/services offered in the metaverse such as motion marks and sound marks. These types of trademarks are difficult to register and protect as there is an absence of international standards for the same (Lukose, 2015).

As the metaverse platforms will provide the users with an interactive immersive experience, they will manage to generate their own virtual 'avatars'. These avatars will make use of AI fed into metaverse platforms to replicate the feelings and emotions of the user. They would be used for making profits by commercializing these virtual characters. Thus, users may claim the 'copyrights' of these avatars as their creative works. Thus, raising the question of ownership of such avatars – are they the property of users or metaverse platform owners? (Kim, Jeon, 2021). The adoption of the metaverse will require innovation in hardware components, software, and design elements, which may be covered under patent legislation. But it will be hard to discern whether the primary technology is new as it may be merely a novel use of pre-existing technology. Regulators have rejected metaverse-related patent applications as "novel non-functional descriptive material" (Chaudhri et al., 2022). Thus, IPR protection in the metaverse will be a big challenge for companies in future.

Theme 5 - Ethical Aspects

The organizations and employees involved in creating metaverse experiences and environments will have an ethical and social responsibility to ensure that they do not cause any risk of harm or adverse impact on their users or society. Some studies have identified serious concerns regarding the ethics, safety, and data security of vulnerable members of society (Lee et al., 2021). The internet is also used for criminality, so it must be seen whether the metaverse gives rise to new types of crimes in the virtual world (Laue, 2011). Several users reported objectionable and offensive behaviors such as harassment of users, sexualization of avatars, pornography, gambling, and misuse of data in existing metaverse environments (Jamison, Glavish, 2022).

There can be other ethical issues in the metaverse as AR and VR technology enables users to completely replace their own physical appearance using their virtual avatars. Thus, users can imagine themselves to be what they want. This may lead to a harmful impact on their self-esteem and with regular use of the metaverse it may start to spill into their actual physical world. Such "beauty filters" that allow users to digitally distort their physical features have already faced a lot of criticism in the past, as it leads to low self-esteem in individuals and negative social behavior (Javornik et al., 2021; Ryan-Mosley, 2021). It may also damage the service experience of users in the metaverse (Golf-Papez et al., 2021)

Thus, the organizations will have an important role to play in ensuring that the virtual world of the metaverse does not promote deception, misinformation, harassment, defamation, or criminal behavior and does not have negative consequences for privacy, authenticity, equality, and inclusivity. Moreover, as the development of the metaverse is dependent on blockchain technology, the companies will have to face controversy surrounding the high energy consumption of servers powering the blockchain networks, which may lead to an increase in carbon emissions and thus, contribute to climate change (Rillig et al., 2022).

Practical Implications

This study identified various aspects of the metaverse that may affect business organizations, namely strategic, technological, human resource-related, legal, and ethical aspects. The current study has laid the foundation for further research on the metaverse as a new paradigm of business. Though the metaverse may establish itself as an important part of people's lives in the future, business organizations need to prepare for the future in the present. Research should also accompany this development from a business and managerial perspective. Thus, the study has several practical implications for business organizations by highlighting the changing needs of companies in the age of the metaverse and its challenges and implications for companies and workplaces. This study accentuates the fact that the companies would be required to devise new marketing, e-commerce, and human resource strategies for taking advantage of the business opportunities presented by the metaverse. It brings attention to skilled human resources being a very pertinent enabler for the adoption of new technology at companies. This study illustrates the important aspects to be considered by the companies for being successful in the metaverse based on which companies can start to strategize and build their workplaces of the future. Along with business prospects, the metaverse will be accompanied by various negative consequences. Companies would be required to be prepared to counter these negative consequences and to understand the legal and ethical implications of the metaverse for their business.

Furthermore this study also has important implications for policymakers as it highlights the legal and ethical aspects of the metaverse that may affect businesses and society in the future. Several experts who participated in the study expressed their concerns about the probable undesirable characteristics of the metaverse in the form of data privacy/security-related issues, cyber fraud, IPR infringement, identity theft, criminal behavior, and so on. The policymakers and regulators would thus be required to issue requisite

policy guidelines for regulating the activities in the metaverse. The construction of a safe metaverse would require collaboration between the government, companies, and researchers.

Conclusion

This study aimed to gather an comprehensive understanding of what challenges and risks will be posed by the metaverse and what aspects of the metaverse will affect business organizations, through a qualitative research approach. The ability to understand it is important as the metaverse continues to develop. There are some significant risks and limitations associated with the metaverse. First of all, it is in the nascent stages of development and causing unknown and unpredictable changes in digital spaces, which has created an environment of uncertainty. Businesses will have to commit substantial time and resources to learn its effective usage. Commerce in the metaverse will be enabled by cryptocurrencies which are still considered to be high-risk and transactions in crypto have not been allowed by several countries. Also, access to a great deal of information will become easier in the metaverse, but it will be quite challenging to discern genuine from fake information (Schwirn, 2022b). Organizations will also have to be more cautious about the privacy and security of their users.

Despite the challenges and risks, business organizations can harness the benefits of the metaverse by adopting the appropriate corporate strategies in the area of marketing, advertising, human resources, finance, legal protection, and risk management. Companies need to understand their place in the metaverse ecosystem and accordingly be flexible and adapt quickly to adopt the new technological advancements. Organizations will have to be ready to make sure that they are not left behind. They need to identify and understand the human aspects of the metaverse and use human-centric approaches for participating in the virtual world by integrating technology with human factors. The metaverse has posed new challenges but also opened a new realm of possibilities and innovation for all businesses. The question is how they prepare for this new paradigm of business.

This study has a few limitations. It was based on the views of experts based in a single country, i.e., India. It is based on a qualitative methodology and does not provide statistically derived findings. Rather it focused on the views of experts from multiple disciplines. As the metaverse is an emerging concept future research studies may consider further analysis into the various aspects of metaverse affecting the business organizations, as highlighted in the current study, in different, specific industries or sectors.

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Assessment of Interorganizational Technology Transfer Efficiency

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Abstract

In this paper we propose a methodology for assessing the efficiency of technology transfer through merger and acquisition (M&A) and empirically estimate the effect of key factors impacting it. We implement data envelopment analysis (DEA) to calculate an efficiency score of the technology transfer process. The DEA efficiency score integrates a set of outputs (post-merger characteristics of an acquirer) and inputs (pre-merger technological parameters of a target); thus, it provides a multidimensional estimate of efficiency adjusted for the value of the acquired technology base.

In the empirical part of this research, we collect data from 434 M&As to study a channel for transferring a technology base across organizational boundaries. Overall, empirical results suggest the adverse outcomes of accumulation of capability to value external technology: the higher the acquirer's R&D intensity, the lower the efficiency of interorganizational technology transfer. The size of acquirer and relative size of the deal also affect the post-merger outcomes significantly and negatively. At the same time, the estimated effect of such technological characteristics of acquirer as capital expenditure intensity and number of patents is insignificant.

Keywords: interorganizational technology transfer; data envelopment analysis; R&D; patents; merger and acquisition

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Introduction

Knowledge management and technological development play an important role in firms' successful strategic decisions. In order to stay ahead of industry innovators, many companies are forced to elaborate new business models, adapt quickly to intensifying technological changes, and develop their own technological capabilities. However, firms might face difficulties creating the knowledge required for successful innovation (Tsai, Wang, 2008; Un, Rodríguez 2018) – thus, management often seeks external sources of knowledge and technology to stimulate internal innovation.

In this study we focus on the merger and acquisition (M&A) channel of interorganizational technology transfer (Buono, 1997). Since firms may find it challenging to create successful in-house innovations (Renneboog, Vansteenkiste, 2019; Rong, Xiao, 2017), some use M&As to source externally generated knowledge (Christofi et al., 2019; Rossi et al., 2013). However, as with any technology transfer across organizational boundaries, a M&A creates additional challenges for the firm's management, particularly because of the specific nature of the technological knowledge and high transaction costs (Lichtenthaler, Lichtenthaler, 2010). This paper addresses several issues including the assessment of the efficiency of technology transfers and the identification of the main factors impacting them. Instead of focusing on a single performance measure, efficiency literature often applies a data envelopment analysis (DEA) approach to construct the efficiency score based on several inputs and outputs of the process (Cooper et al., 2011; Lafuente, Berbegal-Mirabent, 2019). We calculated the DEA efficiency score of each deal in our sample using post-merger financial metrics (profitability and market-based indicators) as outputs and the technological parameters of acquired firms as inputs. Such an indicator provides a comprehensive estimate of the efficiency of a technology transfer from the target to the acquirer.

Another issue within the empirical literature is the assessment of determinants of technology transfer efficiency. Various researchers examine pre-merger characteristics of companies and its effect on post-merger outputs (e.g. Maksimovic et al., 2011). Among the key determinants of the efficiency of technology acquisition, we use the number of patents and R&D expenses of acquired firms as proxies for absorptive capacity (ACAP) – an acquirer firm's ability to evaluate and utilize outside knowledge and technology (Cohen, Levinthal 1990; George et al., 2001). To succeed in external technology exploitation, the technology itself is not enough: a firm's learning and innovative capabilities at the organizational level play a crucial role. In the technology transfer literature, the effect ACAP has on the efficiency of the intra- and inter-firm transfer process is a major research question (Apriliyanti, Alon, 2017; Bengoa et al., 2021).

Thereby, our main contribution is twofold. First, we contribute to the innovation management literature by discussing determinants of the efficiency of technology transfers across organizational boundaries. In particular, we document empirical evidence of the negative implications of ACAP metrics (R&D intensity and number of patents) for post-merger efficiency, which exposes a limit for positive performance implications of ACAP and contributes to a discussion of the prerequisites for a successful transfer of technology. Second, we contribute to the empirical vein of technology transfer research by constructing a multidimensional indicator of efficiency weighted by parameters of the absorbed technology.

Conceptual Background and Hypothesis Formulation

Assessment of the Efficiency of Technology Transfers through M&A

Firms often use M&As as a form of corporate development strategy in order to obtain specific knowledge or a technology to increase innovative performance (Hagedoorn, 1993; Cloodt et al., 2006; Ma, Liu, 2016). Acquired technologies and new knowledge could be decisive factors behind technologically motivated M&As (Colombo et al., 2006; Shin et al., 2017). In fact, acquisitions can potentially bring to companies opportunities to stimulate technological capacities through rapid access to knowledge and a shorter development cycle (Warner et al., 2006). Moreover, technology transfer through M&As might further enhance combining knowledge bases, which allows companies to achieve economies of scale and scope with the more efficient utilization of technological resources (Henderson, Cockburn, 1996; Hagedoorn, Duysters, 2002).

Pioneering innovation management research emphasizes the importance of companies' ability to commercialize outside knowledge during the innovation process (Cohen, Levinthal, 1990). Since the goal of obtaining a technology assumes its application for commercial ends, firm performance indicators are essential metrics of the technology transfer process (Flatten et al., 2011). However, there are several important exceptions. For example, in the case of M&A deals, the acquirer's strategic motive could be the elimination of a competitor, not the technology transfer (Cunningham et al., 2021). Therefore, M&A researchers usually implement objective estimates of post-merger financial efficiency, including accounting- and market-based variables. The list of accounting-based parameters capturing changes in profitability includes return on assets (ROA), return on sales (ROS), and return on equity (ROE) (Liu et al., 2021). Market-based indicators measuring post-merger efficiency include a cumulative abnormal return (CAR) (Wales et al., 2013) and a market-to-book (M/B) ratio (Maditinos et al., 2011). However, these parameters face two limitations in the case of technology transfer research. First, some scholars emphasized that accounting- and market-based parameters captured different dimensions of efficiency and encouraged integrating several metrics to provide

a comprehensive measurement of financial performance (King et al., 2021). Second, financial metrics alone do not capture the value of the absorbed technology, which is essential when assessing the efficiency of technology transfer. Thus, to assess the efficiency of technology transfer, it is necessary to integrate multiple post-merger financial efficiency metrics weighted by the technological characteristics of the target. Within the efficiency literature, scholars often use a data envelopment analysis (DEA) methodology to construct the multidimensional efficiency score (e.g. Cooper et al., 2011; Lafuente, Berbegal-Mirabent, 2019). In the case of technology transfer through M&A, the DEA allows for estimating relative efficiency of deals by using two sets of input and output variables (Wanke et al., 2017).

Absorptive Capacity as a Determinant of Technology Transfer Efficiency

Technologically motivated M&As tend to be comparatively riskier due to uncertainties such as technological barriers and insufficient development resources (Warner et al., 2006). The integration process between companies is time consuming and in some cases technologies might be quickly substituted or become irrelevant which makes technology acquisition obsolete (Hitt et al., 1991). Thus, the post-merger outcomes are not limited by the acquired knowledge base. The efficiency of technology transfer also depends on the firm's ability to exploit external knowledge, which is known as absorptive capacity (ACAP).

Seminal works primarily suggest that higher levels of ACAP usually positively affect efficiency (Cohen, Levinthal, 1990). ACAP as a dynamic capability enables firms to adapt to the changing market environment and thus constitutes a competitive advantage and improves firm performance (Tsai, 2017; Zahra, George, 2002). However, rather than focusing on the positive consequences of a high ability to exploit external knowledge, several studies raise concerns about effects of ACAP growth. The impact of ACAP on post-merger efficiency can be susceptible to the channel of intraorganizational transfers of technology and the characteristics of this process. In the case of technology transfer across organizational boundaries, three arguments might support the non-linear or negative link between the level of ACAP and transfer efficiency.

First, the literature on the U-shaped ACAP-performance relationship associates higher levels of ACAP with poor technological efficiency (Lichtenthaler, 2016; Wales et al., 2013). Initially, as the firm's knowledge base increases, the firm faces positive outcomes: the costs of finding and exploiting a new technology decrease. However, the positive effect remains at a certain level of ACAP. An increasing lack of commonality results in distortion and loss of information, while limitations of the prior knowledge base restrict the efficient exploitation of the new technology (Wales et al., 2013). Thus, further accumulation of ACAP may result in the declining effectiveness of external technology absorption (Brettel et al., 2011). Since our research is focused on large-scale businesses, as opposed to SME research (Chaudhari, Batra 2018) we expect the negative impact of ACAP on post-merger efficiency. In the case of technology transfer through M&A, the greater the ACAP of the acquirer, the more carefully it looks for acquisition targets, but the outcomes of exploiting external technologies after the deal are lower. The strong ability of the acquirer to absorb technology from the outside has adverse effects on post-merger technological efficiency because of: i) higher costs of searching for appropriate and novel knowledge, ii) higher organizational costs for incorporating acquired R&D into already established R&D processes, and iii) higher costs of the transformation of R&D processes to adjust them to the inbound technology (Berchicci, 2013). These additional costs are especially high when the organization, product, and technologies differ between the target and the acquirer (Desyllas, Hughes 2010).

Second, technology acquisition may be the subject of substitutional effects (Desyllas, Hughes, 2010; Szücs, 2014). Particularly in horizontal mergers, patent and R&D activities tend to decline in post-merger periods, indicating the presence of a push-out effect (Haucap et al., 2019). Such difficulties as the incompatibility of knowledge (Wang et al., 2017) and differences in corporate culture (Zhu et al., 2019) may lead to unsuccessful integration between firms and failure to gain value from acquired technologies.

Third, the high level of acquirers' ACAP indicates that the firm has extensive resources to pursue strategic M&As. However, strategic planning may also consider an M&A deal a tool to increase a market share, not a source of outside technology. Here, the argument focuses on large technology-based companies that use M&As to eliminate competitors and shut competitors' technology down protecting their technological advantages (Motta, Peitz 2021). The "killer acquisitions" tend to be pursued by larger companies (Cunningham et al., 2021) that have invested in appropriability to protect their market power (see Capobianco (2020) for examples and further discussion).

Hence, we posit the central hypothesis: the higher the acquirer's ACAP, the lower the efficiency of technology transfers through M&A deals. Considering the complexity of the technology transfer process in terms of antecedents and outcomes, a number of studies suggested measuring the ACAP construct using several variables to capture the richness of the knowledge structure (Jiménez-Barrionuevo et al., 2011). Based on the previous literature, we proxy two subsets of ACAP. Cohen and Levinthal (1990) suggest that a prior related knowledge base enhances the ability to recognize and exploit new knowledge. At the firm level, a pre-existing knowledge base can be proxied by investments in R&D, which remains the most popular proxy of ACAP (Lee et al., 2010; Zahra, Hayton, 2008). Thus, we use the R&D intensity to measure the capacity to value external technology (George et al., 2001), and the first hypothesis proceeds as follows:

H1. The higher the acquirer's R&D intensity, the lower the post-merger firm's performance.

At the same time, we use the number of patents as a second proxy to estimate the ability to apply and exploit external technology (George et al. 2001). The patent count reflects such an aspect of innovation activity as an appropriability mechanism to protect one's innovative competitive advantages (Sun, Zhai, 2018) and the level of appropriability positively correlates with the external technology absorption capabilities (Hurmelinna-Laukkanen, Yang, 2022; Ng, Sanchez-Aragon, 2022). Thus, the second hypothesis proceeds as follows:

H2. The higher the acquirer's patent count, the lower the post-merger firm's performance.

Capital Expenditure, Relative Size of the Deal, and Firm's Size as Determinants of Technology Transfer Efficiency

In addition to the ACAP metrics, we estimate the effect of the acquirer and deal parameters. If we assume that absorptive capacity may decrease the post-merger outcomes, it might also be expected that the relative size poses limits to the positive implications of technology transfer through M&A. Therefore we test the effect of the relative size of the deal on the adjusted financial performance (the ratio of the deal value and total assets) (Asquith et al., 1983). Moeller et al. (2004) found that relative size significantly affects performance, implying that a sizeable acquiring company may overpay for the target and thus be prone to hubris, which is not the case for smaller acquiring companies. Thus, it might be expected that the increase of the relative size of the deal affects M&A efficiency negatively:

H3. The greater the relative size of deal value, the lower the post-merger firm's performance.

M&A scholars often include the size of acquirer as a factor determining the post-merger outcomes (e.g. Moeller et al., 2004; Du, Boateng, 2015). The large size of the acquiring company may indicate managerial hubris or an intention to "empire build". In our study, the model is controlled for acquirer's revenue since total sales is one of the most popular proxies for the size of the firm (Dang et al., 2018). It is expected that large firms achieve fewer gains from technological acquisitions:

H4. The higher the revenue of the acquirer, the lower the post-merger firm's performance.

CAPEX intensity can capture economic shocks to an industry's operating environment (Harford, Li, 2007). Some studies suggest that the intensity of capital investments reflects the company's internal innovation activity (Balsmeier et al., 2017; Stoneman, Kwon, 1996). CAPEX provides resources for a firm's organic growth (Bushman et al., 2011). On the other hand, some researchers consider CAPEX an alternative to M&A because both activities may provide similar outcomes in the firm's development (Hanelt et al., 2021). In the context of our study, we expect CAPEX intensity to have the similar effect on post-merger outcomes as ACAP proxies:

H5. The higher a company's CAPEX intensity, the lower the post-merger firm's performance.

Methodology and Data

The empirical section follows a two-step procedure. In the first step, we calculate the adjusted financial performance using the DEA approach to assess how efficiently the target's technology is absorbed. DEA allows one to estimate the efficiency score based on the metrics of the post-merger financial performance of the acquirer weighted for the parameters of the acquired technological base. Then, in the second step, we estimate the regression equation to investigate the relationship between the efficiency score and metrics of ACAP.

DEA Approach: Calculation of the Efficiency Score

DEA is a popular benchmarking technique for the estimation of a relative efficiency score (Lafuente, Berbegal-Mirabent, 2019). In the case of our research, the M&A efficiency score refers to the merged firm's financial performance relative to the technological characteristics of the target firm. The best performing merged firms are mapped as an efficiency frontier. Any merged firm that performs less well is positioned below the efficiency frontier. The radial distance between a merged company's position and the point on the efficiency frontier indicates the degree of inefficiency. Finally, the efficiency score takes a value from 0 to 1 and allows us to compare the outcomes of M&A deals in the sample.

DEA Outputs: Measures of Acquirer's Post-Merger Financial Efficiency

Post-merger financial performance can be measured by accounting- and market-based metrics. However, both types of measurement may provide fragmented estimates of efficiency when used in isolation. For a more comprehensive understanding of post-merger performance, researchers are encouraged to integrate accounting- and market-based measures (King et al., 2021); thus, we measure the efficiency of the deal using a mix of metrics.

The first market-based metric is the abnormal stock return after the deal is measured as CAR (Bettinazzi, Zollo, 2017). CAR is a dominant measure of stock performance in empirical M&A research to catch the short-term effect of the deal – that is, investors' immediate reaction to the M&A announcement (Renneboog, Vansteenkiste, 2019). We estimated CARs within an event window of three days around the announcement of acquisitions ([–1; +1]). We use the short event window based on efficient market theory (Fama, 1970) and the predictive abilities of investors' reactions: a long event window may deliver inconsistent results because

the estimates may be affected by changes in the time correlation of stock and market returns (MacKinlay, 1997). The CARs are calculated over the event period with an estimation window of 180 days. Since DEA operates with positive output values (Cooper et al., 2011), we constructed the variable CAR+1 by adding 1 to the CAR to avoid negative return values.

In contrast with the short-term CARs, the second market-based DEA output captures long-term performance — expectations of investors measured by the forward-looking post-merger M/B ratio (Maditinos et al., 2011). As for the accounting-based indicators, in the context of M&A research, scholars often prefer to measure post-merger efficiency using ROE and ROA (King et al., 2021). However, ROA may provide biased results because an M&A premium raises the asset base of an acquirer, while ROE is less sensitive to the relative size of the deal (King et al., 2021), so we use ROE as the third DEA output.

Thus, we integrate CAR, ROE, and M/B ratio as our DEA output variables. These measures cover different planning horizons, capture several performance aspects, and provide a complex view of a firm's efficiency.

DEA Inputs: Characteristics of the Target's Technological Base

Technology transfer is a multidimensional process and the absorbed technology has several attributes to be measured. R&D expenses are often used as a proxy for a firm's technological depth – which represents the level of technological expertise (George et al., 2001) – and depth is relevant for R&D efficiency (Ahuja, Katila, 2001; Chen et al., 2011; Laursen, Salter, 2006). The number of patents may indicate the technological breadth associated with the number of potential knowledge applications (Boh et al., 2014). At the same time, the CAPEX intensity can be used as a proxy for technological activity, and it is vital for empirical research in the case of missing or vague data on R&D and innovation expenses (Stoneman, 2001; Stoneman, Kwon, 1996). Finally, the M/B ratio is a proxy for potential growth associated with investors' expectations of technological development success (Gu, 2016). Taken together, these indicators represent key innovation stages from technology research (R&D intensity) to its development (patent activity), implementation (CAPEX intensity), and expected commercialization success (M/B ratio).

DEA Model Specifications and Bootstrapping Procedure

We estimate the efficiency using an input-oriented constant return-to-scale model with radial distance for DEA estimation. This model was developed in the original paper of (Charnes et al., 1978) and is called the CCR model. CCR input-oriented models aim to obtain a proportional reduction in the inputs that can produce the current outputs (Bogetoft, 2000; Korhonen et al., 2003). Generally, after obtaining a new technology, any acquirer will be concerned with how to transform this technology in order to create value for the company and ensure financial performance. We choose several inputs representing stages from research to commercialization. We assume those inputs should be changed proportionally to scale up or down the acquiring technological capacity. At the same time, we are looking at the minimum values of inputs to obtain the desired level of deal efficiency, which justifies the choice of the CCR model for this study.

To address the statistical inference problem with DEA scores (Simar, Wilson, 2000), we use bootstrapping by smoothing the empirical distribution of efficiency scores to obtain the bootstrapped efficiency scores. Bootstrapping includes the following steps. First, we obtain efficiency scores using the DEA CCR model. Then, the smoothed bootstrapping procedure generates a set of bootstrap inputs (Simar, Wilson, 2000). Third, the new DEA is calculated using a set of bootstrap inputs with the same outputs to obtain the DEA-bootstrapped efficiency scores. Finally, we repeat these three steps 3,000 times to generate a set of estimates.

Regression Analysis: What Determines the Efficiency Score

We implemented the econometric analysis to analyze how the efficiency score is influenced by the parameters of the M&A deal and acquirer. The effects are estimated by beta regression, which can be applied if the dependent variable is bound between 0 and 1 (Ferrari, Cribari-Neto, 2004). Beta distribution differs from a normal distribution because it is not necessarily symmetrical and is more heteroscedastic around the mean and less so around 0 and 1. Following Ferrari and Cribari-Neto (2004), we assume that the value of the DEA efficiency score of the i-th firm is drawn from the beta distribution with the mean μ_i. Hence, the beta regression model can be applied:

$$g(\mu_i) = \sum_k^n x_{i,k}\beta_k \,, \quad (1)$$

where g is the logit transformation of the mean of the beta distribution — $g(\mu_i) = \ln(\mu_i / (1 - \mu_i))$;

x is a matrix of values of independent variables;

β is a vector of unknown regression parameters.

Thus, we specify the main model as:

$$g(\mu_i) = \beta_0 + \beta_1 Ln(Patents_i) + \beta_2 R\&D_i + \beta_3 Ln(Rel\ Size_i) + \beta_4 Ln(Revenue_i) + \beta_5 CAPEX_i + \beta_6 International_i + \beta_6 Method\ of\ Payment_i + \varepsilon_i \quad (2)$$

where $Ln(Patents_i)$ is the logarithm of the patent count of the i-th acquirer plus 1;

$R\&D_i$ is the R&D intensity measured by R&D expenses over sales of the i-th acquirer;

$Ln(Rel\ Size_i)$ is the logarithm of the deal size of the i-th deal over the total assets of the i-th acquirer;

$Ln(Revenue_i)$ is the logarithm of the revenue of the i-th acquirer;

$CAPEX_i$ is the capital intensity measured by CAPEX over total assets of the *i*-th acquirer;

$International_i$ is a dummy variable for cross-border deals (1 if the deal is cross-border, 0 – otherwise);

$Method\ of\ Payment_i$ is the transaction payment dummy variable (1 if the payment method is cash, 0 – otherwise).

To test hypotheses, the independent variables include two main parameters of the acquiring companies related to ACAP (R&D intensity and patent count before the M&A deal) as well as acquirer's CAPEX intensity, revenue, and relative size of the deal. The model is controlled for international deals and method of payment. The $International_i$ defines each deal as a domestic or cross-border M&A. The acquisition of technologies offers opportunities for acquiring companies to enter new markets, and cross-border deals have become a popular domain of business globalization. Specifically, large international technological companies, through M&A, transfer necessary knowledge (Bresman et al., 1999). Cross-border M&A may be the only way to obtain technologies and knowledge protected by patents or domestic regulations (Boateng et al., 2008). Several studies demonstrate that international M&A is associated with high abnormal returns (Seth et al., 2002). Moreover, cross-border M&A deals provide better technological efficiency for acquiring companies (Hagedoorn, Duysters, 2002). Following prior studies (e.g. Du, Boateng, 2015; King et al., 2021), we also included the payment method (cash and non-cash method) as a variable, because acquiring companies are more likely to pay for targets with cash and thus expect an increase in synergy value due to risk reallocation (Danbolt, 2004; Du, Boateng 2015).

The main model is estimated for three specifications of the efficiency score measured by four inputs (patents count, R&D intensity, CAPEX intensity, and M/B ratio) and different sets of outputs. The first specification (General Model) uses three variables as the output (CAR, ROE, and M/B ratio). The second specification (Short-term Model) is based on a single output – the short-term performance measured by CAR. Finally, the third specification (Long-term Model) uses ROE and M/B ratio as outputs in the DEA calculation. Different methods of the DEA score estimation allow us to investigate post-merger efficiency for several planning horizons and simultaneously check for the robustness.

For additional robustness check, we implemented models controlled for industry-related information. We identify three types of M&A deals which differ in the relatedness between the merging firms' industries: horizontal, vertical, and conglomerate deals (Tremblay, Tremblay, 2012). Horizontal M&A indicates acquisitions between partners from the same industry, which usually involves technological overlap. Vertical M&A refers to firms merging with customers or suppliers whose technologies may complement the acquirer. Finally, conglomerate M&A usually exhibit low technological relatedness between the acquirer and target. Relatedness may be linked to a higher post-merger performance. First, relatedness lowers information asymmetries. Thus, acquirers can better understand their target's technology and find more suitable targets (Hussinger, 2010). Second, relatedness allows merged M&A teams to cooperate better because they can draw on shared language and compatible cognitive structures (Colombo, Rabbiosi, 2014). Similarly, recombining related knowledge may facilitate innovation rather than recombining distant knowledge (Valentini, Di Guardo, 2012). Third, relatedness allows for a higher post-merger scale and scope in innovation management (Hagedoorn, Duysters, 2002).

Thus, we examine differences in the impact of ACAP in three types of deals (horizontal, vertical, and conglomerate), using two specifications of the main model: type of M&A models with and without a structural break. The DEA efficiency score is determined by four inputs (patents count, R&D intensity, CAPEX intensity, and M/B ratio) and three outputs (CAR, ROE, and M/B ratio). In the model without a structural break, we apply beta regressions to the ACAP metrics, control variables used in the main model, and two additional dummy variables: $Vertical_i$ (1 if the deal is vertical, 0 – otherwise) and $Conglomerate_i$ (1 if the deal is conglomerate, 0 – otherwise). Finally, we test whether there is any structural break in the relationship between ACAP and adjusted performance in different types of deals in the model, which includes four additional variables: $Ln(Patents_i) \times Vertical_i$, $R\&D_i \times Vertical_i$, $Ln(Patents_i) \times Conglomerate_i$ and $R\&D_i \times Conglomerate_i$.

Data Sample.

We drew the data from the Bloomberg database for M&A deals from 2008 to 2017. A total of 5,176 deals took place during this period between companies listed on stock markets. We then excluded M&A deals for which data on R&D expenses and patents were

Table 1. **Mean/Standard Deviation of DEA Inputs/Outputs**

Variables	Main Sample		Sample with Types of M&A	
	Mean	SD	Mean	SD
DEA Outputs				
CAR of the Merged Firm, %	0.230	5.405	0.159	5.432
ROE of the Merged Firm, %	15.456	12.322	15.500	11.267
M/B ratio of the Merged firm	3.698	4.098	3.766	4.179
DEA Inputs				
Patents of the Target	25.467	140.542	24.468	137.684
R&D intensity of the Target, %	6.386	7.993	6.268	7.826
CAPEX intensity of the Target, %	4.515	4.708	4.652	4.843
M/B ratio of the Target	4.388	7.794	4.489	8.248

Source: authors.

Table 2. **Descriptive Statistics of Independent Variables**

	Variable	Mean	CO	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Ln(Patents)	4.12	2.20	1						
(2)	R&D	5.54	6.27	0.12**	1					
(3)	CAPEX	0.03	0.02	0.26***	–0.14***	1				
(4)	Ln(Rel Size)	–4.40	3.39	–0.33***	0.20***	–0.15***	1			
(5)	Ln(Revenue)	9.30	1.66	0.42***	–0.20***	0.14***	–0.43***	1		
(6)	Method of Payments	0.70	0.46	–0.002	-0.05	0.01	-0.06	0.14***	1	
(7)	International	0.40	0.49	0.01	–0.18	-0.04	0.10**	0.08*	0.36***	1

Note: Level of confidence: *** - 1%, ** - 5%, * - 10%. Number of obs.: 434.
Source: authors.

unavailable. The data on patents were collected from the EPO (European Patent Office) PATSTAT database. The combined dataset mainly contained companies from developed countries. Specifically, up to 40% of acquirers and targets were from the USA, followed by companies from Japan, the UK, Australia, Germany, Canada, and others. In addition, 57% of the deals were national and 43% were international. The overall distribution has been obtained for a sample of 434 deals. However, the SIC codes were incomplete for 55 deals, so we could not determine the M&A type. Thus, we found information on the type of deal for 379 M&As (137 vertical deals, 129 horizontal deals, and 113 conglomerate deals). Table 1 describes the inputs and outputs for two samples: the main sample and the sample with the information on the type of M&A.

Table 2 provides descriptive statistics of the independent variables. Targets tend to have higher level of R&D intensity compared to acquirers. Acquirers, in general, have a higher number of patents. These findings are consistent with the literature stating that R&D-intensive firms are more likely to be targeted, and acquirers have a considerably higher number of patents (Bena, Li, 2014). We can see a generally positive reaction from investors to M&A announcements.

Empirical Results

Figure 1 depicts the distributions of the DEA efficiency score.

The results of the regression estimation are presented in Table 3. The general model is based on several variables as DEA outputs to address the short-term and long-term effects. Additionally, we compare results of the general model with the short-term (CAR as the DEA output) and long-term (ROE and M/B as DEA outputs) models. The type of M&A model includes dummy variables for vertical and conglomerate deals. In contrast, four additional variables expand the type of M&A model with a structural break to test the presence of a structural break in the relationship between ACAP and efficiency in vertical and conglomerate deals compared to horizontal M&As.

The empirical results confirm the significant and negative effect of ACAP measured by R&D intensity: the higher the acquirer's R&D intensity, the lower the post-merger efficiency. Thus, the more technologically advanced acquirer is less efficient after the M&A deal. Importantly, this effect remains stable for both the short- and long-term. However, the number of patents has significant negative outcomes within the long-term model only. As in the case of the main specification, estimates of the types of M&A models confirm the significant and negative effect of ACAP measured by R&D intensity.

In addition, we witnessed the significantly negative impact of the relative size variable which is a robust over all specifications in the regression equation. Revenue also negatively impacts post-merger outcomes, although its effect is insignificant in the long-term model. The effect of CAPEX intensity on the efficiency of technology transfer through M&A is insignificant in all the specifications of the model.

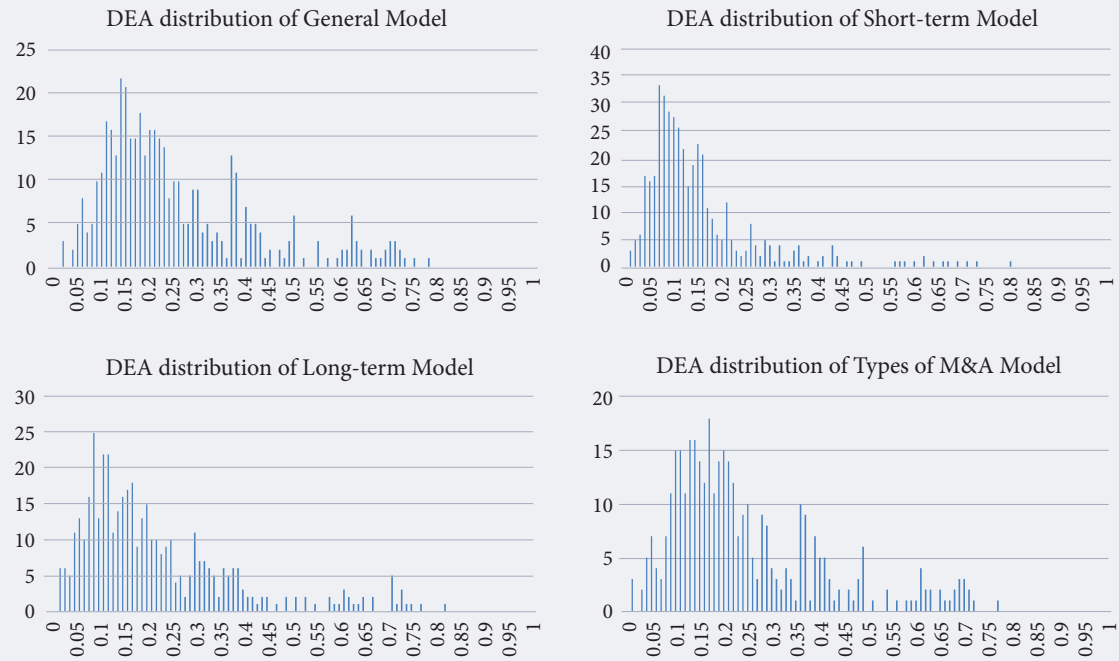
The results show that the efficiency of technology absorption does not depend on the type of deal: the model with the structural break does not confirm the significance of the structural break between vertical, horizontal, and conglomerate deals. At the same time, the type of M&A model without a structural break indicates that the efficiency of vertical deals, on average, is lower than efficiency of technology transfers through horizontal and conglomerate deals.

Discussion and Conclusion

This research concerns the assessment of the efficiency of interorganizational technology transfer and its determinants. Instead of a single performance measure, the efficiency score of technology transfer through M&As is estimated using the DEA approach which has not previously been applied for this purpose in the academic literature. The methodology of DEA allows one to construct a multidimensional metric based on key characteristics of the M&A deal participants. Since the success of technology transfer assumes the commercial exploitation of the absorbed technology, we measure the efficiency using post-merger financial indicators weighted by the technological parameters of a target.

Empirical estimates of the study contribute to the discussion on the impact of ACAP metrics on the tech-

Figure 1. **Distribution of DEA Scores on different models**



Source: authors.

Table 3. **Results of the Econometric Analysis**

Variable	General model	Short-term Model	Long-term Model	Types of M&A model	Types of M&A model with a structural break
Intercept	–0.632***	–1.155***	–1.036***	–0.647***	–0.556**
Ln(Patents)	–0.020	0.015	–0.044**	–0.016	–0.028
R&D	–0.018***	–0.023***	–0.015**	–0.015**	–0.019*
Ln(Rel Size)	–0.062***	–0.084***	–0.044***	–0.067***	–0.067***
Ln(Revenue)	–0.069***	–0.103***	–0.032	–0.069**	–0.072***
CAPEX	1.953	1.788	2.014	1.877	1.779
Method of Payments	0.019	0.021	0.071	0.159*	0.169*
International	0.048	-0.003	0.052	–0.027	–0.027
Number of observations	434	434	434	379	379

Table 3 continued

Variable	Types of M&A model	Types of M&A model with a structural break
Conglomerate	–0.108	–0.321
Vertical	–0.280***	–0.287
Ln(Patents) × Conglomerate		0.053
R&D × Conglomerate		–0.001
Ln(Patents) × Vertical		–0.011
R&D × Vertical		0.010
Number of observations	379	379

Level of confidence: *** - 1%, ** - 5%, * - 10%; Logit link function is applied; Multicollinearity is not present. Dependent variable: Bootstrapped DEA score.

Source: authors.

nology transfer's efficiency. Overall, we discovered that the acquirer's ability to acquire and value external technology (measured by R&D intensity) negatively affects post-merger M&A efficiency. These empirical results are robust over various horizons of planning. At the same time, we found mixed results for the impact of the ability to exploit the absorbed technology (measured by the number of patents). While some prior research found the insignificant effect of patent count on efficiency (George et al., 2001), we distinguish between the short- and long-term effects and document the significantly negative impact of patent count in the long run. Thus, we argue that the accumulation effect of ACAP significantly depends on the technology transfer channel. The efficient absorption of external knowledge requires studying factors influencing the outputs of the transfer process. Within the knowledge-based view of the firm, research on the non-linear relationship between efficiency and ACAP found that a higher

level of prior knowledge is not always a predecessor of successful assimilation and exploitation of external technologies (Lichtenthaler, 2016; Wales et al., 2013). Furthermore, increasing the knowledge base raises the costs associated with knowledge management (Berchicci, 2013).

Another determinant of the interorganizational technology transfer's efficiency is the relative size of the deal: the research confirms the significant and negative effect of the ratio of the deal value to total assets. Since the deal value captures financial and technological characteristics of the target, this result may indicate that the acquisition of the firm with a large technology base reduces the efficiency of technology transfer. The increase in the scale of the acquirer's business also negatively impacts post-merger outcomes and constitutes an obstacle to technology transfer, although the effect of this factor is insignificant in the long-term model. The impact of CAPEX intensity on the efficiency of the technology transfers through M&A is insignificant in all specifications of the model.

Taken together, our results support the proposition that the costs of absorbing a new technology significantly decrease the efficiency of technology transfer across organizational boundaries. The negative impact of the scale of the acquirer's business, R&D intensity, and relative size of the deal may indicate that for large listed companies post-merger efficiency is negatively affected by the higher costs of searching for appropriate external technologies and higher organizational costs for incorporating the acquired R&D into an already established R&D process. A high ability to transform and exploit outside technology (patent count) does not constitute a significant competitive advantage in the short term and only has a delayed negative effect.

The practical implications of this study can support decision-makers when they are considering whether to engage in technologically motivated M&A. Our results suggest that companies may benefit from acquiring technologies despite a low level of pre-merger technological strength. Due to the overall negative impact of the acquirer's prior knowledge base on M&A efficiency, we may conclude that firms with a smaller stockpile of capabilities to exploit external knowledge should pursue external technology absorption through M&A deals despite a possible lack of ACAP. This is in line with the conclusions of Sears and Hoetker (2014), who found that the lack of ACAP and technological overlap does not always harm M&A technology-related efficiency due to the novelty of the acquired technologies. On the other hand, large-scale firms with greater technological capabilities should be more careful with their acquisitions strategy since the absorption of external technologies may be less efficient, especially in the case of the acquisition of a substantial body of external knowledge.

Our results could also be evidence of the substitution effect in technology acquisition, which is in line with several studies on post-merger M&A efficiency (Haucap et al., 2019). Another possible rationale behind the negative implication of ACAP is that, at least on the part of acquirers, the strategic goal of the M&A deal is not the technology acquisition itself but the elimination of competitors. However, those hypotheses require additional empirical testing. First, we assume that all patents and R&D expenses are homogenous in their efficiency impact. However, in some cases acquirers might be ready to pay for the whole knowledge base of target companies in order to gain access to one specific piece of knowledge. Second, we have mainly concentrated on the market or industry similarities for different types of M&A. However, the technological similarity is beyond the scope of this research, leaving potential for this issue to be explored in future studies.

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The Impact of Consumer Culture on Innovation Adoption in Developing Countries

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Abstract

There is limited research on the factors that influence people's continued use of mobile payments in developing countries, and it is likely that these factors vary from country to country. This study aims to explore how the factors affecting the continued use of mobile payments differ between Jordan and India, using the Unified Theory of Acceptance and Use of Technology (UTAUT2) as a framework. Additionally, this study extends the UTAUT2 model by including other factors such as trust, advertising value, payment culture, awareness, smartphone experience, and satisfaction. The study employs the fuzzy Analytic Hierarchy Process (AHP) approach to rank the factors that affect the intention to continue using mobile payments. The results suggest that price value and payment culture have the greatest influence on both Jordanian and Indian perceptions. Furthermore, habit was found to be the third most important factor affecting Jordanian perceptions, while smartphone experience was the third most significant factor affecting Indian perceptions.

Keywords: UTAUT2; Multi-Criteria Decision Making; fuzzy AHP; mobile payment

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Introduction

Mobile payment is a recent technology; it refers to the use of smartphones to make payments for bills, services, or goods (Damaini, Nugroho, 2018). As the world rapidly shifts to smartphones, it also increases the usage of mobile devices to make payments (Zhang et al., 2018). The popularity of smartphones is rapidily growing, it has been estimated by the researcher that by the end of 2019 the users of mobile devices will reach over five billion. Economical internet access and reasonable prices of mobile phones are two key points that boost the usage of smartphones (Shaw, Sergueeva, 2019). Recently, the traditional methods of payment, i.e., card or cash, are now replaced with mobile payment methods. This change is by the advancement in technology on the Internet, economic conditions, multiple social networks, and maximum customs of mobile. We can say that smartphones are an inescapable product and almost every individual has access to use them thus, it allows users to pay their bills through a mobile service payment system. The facility is not only limited to the digital system adoption rather it has been espoused by any business in order to provide access anytime, to anyone, and anywhere (de Luna et al., 2019).

Mobile payments are defined as "any payment transaction in which a mobile device is used to initiate, authorize and confirm the exchange of money" (ITU, 2019). This includes payments made through mobile banking apps, payment services such as Apple Pay, Samsung Pay, and Google Pay, and other payment apps that allow users to transfer money, pay bills, and make purchases using their mobile devices.

Mobile payments have grown significantly in popularity in recent years. According to a survey by the US Federal Reserve, the percentage of smartphone owners who have used mobile payments in the past 12 months increased from 24% in 2015 to 33% in 2019 (FRS, 2019). This growth can be attributed to the convenience and ease of use of mobile payments. With mobile payments, users can make transactions quickly and easily, without the need to carry cash or cards. Mobile payment is an innovation and a blessing for those individuals who do not choose to carry physical cash or credit cards. Mobile payment services have beenactivated in many developing countries. Another advantage of mobile payments is the added security they provide. Mobile payment services often require additional authentication steps such as biometric verification or password protection, making them more secure than traditional payment methods.[1]

This system of payment is being established in developing countries like Asia and Africa. The method of mobile payment facilitates P2PTs (person-to-person transfers), paying fees, motivating quick, small buying, paying bills, and the purchase of services or goods. It is a normal practice in a mobile payment system that their mobile network operators (MNOs) operate in many different regions or countries so that out of the border business and remittances can take place without any hurdles (Iman, 2018). Whereas, in emerging countries such as India and Jordan mobile payment systems are crucial because they help to revolutionize commerce and finance. Mobile payments are an increasingly popular and convenient way for people to make financial transactions. As technology continues to evolve, it is likely that we will see even more growth in the use of mobile payments in the future.

On the other hand, research on technological advances and mobile payment systems has mainly focused on established countries, with little attention given to emerging markets (Dhanapal, Sharma, 2022). The lower levels of technological infrastructure and adoption in emerging markets make it challenging to implement and study mobile payment systems in these contexts (Parker, Venkatesh, 2021). Unique cultural and societal factors in emerging markets may affect the adoption and use of technology and mobile payment systems, making it difficult to generalize findings from established markets (Kim et al., 2022). However, there is a growing recognition of the potential for technology and mobile payment systems to drive economic growth and improve access to financial services on emerging markets (Biradavolu et al., 2021).

Therefore, the current study contributes by examining how factors affecting individuals' intention to continue using mobile payments differ between Jordan and India. The study uses the Unified Theory of Acceptance and Use of Technology (UTAUT2) as a theoretical framework and extends it with additional factors such as trust, advertising value, payment culture, awareness, smartphone experience, and satisfaction. The study also employs the Fuzzy Analytic Hierarchy Process (AHP) approach to rank the factors that affect continuing intention to use mobile payment. The study found that price value and payment culture were the most significant factors influencing both Jordanian and Indian perceptions. Furthermore, habit was ranked as the third most influential factor for Jordanian perceptions, while smartphone experience was ranked as the third most influential factor for Indian perceptions. This research provides insights into the factors that influence individuals' intention to continue using mobile payments in different cultural contexts, which can be useful for policymakers, mobile payment providers, and researchers.

Literature Review

The researcher combines the eight models of theories such as MM, TRA, and TPB. TAM, IDT, MPCU, and SCT to construct a Unified Theory of Acceptance Use of Technology. The current study brings out the four basic variables from the eight main theories of UTAUT

[1] https://usa.visa.com/run-your-business/small-business-tools/payment-technology/mobile-payments-security.html, accessed 17.03.2023.

that show 32 different impacting factors. The four variables are effort expectancy, facilitating conditions, performance expectancy, and social influence. UTAUT has the highest explanatory power compared to any other technical model - 70% explanatory power. For this reason, the UTAUT model has been widely discussed in research work (Venkatesh et al., 2012).

Furthermore, UTAUT2 was proposed by Venkatesh et al. (2012) by using the UTAUT model as the basis, the updated model deals with the behavior of customers using information technologies. UTAUT2 added three more variables to enhance the productivity of the model, namely, habit, price value, and hedonic motivation. These three new variables have proven to be essential to studying information technology acceptance levels of users. Although the concept of UTAUT2 was discovered later and narrowly explained compared to TAM and UTAUT, it has garnered remarkable attention from scholars, specifically researchers of mobile businesses. Handayanto & Ambarwati (2022) proposed factors that influence the intention to continue using mobile payments. UTAUT2 was used as a foundation to conduct empirical research on mobile payment adoption intentions (Putri, 2018).

The UTAUT includes the two key factors from the TAM (perceived usefulness and perceived ease of use), but also incorporates additional factors such as social influence and facilitating conditions. While incorporating the attitudes and subjective norms from TRA, it adds additional factors such as facilitating conditions and behavioral intention. The model incorporates performance expectancy, effort expenctancy, and social influence from TPB, motivational factors from MM theory and innovation factors from IDT, however, it additionally includes social influence and facilitating conditions. The perception of the system is taken from MPCU and social and cognitive factors have been taken from SCT. Moreover, the UTAUT specifically focuses on technology acceptance and use. Hence, the UTAUT is considered a comprehensive and well-developed model that considers a wide range of factors that influence technology acceptance and use. It has been widely used and tested in a variety of contexts and has been found to be effective in predicting technology adoption and use (Venkatesh et al., 2016; Dwivedi et al., 2017).

UTAUT 2 factors

Performance Expectancy. Performance expectancy can be described as the state when technology usage benefits customers in a certain way (Venkatesh et al., 2012; Gharaibeh et al., 2018, Zhang, Li, 2021). The payment by using mobile phones can be increased by a positive perception of a customer therefore, it also impacts the intention to adopt mobile payments. Performance expectancy is the most effective construct that helps to forecast the interest of the user in using mobile payment systems (Sheikh et al., 2017). When the daily use of technology is beneficial for the customer, then they are motivated to adopt the latest technology (Alalwan et al., 2017; Wang et al., 2021).

Effort Expectancy. Effort expectancy can be referred to as the level of ease a consumer feels when using a system (Gharaibeh et al., 2018; Venkatesh et al., 2003; Wang et al., 2020). Davis (1989) further elaborates upon the concept saying that the use of mobile payments involves the use of technology so the role of effort expectancy is important to understand in order to analyze customers' intention to adopt (Chen, Li, 2021). Effort expectancy can also be defined as the minimum effort required by the customer to use a given technology (Venkatesh et al., 2012). It is useful to check the probability of a new technology's success and adoption (Miltgen et al., 2013). If customers perceive that the use of mobile payments is easier than any other method, such services would perform well (Wang et al., 2020).

Social Influence. Social influence is the degree to which one individual can impact the perception of others, it can be further explained as how one person's belief that a new technology must be used can impact the adoption of that technology by another person (Wu et al., 2021; Venkatesh et al., 2003). In the case of payment via mobile devices, social influence would help motivate individuals to use that system, the social environment may include friends, family, or co-workers (Zhou et al., 2010). Before the adoption of a technology, it is a normal practice for an individual to search for feedback and guidance from prior or existing customers and this assists them in adopting the technology. Literature has defined social influence as the key factor in behaviural intention to adopt a technology, especially online payment systems (Alalwan et al., 2017; Turel, Qahri-Saremi, 2019).

Facilitating Condition. The facilitating condition can be explained as the intensity or level to which an organization or technology is offered to help a customer (Gharaibeh et al., 2018; Venkatesh et al., 2003). The consumer considers the condition suitable when the firm supports the use of the technology and makes it easier (Venkatesh et al., 2012). It has been stated by researchers that if the mobile payment system has the proper operational infrastructure to facilitate users, then the number of mobile payment users would increase (Oliveira et al., 2016). The government should come forward to facilitate and develop an ecosystem that supports internet usage and also motivates organizations to create such an environment where mobile payment systems enhance and smoothly flourish (Sobti, 2019).

Hedonic Motivation. Hedonic motivation is considered a pillar of human behavior and experience (Gharaibeh et al., 2018; Piotrowski, Armstrong, 2022). It is effective in bringing out well-being in an individual as well as maintaining good behavior. However, it is difficult to sustain hedonic motivation because it has an adaptive impact on a user (Ozturk, Bilgihan, 2021). We can elaborate upon this motivation as the pleasure or enjoyment a person feels while using a technology. For

any customer, motivation is the key factor to continue using any technology or adopting the new technology (Venkatesh et al., 2012). As mobile phone payment is a very recent technology and users also enjoy it, this leads to the adoption of this technology (Oliveira et al., 2016). The hedonic motivation concept is a detailed and extensive version of perceived enjoyment and is also incorporated into the acceptance of technology.

Price value. The price value concept falls into the financial side of the system or product usage. As the current study takes into account the Indian and Jordan markets, the construct of price value is important because these countries are price sensitive. Both countries proposed many offers like points, discounts, and coupons. A study was conducted by Alalwan (2020) to check the correlation between user satisfaction and price value. The result shows that until mobile payment providers offer price value deals, they would not have satisfied users of the mobile payment system.

Habit. Habit is defined as a natural action or behavior of an individual that he or she automatically performed due to learning. In the case of technology, when a user has been using a certain technology for some time, they would inevitably use it without giving it a second thought (Zhao et al., 2021; Amoroso, Lim, 2017). Furthermore, if a user of mobile payment shows habitual behavior while using the application we consider that their requirements and needs fulfilled. Additionally, in Jordan, mobile payment providers offer customer loyalty rewards to regular customers, thus consumers have a high tendency to remain with the same service company to earn higher rewards. According to Kim et al. (2014), there is a strong correlation between continuous intention and perceived substituting costs from habit. Another study carried out by Wilson et al. (2010) found a positive relationship between habit and performance expectancy. Put simply, habit is a behavior with which a person is satisfied and agreeable to continue doing.

Extended UTAUT 2 model with six factors

Advertising value

Advertising effectiveness is measured by the value of advertising; researchers defined it as an analysis of advertising utility and worth to the consumers (Ducoffe, 1995). The companies offering mobile payment services should also focus on the development of their application to the lifestyles and requirements of their users. The real challenge for mobile payment service providers is to convey their message to the public in a way that motivates them to start using their services and for non-interested parties, to garner interest in the adoption of mobile payments (Humbani, Wiese, 2018). It is a natural that a person be more likely to adopt those innovations about which they have awareness and also perceive value for money (Pham, Ho, 2015). Thus, to make mobile payment services more popular, it is important to educate customers about the application of mobile payments and also highlight the factors that add value to their adoption (Humbani, Wiese, 2018). To achieve this objective, mobile advertisements play a vital role and assist customers in learning about the advantages of mobile payment systems, which results in mobile payment acceptance and adoption.

While UTAUT is a useful model for understanding technology adoption and use, it is important to also consider the role of advertising value in the adoption and use of mobile payments. Advertising value refers to the perceived value that individuals place on advertisements related to mobile payments, such as those that promote the benefits and convenience of using mobile payments. Advertising value is an important factor to consider when trying to understand and predict individuals' adoption and use of mobile payments, as it can play a key role in creating awareness, influencing perceptions of usefulness and ease of use, and exerting social influence (Xu et al., 2018).

Payment culture

Cultural value significantly impacts the way a person processes information (Baptista, Oliveira, 2015). The term payment culture can be explained as a combination of opinions, values, beliefs, and attitudes that inform a group and help them to act in a certain way (Tam, Oliveira, 2017). This research has paid special attention to uncertainty avoidance because it is the main component in payment culture and refers to the provided code of conduct influencing both the service and user to reduce uncertainty (Baptista, Oliveira, 2015; Fan et al., 2018). When an individual is not willing to face uncertainty, he or she may encounter a rough situation like ambiguity and thus may choose to avoid the risk altogether (Baptista, Oliveira, 2015). Baptista & Oliveira (2015) and Fan et al. (2018) concluded that mobile payment adoption intention has been highly influenced by payment culture.

Payment culture refers to the prevailing attitudes and behaviors related to payment methods within a society or culture (Kim, 2021). For example, in some cultures, cash is the preferred payment method, while in others, electronic payments such as credit cards and mobile payments are more widely used. Payment culture is an important factor to consider when trying to understand and predict individuals' adoption and use of mobile payments, as it can influence habitual behavior, perceptions of ease of use and trust, and social influence (Jang et al., 2020). By taking into account payment culture and the other UTAUT factors together, we gain a more comprehensive understanding of the factors that influence mobile payment adoption and use.

Trust in mobile payment

Trust is subjective, it is a belief that an entity will meet its obligations and, in this case, fulfil its role in the transaction of electronic payments, where a customer has to experience high risks because of the loss of control

and environmental uncertainty (Zhou, 2011). Trust is also a good predictor of future activities among parties and can build connections, both commercial and interpersonal (Sharma, Sharma, 2019). In short, trust is a guarantee that users will experience a positive environment, honesty, goodwill, and facility in using mobile payments.I If a consumer has no trust in a mobile payment service provider, they cannot have a good experience (Zhou, 2013). Trust can be enhanced with a good online environment that includes strong privacy and minimal social cues (Singh et al., 2018; Zhou, 2012).

The intention of a consumer to use a service is based on the trust they attain from an improved system and process. The intention of the user is related to the ambiguity and perceived risk of service usage. In this case, trust help to avoid ambiguity and improve the intention of a user to continue employing a particular technology (Belanche et al., 2014). Therefore, trust strengthens the provider and receiver relationship and continuing intention to use a technology in the long term. Trust is a critical factor in the UTAUT model for understanding mobile payment adoption and use (Sharma, Barua, 2021). Trust can be defined as the belief that the mobile payment system is reliable and secure, and that users can depend on it to complete transactions without the risk of fraud or losses (Zhou, 2021).

Awareness of mobile payments

Awareness related to a technology directly influences technology acceptance. The well-informed users have a continuing intention to use mobile payment services. With the help of awareness, the consumer can have full knowledge of its usefulness. The convenience of mobile payments and the high spread of technology increases the need for a customer to become well-aware (Öztüren, 2018). Thus, awareness is directly related to continuing intention to use a technology.

The importance of awareness for mobile payment systems can be seen in several studies and reports. For example, a report from the Federal Reserve Bank of Atlanta found that "lack of awareness and education are among the key reasons for low adoption rates" of mobile payments in the United States (Adams, 2016). Similarly, a study conducted by the Pew Research Center found that while 29% of US adults had used a mobile payment system in 2015, many were still hesitant to adopt the technology due to concerns about security and privacy (Smith et al., 2012).

Another report, by the consulting firm Accenture, found that while 19% of US consumers had used mobile payments in 2015, only 9% used them regularly. The report attributed this low adoption rate to "a lack of awareness, concerns over security, and limited merchant acceptance" (Accenture, 2016). To address these concerns, it is essential for mobile payment providers and financial institutions to prioritize education and awareness efforts. This can include providing clear and concise information about the security measures in place to protect users' data, as well as tips and best practices for safe mobile payment use.

Customer satisfaction

Satisfaction can be described as a positive feeling that one can experience from the use of an application designed to execute a mobile payment. A satisfied customer is a key source to bringing new customers via positive feedback (Thong et al., 2006) and is also a key source of revenue for the company. A prior study also mentioned that satisfaction is the main component of repeated use of a technology (Mouakket, Bettayeb, 2015). Continuing intention to use describes a current user of mobile payments who wants to keep using it in future (Setterstrom et al., 2013). It has been discussed in the literature that the continuing intentions have been influenced by customer satisfaction (Chen et al., 2012).

Recent academic work has highlighted the importance of satisfaction in mobile payment systems. For example, a study by Lee, Kwon, and Kim (2021) found that satisfaction with mobile payment systems positively influenced users' intention to continue using the technology. Similarly, a study by Liao and Chen (2021) found that satisfaction with mobile payment systems was positively related to users' trust in the technology, which in turn was positively related to their intention to use the technology in the future. The study also found that factors such as perceived ease of use, perceived usefulness, and perceived security were important determinants of users' satisfaction with mobile payment systems.

In order to improve satisfaction with mobile payment systems, it is important for providers to focus on factors such as usability, security, and reliability. For example, providers can offer clear and easy-to-understand instructions on how to use the technology, as well as robust security measures to protect users' personal and financial information.

Smartphone Experience

Experience can be defined from the starting time of technology use to the current date; it is measured by level of use and based on time (Venkatesh et al., 2012). Experience is considered a significant measure in the process of technology adoption as high experience in technology results in the positive perception of technology use by customers (Faqih, Jaradat, 2015). Experience allows individuals to maintain their behavior over time (Castaneda et al., 2007). Smartphone experience is essential to the success of mobile payment systems as it provides a convenient and secure platform for users to make transactions. Recent studies have shown that customers are more likely to use mobile payments if they find the experience easy and convenient (Elok et al., 2021). Therefore, mobile payment systems should prioritize a seamless and user-friendly experience, robust security features, and convenience

to drive adoption (Accenture, 2019). Thus, the current study suggests that high experience is directly correlated with continuing intention to use a technology.

Methodology

This research aims to rank the key factors that are important for the adoption of mobile payment systems. The authors employ the fuzzy AHP approach developed by Professor Saaty in 1979 due to its inherent ability to deal with complicated and contradictory issues (Saaty, 1979; Ibrahim et al., 2021; Saraswat et al., 2021). This approach can solve complex problems through a network- or hierarchical structure-based approach (Ren, Sovacool, 2015). The top level of the hierarchy comprises the research study's goal/the identified problem, the middle level holds the factors to be examined for the analysis, and finally, the lowest level provides possible alternatives (Saraswat et al., 2021).

In the present study, the qualitative evaluations of eleven experts are collected among which six are from Jordan and five are from India. These evaluations are converted into crisp numeric weights using Buckley's geometric mean value method.

The first step of fuzzy AHP is to perform a pair-wise comparison, to obtain the relative importance of decision criteria.

$$p = (a_1 \times a_2 \times .... \times a_k)^{1/k}, q = (b_1 \times b_2 \times ... \times b_k)^{1/k}, \\ r = (c_1 \times c_2 \times ... \times c_k)^{1/k} \quad (1)$$

There are k decision criteria that need to be compared pairwise.

For each pair of criteria, a value a(i,j) or b(i,j) etc. is assigned to denote the relative importance of criterion i compared to criterion j. This value is usually determined through a pairwise comparison matrix, where decision-makers compare each criterion to every other criterion and assign a score based on their relative importance.

The values for all pairwise comparisons are multiplied together for each criterion and then raised to the power of 1/k (where k is the number of criteria).

The resulting values for each criterion (p, q, r) represent their relative importance compared to all other criteria.

Obtaining the fuzzy weights by multiplication of fuzzy geometric mean and reciprocal of summation of those fuzzy geometric mean values is explained in Eq. 2.

$$w_l = p_l (p_1 + p_2 + ... + p_k)^{-1}, w_m = q_m (q_1 + q_2 + ... + q_k)^{-1}, \\ w_u = r_u (r_1 + r_2 + ... + r_k)^{-1} \quad (2)$$

In simpler terms, Equation 2 is used to convert the pairwise comparisons made by decisionmakers into a set of fuzzy weights for the criteria. The fuzzy geometric mean values (p, q, r) are used to represent the importance of each criterion, and the reciprocals of the summation of these values are used to normalize them to obtain weights that add up to 1.

It is worth noting that the fuzzy AHP method can be used to handle imprecise and uncertain information, which is often present in real-world decision-making scenarios. The use of fuzzy sets allows decisionmakers to express their judgments in linguistic terms (e.g., very important, somewhat important) rather than precise numerical values (Kahraman, Yazici, 2013).

Obtaining the de-fuzzified crisp numeric values (DCNV) by an average of the fuzzy lower, medium, and higher values is given in Equation 3

$$DCNV = (w_l + w_m + w_u) / 3 \quad (3)$$

After obtaining the fuzzy weights for each criterion (w_l, w_m, w_u) using Equation 2, we need to obtain a single numerical value for each criterion that can be used for further analysis.

The de-fuzzification process involves combining the fuzzy lower, medium, and higher values for each criterion to obtain a single numerical value.

Equation 3 computes the average of the fuzzy lower, medium, and higher values, weighted by the fuzzy weights obtained in Equation 2 (Wu, Olson, 2008).

In order to confirm that the decisionmaker's assessment was accurate and free of conflicting factors, the consistency ratio was examined. A consistency ratio below 0.1 indicates that the criteria weight is truly valid.

$$CR = CI / RI \quad (4)$$

$$CI = (\lambda_{max} - n) / (n - 1) \quad (5)$$

Equations 4 and 5 are used to calculate the consistency ratio in the Fuzzy Analytic Hierarchy Process (AHP), which is used to validate the consistency of the decisionmaker's judgments. Here is an explanation of each component of the equations:

- The consistency ratio (CR) is a measure of the consistency of the pairwise comparisons made by the decisionmaker. It is calculated as the ratio of the consistency index (CI) to the random index (RI).
- The consistency index (CI) measures the extent to which the pairwise comparisons made by the decisionmaker are consistent with each other. It is calculated as the difference between the maximum eigenvalue (λmax) and the number of elements (n), divided by (n-1).
- The random index (RI) is a reference value used to determine the threshold for an acceptable level of consistency. It is calculated based on the number of elements (n) in the pairwise comparison matrix..

Analysis and Results

To collect the responses, an online survey has been carried out among the experts of Jordan and India. Determining the appropriate sample size for Fuzzy Analytic Hierarchy Process (AHP) depends on several factors, such as the number of decision criteria, the complexity of the decision problem, and the level of precision desired in the results. Generally, there is no fixed rule for determining the sample size for Fuzzy AHP, as it can

Table 1. **Triangular Linguistic Scale for Weights of Decision Criteria**

Linguistic terms	Numeric Nomenclature	Fuzzy score
Perfectly strong (PS)	9	(2, 2.5, 3)
Highly strong (HS)	8	(1.5, 2, 2.5)
Moderately strong (MS)	7	(1, 1.5, 2)
Lightly strong (LS)	6	(1, 1, 1.5)
Equal (E)	5	(1, 1, 1)
Lightly weak (LW)	4	(0.667, 1, 1)
Moderately weak (MW)	3	(0.5, 0.667, 1)
Highly weak (HW)	2	(0.4, 0.5, 0.667)
Perfectly weak (PW)	1	(0.33, 0.4, 0.5)

Source: authors.

vary based on the specific context of the decision problem.

However, some researchers have suggested that a sample size of at least 10 to 15 decisionmakers is appropriate for Fuzzy AHP to achieve reliable results (Buyukozkan, Cifci, 2012; Zavadskas et al., 2016). It is also recommended to use sensitivity analysis to determine the robustness of the results against different sample sizes. Hence this study collects the data from the 11 experts. The experts were asked to assign the relative importance among the criteria using a triangular linguistic scale as shown in Table 1. The scale carries the nine classes namely, perfectly strong, highly strong, moderately strong, lightly strong, equal, lightly weak, moderately weak, highly weak, and perfectly weak.

Further, the linguistic weights of experts were converted into the crisp numeric weights incorporating the discussed methodology. Here, Table 2 comprises the details of fuzzy geometric mean values, fuzzy weights, and normalized weights of criteria. The criteria were ranked according to the order of highest normalized weights to least normalized weights.

Further, the assigned normalized weights of decision criteria are graphically shown in Figure 1. It shows that the criterion price value carries the highest weighted normalized index of 0.235, followed by payment culture (0.176) and habit (0.148). On the other hand, the least preference is given to criterion effort expectancy which carries the weight share of 0.010.

Furthermore, in terms of countries, the study also elaborately discusses the perception of Jordan and India. Based on Table 3 and Figure 2 the results indicated that among the most important factors that affect the intention to continue using mobile payment technology from the Jordanian perspective, price value is the most important followed by payment culture, habit, smartphone experience, advertising value, facilitating condition, trust, awareness, satisfaction, performance expectancy, hedonic motivation, effort expectancy, and social influence.

Finally, the perceptions of Indian experts is elaborated. Based on the Table 4 and Figure 3, the results indicated that the most important factor that effect the intention to continue using mobile payment technology from the Indian perspective is price value, followed by payment culture, smartphone experience, facilitating condition, habit, advertising value, awareness, trust, performance expectancy, satisfaction, hedonic motivation, social influence, effort expectancy.

Discussion

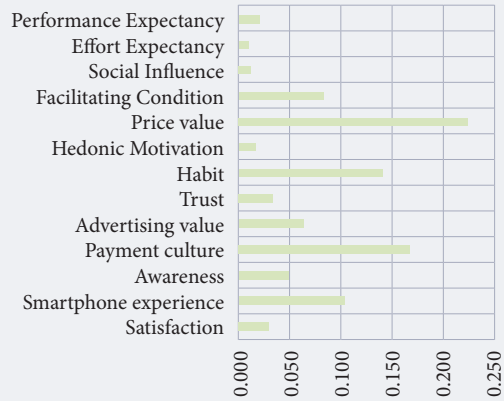
The main purpose of the current study is to identify the factors that impact the intention to continue using mobile payments and rank them Jordan and India. This research incorporated UTAUT 2 extended models that take into consideration habit, performance expectancy, hedonic motivation, effort expectancy, price value, facilitating condition, and social nfluence along with additional six factors: smartphone experience, trust,

Table 2. **Weights of Decision Criteria Using Fuzzy AHP Approach**

Criteria	Fuzzy Geometric Mean Values	Fuzzy Weights	Normalized weight (center of area)	Ranking
Performance Expectancy	(0.383, 0.433, 0.494)	(0.016, 0.021, 0.028)	0.021	10
Effort Expectancy	(0.163, 0.182, 0.264)	(0.007, 0.009, 0.015)	0.010	13
Social Influence	(0.229, 0.258, 0.295)	(0.010, 0.013, 0.017)	0.013	12
Facilitating Condition	(1.568, 1.795, 2.048)	(0.066, 0.087, 0.115)	0.087	5
Price value	(4.222, 4.873, 5.513)	(0.179, 0.237, 0.310)	0.235	1
Hedonic Motivation	(0.301, 0.347, 0.406)	(0.013, 0.017, 0.023)	0.017	11
Habit	(2.643, 3.052, 3.484)	(0.112, 0.148, 0.196)	0.148	3
Trust	(0.648, 0.726, 0.813)	(0.027, 0.035, 0.046)	0.035	8
Advertising value	(1.193, 1.367, 1.570)	(0.051, 0.066, 0.088)	0.067	6
Payment culture	(3.089, 3.635, 4.181)	(0.131, 0.177, 0.235)	0.176	2
Awareness	(0.907, 1.047, 1.214)	(0.038, 0.051, 0.068)	0.051	7
Smartphone experience	(1.920, 2.238, 2.580)	(0.081, 0.109, 0.145)	0.109	4
Satisfaction	(0.551, 0.630, 0.728)	(0.023, 0.031, 0.041)	0.031	9

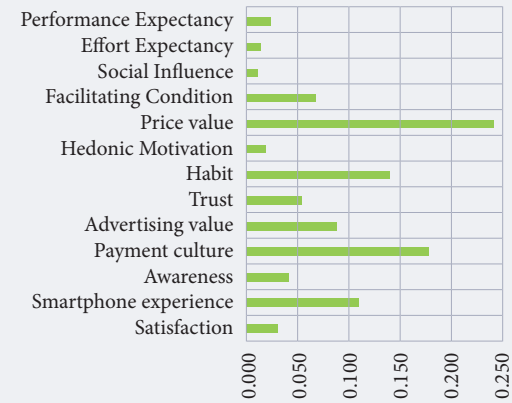
Source: authors.

Figure 1. Preference Score of Decision Criteria



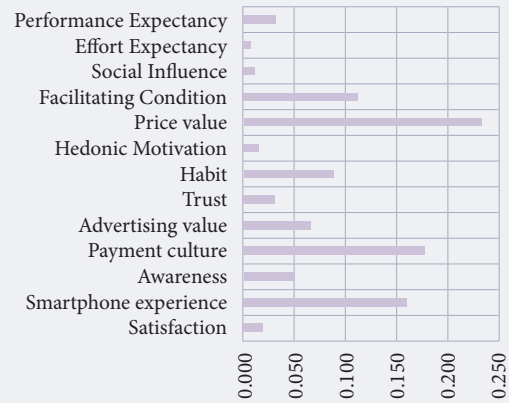
Source: authors.

Figure 2. Preference Score of Decision Criteria in Geographical Location of Jordan



Source: authors.

Figure 3. Preference Score of Decision Criteria in Geographical Location of India



Source: authors.

satisfaction, advertising value, awareness, and payment culture. The literature has little discussion about the intention to continue using mobile payments on a comparative basis. This study compares two countries, Jordan and India, and provides knowledge about mobile payment service providers and wider mobile technologies in these countries.

Comparing the results of this study in both countries, we find similarities in the factors that influence the intention to continue using mobile payment technologies. Price value is a highly important factor in Jordan. The same result is found in India. These results indicate the fact that many services provided are now charging transaction fees. Citizens of these countries are generally in the low-income bracket and thus highly affected by cost.[2] Thus, the author suggests that for the emerging markets, it is important that mobile payment service providers have low prices to capture such markets.

The second most significant factor that affects the Indian and Jordanian customers' intention to continue using mobile payments was payment culture. Payment culture influences the intention of a user to adopt mobile payment services. The result is consistent with earlier studies (e.g., Yang, Fang, 2021; Oh, Lee, 2021; Lu et al., 2020). The technology of mobile payment is also affected by uncertainty. In an environment where the uncertainty is lower, there is a higher chance of customers continuing to use technology compared to the environment where there is a high level of uncertainty. Thus, the current study found that payment culture is the second essential factor that impacts the adoption of mobile payment technology in India and Jordan. We can conclude that in both countries customers follow the provided rules and regulations proposed by the service provider companies so that they can reduce uncertainty to the maximum possible extent.

Conclusion

In conclusion, this study aimed to investigate the factors that impact intentions to continue us of mobile payment technology in the emerging markets of India and Jordan. The research incorporated UTAUT2 extended models with six additional factors to compare the two countries. The findings showed that both India and Jordan have similar factors that significantly influence intentions to continue using mobile payments. Price value and payment culture emerged as the most crucial factors in both countries. The study also highlighted the importance of low-cost services in captur-

[2] The importance of price value as a factor in the intention to continue using a technology is not unique to Jordan and India. Many recent studies have also found similar results in various contexts. For example, a study conducted in Malaysia found that perceived usefulness and price value significantly influenced intention to continue use of mobile banking services (Shah Alam et al., 2020). Another study conducted in China also found that price value played a significant role (Yang, Huang, 2021). Furthermore, a study conducted in the United States found that perceived usefulness, ease of use, and price value were significant predictors of continuing use of mobile health applications (Tsai et al., 2020).

Table 3. **Weights of Decision Criteria Using Fuzzy AHP Approach in Jordan**

Criteria	Fuzzy Geometric Mean Values	Fuzzy Weights	Normalized weight	Ranking
Performance Expectancy	(0.398, 0.453, 0.521)	(0.017, 0.023, 0.031)	0.023	10
Effort Expectancy	(0.24, 0.27, 0.308)	(0.011, 0.014, 0.018)	0.014	12
Social Influence	(0.188, 0.215, 0.253)	(0.008, 0.011, 0.015)	0.011	13
Facilitating Condition	(1.145, 1.313, 1.505)	(0.05, 0.066, 0.089)	0.067	6
Price value	(4.047, 4.706, 5.354)	(0.178, 0.238, 0.316)	0.237	1
Hedonic Motivation	(0.314, 0.366, 0.424)	(0.014, 0.019, 0.025)	0.019	11
Habit	(2.302, 2.715, 3.135)	(0.101, 0.137, 0.185)	0.137	3
Trust	(0.899, 1.047, 1.227)	(0.04, 0.053, 0.072)	0.053	7
Advertising value	(1.489, 1.711, 1.954)	(0.065, 0.087, 0.115)	0.087	5
Payment culture	(2.937, 3.46, 3.983)	(0.129, 0.175, 0.235)	0.175	2
Awareness	(0.704, 0.802, 0.917)	(0.031, 0.041, 0.054)	0.041	8
Smartphone experience	(1.791, 2.117, 2.47)	(0.079, 0.107, 0.146)	0.107	4
Satisfaction	(0.509, 0.587, 0.683)	(0.022, 0.03, 0.04)	0.03	9

Source: authors.

Table 4. **Weights of Decision Criteria using Fuzzy AHP Approach in India**

Criteria	Fuzzy Geometric Mean Values	Fuzzy Weights	Normalized weight	Ranking
Performance Expectancy	(0.595, 0.678, 0.78)	(0.024, 0.031, 0.042)	0.032	**9**
Effort Expectancy	(0.141, 0.154, 0.169)	(0.006, 0.007, 0.009)	0.007	**13**
Social Influence	(0.216, 0.245, 0.278)	(0.009, 0.011, 0.015)	0.011	**12**
Facilitating Condition	(2.101, 2.408, 2.735)	(0.086, 0.112, 0.146)	0.112	**4**
Price value	(4.415, 5.022, 5.681)	(0.18, 0.233, 0.302)	0.233	**1**
Hedonic Motivation	(0.282, 0.321, 0.371)	(0.011, 0.015, 0.02)	0.015	**11**
Habit	(1.652, 1.891, 2.159)	(0.067, 0.088, 0.115)	0.088	**5**
Trust	(0.595, 0.66, 0.728)	(0.024, 0.031, 0.039)	0.03	**8**
Advertising value	(1.236, 1.422, 1.64)	(0.05, 0.066, 0.087)	0.066	**6**
Payment culture	(3.256, 3.835, 4.411)	(0.133, 0.178, 0.235)	0.178	**2**
Awareness	(0.906, 1.042, 1.203)	(0.037, 0.048, 0.064)	0.049	**7**
Smartphone experience	(3.025, 3.443, 3.906)	(0.123, 0.16, 0.208)	0.16	**3**
Satisfaction	(0.367, 0.414, 0.47)	(0.015, 0.019, 0.025)	0.019	**10**

Source: authors..

ing semerging market. Furthermore, the research provides insights for mobile payment service providers who are attempting to develop strategies to increase user adoption. The study recommends that the service providers should focus on creating a payment culture, reducing uncertainty, and increasing customer satisfaction to encouragec continued use of mobile payment technology. Overall, this study contributes to the limited literature on comparative analyeis of mobile technology use intentions on emerging markets and offers recommendations to mobile payment providers to help them increase market share.

Although the current study has contributed to the existing literature, it has some limitations. Firstly, the study uses 11 experts, five from India and six from Jordan, thus the results are limited to these findings. It would be useful to analyze the data by incorporating more experts from both the countries., which would furhter enhance the validity of the research. Secondly, the results are restricted to the Indian and Jordanian markets and they cannot be applied to any other country because every country has its own characteristics and dynamics. Therefore, it is suggested that future researchers analyze the same factors by using different countries to check the reliability of the results. Lastly, the literature has mentioned different significant factors that have an impact on intention to continue use of a technology, but the current study focuses on the UTAUT2 model with a few different factors (payment culture, trust, satisfaction, advertising value, and smartphone experience, and awareness). Future research can analyze other factors like performance, privacy, security, and mobile application quality.

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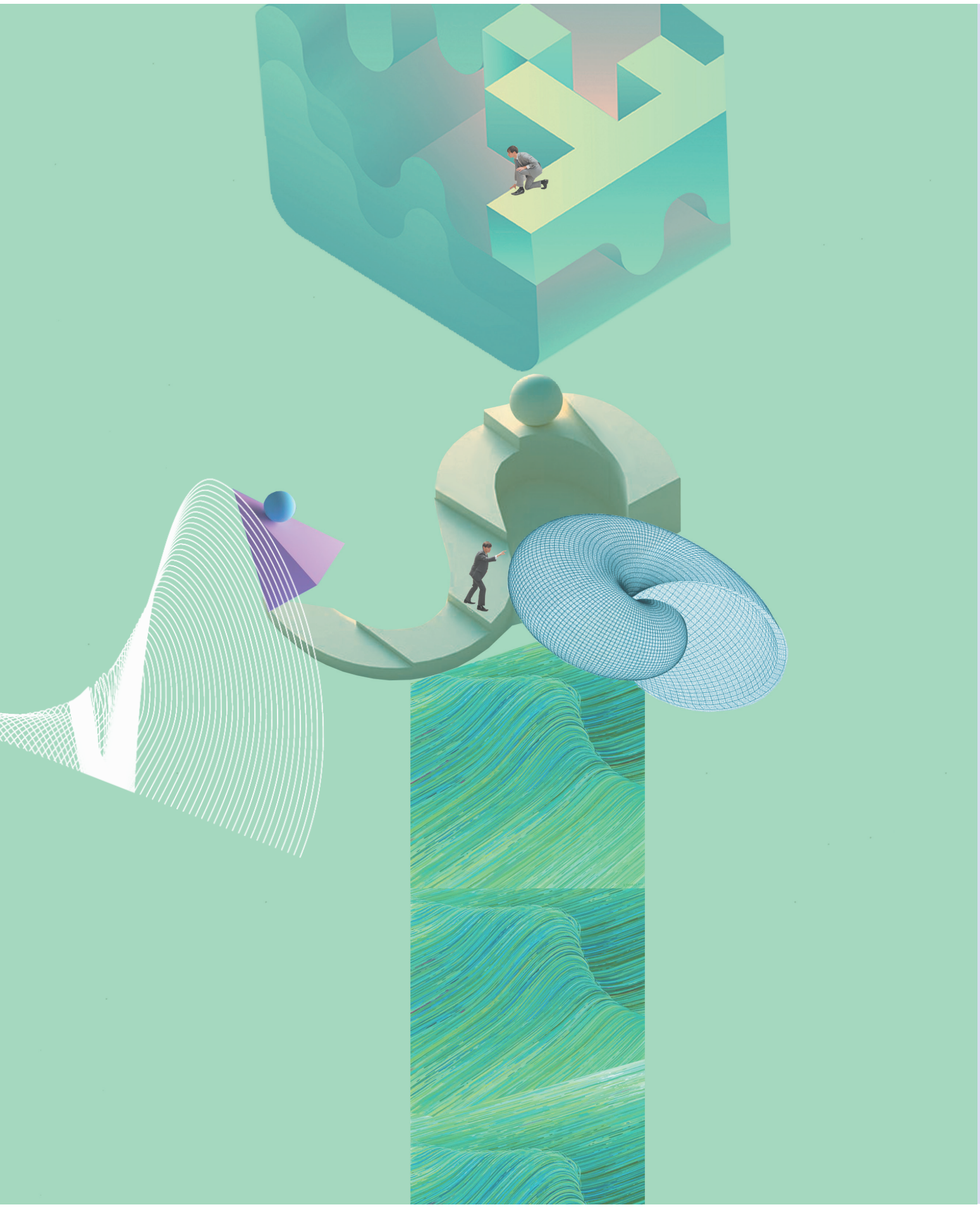
MANAGEMENT MODELS



Modeling Challenges for Building Technological Capacities to Achieve Sustainability in the Food Industry

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Abstract

The food industry plays a key role in the economy. The high potential of this field and its contribution to sustainable development is revealed by being well equipped with advanced production and management technologies. In developing countries, including India, the sector is insufficiently focused on building this capacity and harnessing its effects for progress.

The saturation of the economy with innovation and communication diversity gives it increased complexity, nonlinearity, interconnectedness and interdependence. Such synergy has two poles. With proper management and holistic coverage of complex systems, it generates a cascade of self-reinforcing positive development processes. However, in their absence, there are large-scale problems that hinder the transition to a «green» model of development, which is especially relevant for the agricultural sector as one of the main pollutants of the environment and the triggers of climate change.

The article analyzes the relationship between the complex problems, assessing their strength of influence, the degree of dependence on other factors. It reveals the «points of application» of efforts, the work with which will launch self-organizing processes, allowing to eliminate other barriers to the goals of sustainable development.

Keywords: economic complexity; interdependencies; innovative technologies; food processing industry; challenges for sustainable development; interpretive structural modeling; MICMAC analysis; India

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Introduction

Sustainability has turned out to be a global necessity for organizations across industries. However, achieving sustainability is a cumbersome task due to multiple challenges. These challenges are industry-specific and their magnitude differs from industry to industry. The food industry is more complicated than other industries because of the perishable nature of the food. Food waste accounts for eight to ten percent of greenhouse gas (GHG) emissions, leading to climate change and extreme weather conditions like droughts and floods. Food waste and GHG emissions account for a good part of environmental damage, such as crop yields and the lower nutritional value of crops, and pose a threat to nutrition and food security (FAO, 2019).

In India, the food processing industry has enormous potential to increase revenue and create jobs (Dharni, Sharma, 2015). India has a considerable resource base in this regard and ranks first in the production of many food items.[1] However, the food processing industries in India face sustainability-related challenges like the lack of food quality, a lack of linkages among the government, farmers, and food processing firms, poor government policies, and a lack of technology adoption (Gardas et al., 2017; Kumar et al., 2020; Sharma et al., 2019; Singh et al., 2021).[2] Thirty to thirty-five percent of food is lost due to inefficient handling, inadequate supply chain infrastructure, and poor transport in India (Parwez, 2016). The other prominent challenges associated with sustainability in the Indian food processing industry are a lack of management commitment toward sustainability and a lack of supply chain collaboration (SCC) (Lahane et al., 2020; Siddh et al., 2021). The rate at which India consumes resources and produces solid waste poses a severe threat to sustainability.

Therefore, it is vital to identify challenges associated with sustainability and understand the complexities among them in the context of the Indian food processing industry. Although many researchers studied challenges in the food industry, very few worked on classifying and prioritizing these challenges.[3] Researchers found a paucity of studies with regard to sustainability in developing countries, particularly in the food industry (Balaji, Arshinder, 2016; Kurniawati et al., 2022).

Considering these gaps, the objectives of this study are to identify the challenges associated with sustainability in the Indian food processing industry, and to analyze the relationships between these challenges, and then prioritize them. Further, Matrices d'Impacts Croises Multiplication Appliqué a un Classement (Cross-impact matrix multiplication applied to classification) (MICMAC) analysis is also carried out to classify these challenges. The findings of this study will strengthen the literature and assist the policymakers at the Indian food processing firms by prioritizing and classifying the sustainability-related challenges.

Challenges Associated with Sustainability

Modern economic systems are characterized by increased complexity, very dense interconnectedness, and interdependence of items and compounds. They tend to distribute resources and opportunities unevenly. Due to a complex combination of factors (favorable conditions for the development of human capital, etc.), developed countries receive more return on their resources by offering a wide range of products produced using a variety of technologies (Balland et al., 2022). There are mutually reinforcing interaction effects (positive feedback loops) between related elements. Thus, strengthening the influence of one problem worsens the situation with another, or, under favorable circumstances, there is a positive synergy between the factors that contribute to economic growth. These patterns are clearly illustrated by the processes taking place in the food industry of developing countries, including India.

Another observation of direct relevance to the issue raised in our paper is that developed economies that are able to deploy more advanced technologies tend to have lower GHG intensity (Romero, Gramkov, 2021). Such an effect is explained by the increased opportunities for highly diversified economies to produce more efficient and environmentally friendly products. These findings are supported by studies on samples from more than 80 countries over the past two decades (Boletti et al., 2021; Neagu, 2019).

This section provides a brief discussion on the challenges associated with sustainability in the Indian food processing industry. Eleven challenges identified through a review of the literature are listed in Table 1. Let us consider them in more detail.

Lack of food quality and safety. The degradation of food quality generally occurs due to improper handling and packaging as well as the lack of temperature-controlled transport and cold storage, while food safety problems arise due to inefficient processing (Marucheck et al.,

[1] India ranks first in the production of milk, tea, spices, cashews, pulses, and sugarcane and second in fruits and vegetables, wheat, and rice. The Indian food processing market may reach $535 billion by 2025-2026. About 1.77 million people are employed in the Indian food industry (IBEF, 2022). For comparison: China is Asia's largest food processing nation, with a revenue of $1,319 billion (https://www.statista.com/outlook/cmo/food/china, accessed 11.06.2023.). Whereas the revenues of a few other Asian nations are as follows: Japan - $651 billion (https://www.statista.com/outlook/cmo/food/japan, accessed 11.06.2023), Russia - $104 billion (https://www.trade.gov/country-commercial-guides/russia-agribusiness, accessed 11.06.2023), South Korea - $99.09 billion (https://www.statista.com/statistics/780672/south-korea-processed-food-market-size/, accessed 11.06.2023), and Malaysia - $49.51 billion (https://www.statista.com/outlook/cmo/food/malaysia/, accessed 11.06.2023).

[2] Most Asian countries have similar challenges, such as underdeveloped supply chain infrastructure and poor government policies (Khan et al., 2022). The food waste in China is around 35 million tons in production, processing, and transportation due to a lack of supply chain infrastructure (Farooque et al., 2019).

[3] Gardas et al. (2018) recommended more studies on challenges in the Indian food industry using Interpretive Structural Modeling (ISM).

Table 1. **Challenges Associated with Sustainability**

Challenges	Source
C1 Lack of food quality and safety	(Jose, Shanmugam, 2020; Kumar et al., 2020; Routroy, Behera, 2017)
C2 Inadequate supply chain infrastructure	(Aggarwal, Srivastava, 2016; Gardas et al., 2018; Kumar et al., 2020; Kumar et al., 2021)
C3 Food waste	(Kumar et al., 2020; Parwez, 2016; Routroy, Behera, 2017)
C4 Improper packaging	(Aggarwal, Srivastava, 2016; Parwez, 2016; Routroy, Behera 2017)
C5 Lack of technology adoption	(Kumar et al., 2021; Naik, Suresh, 2018; Routroy, Behera, 2017; Yadav et al., 2020; Zhu et al., 2018)
C6 Lack of SCC	(Lahane et al., 2020; Parwez, 2016; Yadav et al., 2020)
C7 Poor demand management	(Kumar et al., 2020; Raut, Gardas, 2018)
C8 GHG emissions	(Ghadge et al., 2021; Jose, Shanmugam, 2020; Zhu et al., 2018)
C9 Lack of management commitment towards sustainability	(Lahane et al., 2020; Pullman et al., 2009; Siddh et al., 2021)
C10 Poor government policies	(Kumar et al., 2021; Parwez, 2016; Prakash, 2018; Sharma et al., 2019; Yadav et al., 2020)
C11 Lack of market linkages	(Gardas et al., 2017; Lahane et al., 2020; Naik, Suresh, 2018)

Source: authors.

2011). If the produced food does not meet the necessary quality and safety guidelines, it leads to food insecurity and scarcity (Trivedi et al., 2019). The consumption of unsafe food harms public health and significantly affects a firm's profits (Akkerman et al., 2010).

Inadequate supply chain infrastructure. The lack of cold storage, refrigerated trucks, proper roads, and proper transportation are supply chain infrastructure problems (Aggarwal, Srivastava, 2016; Kumar et al., 2020). Insufficient cold storage and too few refrigerated trucks affect food quality and shelf life (Dharni, Sharma, 2015). Poor roads and warehousing affects the livelihood of farmers and other intermediaries who are involved in agribusiness (Parwez, 2016).

Food waste. Food waste is a significant challenge faced by food processing firms in India (Parwez, 2016; Routroy, Behera, 2017). Food waste occurs due to inefficient handling, packaging, storage, and demand forecasting (Shukla, Jharkaria, 2013). Food waste results in GHG emissions through landfills, increasing waste disposal costs and reducing profits (Kumar et al., 2020).

Improper packaging. Inappropriate packaging of food products leads to the depletion of quality, the reduction of shelf life, and food waste (Rais, Sheoran, 2015). Non-recyclable packaging damages the ecosystem through litter and leads to environmental degradation. Recycled and eco-friendly packaging will help firms progress in sustainability. Using recyclable materials like cardboard and glass can reduce packaging costs per unit of a product while minimizing the environmental impact (do Canto et al., 2021).

Lack of technology adoption. Indian food processing firms are hesitant to adopt new technologies (Shukla, Jharkharia, 2013). Slow or non-existent technology adoption hinders the organization's growth (Siddh et al., 2017). With mounting consciousness regarding sustainability and consumer apprehensions about food safety, firms face the challenge of choosing the right measures by incorporating technology. The supply chain of food processing firms is extremely complex, unorganized, and involves multiple intermediaries, and they need state-of-the-art technologies like blockchain, which helps improve the coordination among them (Yadav et al., 2020). Gupta et al. (2019) posited that technology reduces environmental risks at the production and processing level and makes the product cheaper, leading to the commercial success of the products.

Lack of SCC. The lack of collaboration among the supply chain members leads to inefficiencies in the supply chain, quality degradation, and food waste (Despoudi et al., 2018). There was a loss of $6.7 billion in the fruit and vegetable sector due to a lack of collaboration among supply chain partners (Balaji, Arshinder, 2016). Strengthening collaboration across the supply chain leads to better demand forecasting and inventory management (Aggarwal, Srivastava, 2016).

Poor demand management. Inaccurate forecasting of consumer demand leads to poor demand management. Poor demand forecasting and management may lead to overstocking, stockouts, increased inventory costs, revenue loss, and food waste (Balaji, Arshinder, 2016). Unintegrated systems and processes and no real-time data sharing lead to poor demand and inventory management (Raut, Gardas 2018). Close collaboration with supply chain members is a prerequisite for proper demand management, which helps in averting food waste (Mena et al., 2014).

GHG emissions. GHG emissions are one of the most significant challenges faced by food processing firms. Food processing firms generate GHG emissions throughout their operations, especially during transportation and distribution. These emissions adversely impact ecology and contribute to climate change and pollution (Sharma et al., 2019).

Lack of management commitment toward sustainability. Management commitment toward sustainability is an important factor in achieving sustainability at an organization (Pullman et al., 2009). Lack of management commitment toward sustainability leads to many inefficiencies at firms with regard to social, economic, and environmental factors. Management often disregards sustainability as there are no immediate financial gain and clear involvement of higher costs (Siddh et al., 2021). Sustainability in the food processing industry is primarily driven by management commitment (Ghadge et al., 2021).

Poor government policies. In developing nations like India, poor government policies are a major obstacle to sustainability. Government support is necessary to

Table 2. **Experts Profile**

№	Experience in years	Role
	Food Industry	
1	8	Operations Manager
2	15	Managing Director
3	7	Junior Manager
4	8	Supply Chain Manager
5	9	Senior Manager
6	13	Procurement Head
	Academia	
7	11	Assistant Professor
8	12	Assistant Professor
9	15	Professor

Source: authors..

develop infrastructure facilities like roads, cold storage, and financial aid for food processing firms (Singh et al., 2021). Government policies are essential enablers of sustainability in the food industry (Kumar et al., 2020). Proper government policies help reduce inefficiencies, food waste, and GHG emissions (Sharma et al., 2019).

Lack of market linkages. Poor access to the market, the lack of multiple marketing channels, and the lack of organized supply chains are some barriers to sustainability in developing nations like India (Negi, Anand, 2015; Parwez, 2016). In India, there are not many direct linkages between farmers and processing firms, and the marketing channels are long due to multiple intermediaries, which leads to a depletion in product quality, leading to higher procurement costs for processing firms while fetching lower prices for farmers (Gardas et al., 2017).

Box 1. **Steps in ISM**

- Variables related to the problem are listed using either primary or secondary research.
- Using expert opinion, the structural self-interaction matrix (SSIM) establishes interrelationships among the variables using V, A, X, and O.
- Developing the initial reachability matrix (IRM) by transforming SSIM from V, A, X, and O to 0,1.
- Developing the final reachability matrix (FRM) by checking for transitivity in the IRM. Transitivity in ISM implies that if C1 and C2 are related, C2 and C3 are related, then C1 and C3 are related.
- Formation of different levels through partitioning FRM.
- Formation of digraph
- An ISM model is formed by substituting the nodes of digraphs with the variables in the study. Thus, a prioritization model of hierarchy is created.
- The model is looked over to see if there are any conceptual inconsistencies..

Source: authors.

Methodology

This study employed the ISM-MICMAC methodology to meet the research objectives. In the first stage, thirteen significant challenges pertinent to the food processing firm were identified through literature searches.[4] Following a literature review, the research problem underwent brainstorming sessions with experts from academic and industrial organizations to validate the identified challenges in an Indian setting. The participants in the study consist of six food industry professionals and three academicians. Table 2 depicts the experts' profile. Finally, eleven challenges that emerged from the literature review were retained and others were left out as they were overlapping and not unique. Further, the experts assisted in forming the interrelationships among the identified challenges.

ISM Analysis

ISM methodology is used to identify relationships between the variables of interest and present the variables in order of priority. Weakly articulated conceptual schemas of systems are transformed into explicit and well-defined models through ISM (Attri et al., 2013). Hierarchical arrangements of variables corresponding to a specific problem can be predicted using ISM. There are many complex challenges associated with sustainability in the food processing industry and ISM assists in dealing with complex relationships among the various variables under examination (Bhadani et al., 2016). Steps in ISM are represented in Box 1.

MICMAC Analysis

MICMAC is built on a matrix multiplication property (Sharma et al., 1995). MICMAC analysis classifies the identified challenges that drive the system into four groups (Bhadani et al., 2016). Challenges are plotted subject to their dependence and driving power, ranging from 0 to the total number of challenges. The plotted values are represented in four quadrants on horizontal and vertical axes bifurcated at mid-points.

ISM aids in bringing together fragmented and scattered knowledge and creating cohesive and actionable information. Hence, it is instrumental in inherently multidisciplinary areas, such as sustainability. ISM, used in tandem with MICMAC, is an engaging tool for visualizing the challenges and relationships among various factors (Ahmad, Qahmash, 2021). ISM is distinct and superior to other multiple criteria decision-making techniques as it establishes relationships and prioritizes the identified variables using a group of experts, which helps one interpret complex real-life problems easily (Mangla et al., 2018; Soni et al., 2020).

[4] The following keywords were used: 'challenges', 'issues', 'barriers', 'food processing', ,agri-food', 'food supply chain', 'sustainability'.

Table 3. **SSIM Matrix**

№	Challenge	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
C1	Lack of food safety and quality	1	A	V	A	A	A	A	V	A	A	A
C2	Inadequate supply chain infrastructure		1	V	V	O	A	O	V	A	A	X
C3	Food waste			1	A	O	A	A	V	A	A	A
C4	Improper packaging				1	A	A	O	V	A	A	A
C5	Lack of technology adoption					1	A	V	V	A	A	A
C6	Lack of SCC						1	V	V	A	A	A
C7	Poor demand management							1	V	A	A	A
C8	GHG emissions								1	A	A	A
C9	Lack of management commitment towards sustainability									1	A	O
C10	Poor government policies										1	V
C11	Lack of market linkages											1

Note: V specifies challenge i helps to reach challenge j; A specifies challenge j helps to reach challenge i.; X specifies challenges i and j complement each other; O specifies challenges i and j are not associated.

Source: authors.

Hence, ISM – MICMAC is an appropriate technique for this study.

Results

SSIM, IRM, and FRM Analyses

SSIM is formulated from the eleven challenges identified in Table 1. V, A, X, and O specify the relationships among the challenges. SSIM is shown in Table 3.

The IRM is formed by transforming SSIM in accordance with the following guidelines. The IRM is shown in Table 4.

After applying transitivity, the IRM is transformed into the FRM. In this study, C6-C5 is allotted as 1, demonstrating their relationship. C6 has a relationship with C3, but C5 does not have a relationship with C3. After applying the concept of transitivity, the cell C5-C3 changes from 0 to 1* in the FRM. Similarly, transitivity is checked for all other challenges. The FRM is illustrated in Table 5.

Level Partition

The FRM is divided into a reachability set, an antecedent set, and an intersection set for the formation of levels. The reachability set is defined as challenges that a particular challenge can reach. Similarly, an antecedent set is a set of challenges that reach a specific challenge. The challenges commonly present in the reachability and antecedent sets are listed in the intersection set. A level is formed when a challenge has the same reachability and intersection set. Then those challenges are eliminated from each challenge's reachability and antecedent sets. Several iterations were performed on the reachability and antecedent sets to arrive at the

Table 4. **IRM Matrix**

№	Challenge	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
C1	Lack of food safety and quality	1	0	1	0	0	0	0	1	0	0	0
C2	Inadequate supply chain infrastructure	1	1	1	1	0	0	0	1	0	0	1
C3	Food waste	0	0	1	0	0	0	0	1	0	0	0
C4	Improper packaging	1	0	1	1	0	0	0	1	0	0	0
C5	Lack of technology adoption	1	0	0	1	1	0	1	1	0	0	0
C6	Lack of SCC	1	1	1	1	1	1	1	1	0	0	0
C7	Poor demand management	1	0	1	0	0	0	1	1	0	0	0
C8	GHG emissions	0	0	0	0	0	0	0	1	0	0	0
C9	Lack of management commitment towards sustainability	1	1	1	1	1	1	1	1	1	0	0
C10	Poor government policies	1	1	1	1	1	1	1	1	1	1	1
C11	Lack of market linkages	1	1	1	1	1	1	1	1	0	0	1

Note: V: Entry in the grid (i, j) becomes 1, and the entry in the grid (j, i) becomes 0; A: Entry in the grid (i, j) becomes 0, and the entry in the grid (j, i) becomes 1; X: Both the entries (i, j) and (j, i) become 1; O: Both the entries (i, j) and (j, i) become 0.

Source: authors..

Table 5. **FRM Matrix**

№	Challenge	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Driving Power
C1	Lack of food safety and quality	1	0	1	0	0	0	0	1	0	0	0	3
C2	Inadequate supply chain infrastructure	1	1	1	1	1*	1*	1*	1	0	0	1	9
C3	Food waste	0	0	1	0	0	0	0	1	0	0	0	2
C4	Improper packaging	1	0	1	1	0	0	0	1	0	0	0	4
C5	Lack of technology adoption	1	0	1*	1	1	0	1	1	0	0	0	6
C6	Lack of SCC	1	1	1	1	1	1	1	1	0	0	1*	9
C7	Poor demand management	1	0	1	0	0	0	1	1	0	0	0	4
C8	GHG emissions	0	0	0	0	0	0	0	1	0	0	0	1
C9	Lack of management commitment towards sustainability	1	1	1	1	1	1	1	1	1	0	1*	10
C10	Poor government policies	1	1	1	1	1	1	1	1	1	1	1	11
C11	Lack of market linkages	1	1	1	1	1	1	1	1	0	0	1	9
	Dependence Power	9	5	10	7	6	5	7	11	2	1	5	

Source: authors.

levels of challenges. Partitioning the reachability matrix into levels along with iterations is presented in the Appendix. This model contains eight levels of challenges, as depicted in Table 6.

ISM Model

The digraph is developed from the FRM, depicting the relationships between the challenges, as shown in Figure 1. The transitivity links in the digraph are removed and transformed into an ISM model, which depicts the prioritization of challenges as presented in Figure 2. The findings revealed that poor government policies at Level 8 and the lack of management commitment toward sustainability at the Level 7 are the most significant challenges faced by the Indian food processing industry and impact other challenges. As a top-level challenge, GHG emissions are driven by all other challenges. The bottom-level challenges in the ISM are of the highest importance. The challenges present at the bottom significantly impact the challenges above them in the hierarchy. Government policies bring a change in management commitment which results in better SCC and improvement in the supply chain infrastructure and market linkages. SCC leads to technology adoption among the firms, leading to improved demand management and packaging. Thus, these lead to better food quality and safety, reducing food waste and GHG emissions.

MICMAC Analysis

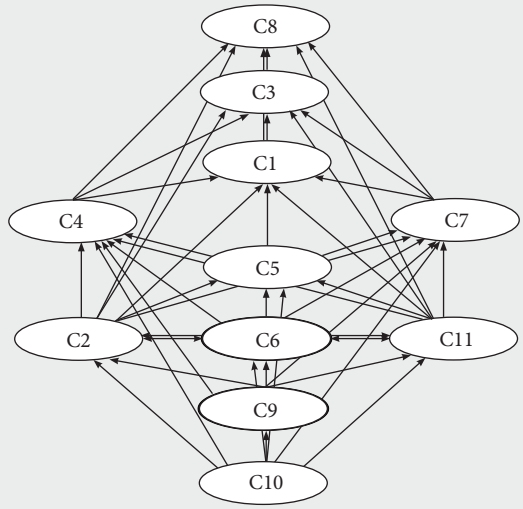
This method determines the driving power and dependence power of each challenge for further insights regarding these challenges. The challenges were divided into four clusters built on dependence and driving power, visually represented in four quad-

Table 6. **Levels of Challenges**

№	Challenge	Level
C1	Lack of food safety and quality	3
C2	Inadequate supply chain infrastructure	6
C3	Food waste	2
C4	Improper packaging	4
C5	Lack of technology adoption	5
C6	Lack of SCC	6
C7	Poor demand management	4
C8	GHG emissions	1
C9	Lack of management commitment towards sustainability	7
C10	Poor government policies	8
C11	Lack of market linkages	6

Source: authors.

Figure 1. **Digraph of challenges associated with sustainability in the Indian food processing industry**



Source: authors..

rants, as shown in Figure 3. A description of the challenges' distribution within the quadrants is presented in Table 7.

Implications and Conclusion

This study has identified and analyzed the relationships among the challenges associated with sustainability in the Indian food processing industry. Eleven sustainability-related challenges were identified for this purpose. Further, a model was developed for prioritizing the challenges using the ISM approach. MICMAC analysis was also employed to categorize the challenges based on their dependence and driving power. The observations of this study will deliver profound insights to managers, policymakers, and decision-makers who plan to overcome sustainability-related challenges at their organizations.

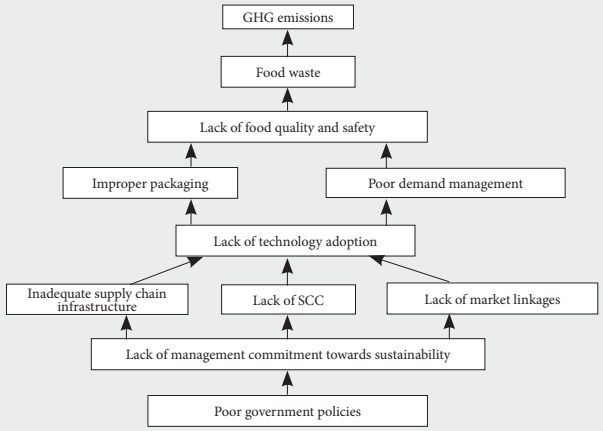
Findings from the ISM reveal eight levels of sustainability-related challenges. Poor government policies and the lack of management's commitment toward sustainability are the key challenges at Levels 8 and 7, respectively, as shown in Figure 2. Therefore, the managers should prioritize these two challenges as addressing these would aid in overcoming other challenges for the food processing firms. It is evident from the MICMAC analysis that challenges such as lack of food quality and safety, food waste, improper packaging, GHG emissions, and poor demand management are heavily dependent on other challenges such as poor government policies and regulations, the lack of management's commitment toward sustainability, the lack of market linkages, the lack of SCC, and the lack of supply chain infrastructure. Thus, management should focus on the challenges with strong driving power as they have a greater capacity to influence challenges with weak driving power.

The outcomes are consistent with those of earlier research, which identified a lack of SCC, inadequate supply chain infrastructure, poor government policies, technology adoption, and food waste as major challenges in the food industry (Sharma et al., 2019). The present study also resonates with a study on Chinese food supply chains, where the authors revealed limited technology adoption, organizational management, weak environmental regulations, and the lack of SCC as the barriers to sustainability (Farooque et al., 2019). It can be deduced that the challenges at the foot of the ISM model are the origins of other challenges.

Government policies play an essential role in changing management's commitment toward sustainability, leading to the improvement in sustainability at the firm. Apart from the role played by the state, the municipal authorities also need to act responsibly by improving the market linkages across the chain and facilitating the ease of doing business in the food industry, opening the market for food processing firms that can invest in supply chain infrastructure. The experts concurred that effective government policies combined with local governance are required to develop supply chain infrastructure. Municipal authorities could also create awareness among the firms and consumers regarding the importance of sustainability.

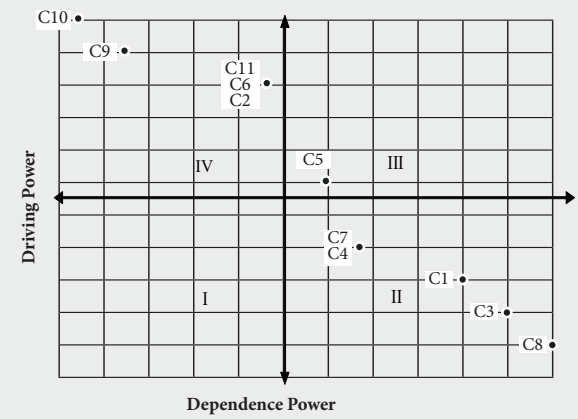
From the organizational context, management commitment toward sustainability, lack of technology adoption, lack of SCC, poor demand management, and improper packaging are the important issues to be addressed by the managers of the food processing industry. Top management commitment is crucial for achieving sustainability at the firm level. Food processing organizations need to use advanced technologies to improve food quality and reduce food waste. Technology adoption enhances and facilitates information sharing across the supply chain, improving supply chain collaboration and resulting in better demand forecasting. Technology itself is not transformative, but when accompanied by effective governance, it becomes crucial to address the needs of society. Technology accelerates the growth of the entire global food value chains by

Figure 2. **ISM Model**



Source: authors.

Figure 3. **Driver - Dependence matrix**



Source: authors.

Table 7. **Challenges' distribution by type**

Quadrant	Driving / dependence power ratio	Nature of challenges	Challenges included
I – Autonomous challenges	Weak / weak	These challenges remain unaffected and do not impact other challenges	—
II – Dependent challenges	Weak / strong	The challenges that highly depend on other challenges in the study	• Lack of food quality and safety • Food waste • Improper packaging • GHG emissions • Poor demand management
III – Linkage challenges	Strong / strong	These challenges are unstable and affect other challenges	• Lack of technology adoption
IV ¬– Independent challenges	Strong / weak	These challenges must be given more attention as they help overcome other challenges	• Poor government policies • Lack of management commitment towards sustainability, • Lack of market linkages • Lack of SCC • Inadequate supply chain infrastructure

Source: authors..

adding value to the product at each stage of supply chain (Katalevsky, 2022). Government policies that incentivize low-carbon technology have the potential to expedite the transition toward a more sustainable food design (Herrero et al., 2020).

The present study substantially contributes to the domain of sustainability through a comprehensive understanding of the challenges in the food processing sector. The prioritization of challenges will help managers focus on the challenges of the highest importance in overcoming sustainability-related challenges. The study's findings will also assist the government in developing policies in order to address the challenges associated with sustainability. Furthermore, the classification of challenges using a MICMAC analysis helps the food processing firms to identify the challenges in accordance with driving power and dependence, which helps one to manage the challenges effectively. Though the challenges are prioritized from the Indian perspective, the approach may also be applied to other developing nations.

Although several contributions are made, this study has limitations. Logistical and infrastructural challenges that seem to act as impediments to sustainability would likely be mitigated with time as India moves up the development ladder. The relationships among the challenges were created based on the knowledge of the experts, which is subjective. Also, the challenges presented in the study may not be exhaustive; future research may uncover other relevant challenges. As for the methodological aspect, experts' prejudices may affect the ISM. Fuzzy theory can be added to the methodology to resolve this issue. This study employed nine experts to apply the ISM methodology. Future studies may use a larger number of experts for more robust validation. Future researchers should employ alternative approaches like fuzzy MICMAC and total interpretive structural modeling to gain additional insights.

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Appendix 1. **Iterations for level partitioning**

№	Challenge	Reachability set	Antecedent set	Intersection set
		Level 1		
C1	Lack of food safety and quality	1, 3, 8	1, 2, 4, 5, 6, 7, 9, 10, 11	1
C2	Inadequate supply chain infrastructure	1, 2, 3, 4, 5, 6, 7, 8, 11	2, 6, 9, 10, 11	2, 6, 11
C3	Food waste	3, 8	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	3
C4	Improper packaging	1, 3, 4, 8	2, 4, 5, 6, 9, 10, 11	4
C5	Lack of technology adoption	1, 3, 4, 5, 7, 8	2, 5, 6, 9, 10, 11	5
C6	Lack of SCC	1, 2, 3, 4, 5, 6, 7, 8, 11	2, 6, 9, 10, 11	2, 6, 11
C7	Poor demand management	1, 3, 7, 8	2, 5, 6, 7, 9, 10, 11	7
C8	GHG emissions	8	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	8
C9	Lack of management commitment towards sustainability	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	9, 10	9
C10	Poor government policies	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	10	10
C11	Lack of market linkages	1, 2, 3, 4, 5, 6, 7, 8, 11	2, 6, 9, 10, 11	2, 6, 11
		Level 2		
C1	Lack of food safety and quality	1, 3	1, 2, 4, 5, 6, 7, 9, 10, 11	1
C2	Inadequate supply chain infrastructure	1, 2, 3, 4, 5, 6, 7, 11	2, 6, 9, 10, 11	2, 6, 11
C3	Food waste	3	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	3
C4	Improper packaging	1, 3, 4	2, 4, 5, 6, 9, 10, 11	4
C5	Lack of technology adoption	1, 3, 4, 5, 7	2, 5, 6, 9, 10, 11	5

C6	Lack of SCC	1, 2, 3, 4, 5, 6, 7,11	2, 6, 9, 10, 11	2, 6, 11
C7	Poor demand management	1, 3, 7	2, 5, 6, 7, 9, 10, 11	7
C9	Lack of management commitment towards sustainability	1, 2, 3, 4, 5, 6, 7, 9, 11	9, 10	9
C10	Poor government policies	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	10	10
C11	Lack of market linkages	1, 2, 3, 4, 5, 6, 7, 11	2, 6, 9, 10, 11	2, 6, 11
		Level 3		
C1	Lack of food safety and quality	1	1, 2, 4, 5, 6, 7, 9, 10, 11	1
C2	Inadequate supply chain infrastructure	1, 2, 4, 5, 6, 7, 11	2, 6, 9, 10, 11	2, 6, 11
C4	Improper packaging	1, 4	2, 4, 5, 6, 9, 10, 11	4
C5	Lack of technology adoption	1, 4, 5, 7	2, 5, 6, 9, 10, 11	5
C6	Lack of SCC	1, 2, 4, 5, 6, 7,11	2, 6, 9, 10, 11	2, 6, 11
C7	Poor demand management	1, 7	2, 5, 6, 7, 9, 10, 11	7
C9	Lack of management commitment towards sustainability	1, 2, 4, 5, 6, 7, 9, 11	9, 10	9
C10	Poor government policies	1, 2, 4, 5, 6, 7, 9, 10, 11	10	10
C11	Lack of market linkages	1, 2, 4, 5, 6, 7, 11	2, 6, 9, 10, 11	2, 6, 11
		Level 4		
C2	Inadequate supply chain infrastructure	2, 4, 5, 6, 7, 11	2, 6, 9, 10, 11	2, 6, 11
C4	Improper packaging	4	2, 4, 5, 6, 9, 10, 11	4
C5	Lack of technology adoption	4, 5, 7	2, 5, 6, 9, 10, 11	5
C6	Lack of SCC	2, 4, 5, 6, 7,11	2, 6, 9, 10, 11	2, 6, 11
C7	Poor demand management	7	2, 5, 6, 7, 9, 10, 11	7
C9	Lack of management commitment towards sustainability	2, 4, 5, 6, 7, 9, 11	9, 10	9
C10	Poor government policies	2, 4, 5, 6, 7, 9, 10, 11	10	10
C11	Lack of market linkages	2, 4, 5, 6, 7, 11	2, 6, 9, 10, 11	2, 6, 11
		Level 5		
C2	Inadequate supply chain infrastructure	2, 5, 6, 11	2, 6, 9, 10, 11	2, 6, 11
C5	Lack of technology adoption	5	2, 5, 6, 9, 10, 11	5
C6	Lack of SCC	2, 5, 6, 11	2, 6, 9, 10, 11	2, 6, 11
C9	Lack of management commitment towards sustainability	2, 5, 6, 9, 11	9, 10	9
C10	Poor government policies	2, 5, 6, 9, 10, 11	10	10
C11	Lack of market linkages	2, 5, 6, 11	2, 6, 9, 10, 11	2, 6, 11
		Level 6		
C2	Inadequate supply chain infrastructure	2, 6, 11	2, 6, 9, 10, 11	2, 6, 11
C6	Lack of SCC	2, 6, 11	2, 6, 9, 10, 11	2, 6, 11
C9	Lack of management commitment towards sustainability	2, 6, 9, 11	9, 10	9
C10	Poor government policies	2, 6, 9, 10, 11	10	10
C11	Lack of market linkages	2, 6, 11	2, 6, 9, 10, 11	2, 6, 11
		Level 7		
C9	Lack of management commitment towards sustainability	9	9, 10	9
C10	Poor government policies	9, 10	10	10
		Level 8		
C10	Poor government policies	10	10	10

Source: authors.

New Governance Approaches to Prevent the Collapse of Complex Socioeconomic Systems

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Abstract

Modern socio-economic and technological systems are constantly becoming more complex, and as a consequence, the risks of their failures are increasing. Effective management requires tools appropriate to the new challenges. Complexity science offers a number of concepts that individually help to cope with increasing complexity and its effects to a greater or lesser extent. However, a more effective approach is their skillful synthesis, which allows to cover the system holistically, to identify the origin of potential crises and catastrophes that would otherwise remain «hidden», and to outline preventive corrective measures. The article presents a review and comparative characterization of paradigms of perception of complex systems extrapolated to the sphere of management. Using multilayer causal analysis, the case of two high-profile disasters that occurred with Boeing airplanes is considered. The concept of «orphan systems» is proposed, which allows to catch weak signals about the dangerous drift of the system, to react in time and take an appropriate managerial actions.

Keywords: management science; strategies; holistic approach; complex socio-economic systems; risk management; technological innovation; dynamic complexity; transformation; competitiveness

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Introduction

Complex systems have been and to a large extent remain the terra incognita of modern management science. Despite the enormous increase in knowledge about dynamic complexity achieved in natural sciences and engineering and the growing interest in relevant tools, the understanding of this phenomenon remains fragmented and blurred, which does not allow for capture it fully. Given the variety of methods for describing complex processes and systems, in most cases the latter's behavior can only be explained post factum. Although they are believed to be unpredictable, in some cases it is possible to identify the forces that determine their development vectors.

This paper attempts to classify the existing approaches to describing and managing complex socioeconomic systems. Using the multilayer causal analysis method, the Boeing case was explored, which illustrates how the lack of a holistic approach to a complex production system and the failure to understand the nature of its hidden transformations did not allow for the detection of weak signals, harbingers of disasters, in time and subsequent switch of the system into safe mode.

This paper begins with an analysis of modern scientific paradigms of complex socioeconomic systems' perception: their initial assumptions, features, and predictive potential. Then the two crashes of Boeing 737 MAX aircraft (in 2018 and 2019) are analyzed as examples of major failures of complex social systems. An attempt was made to identify the underlying causes of the system's collapse in the scope of one of the paradigms. The author's vision of the dynamics of complex socioeconomic systems' development is proposed. The "orphan system" and "system drift" concepts are introduced, which help one to better understand the processes taking place in the systems under consideration and the logic of their changes.

Management Paradigms of Complex Systems

The professional community identifies four main complex system perception paradigms, each of which, with their respective strengths and limitations, can enrich management practices.

Mechanistic paradigm. Complex socioeconomic systems are compared with corresponding feedback-driven technical systems based on the interactions between their elements (Rosenblueth et al., 1943; Wiener, 1948; Boulding, 1956; Von Bertalanffy, 1950; Forrester, 1969, 1971). This modeling area is currently known as system dynamics (Richardson, 1991; Sterman, 2002). The origins of this approach are sometimes traced back to Isaac Newton's works. In economics it was first applied by Adam Smith, but has reached its prime with the rise of Taylorism in the 20th century. The economy is seen as an equilibrium machine brought to balance by an external force: the "invisible hand of the market". It can be represented as a model, albeit a simplified one (Raskov, 2005). From the standpoint of a mechanistic, engineering perception of the world, the more complex the system, the more unpredictable is its behavior and the higher is the probability of its elements' failing. Automation strengthens the links between system elements and subsystems, so the system becomes less and less controllable (Perrow, 1999). Various failure warning mechanisms only complicate the system, thus increasing the risk of accidents further. Many large, resonant catastrophes resulted from such processes and thus can be classified as "natural". Detecting weak signals (harbingers of accidents) is a way to minimize risks, but this approach often does not work because by the time "sufficient" information is obtained, no time to respond is left (Ansoff, 1979).

The ***natural science paradigm*** extrapolates natural sciences' patterns (mainly from physics and chemistry) and applies them to socioeconomic systems. Its main areas include econophysics and synergetics. Researchers with a background in physics who have devoted themselves to studying economic matters, primarily financial market-related, work in this area. Concepts such as power laws of distribution, phase transitions, diffusion, correlation, turbulence theory, and so on are applied. This is justified by the fact that it is impossible to perform large-scale experiments in economic theory and finance, so one cannot do without statistical physics tools. Financial markets are seen as non-linear complex open systems. Econophysics gained momentum in the 1980s thanks to the work of the Santa Fe Institute researchers (Arthur, 2001; Mantegna, Stanley, 1999; Sornette, 2003; Helbing, 2012; etc.), and in its turn contributed to the development of an agent-based simulation method which describes market players' interaction using physics principles. Synergetics studies complex systems' self-organization (Haken, 1981; Prigogine, Stengers, 1984; Ebeling, Feistel, 1986; Kurdyumov, 2006; etc.)

Self-organization is defined as non-equilibrium processes that under the influence of systemic driving forces lead to the emergence of more complex structures. One of these processes is a thermodynamic equilibrium: a mechanism describing complex chemical reactions similar to phase transitions in physics (Prigogine, Stengers, 1984; etc.). In their development, complex systems periodically come to bifurcation points characterized by high uncertainty, so even minor events can radically change the course of the system's evolution. Proponents of this approach suggest that the system's behavior can be predicted through identifying the order-defining parameters (attractors), which are few. They are determined by the behavior of system elements and subsystems in dynamics, but then suppress them and set the vector for the whole system. Knowing potential attractors and understanding the laws of complex systems' evolution makes it possible to predict their path with a certain probability. By affecting complex systems near bifurcation points, one can turn their further development toward a preferred direction, since "when passing through forks, the environment becomes sensitive to collective and individual

actions which can lead to the emergence of new social, cultural, technological, and other patterns" (Knyazeva, 2020).

The ***evolutionary biological paradigm*** uses the biological metaphor and the evolutionary mechanism concepts to describe complex socioeconomic systems (Schumpeter, 1912; Alchian, 1950; Moore, 1993; Nelson, Winter, 1985; etc.). This approach is primarily reflected in the "evolutionary economics" theory according to which markets, as complex systems, dynamically change over time due to competition and survival of the fittest (Williamson, 1996; Beinhocker, 2006; Dosi, 1982; etc.). Change is open and determined by heredity and survival. Business processes can be changed by introducing new practices and technologies and passed on to new generations of economic agents like genetic information. Change can be intentional or accidental. Survival is determined by the effects of the external environment (market); the fittest take root in it, which corresponds to the logic of innovation dissemination. According to this new look at adaptation, companies not only adapt to the external environment, but can themselves change it to suit their needs, creating market niches (in the economic context, territorial clusters, value creation ecosystems, industry-specific competition rules, etc.) (Nelson et al., 2018). Macroevolutionary leaps do not add up to a set of microevolutionary changes but are also explained in terms of macrolevel phenomena such as behavioral patterns. As the animal world adapts to climatic and geological changes, so complex social systems have to adapt to changing external conditions.

The ecosystem paradigm is one of the mainstreams of modern strategic management, based on the competitive cooperation and the development of business ecosystem concepts. A popular tool is multi-agent modeling, which reproduces agents' behavior (individuals, organizations, and other autonomous subjects), the rules of their interaction, and the environment in which they operate. The behavior of the entire system (at the macro-level) is determined by the numerous strategies of individual agents who imitate each other, "infect" each other with ideas and rules, and thus create the emergent behavior phenomena. The computational power available today allows one to describe agents' actions in nuances and build sophisticated models. For example, consumer behavior is studied taking into account rational and irrational decision-making aspects (cultural and religious ones) as well as multi-criterial and context-based choice situations. (Katalevsky, 2015). Agent-based modeling allows one to visually trace how small, and seemingly secondary, factors that determine players' behaviour and interaction lead to significant social consequences (Wilensky, Rand, 2015).

Anthropocentric paradigm. This is the only approach to complex systems focused not on the complex processes as such or on adaptive ecosystems, but on the individual who makes the decisions and their motives. In our opinion, this approach seems to be the most objective in comprehending complex social systems and serves as the basis for a realistic assessment of their development. It blends the achievements of economics, sociology, psychology, management science, and political science. The essence of individual and collective human behavior is studied, along with the specifics of people's interactions with the environment and the logic behind their choices (Simon, 1972; Deming, 2000; Lindblom, 2001; Schelling, 1978; Ackoff, 1978; Mintzberg, 2013; Akerlof, 2000). The growing popularity of the anthropocentric paradigm is in line with economists' growing interest in studying the substance and motives of human behavior (Kahneman et al., 1982; Thaler, 1994; Sunstein, 2014; Ariely, 2008; etc.). Economic processes are perceived as emerging social phenomena determined by group interactions (Andersen, Nowak, 2014). Sociologists call such phenomena "constructing social reality" (Berger, Luckmann, 1966). Several levels of systems analysis are typically distinguished: micro-level (individual choice), meso-level (group decisions)[1], and macro-level (the entire economic system) (Dopfer, 2004). In the first case, the combined decisions determine the behavior of a person, in the second of a group, and in the third of the entire macrosystem. The process evolves along the chain from the micro to the macro level and is described by the unintentional segregation model (Schelling, 1978). It has been proven that individual behavior is not always rational; its nature is much more complex than previously thought (Simon, 1972; Kahneman et al., 1982). Since the early 2000s the identity theory has been gaining popularity, which emphasizes the importance of the social group with which an individual identifies (Akerlof, Kranton, 2010). The perception of stories (narratives) determines individual economic strategies which affect the macroeconomic system's behavior as a whole.

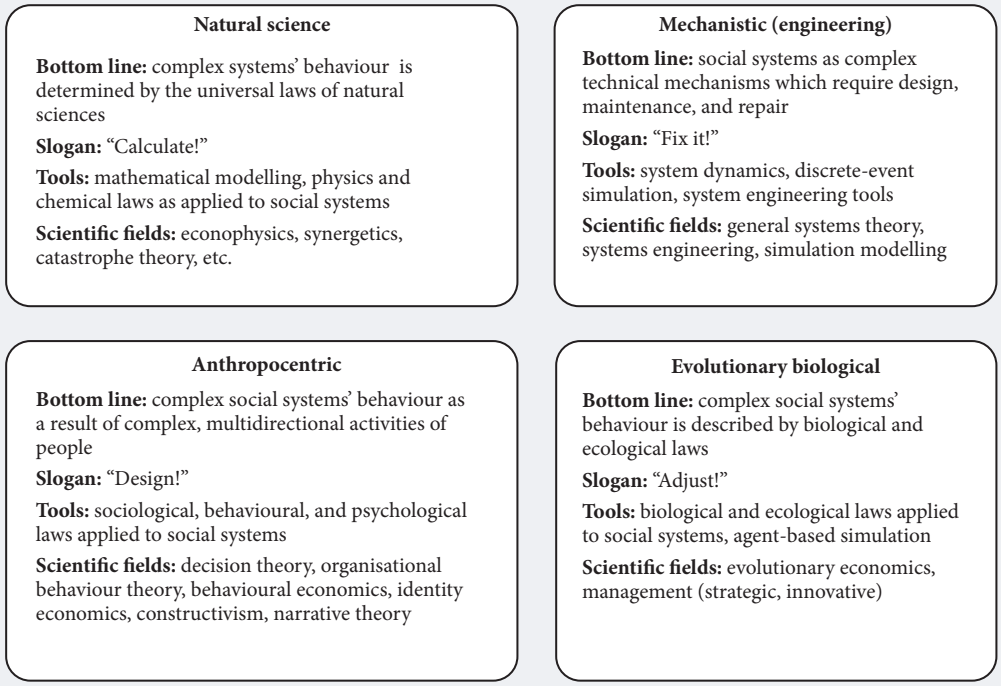
The main characteristics of the four approaches described above are structured in Figure 1. Their features largely determine the range of solutions they offer and their limitations. The choice of approach in many ways defines the result.

Limitations of the Considered Approaches

The limitations of the technical paradigm based on the "Fix it!" logic are due to the fact that a complex system can only be "fixed" a posteriori, i.e., after a "breakdown". Further, often it is impossible to comprehend in which part of the system a problem will arise. Neither the human factor, nor the socio-cultural context

[1] At the same time different concepts of a group can be used (several people, or a social stratum).

Figure 1. **Main Scientific Paradigms for the Perception of Complex Systems**



Source: author.

are taken into account. Effective organizations tend to apply interconnected, highly integrated processes and routines that allow complex work to be completed on time. However, if an error "penetrates" such a structure, it rapidly "infects" the entire system. An analysis of 80 complex technical system failures in the UK showed that the more a hierarchical organisation strives for order based on bureaucratic procedures, the more prone it is to errors (Turner, 1978). Excessive ordering of business processes increases the likelihood that work will be done according to plan, but at the same time errors will be reproduced and replicated throughout the system. Thus, complex systems' failures can be caused both by violating the order and excessively increasing it. A healthy organizational management process is achieved by avoiding excessive control, building a less rigid hierarchy, coordinating autonomous teams' operations, encouraging diversity of opinions, and flexibility in decision-making (Weick, 1998).

The arsenal of the natural science paradigm primarily includes complex mathematical tools (chaos theory, correlation, time series, etc.). Its limitation is that individual behavior and motives cannot be mathematically calculated. This approach can be used to describe certain phenomena such as, e.g., group behavior during emergency evacuations or price fluctuation patterns on financial markets. However, since the human factor with its complex motives is removed from these models, they do not allow one to holistically interpret complex phenomena.

The evolutionary biological paradigm is actively applied in present-day strategic management because it offers effective analogy models and "working" strategies (such as co-evolution, "competitive cooperation" (co-opetition), etc.). Since even large companies find it difficult to compete on their own, the "joining the pack" approach appears to be promising. Organizations create their own ecosystem or join the dominant one. However, this model also greatly reduces the choice of strategies, since adapting is not always the only right way nor does it guarantee long-term survival, which is confirmed by numerous historical examples. Real life is much richer and offers a wide variety of options.

The anthropocentric paradigm proceeds from the understanding that a person's actions are determined by their identity and by socio-cultural factors, so it proposes to focus on designing social systems (hence its notional slogan "Design!"). It is quite popular with institutional economists who pay particular attention to the norms, laws, and cultures which determine economic behavior.[2] Other approaches, with the exception of the anthropocentric one, prefer "not to see" individu-

[2] The importance of this approach is indirectly confirmed by the Nobel Prize awarded to a number of economists who can be counted among the supporters of the anthropocentric paradigm: Herbert Simon (in 1978), George Stigler (1982), Douglas North (1993), George Akerlof (2001), Daniel Kahneman (2002), Robert Aumann and Thomas Schelling (2005), Elinor Ostrom (2009), and Richard Thaler (2017).

als, which is reflected in their terminology (McCloskey, 1993). For example, the technical and econophysical paradigms "animate" complex systems: according to them, the latter "adapt", "develop", "interact", etc. Complex systems are presented as self-sufficient objects endowed if not with reason, then with high autonomy. Man as a manager is excluded from consideration. Still, the technical paradigm indirectly implies that complex systems' mechanisms must be designed, maintained, and, at least occasionally, repaired by someone. That is, the individual is the subject, while the complex system is the object of management.

It seems that the mechanistic, natural science, and evolutionary paradigms of illustrating complex systems, despite using different perspectives, still do not adequately describe social systems. An exclusive reliance on them will inevitably lead to methodological errors when it comes to analyzing individuals' complex behavior mediated by the social context, specific worldviews, and traditions. Unlike the other approaches, the anthropocentric paradigm blends the widest layer of interdisciplinary research in economics, sociology, psychology, and management, and thus, in our opinion, allows for the most realistic modeling of human behavior in complex systems. A good example of the anthropocentric approach is the "garbage can theory" (Cohen et al., 1972), which has greatly influenced economics, sociology, and management. It challenged the prevalent rational decision-making paradigm at the time by offering the most realistic description of the process. Among other things it was applied to explain the causes of technical disasters (Sagan, 2020).

From the point of view of managing complex socioeconomic systems, analysing the system built around the production of Boeing passenger aircraft, and the specifics of the US aircraft industry regulation is of great practical interest. This case, viewed through the prism of anthropocentric approach, shows how the evolution of complex relationships between various influence groups inside and outside Boeing has led to high-profile technical disasters.

Boeing 737 MAX Case Study: A System Error that Cost 346 Human Lives

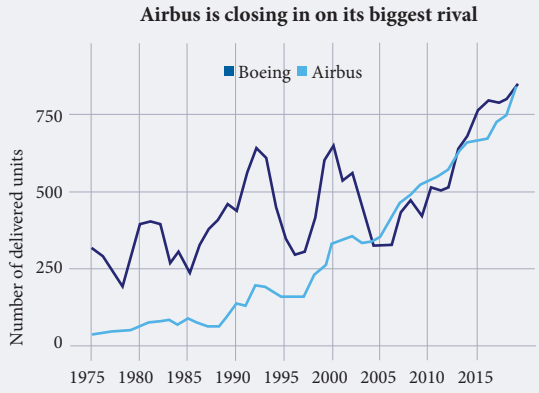
At the end of the last decade, two dramatic accidents happened within several months of each other, both related to Boeing, a long-term global aircraft industry leader. In the fall of 2018, a Lion Air flight crashed, and in the spring of 2019, an Ethiopian Airlines flight also crashed. In both cases the aircraft were from the Boeing 737 MAX series, which were approved by the US Federal Aviation Administration (FAA) as safe to fly two years earlier. Together, the two tragedies claimed 346 lives. By the special FAA order of 13 September 2019, all Boeing 737 MAX aircraft in the United States were grounded pending the completion of an investigation; three months later Boeing suspended the production of this aircraft series and fired the CEO. What is of interest in this story is not so much the technical causes of the disaster, as the answers to the questions concerning which systemic factors led to these events, when did these factors arise, how they evolved, and whether it was possible to prevent the tragedy. We are talking about a complex socioeconomic system that is subject to one of the most stringent, thorough, and technically advanced regulation in the world. How did the actions of various interest groups lead it to gradually evolve into a "orphan system" that failed on a massive scale? Our analysis is based on the findings of an independent investigation of the incidents in question, conducted by the US authorities (HCTI, 2020).

Technical Explanation of the Causes of the Disaster

According to experts, the Boeing 737 series is a global civil aviation "bestseller": over 15,000 aircraft have been sold in total. The Boeing 737 MAX modification was Boeing's answer to its main rival Airbus's plans to launch an improved version of the A320 aircraft - the A320neo, 14% more fuel-efficient than its predecessors. To match the rival design, the 737 MAX series was given larger, upgraded engines. The company positioned this aircraft as being similar to the flagship model (737), which made it unnecessary to retrain pilots for flying it. However, the use of larger engines necessitated structural changes, which in certain cases caused the aircraft to destabilize during flight. In an attempt to eliminate this factor, Boeing developed the Maneuvring Characteristics Augmentation System (MCAS), which automatically corrected the plane's position in the air. When the aircraft was under manual control, the MCAS was supposed to be activated by the pilot. But, as it turned out during the investigation of the disasters, in some cases the system failed: many times it engaged on its own. Further it was impossible to turn it off or put the aircraft into manual control mode (HCTI, 2020).

After the first crash, Boeing blamed the pilots for being underqualified. Only after the second accident did the company acknowledge the problems with the MCAS. In a critical situation the pilots were expected to deal with it by switching the aircraft to manual control mode. But as was noted, no additional pilot training was carried out. Further, it turned out that switching to manual mode was impossible in principle, since during MCAS operation this mode was turned off by default. Errors in the MCAS design violated the main design regulation, according to which automated systems' operation must not hinder the actions of the pilot (HCTI, 2020). After the two accidents Boeing made a number of technical improvements to the MCAS: more sensors were added, the possibility of its spontaneous engagement during the flight was eliminated, the opportunity to switch to manual control was ensured, and additional pilot training was conducted. However, the aircraft design and software faults do not fully explain why things "went wrong". To understand the reasons, one must look at deeper corporate culture issues.

Figure 2. **Comparison of Airbus and Boeing Output Growth**



Source: author, based on: https://finance.yahoo.com/news/1997-merger-paved-way-boeing-090042193.html, accessed 17.02.2023.

Features of the Boeing Corporate Culture

Established over a hundred years ago by the experienced pilot William Boeing, the company quickly began to receive orders from the US Navy, which facilitated its subsequent rapid growth.[3] The founder created a culture that could be described as "a community of engineers dedicated to building excellent aircraft" (Frost, 2020). It was based on a philosophy of increased attention to detail, in line with the belief that neglecting cause-and-effect relationships leads to incorrect interpretations, which, in turn, results in making wrong decisions.[4] In 1960-1970 the US air transportation industry was heavily regulated, the market did not grow particularly rapidly and the competitive pressure on Boeing was not high. However, with the deregulation of the sector and the rise of competition (Figure 2), the company faced the need to optimize costs. In 1997 Boeing merged with McDonnel Douglas. At the time such a deal seemed to be a perfect solution for both parties: Boeing was the leader in civil aircraft construction and McDonnell Douglas got an opportunity to make a leap to the top on the strength of its partner's competencies. Otherwise, developing a new competitive aircraft would require $30 billion and 10 years of work, provided that competitors would not make any progress during that time (Callahan, 2020). This has changed the corporate culture: the focus on solving complex engineering problems was replaced by the desire to increase financial gains. However, in the clash of the two parties' corporate cultures, the philosophy of the smaller McDonnell Douglas prevailed. As a consequence, Boeing has shifted from its emphasis on solving complex technical problems and conducting costly breakthrough research to increasing profits by cutting costs and abandoning radical innovation in favor of upgrading older models (Frost, 2020).

Boeing employees had a hard time adapting to the new philosophy, which contradicted their main value: "making excellent aircraft" (Greenberg et al., 2010). The focus on minimizing costs and maximizing profits created "fertile" ground for "replicating" technical errors. Industry experts estimate that in 2011 the cost of designing a new aircraft would be $10 billion, while repurposing the 737 MAX from the 737 NG series model only cost $3 billion. In seven short years, the gradual effect of these destructive forces led to two major disasters. What seemed to be just an unacceptable engineering error (the MCAS problem), actually had deep roots: a new driving motivation focused on short-term financial results. However, the landscape of the possible causes of the crash would not be complete without examining how the technical issues were overlooked by the key industry regulator, the Federal Aviation Administration (FAA).

Miscalculations of the Industry Regulator

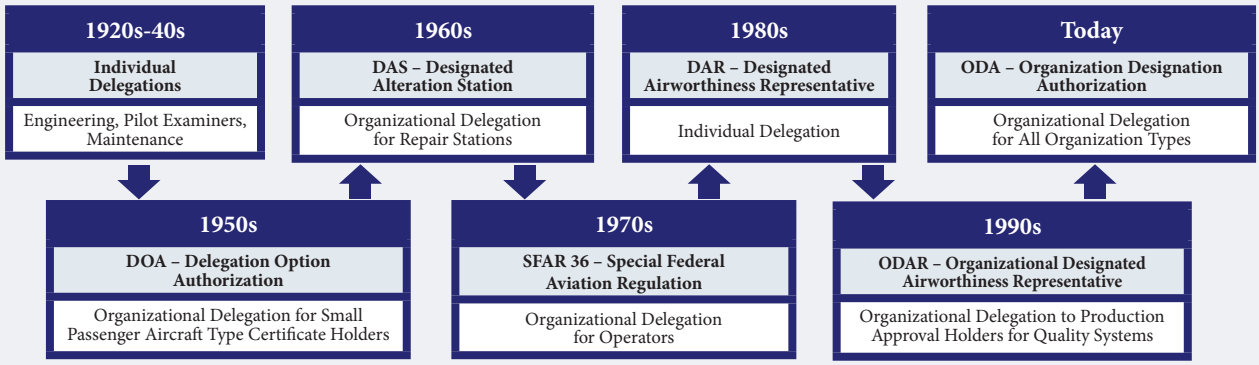
The 737 MAX development team was under intense pressure from management to get the aircraft to market faster. As a result, a "concealment culture" evolved at the company, which amounted to misinforming the FAA – the agency responsible for the certification of all aviation equipment supplied to the US market. Since the FAA did not have sufficient human resources to independently perform all necessary tasks, it had the right to delegate some of its certification responsibilities to qualified third-party professionals (Figure 3). These professionals, known as "designated engineering representatives", were employed (and paid) by Boeing, but reported not to the Boeing management but to the FAA supervisors. They were the FAA's "eyes and ears" in the field, thoroughly familiar with the intricacies of the certification process and believed to take an unbiased approach to certification. This practice was first implemented by the FAA in the 1950s and has since evolved towards a gradual expansion of the FAA field representatives' powers (Figure 3). This approach was applied to well-known, low-risk technological solutions. It allowed the FAA to focus solely on assessing high-risk technologies (projects critical to safety or radical innovations). However, in reality this "strategy" led to ignoring a number of certification requirements, which also contributed to the Boeing aircraft disasters.

Figure 4 shows the gap between the rate at which new technologies subject to certification are introduced by the industry and the FAA's "throughput capacity" (internal resources to process applications). In the case

[3] https://www.businessinsider.com/how-boeing-737-max-plane-became-best-seller-2019-3, accessed on 14.04.2023.

[4] https://www.boeing.com/history/pioneers/william-e-boeing.page, accessed on 19.03.2023.

Figure 3. **Development of the FAA Certification Delegation System**

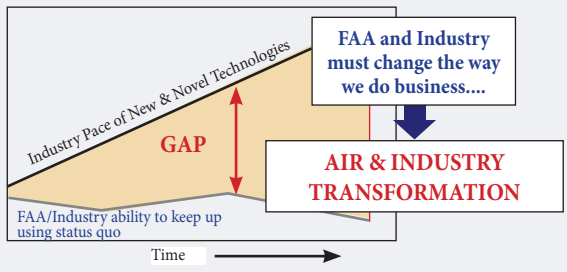


Source: adapted by the author from (HCTI, 2020).

of the Boeing 737 MAX in 2013, the FAA delegated 28 of the 87 certification operations to the company itself. By the end of 2016, this ratio was already 79 to 91. According to the findings of the investigating panel, the FAA "outsourced" to the aircraft manufacturer too many certification responsibilities (OIG, 2020). Plus, seemingly minor changes were made to the delegation regulations in 2005, which, as it turned out later, had a significant impact on the certification process and its results (Figure 5). Under the previous system, designated engineering representatives, despite being fully funded by Boeing, reported directly to the FAA. With the introduction of the new system, Boeing itself gained the right to appoint such experts (Figure 5); they handed the information over to their managers, who processed it and the passed it on to the FAA (a similar system was approved by the FAA itself).

A few months before the first crash, Boeing and the FAA jointly collected and published statistics according to which in 2010-2018 civilian air carriers had a single fatal accident. Overall, US civil aviation fatalities (per 100 million passengers carried) over the past 20 years have fallen by 95%.[5] Excessive complacency with such a picture has led to a gradual relaxation of the FAA control of certification processes. However, the MCAS was not the first technical issue that the FAA missed. A few years earlier problems with the spontaneous combustion of lithium-ion batteries in the Boeing 787 Dreamliner series were discovered during commercial operation of the aircraft. As with the MCAS later, all aircraft in the series were grounded pending the completion of an investigation. During the certification one of the FAA engineers suggested putting the batteries in a steel case, but Boeing rejected this recommendation, and the FAA officials went along with the company's decision. Only after several spontaneous combustions and the complete termination of all Dreamliner flights was the steel casing idea implemented (HCTI, 2020). Thus, even before the Boeing crash, the FAA's supervision delegation system was failing. However, these failures were seen as rare occurrences, so the general certification procedure remained largely unchanged.

Figure 4. **Gap between the Rate of New Technology Development and FAA Certification Potential**



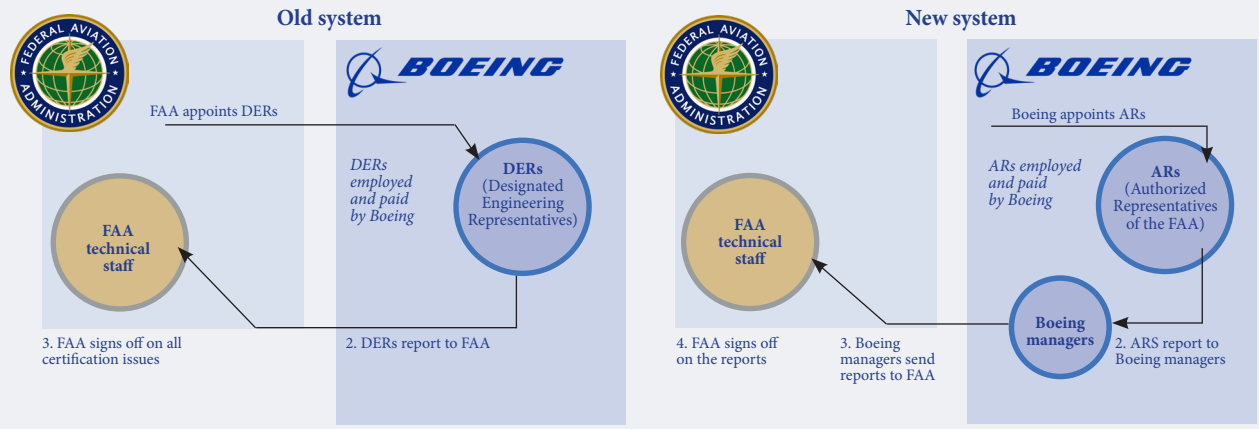
Source: author.

There is another critical factor in the process under consideration: a conflict of interest in the form of the manufacturing company's pressure on FAA experts. As of 2013 the FAA began to survey its designated representatives and in 2016 the company got involved too. Many respondents reported being pressured, to varying degrees, by Boeing's management to speed up certification. Distorted communication between Boeing and the FAA (information was funnelled through a double filter) served as an aggravating factor. For this reason, the FAA was unable to adequately assess the risks associated with technical flaws in the design of the MCAS.

An analysis of the chain of factors that led to the disaster allows one to build a hierarchy of underlying causes of the system's degradation. The main factor was the shift in Boeing's values hierarchy (flight safety faded into the background in favor of maximizing financial

[5] https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=22975, accessed on 18.02.2023.

Figure 5. **Previous and New FAA Delegation Procedures**



Source: author, using: https://www.pulitzer.org/winners/dominic-gates-steve-miletich-mike-baker-and-lewis-kamb-seattle-times, accessed 17.02.2023.

results), which led to a "shortening" of strategies' lifespan. The changes in the FAA certification system also made a contribution (Figure 6).

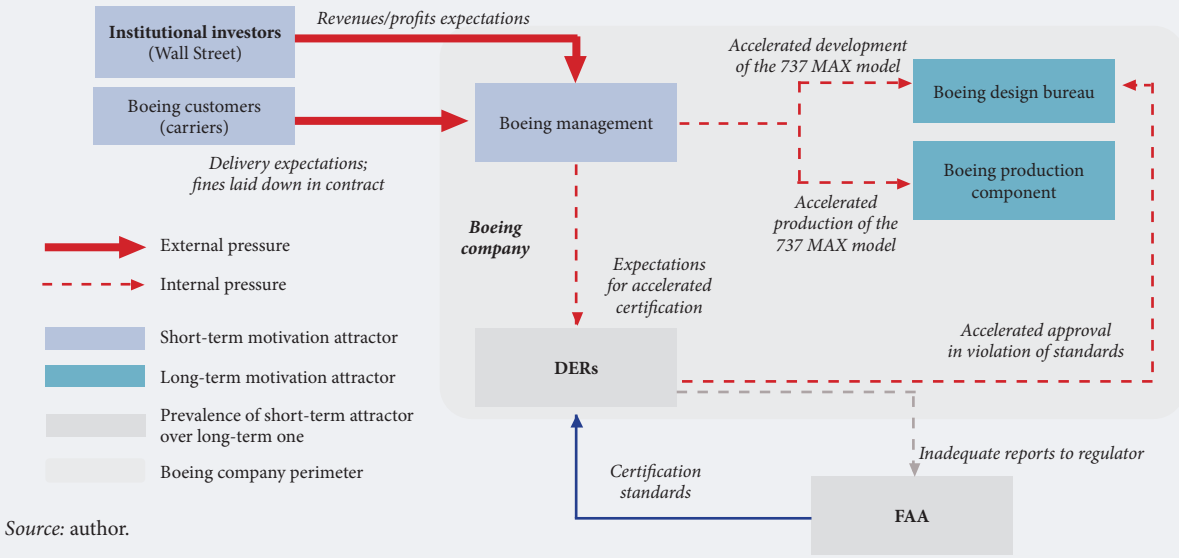
Boeing 737 MAX Production Race

The report by the experts who investigated the causes of the tragedies highlights the "production race" for the Boeing 737 MAX assembly. The company sought to deliver the aircraft to customers as quickly as possible. If in 2010 the output was just over 30 aircraft per month, in 2014 this figure reached a record for Boeing at that time at 42, and shortly before the first disaster it was planned to increase it to 57. The focus on stepping up the financial indicators replaced the more important goal of introducing the most advanced safety technologies and innovations in general, leading to an increased load on production facilities.[6] Taken together, all this caused a serious degradation of the flight safety system.

The Evolution of Complex Systems: Why Failures are Inevitable

We have described the "orphan system" phenomenon using the development of Boeing 737 MAX aircraft series as an example. Any complex system has internal contradictions of some kind due to its inherent multidimensionality and multiple "tension points" arising due to various internal and external forces. The system becomes "orphan" when its key players refuse to perceive it as a whole and take responsibility for its long-

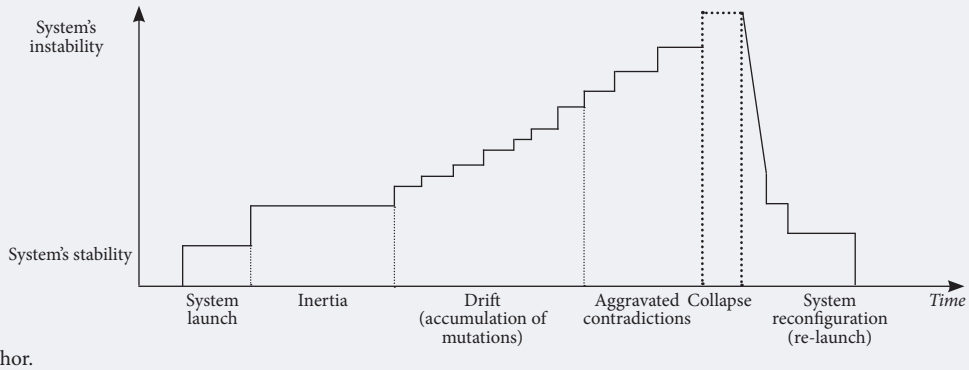
Figure 6. **Diagram of Motivational Factors of the Main Players in the Boeing 737 MAX Case**



Source: author.

[6] https://www.seattletimes.com/business/boeing-aerospace/737-problems-have-grown-in-rentondespite-boeings-reassurances, accessed on 17.02.2023.

Figure 7. **The Evolution of "Orphan" Systems**



Source: author.

term sustainability. Instead, the problem is passed to another player (and sometimes to subsequent generations, as, e.g., in the case of the natural environment). This system state becomes a natural outcome when internal contradictions gradually intensify over the course of the system's drift. The drift happens as follows: first, there is a slow accumulation of errors ("mutations") which is hard to analyze objectively; values and fundamental principles deform, the planning scope shifts from long to short term. The danger is that the organizational system misses this process altogether due to its gradual and prolonged nature. As a result, the system loses its "owner" and starts to change under the influence of the dominant "pressure" vector.

Several factors have become critical in the process of the complex US civil aircraft manufacturing regulation system turning into a "orphan" one. The system drift was mainly driven by changes in the company's culture, the shift of the motivational factor from long term (passenger safety) to short (annual financial result), and the FAA's new aircraft certification policy which created a conflict of interest with the company's management. Communication distortions due to the fact that information from the company could only reach the FAA after passing through several "filters" made additional contribution. As a result, the regulator simply could not detect technical problems in time.

Principles of "Orphan" Systems' Evolution

Complex systems can be in a stable or unstable state. The transition from the first to the second happens in several stages (Figure 7):

1. *Creation and launch.* The system's foundation is laid, its development vector is set, and links between the elements established.

2. *Inertia.* The system develops in accordance with its basic value principles.

3. *Drift (accumulation of mutations).* The system gradually begins to change under the influence of internal and external stakeholders, accumulating "mutations". Its elements deform, while the links between them and the basic principles are eroded (at Boeing, this process began in the 1990s).

4. *Aggravation of contradictions.* The system gradually moves away from its basic principles. Conflicts between goals, objectives, and values increase, communications become distorted.[7] Instability arises, contract and project deadlines are no longer met, even intermediate objectives are failed. All resources are thrown toward finding quick solutions, which worsens the situation further: each element is only interested in "saving itself". The system arrives at the pre-collapse stage.

5. *Collapse.* The accumulated contradictions lead to a major failure which causes the partial or complete destruction of the system. As our analysis shows, it was "programmed", inevitable, albeit delayed.

6. *Intervention.* The system is reconfigured and updated. After that, if the lessons have not been learned, the cycle described above repeats.

This process is common for all types of organizations and socioeconomic systems. The larger the system, and the tighter its elements are interlinked, the more prone it is to become "orphan". Holistic thinking and understanding complex systems' behavior allows one to detect the emergence of a destructive drift in time and take steps to push the system toward the desired direction.

Conclusion

The paper analyzes the little-studied "orphan" systems phenomenon. More complex socioeconomic systems imply an increased number of participants and stronger interconnections between them. At the same time, key system participants' basic values deform, while communications and links in the original system architecture get distorted. The system begins to change under the influence of multidirectional pressure vectors from interest groups, gradually drifting toward

[7] From R. Ackoff's speech. https://www.youtube.com/watch?v=EbLh7rZ3rhU, accessed on 18.04.2023.

collapse. Only a timely and adequate managerial intervention can reconfigure the system and direct it along the desired path.

Complexity science offers a number of concepts which, individually, can to some extent help companies and organizations of different sizes cope with increasing complexity and its effects. However, a more effective approach is skilfully blending them, which allows one to holistically address the entire system, identify the origins of potential crises and catastrophes (which would otherwise remain "hidden"), and outline relevant preventive measures.

This paper presents an overview and a comparison of complex systems' perception paradigms extrapolated to the field of management. Using multilayer causal analysis, the case of two resonant disasters with Boeing aircraft is considered, which most vividly illustrates the emergence of "orphan" systems. However, no matter how destructive the effects of the system's degeneration in the course of its implicit and extended transformation are, it is always possible to reconfigure and improve it with the help of holistic thinking and understanding the nature of complex systems.

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Risk Management Strategies for the Banking Sector to Cope with the Emerging Challenges

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Abstract

The banking industry is facing unprecedented challenges, including cybersecurity threats, the need for rapid technology upgrades, a high degree of uncertainty, aggressive entry of technology giants into the financial market, and others. Like most traditional sectors, banks are trying to keep up with the pace of change, monitor emerging risks, and adjust their development strategies. The article analyzes the emerging trends for the banking sector globally and, in particular, in the context of Israel. Interviews with representatives of the most influential national banks formed the information basis of the study. Shifts in corporate strategies, requests for new business models and «working with the future» were identified. The results emphasize the importance of an integrated, holistic approach to risk management and may be useful for banks not only in Israel, but also in other countries and regions.

Keywords: innovation strategies; future of banks; transformation; new technologies; financial innovation; risk management; stress testing; foresight; scenario planning

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Introduction

Global challenges place new demands on response and technological upgrade strategies in many sectors, including the financial one. Striving for economic stability is becoming a driver for revising risk management approaches, and for enriching them with new content (Braumann et al., 2020; Arshad et al., 2016). The role of the banking industry in the economy remains vital due to increasingly more stringent regulations (Storm, 2018; Sawyer, 2014).[1] The state uses banking mechanisms to achieve economic growth without significant inflationary costs (Alaeddini et al., 2023; Mishi, Tsegaye, 2017). While the financial sector has a high responsibility, it also faces higher risks than other industries (Domański, 2016). Along with the customary problems regarding lending etc., new, difficult to predict ones are emerging and creating network effects throughout the system, such as, e.g., cyberthreats. In this context the need to revise strategies, and apply advanced monitoring and proactive evaluation technologies sharply increases, including stress testing, foresight studies, scenario planning, etc. Classic risk management tools include such indicators as liquidity and capital ratio, growth rates, return on assets, and financial instruments to total assets ratio (Gouiaa et al., 2020). However, this established "arsenal" turned out to be powerless in the face of major shocks of the last two decades (the financial crisis of 2008, the COVID-19 pandemic, etc.), and the need to quickly adapt to emerging advanced technologies. A broad field has appeared for researching the causes, and finding ways to prevent the recurrence of such systemic failures (Maingot et al., 2018; Ker, 2020; Iavicoli et al., 2021).

This turbulent context has affected the Israeli financial system too, making a negative impact on its performance (Lurie, 2019; Demirgüç-Kunt et al., 2021; Bozou, Benchimol, 2023). The increased regulation of the banking sector during the recession following the global financial crisis turned out to be insufficient to promote economic growth (Rosenberg, 2010). Over the next decade national banks have consistently automated their operations, introduced artificial intelligence (AI) tools, and encouraged customers to switch to digital services (Lurie, 2019). Technological development has been accompanied by such inherent features as increased complexity, uncertainty, and disparity.

The paper attempts to provide a systemic overview of the emerging trends affecting the banking sector and of the risk management literature, and analyse preventive practices of responding to emerging challenges using Israeli banks as an example.

Literature Review

The impact of technological trends on the financial sector

The transformation of the banking sector caused by the rapid technological development, and the future shape of the former are being actively discussed at various venues. Over the past 20 years the average number of cash transactions has decreased by more than 45%, and their per hour intensity by almost a third, while the average transaction cost (previously 85 US cents) has increased by 25%. The average number of daily bank closures is forecasted to increase to 10-15.[2]

Technology companies such as Amazon, Google, Uber, Etsy, etc. may become the largest banking services providers by 2025. The solutions they offer significantly improve user experience, speed up the service, and change relevant standards. The line between fintech players and banks is slowly blurring, leaving the latter facing extraordinary challenges including competition in using broadband communications, AI, cloud computing, and other advanced technologies.

Along with technology giants, small start-up providers are also entering the financial services market.[3] New banks specialising in mobile smartphone applications (such as Neon, Revolut, Transferwise, Zak, etc.) offer attractive services at lower prices than the "classic" ones. The high competitiveness of such players in routine operations including currency exchange is due to a convenient user interface which many conventional banks still fail to offer.[4] In turn, apart from access to advanced technologies BigTech companies have the advantage of possessing immense amounts of customer data.[5]

Among the technologies capable of changing the banking industry landscape, AI is usually singled out, applied to generate investment recommendations, compare products, and interact with customers more effectively.[6] Another transformational technology is blockchain, which increases the reliability and transparency of transactions (Sikorski et al., 2017; Thompson, 2017; Shin, 2017; Li et al., 2018; Drasch et al., 2018; Min, 2019). Its best-known application area is cryptocurrencies (Bitcoin, etc.),

[1] In European countries, the list of routine transactions in which the use of cash is prohibited is growing all the time, so intermediaries in the form of official financial institutions are required to complete them (Lazarus,2017).

[2] http://www.foresightfordevelopment.org/featured/banking, accessed on 14.06.2023.

[3] https:// www.bbva.com/en/the-financial-sectors-new-competitive-scenario/, accessed on 14.06.2023.

[4] https://www.handelszeitung.ch/unterne hmen/revolut-zak-und-co-sind-teilweise-gunstiger, accessed on 14.06.2023.

[5] www.moneycab.com/finanz/banken-rechnen-mit-haerterem-wettbewerb-und-neuen-konkurrenten/, accessed on 14.06.2023.

[6] https://www.forbes.com/sites/danielnewman/2019/01/16/top-7-digital-transformation-trends-in-financial-services-for-2019/, accessed on 14.06.2023.

which allow to make transfers directly without using banks as intermediaries (Eagleton, Williams, 2011; Dwyer, 2015; Makhdoom et al., 2019). This technology is still at an early stage of the innovation life cycle, but it's highly likely to become the main banking tool. The amount of funds generated using it is predicted to increase annually by 100% until 2030 (Harris, Wonglimpiyarat, 2019). Such innovations can radically change the global payment system.

Risk management practices

Risk management is key to sustainable and dynamic development (Loan, 2020). There's no universally accepted definition of this concept, but the essence is in monitoring and assessing threats, developing strategies to minimise them and making use of the emerging opportunities (Dubois et al., 2010; Hansika, Amarathunga, 2016). In the banking sector risks are usually classified by the time of their occurrence, duration, the likelihood of realisation, and the costs of preventing or eliminating the consequences. Most often risks are divided into internal (provoked by unethical or unauthorised actions of personnel) and external ones (those due to macroeconomic shifts, political crises, or natural disasters) (Kaplan, Mikes, 2012). A risk management strategy will help the organisation achieve sustainable development if it's based on a correct assessment of the risk, including its nature (financial, operational, technological, legal, reputational), and was developed by the organisation itself (Smith, 2019, Renn, 2004). Improved regulation of the financial sector, and better communication between its participants also make a positive contribution (Hansika, Amarathunga, 2016).

"Conventional" risks in the financial sector are managed on the basis of the so-called Basel Accords. However, they are updated slowly and thus cannot offer relevant tools to respond to emerging challenges. Accordingly, banks are encouraged to develop flexible, adaptive strategies on their own (Pervez et al., 2022). The financial system must be adapted to such technological trends as the proliferation of blockchain technologies using "regulatory sandboxes" (Guo, Liang, 2016). New approaches are also needed to support more sophisticated customer relations, including customer service, consumer value creation, and brand development (Laketa et al., 2015). The above challenges are in many ways related to the transition to environmentally and socially responsible corporate governance (ESG) (Kalfaoglou, 2021).

The shift to online banking is accompanied by an increase in external cyber-attacks which cause significant damage due to the possible blocking of transactions and leakage of confidential information (Rehman, 2021).[7] Researchers note the high potential of information security technologies such as biometric identification, machine learning, big data analysis, and their various combinations (Ghelani et al., 2022). In particular, it is proposed to use data encryption, special authentication procedures, and multi-level verification (Alzoubi et al., 2022).

The most popular threat response tools include staff training and development, compliance with optimal lending restrictions, and diversification of lending (Youssef, 2019). However, in most cases "getting ahead" requires adopting special strategies designed taking into account various specific aspects (Kaplan, Mikes, 2012). Researchers have paid sufficient attention to common methods such as hedging, diversification, internal management, and capital adequacy ratios (Curti et al., 2020; Gallati, 2022). E.g. hedging is based on setting flexible transaction terms and using "umbrella insurance" (Etges et al., 2019). Diversifying investments across regions and industries has become a common approach, which allows to reduce potential losses in one area by generating income in others (Acharya et al., 2017). However, lack of adequate competencies in alternative investment areas can expose the portfolio to other, unexpected risks (Karkowska, 2019). Yet another possible solution is sharing risks with counterparts through insurance and partnership agreements (Nijskens, Wagner, 2011). However, this approach has its limitations because, despite reduced risks for individual players, at the system level they increase.

In addition, there are capital adequacy requirements to cover customer losses in extreme cases and overcome recession effects. To assess the bank's readiness for possible adverse situations, scenario analysis and stress testing are carried out, as a basis for decision-making. In the increasingly complex context, flexibility, proactive preventive policies, and rapid adaptation to emerging technological and other challenges are of critical importance for banks.

A wide variety of threat assessment and neutralisation tools have been accumulated. However, using then individually is ineffective due to the increased rate of social and technological trends' dynamics. Therefore the existing techniques only work in combination, and in certain cases new, radical approaches must be developed to accomplish particular objectives (Stanikzai, Shah, 2021).

Foresight methods, including scenario planning, monitoring weak signals from the external environment, etc. allow to obtain a better understanding of customers' future behaviour, possible changes in legislation and other uncertainties, which provides a sound basis for strategy development (Jafari, Tabatabai, 2017). The uncertainty aspect forces us to re-

[7] Massive data breaches have become a daily reality. The growing vulnerability of today's digital society is evidenced by regularly appearing news about such incidents involving companies such as Equifax, Chipotle, Gmail, Arby's, Verizon, Yahoo, and Uber.

think the planning process, because tracing all possible causal relationships and effects is too difficult.

An analysis of foresight projects provides an idea of the future context. Recognising their growing reliance on technology and big data, banks are exploring opportunities to gain a competitive advantage by applying them (PWC, 2016). To this end internal think tanks are increasingly being established (Baumgartner, Peter, 2022). Artificial intelligence, blockchain, and other technologies already facilitate transactions' scalability. Against this background, bank personnel find themselves in an ambiguous situation: on the one hand, it becomes possible to focus on complex operations more, while on the other, the number of staff is reducing.

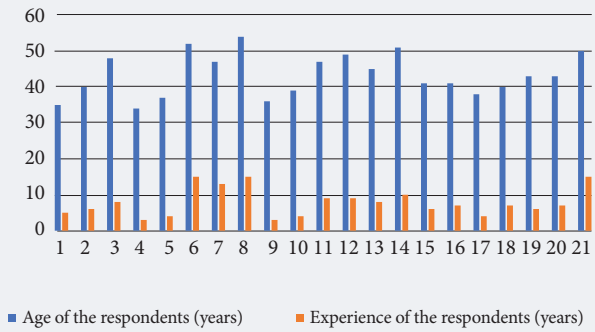
According to various estimates, the future landscape of the financial sector will largely be determined by the strategic course its players take: towards increased competition among themselves, or, on the contrary, strengthening partnerships (or a combination of these approaches). Most banks are still competing to build their own blockchain systems, but for this technology to become widely used, a collaborative cross-industry effort is needed to build an extensive computer and internet infrastructure.[8] Achieving long-term sustainability requires taking a holistic, integrated approach to identifying the emerging drivers today, and correctly interpreting them.

Research Methodology

In line with the abovementioned objective of the study an empirical qualitative approach was chosen, to fully take into account and better understand the various perceptions of the situation and the relevant experience (Creswell et al., 2007; Salloum et al., 2021). Face-to-face semi-structured interviews were conducted with risk managers of major Israeli banks (21 respondents). They were selected to ensure the sample was representative in terms of coverage (national and international banks), specialisation (banks offering mortgages, etc.), location, and other factors. The sample comprised respondents involved in risk management due to their job responsibilities, or those who showed an interest in this topic, had relevant experience and the ability to articulate it. The respondents and the banks have been kept anonymous for confidentiality reasons. Their demographics and work experience details are shown in Figure 1.

To ensure comparability of the results, all respondents were asked the same open-ended questions. Initial assumptions regarding the aspects under consideration were clearly formulated beforehand, to avoid bias in the wording of the questions. During

Figure 1. **Demographics and Job Experiences of the Risk Managers**



Source: authors.

the interviews and between them the focus shifted from broad open topics to more targeted and specific ones (Salloum et al., 2021; Tuffour, 2017). The interviews continued until theoretical saturation was reached, the first signs of which appeared after the fourteenth interview. For greater reliability seven more experts were interviewed, but the "added value" of these conversations turned out to be not significant enough to expand the information basis for the analysis. The minutes and audio recordings were transcribed and converted into electronic text format.

The respondents' characteristics directly related to the object of the study were taken into account. To maintain anonymity, the respondents were assigned codes. The information obtained during the interviews was structured by topic (Table 1), after which a comparative analysis was carried out using ATLAS.ti. The data was checked against the list of initial assumptions to avoid making biased conclusions. In line with the recommendation to use previously published literature as an additional information source (Glaser, 1978), the results of other studies were considered. To further increase the conclusions' reliability, the transcripts were agreed with the respondents. After summarising the interview results the respondents were given the opportunity to provide feedback, which was recorded and made use of. Finally, a summary of all interviews was also made available to the respondents, and adjusted on the basis of their feedback.

Results

The authors' interpretation of the data collected during the interviews served as the basis for identifying the topics for further analysis (Table 1).

Based on mention frequency, the respondents saw data breach-related cyber threats, digital disruptions,

[8] Past experience shows that partnerships between the financial and related industries promote application of financial innovations. Examples include the worldwide network of interbank ATMs Cirrus and the payment systems VISA, MasterCard, UnionPay, JCB, Diners.

Table 1. **Derived Themes and Sub-themes of Study**

Code	Topic	Sub-themes
1	Emerging Challenges and Evolving Risks to the Current Banking Sector	Cybersecurity Threats, technology advancements, economic volatility, regulatory changes, customer expectations
2	Prioritization and Impacts of Evolving Risks and Challenges	Potential impact, regulatory requirements, probability, customer demands, Effects on business models, risk profiles, alignment with organizational objectives, strategic decision-making
3	Difference of Emerging Risks and Challenges from Traditional Risks	Differences in nature, characteristics, impact, mitigation strategies
4	Risk Management Strategies for Emerging Challenges	Risk assessment frameworks, technology solutions, robust internal controls, scenario analysis, compliance measures, stress testing, business continuity planning risk transfer mechanisms
5	Formulation, Implementation, and monitoring of Risk Management Strategies in Banks	Key stakeholders, strategy development, performance monitoring, risk governance frameworks, reporting mechanisms, continuous improvement efforts, alignment with regulatory guidelines.
6	Adapted Risk Management Strategies and their Effectiveness	Identification of strengths, areas of improvement, weaknesses, challenges faced in mitigating emerging risks. success stories.
7	Measurement of the Effectiveness of Employed Risk Management Strategies	Data analysis methods, Key performance indicators (KPIs) reporting frameworks, continuous assessment, benchmarking against industry standards, improvement processes.
8	Collaboration with other Organizations to Tackle Emerging Challenges	Partnerships with other banks, technology firms, industry associations, cross-sector collaborations, academic institutions, regulatory authorities, external consultants, international collaborations.
9	Recommendations and Limitations to Improve Risk Management Strategies	Resource constraints, integration challenges, technological advancements, regulatory complexities, siloed approaches, enhance risk management strategies.

Source: authors.

emerging technologies, customer expectations, economic volatility, regulatory changes, geopolitical uncertainty, market fluctuations, financial crime, and cultural, behavioural, and reputational risks as key challenges for Israeli banks. To detect threats, Israeli banks use careful monitoring, evaluation, audit, partnerships, market research, and feedback analysis (see Table 2 for more).

The banks in Israel rank threats based on their impact, relevance to organisational goals, customer needs, likelihood of realisation, and regulatory requirements. New trends fundamentally affect the Israeli banking sector because they shape customer behaviour, current operations, technology adoption, regulatory environment, risk profiles, business models, and strategic decision making. Approaches based on data analytics, automation, artificial intelligence, and digital currencies (decentralised and cryptocurrencies) are becoming a source of both challenges and opportunities.

The respondents' answers showed that emerging challenges differ from the traditional ones in their nature and effects, and require adapted strategies and special competencies to counter them. They are more dynamic, unpredictable, and complex due to technological development and increased number of cyber-attacks, systemic in nature, and make a cascading effect on the sector in question. The high rate of proliferation, and the lack of statistical estimates for previous periods makes it difficult to identify and quantify such threats. Since they are not covered by a specific regulatory framework, countering them is particularly important for banks' reputation and maintaining customer confidence. This, unlike traditional factors which banks can handle on their own, requires cooperation with other organisations.

To proactively identify and minimise the long-term impact of negative factors, Israeli banks are designing mechanisms for regular monitoring and evaluation. One of the banks has set up a special division responsible for fostering a risk management culture. Its functions include regularly informing the personnel about the nature and consequences of emerging threats, and holding training events to develop relevant competencies.

Cyberthreat monitoring amounts to identifying vulnerabilities using special protocols. Possible response scenarios are developed. The surveyed banks' cooperation with other financial and related organisations, and information sharing help to manage technological risks. Trending provides an information basis for optimising and adjusting management strategies in line with the nature of the challenges. Their effectiveness is evaluated through scenario analysis and stress testing. The risk portfolio can be diversified by distributing assets and investments

Table 2. **Main methods of risk management specified by respondents**

Domain-related risks	Governance methods
Cybersecurity and data privacy	Monitoring, robust risks assessment, vulnerability assessment, audit, staying up dated, penetration testing, data protection regulations
Digital disruption and technological advancement	Monitoring of fintech landscape, assessment of technology risk and collaborations with IT teams
Economic volatility	Scenario analysis, stress testing, and market trend analysis
ESG-related challenges	Collaborations, partnerships, competitive analysis, comparisons of challenges and opportunities

Source: authors, based on interview results.

across regions, lines of business, and sectors. This allows to smooth out the danger zones, balance various impacts, and mitigate the consequences. Taking into account social and environmental factors in developing investment and lending strategies contributes to switching to a green development model.

Risk management strategies are designed by key stakeholders, taking into account the organisation's various outlooks and goals. These strategies are implemented by special divisions responsible for coordinating the tracking of new threats by other bank departments. The collected information is analysed to develop response measures; employees are given appropriate retraining.

Risk management is the subject of open discussions with stakeholders (customers, employees, etc.); the approaches are regularly refined based on the feedback received. The performance is evaluated through independent audit.

The respondents noted that iterative strategy development allows them to proactively identify and minimise the impact of emerging risks on the bank's operations. This process should be regular, based on monitoring, scenario analysis, and stress testing taking into account the characteristics of specific threats to neutralise their consequences. An important role in effective management of, and response to new challenges play partnerships with other banks, industry associations, and fintech start-ups. Cooperation with government agencies contributes to the development of the regulatory framework. The recommendations most frequently suggested by the respondents included increasing investments in infrastructure and analytics tools to better integrate and structure data; stepping up knowledge sharing; strengthening cybersecurity; and implementing inclusive training programmes. Weaknesses mentioned by the respondents included poor integration of knowledge, inability to quickly adapt to new technologies, budgetary constraints, lack of awareness, complex rules and regulations, data privacy vulnerabilities, poor communication, and uncoordinated approaches.

Conclusion

The banking sector is facing various kinds of unprecedented challenges. The most important ones are related to the dissemination of advanced technologies, increased cyberattacks, and pressure from high-tech giants who aim to capture a significant share of the financial market by meeting customer needs better.

Using the Israeli banking system as an example, this paper explores approaches to strategies for countering existing and emerging threats. The information basis was obtained by surveying risk management experts representing Israeli banks. The interview analysis showed that on the whole, the respondents confirmed the priority of the above factors, and applied many of the established management tools including preventive ones.

To improve the effectiveness of the risk management system, the experts first of all recommended to strengthen financial sector organisations' partnership with external stakeholders to share knowledge and experience, increase investment in advanced technologies, regularly monitor the emergence of new threats and opportunities, adapt action plans, and help employees develop relevant competencies.

In general, the study results emphasize the importance of an integrated, holistic approach to security. The existing knowledge on emerging challenges for the banking sector was structured, along with the approaches to managing and ways of neutralising them; the available information was supplemented by an analysis of the situation in Israel. Despite the small sample limitation (21 interviews), the findings may be useful not only for Israeli banks but also for those in other countries and regions, and serve as a guide for further research in this field.

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Conceptual Frameworks of Strategic Management

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Abstract

Plentiful works have been devoted to theories and practices of business management, but comparative studies of their advantages and limitations are rarely carried out. In an attempt to fill this gap, the article provides a systematic analysis of management concepts that have gained the major attention in recent years. The search was carried out using the Web of Science database. Ten theories were selected and analyzed in detail, which are the considered most frequently within selected body of articles. The spheres of their application, advantages and limitations, connections between them are indicated. This study deepens the understanding of the theories of entrepreneurship management and shows which of them are the most prolific for improving the efficiency and competitiveness of enterprises and shaping their strategic vision of the future. Directions for further research are shown to overcome the limitations of the presented concepts.

Keywords: business management; strategic management; management concepts; theory of variable practice; evidence theory; game theory; business practices; stakeholders

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Introduction

Nowadays, entrepreneurs are facing the challenge of investing in the best combination of projects considering their limited resources. In a multi-dimensional setting, this process has its complexities that need to be dealt with by applying competent management systems (Ershadi et al., 2020). In order to ensure entrepreneurial enterprises reach a better state of development, entrepreneurship management research is very necessary. Entrepreneurship management involves imaginative and creative abilities, skills, and proficiencies to adeptly open and manage a company. It is the general term for a series of activities such as planning, organizing, directing, coordinating, and controlling the production and operation activities of enterprises, which is the objective requirement of socialized mass production. To obtain more revenue, high efficiency, better development, and less waste, an enterprise must achieve the maximum input-output efficiency by using human, material, financial, information, and other. They must adopt advanced methods to maximize effectiveness while minimizing costs and risks. The number of organizations that adopt this approach is on a steady rise due to its proven benefits in practice. The advantages encompass the risk-reward balance in business areas (Paquin et al., 2016), an ability to drive better business decisions based on operations, optimized budget allocation (Oostuizen et al., 2018), real-time collaboration between line and functional managers (de Medeiros et al., 2019), and the appropriate use of available resources (Bhatia et al., 2020). These management theoretical approaches help entrepreneurs invest their resources in the projects that support the strategic direction and bring them competitive advantages in the long term.

Although some studies have been published on entrepreneurship management studies and management theories (Ratten, 2011), there is still a lack of studies on the use of management theoretical approaches in entrepreneurship management research. This work aims to show how the theme of management theoretical approaches has been approached in the scientific literature and analyzing the contribution of these studies to the theories. In addition, it identifies published articles, with relevance and scope, on the themes of management and entrepreneurship management, using Systematic Literature Review (SLR). The question to be answered by the SLR is: what are the most frequently used theories in management?

Research Method

Information Repository

The SLR was carried out using the Web of Science database. The aim was to identify the management theories studies that contribute to entrepreneurship management. Initially, the search focused on articles mentioning "entrepreneurship management" or "business management" associated with the term "management theories" in titles, abstracts, and keywords. The results were then filtered by subject area in order to source articles categorized as business, management, or economics. The search was limited to a specific timespan from 2016 to 2022. The articles were filtered by language and include only international publications in English.

Research Protocol

In this research, the qualitative analysis of the articles was prioritized, aiming at constituting a matrix that could represent the evolution of the topic of management that is currently being used by experts in the field of entrepreneurship management. In phase 1, the first stage of the research was carried out using the database of SSCI WOS. At the beginning of the searches, the search string was defined containing the keywords "management theories" or "strategy theories", added to "business management", "entrepreneurship management", or "firm management". A total of 580 articles were found in the WOS database

In phase 2, to meet the research objective, some exclusion criteria were established as filters for the selection of relevant results, focusing on the areas of interest: business, management, and economics for the articles found in WOS and the specific name of a theory (for example 'institutional theory'). The search in the algorithm resulted in 152 articles. Then followed the selection of articles published in the period of interest to us (2016–2022). The remaining 119 publications became the subject of in-depth reading. Twenty-four theories emerged as eligible for analysis (Table 1).

In phase 3, the selection of theories highlights the correlation of management theoretical approaches and entrepreneurship management. The theories were selected by the keywords of management theories in business/entrepreneurship by which the paper was indexed by SSCI. The most common management theoretical approaches were found from these selected articles in the index, most of which were chosen from Q1or Q2. These are Institutional theory, Evidence theory, Agency theory, Stakeholder theory, Social capital theory, Management fashion theory, Practice variation theory, Game theory, Grounded theory, and Planned behavior theory.

Theoretical Approaches to Management

In this section of the study, we will present the most frequently used theoretical approaches.

Institutional Theory

Institutional theory is mainly devoted to exploring and explaining why organizations are accustomed to adopting certain practices and ideas that are generally popular, but whose economic benefits are not obvious (Meyer, Rowan, 1977; Scott, 1987; Zucker, 1987). Institutional theory is now firmly established as the standard theory for describing organization-environment relationships and the spread and adoption of popular organizational practices (Suddaby et al., 2010). Its claims contradict the two main assumptions of institutional theory (isomorphism and decoupling), but open up an important

area of organizational analysis: the transmission of ideas from one setting to another (Piekkari et al., 2020).

However, institutional theories can be more or less accused of violating the basic laws of the construction of these theories. the most serious problem that really leads to the frequent emergence of alternative theories and revisions is the so-call"d "growth prob"em" (Aksom, 2020). Although this is the dominant theory of organizations (Greenwood et al., 2008; Alvesson, Spicer, 2019), as internally consistent and explaining a wide range of empirical observations, institutional theory is clearly not a complete theory. Institutional theory predicts consistency with institutional mandates, isomorphic tendencies over time at the macro level, and decoupling as an organizat'on's individual response to institutional demands. This forces organizations to imitate each other and over time the system becomes more and more homogeneous while local adaptation and tendency to change must be acknowledged and divided into the different aspects of the theory of perspective. Aksom (2023) first observed that system theory is used to overestimate the practice of most organizational system's potential, in reality, most practices fail to gain adequate institutional support (Firsova et al., 2022). With the development of institutional theory, some branches have moved closer to behavioral theory. Furthermore, institutional theory has also studied the founding conditions for new firms. This work questions the conventional assumption that entrepreneurs are rationally able to locate opportunities, and it instead posits that the key sources of an organization's founding activities are the institutional features of the social group to which entrepreneurs belong or the symbolic environment they face.

Evidence Theory

The evidence theory was first proposed by Dempster and Shafer (Dempster, 1968; Shafer, 1976) to integrate the available alternatives into a collective theory to select the best alternative actions. Hatefi et al. (2019) used the theory of evidence to develop a new model for assessing environment-related risk factors. The proposed method is applied to an Iranian oil company and compared with the traditional risk assessment method and fuzzy inference system method. The results show that the proposed model is superior under uncertain conditions. Li et al. (2015) found that most of the previous working methods based on fuzzy soft sets were based on different types of horizontal soft sets, which made them too complex to be studied by decisionmakers. Therefore, they proposed a new fuzzy soft set method that combines grey correlation analysis with the theory of evidence in medical diagnostic problems. In their approach, the Rules of Evidence (Dempster, 1968) aggregate the available schemes into a collective scheme to select the best one. Wang et al. (2016) combined the fuzzy measure and theory of evidence to enhance the functioning of the decision method based on a fuzzy soft set, resulting in less uncertainty and correspondingly improving the level of selection decision. Ballent et al. (2019) argue that the evidence theory can provide a basis for considering various expert beliefs in the examination of structural vulnerability and damage, thus generating subjective assessments. Muriana and Vizzini (2017) pointed out that quantitative risk assessment is an effective tool for rapid decision making. At the same time, progress was made with the target prior to the adverse impact of the risk profile. Therefore, corrective and preventive measures must be developed based on risk indicators to balance risks. Niazi et al. (2016) discuss how many software organizations do not pay enough attention to management and risk assessment before embarking on global software development. To this end, they propose a two-step approach that identifies and analyzes 19 risks associated with global software development from client and vendor perspectives. Pan et al. (2019) proposed a new mixed interval valued fuzzy set that improves evidence theory and fuzzy Bayesian networks for risk assessment and risk analysis under complex, uncertain conditions. The results show that this method can reduce the possibility of potential failure and improve the risk level when failure occurs. Qazi et al. (2016) proposed a new approach to risk assessment by simultaneously considering complexity. They found that there are interdependencies among complexity drivers, risks, and goals, and their approach is also able to prioritize complexity drivers, risks, and strategies. Sangaiah et al. (2018) proposed a hybrid approach to software risk assessment, including fuzzy decision trial and an evaluation laboratory, fuzzy multi-criteria decision making (MCDM) and multi attribute decision making (MADM). Compared with the classical method, this method can provide more efficient results. Suresh and Dillibabu (2020) focus on the risk assessment of software using a machine learning mechanism based on mixed fuzziness, which is based on multi-criteria decision making based on adaptive neurofuzzy reasoning systems and the TODIM (an acronym in Portuguese for iterative multi-criteria decision-making – "Tomada de Decisão Iterativa Multicritério") approach based on intuitive fuzziness. Tonmoy et al. (2018) studied coastal risk identification and assessment in Australia. They found that informing and consulting stakeholders had a positive impact on risk management planning. Zou et al. (2017) point out that multidisciplinary collaboration in risk management is a necessary condition for more success. In most classical risk assessment methods, risks are usually analyzed separately.

Agency Theory

Agency theory originated from the work of Jensen and Meckling (1976), who regard corporate shareholders and managers as rational and self-interested actors and aimed to conduct the economic characterization of the relationship between these two groups. Eisenhardt (1989) reviewed the two extreme positions of agency theory, namely supporters who see agency theory as a revolutionary theory, Jensen and Ruback (1983), and opponents who see agency theory as unclear, narrow, and without testable implications (Perrow, 1986). The study concludes that the theory is unique, clear, and em-

Table 1. **Management Theoretical Approaches with at Least One Paper Published in the Field of Entrepreneurship Management throughout 2016–2022**

Theory	Number of papers
Institutional theory	22
Evidence theory	20
Practice variation theory	18
Game theory	10
Grounded theory	9
Agency theory	9
Social capital theory	5
Planned behaviour theory	4
Management fashion theory	3
Stakeholder theory	3
Information processing theory	2
Resource dependence theory	2
Systems theory	2
Relational contract theory	1
Signaling theory	1
Planning-performance theory	1
Middle-range theory	1
Dynamic capabilities theory	1
Prototype theory	1
Quadrant theory	1
Activity theory	1
Actor-network theory	1
Structuration theory	1

Source: authors.

pirically testable, and can be used to solve the principal-agent problem of any firm. Agency theory still has many boundary conditions that require further theoretical development (Bendickson et al., 2016). 'Agency theory is based on the idea of the separation of ownership and control, which is a very important issue in organizations (Berle, Means, 1932; Jensen, Meckling, 1976).

Due to the separation of ownership and control, the board cannot fully trust the management of the organization. As a result, there may be conflicts between the owners and their agents which may result in agency costs that minimize these conflicts. According to neoclassical economics, agency theory has been criticized because an agent may act in his/her best interests rather than those of the principal or owner (Donaldson, Davis, 1991). The theory may also be criticized given that the company's management may not be credible. Therefore, owners must strictly monitor managers' performance, which is the main goal of agency theory. Turner and Muller (2003) used the agency theory for the first time in governance literature to describe the relationship between managers (agents) and principals (owners). The researchers concluded that the owner needed to monitor the performance of the agent. Therefore, the owner can ensure that the manager's goals are aligned with the owner's goals. Turner et al. (2010) argues that agency theory is used to emphasize the relationship between owners and managers in the context of project management (PM). Given the role of governance as explained (Turner, 2009), it helps to set goals, then identify ways to achieve those goals and monitor performance. This seems to be a good illustration of agency theory. In addition, this principal-agent relationship should be strictly monitored to reduce planning and control risks and uncertainties for the team. Therefore, it can be argued that performance can be improved through continuous monitoring by the owner, as more intensive monitoring can resolve differences in work in a timely manner, resulting in better results. In light of the above discussion and taking into account the objectives of this study, agency theory is used to inform the current research because it focuses on monitoring, which is essential for improving performance.

Stakeholder Theory

Stakeholder theory is widely used in management and mainly used in examining the organizational environment, strategic management, ethical issues, business planning processes, e-government, project management, and environment management. (Dwivedi, Momaya, 2003). The stakeholder theory is a prominent management approach that has primarily been adopted in the past few years (Pedrini, Ferri, 2019). More recent studies have started to consider how stakeholder theory relates to firm performance, investigating how the understanding of stakeholders' claims could serve business objectives (Ranängen, Zobel, 2014; Heikkurinen, Bonnedahl, 2013; Matos, Silvestre, 2013). Stakeholder theory has grown into one of the most frequently used approaches to organizational sustainability. Stakeholder research has provided considerable insight into an organization's relationship with nature, and advanced approaches that consider the intrinsic value of non-human nature. Scientific information has evidenced an alarming decline of biodiversity, climate change, and ecosystem degradation (Steffen et al., 2015). These challenges have generated research on the relationships between business organizations and the environment since the mid-1990s (Heikkurinen et al., 2016). Within these endeavors, stakeholder theory has become a prominent approach to organizational sustainability studies (Hörisch et al., 2014; Schaltegger et al., 2023).

A stream of stakeholder research has identified non-human nature (hereafter also 'nature' for simplicity) as a stakeholder (Driscoll, Starik, 2004; Starik, 1995). This approach has sought to overcome the predominantly anthropocentric focus that depicts nature primarily as a resource to enhance human and organizational well-being (Driscoll, Starik, 2004). Ethical approaches that go beyond anthropocentrism, such as ecocentrism (Starik, 1995), Gaia-centrism (Waddock, 2011), and ethics of care (Tallberg et al., 2022) have promoted the intrinsic value of non-humans in stakeholder relationships. Notwithstanding the advancement of these contributions, more nuanced conceptualizations of nature are still lacking, yet they are necessary for identifying how how the environment impacts stakeholder relationships. Stakeholder research has studied organization–nature relations using descriptive, instrumental, and normative aspects and advanced two approaches: nature as a

stakeholder and nature as a shared concern among human stakeholders (Schaltegger et al., 2023). The former posits that nature acts as a stakeholder due to its physical, legal, socio-emotional, and ethical characteristics (Driscoll, Starik, 2004; Tallberg et al., 2022 and its capacity "to affect and be affected" by organizational activities. The latter maintains that nature cannot articulate its stakes (without a human voice) and cannot therefore hold stakeholder status (Näsi et al., 1998).

Social Capital Theory

Social capital theory is a theoretical framework used to describe the potential links between multiple social capital dimensions and knowledge integration (Cao et al., 2015). The core effect of social capital theory is that individuals' or organizations' networks of relationships are valuable resources that facilitate collective actions (Adler, Kwon, 2002; Inkpen, Tsang, 2005). Two main views have emerged on the source of social capital value in the relationship, namely the structural and relational aspects (Kostova, Roth, 2003). Based on social network theory, the structural view argues that it is the structure of the relationship that provides value for individuals (e.g. Baker 1990). On the other hand, the relational view contends that it is the nature (i.e., content) of the relationship within the structure that generates value for individuals (Kostova, Roth, 2003).

Integrating these two perspectives, Nahapiet and Ghoshal (1998) defined social capital as "the sum of the actual and potential resources embedded within, available through and derived from the network of relationships possessed by an individual or social unit". Under this conceptualization, Nahapiet and Ghoshal (1998) proposed that social capital is a tripartite concept consisting of relational, cognitive, and structural capital. Relational capital refers to the goodwill that exists between a buyer and a supplier and this goodwill is leveraged through a history of repeated interactions (Burt, 1997). Relational capital is a multi-faceted concept including trust, obligation, respect, and friendship that is present in the relationship between a buyer and a supplier (Nahapiet, Ghoshal, 1998). Cognitive capital portrays those resources providing shared representations, interpretations, perceptions, and systems of meaning in the relationship (Nahapiet, Ghoshal, 1998). Cognitive capital manifests when buyer and supplier have shared language and codes (Nahapiet, Ghoshal, 1998). Structural capital refers to the overall pattern of connections between a buyer and a supplier (Nahapiet, Ghoshal, 1998). Structural capital reflects the presence, frequency, and strength of social interactions between a buyer and a supplier (Tsai, Ghoshal, 1998). Social interactions represent the social processes and activities that are conducted between a buyer and a supplier to coordinate and structurally embed the relationship (Roden, Lawson, 2014).

Management Fashion Theory

MF theory is the result of a paper by Abrahamson (1991) in which he identified and addressed flaws in the innovation communication literature. In his 1996 paper, he focused more on institutional explanations of diffusion, but recognized that both institutional theory and diffusion theory have one important thing in common: a bias in favor of innovation, referring to the fact that many inefficient innovations tend to spread widely, while efficient ones tend to fail (Abrahamson, 1991, 1996). Institutional theory recognizes this phenomenon because the nature of the efficiency category is summarized as the more basic attribute – the institutional value of social construction that determines the prospect of innovation. Successfully disseminating and institutionalizing practices that gain social support and acceptance is the goal, regardless of their true technical and economic value.

MF theory extends institutional theory in two important ways. First, institutional theory is used to overestimate the amount of truly institutionalized practice: most are fads and trends that suddenly catch on, but decline and leave room for new ones (Abrahamson, Fairchild, 1999; Aksom, 2023). The ephemeral nature of most ideas and practices contradicts institutional arguments, since institutional theory holds that institutionalization is a final state (Aksom, 2020, 2023). If organizational practices achieve a complete institutionalization, they cannot be de-institutionalized and replaced because the participants cannot recognize the need for change. Abramson addresses this paradox in the second key idea of his theory, the nature of progress. MF theory covers three important topics in organizational analysis (the emergence, proliferation, and decline of popular management concepts) because it primarily aims to answer two questions: "Why are effective management concepts not widely disseminated", and "Why do the emergence, popularity, and decline of management concepts have a cyclical nature" (Abrahamson, 1996; Abrahamson, Fairchild, 1999; Madsen et al., 2020; Stenheim, 2013; Piazza, Abrahamson, 2020). Institutional theory has its own unique answer to the first question (this is due to institutional forces and socially constructed definitions of rationality and efficiency), but it has a problem with the second question, which is beyond the domain of institutional theory (Furnari, 2014; Aksom, 2023). Institutional theory is concerned with the proliferation and institutionalization of already popular practices and organizational structures, and prior to the 1990s it did not explore the causes of emergence and disappearance.

Practice Variation Theory

Ansari et al. (2010) start from the widely accepted observation in modern management and organizational research that practice change should be viewed as the rule, not the exception, because there are few practices that are appropriate for any context. According to their theory, regardless of the organizational motivation for adopting management practices, the lack of a potential technical, cultural, or political "fit" between practices and their new local context is the main source and cause of practice adaptation and modification (Ansari et al., 2010). This approach aims to connect the supply-side and demand-side perspectives in communication and adoption by theorizing how the characteristics of com-

munication practices interact with the characteristics of adopters. To some extent, this view reflects Oliver's three preconditions for de-institutionalization – cultural, technological, and political. In order to ensure the adaptability of adopted innovations, organizations should achieve these three forms of fitness and they argue that technical, cultural, and political incompatibilities trigger different mechanisms and patterns of adaptation on the part of adopting organizations (Ansari et al., 2010; Scarbrough et al., 2015). Two dimensions of practice adaptation are used – authenticity (whether the adapted practice is substantially similar or different from the previous version of the practice) and universality (whether the degree of practice implementation is greater or less than that of the previous version of the practice) (Ansari et al., 2010; Scarbrough et al., 2015). The theory shows how three forms (cultural, technological, and political) of fit and misfit result in different adaptation patterns of diffusing practices across the fitness landscape, and they furthermore suggested that practice allowances can both enable and constrain these adaptation patterns. This distinction effectively captures variation in the adoption and adaptation process, as some organizations adopt less extensive versions of the global standard, while others may fully implement the practice (Firsova et al., 2022).

Game Theory

First proposed by John Nash (Nash, 1951), game theory has over time found application in many natural sciences and socio-humanities, including experimental economics (Smith, 1992; Plott, Smith, 2008; Crawford, 1997; etc.) and behavioral economics (Camerer, 1997; Fudenberg, 2006; Shubik, 2002; etc.). In a broad sense, it describes options for the strategic interaction of parties with diverging interests (Shubik et al., 1981; Shapiro, 1989). In recent years game theory has been extensively used when studying decision-making in building safety management in the construction sector (Wang, Wang, 2021). Building safety actors often have a relationship of conflicting interests, so many scholars believe that game theory can effectively analyze the decision-making behavior of each stakeholder in building safety management. Construction safety management is a complex cooperative system, and the safety goal of the system is realized on the basis of binding agreements between all parties and a win-win situation, namely the cooperative game model in game theory. Chen (2022) established a game model with contractors, supervision engineers, and government regulators as the interested subjects, and conducted a quantitative analysis through a game matrix to study the causes of building safety. Xiao and Sun (2009) established a game model of construction safety management and conducted a two-by-two game analysis of government and construction enterprises, construction enterprises and construction enterprises, and construction enterprises and construction employees, respectively. Most of these studies are based on static game analysis, in which it is difficult to truly reflect the decision-making process and rules of security actors in the management process. Therefore, the security management strategies proposed are not of sufficient guiding value to solve practical problems.

Building safety behavior subjects constantly act based on their own interests and constantly adjust safety strategies (Zeng, Chen, 2013). Therefore, some scholars use evolutionary game theory to study the mechanism behind the formation of a security management equilibrium. For example, Chen et al. (2021) used evolutionary game theory to analyze the characteristics of evolutionary game behavior between tunnel general contractors and safety regulatory authorities. Feng et al. (2013) took China's construction safety supervision as the research object and established a rent-seeking evolutionary game model among the state, government safety supervision departments, general contractors, and other rational stakeholders with boundaries. Cheng and Chen (2009) used the evolutionary game method to analyze the interaction process between the safety behaviors of construction enterprises and the regulatory behaviors of government regulators.

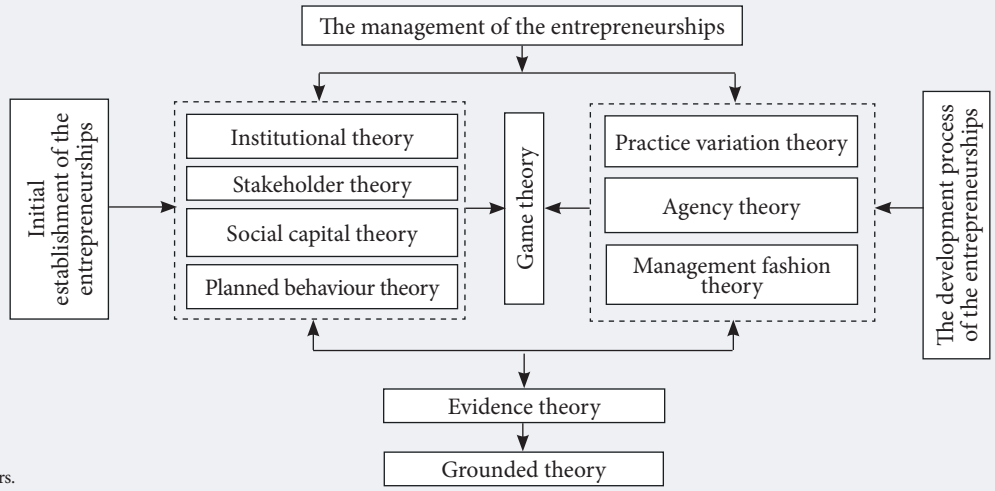
The application of game theory in the field of building safety management is expanding from a static game to a dynamic game. However, it can be seen from the above literature that scholars differ on the definition of the game subject in construction safety management and there are too many safety actors, which leads to unclear guiding principles derived from the research results for China's construction safety management. This paper only analyzes the evolutionary game of two key safety stakeholders in construction engineering.

Grounded Theory

This approach, originating in (Glaser and Strauss, 1967), involves the systematic development and inductive application of reasonable concepts to explain various phenomena. When using it, researchers do not start from a list of ready-made concepts, but as they collect data, they develop new theories or models to explain the established facts (Ralph et al., 2015; Bryant, Charmaz, 2007; etc.). The process continues until a level of saturation is sufficient to identify and understand the motivations of the players and their networking (Corbin and Strauss, 2015; Creswell, 2013). Grounded theory is based on an inductive approach (Martin and Turner, 1986; Faggiolani, 2011), which radically distinguishes it from the "traditional" model of scientific research based on the deductive-hypothetical method.[1] In particular, grounded theory provides high efficiency in studying the complex phenomenon of corruption - the causes and circumstances of its occurrence, assistance to individual countries by international organizations in the fight against this phenomenon, and evaluating the effectiveness of anti-corruption initiatives (Corbin, Strauss, 2015).

[1] When applying the deductive-hypothetical method, an existing theoretical basis is first selected, one or more hypotheses are derived with its help, and only then data is collected to test their validity (Allan, 2003).

Figure 1. **The Links between the Considered Theoretical Approaches to Management**



Source: authors.

Planned Behavior Theory

Planned behavior theory was developed on the basis of the rational behavior theory (RBT) of Fishbein and Ajzen (1975). In the original model of rational behavior, intention plays a central role in determining planned behavior. This variable is influenced by two key factors, including subjective norms and attitudes toward the behavior. Subjective norms refer to the social pressure felt to perform the behavior in question, while attitudes about behavior refer to the individual's evaluation of the behavior from a rational perspective (i.e., based on the perceived benefits and costs that the behavior may impose on the individual). Theoretically, the more intense the social pressure a person feels and the more favorable the outcome of a person's desired behavior, the more likely he is to engage in that behavior and therefore the more likely he is to engage in that behavior. Ajzen (1991) introduced in planned behavior theory the construction of perceived behavioral control (i.e. perceived ease or difficulty of performing a behavior) as an antecedent variables of intent and behavior. Given that this variable is based on an individual's perception of personal and environmental factors that promote or hinder his or her capacity to act, PBT is superior to RBT in predicting behavior in more specific and complex environments (Ajzen, 1991). Previous studies have applied PBT and demonstrated the usefulness of the model in predicting recycling intentions (Taylor, Todd, 1995;Greaves et al., 2013; Botetzagias etc., 2015; Passafaro et al., 2019) and recycling behavior (Tang et al., 2011; Mukherjee, Zhao, 2017; Passafaro et al., 2019).

Discussion and Implications

The aim of our paper was to investigate the most frequently used management theories in entrepreneurship and build a model illustrating such theoretical approaches to entrepreneurial management. From the study of the literature review, it can be seen that institutional theory, stakeholder theory, social capital theory, and planned behavior theory are important for the analysis of the founding conditions for new firms. On the other hand, practice variation theory, agency theory, and management fashion theory are crucial for the development process of the entrepreneurial firms. The whole process of the development of the such innovative firms can use evidence and game theories to help these companies make the best choices. The grounded theory is the best choice for studying the complexity of corruption impacting the management of entrepreneurial enterprises. An illustration of such theoretical approaches to management can be seen below(Figure 1).

Through an analysis of the most frequently used management theories, it can be found that these theories have made a great contribution to the development of general management practices and the management of entrepreneurial enterprises. The evidence theory was used to integrate the available alternatives into one collective to choose the best alternatives. The disadvantages of such an approach include the fact that the need for evidence is independent (sometimes not easy to meet), the theory of evidence synthesis has no solid theoretical basis, and its rationality and validity are controversial. Agency theory continues to have many boundary conditions. However, the theory assumes that the contract has integrity and advocates that the difficulties encountered by the contract should be discussed in advance. In fact, we cannot predict what will happen after the contract, so the prior assumption is not applicable to real enterprises.

Stakeholder theory is useful for exploring how these stakeholders impact firm performance. Further, social capital theory is very important for integration management. There are however some problems in the practice of stakeholder theory. First, stakeholder theory opposes the unitary goal of profit maximization. On the surface, it is beneficial to coordinate the relationships among

stakeholders and meet the interests of all parties, but in practice, it may lead to the failure of enterprises to survive. Second, the goals of many stakeholders do not match the goals of enterprise development. For example, well-known stakeholders (banks, managers, employees, and suppliers) are closely related to corporate value, they are all fixed claimants of corporate cash flow. They care less about the rise of corporate performance than its fall. Compared with shareholders, they are unable to achieve complete consistency with corporate development objectives.

Management fashion theory answered the question of why efficient management concepts fail to diffuse widely, while inefficient ideas and practices successfully diffuse and why there is a cyclic nature of management concepts' emergence, popularity, and decline. However, the cyclical nature of management fashion theory often leads managers to focus more on the short-term results of a management approach than on its long-term impact on the organization. Meanwhile, practice variation theory emphasize two dimensions of practice adaptation: authenticity and universality. It explains that individuals see, understand, and experience the world from their own perspectives (Orgill, 2012). Therefore, inexperienced business managers may not manage as effectively as an experienced business manager.

Game theory can effectively analyze the decision-making behaviors of all stakeholders in construction safety management. The object of game theory is assumed to be a 100% rational economic man, not a natural person. Generally speaking, economic man is rational and thinks with 100% integrity, ignoring the surrounding environment and public opinion. However, real people are usually emotional and do not necessarily consider all aspects of the problem. That said, they should take into account the surrounding environment and public pressure. So this is a flaw of game theory.

Grounded theory was considered as the best fit for the study of the complex phenomenon of corruption in management. While widely used, grounded theory also has its own limitations. First, grounded theory pays too much attention to theoretical construction and neglects a detailed analysis of the studied phenomena. Although grounded theory pays attention to the experience of participants, these data are used as evidence to establish the theory, and its real purpose is not to reveal the real experience of participants. Secondly, grounded theory emphasizes that theories must be based on data. However, the analysis and processing of a large amount of data are time-consuming and laborious, which excessively relies on the conceptual skills of researchers. Due to the need to use a large number of samples, there is a certain degree of difficulty. As management is a complex aggregation, human behavior is crucial for the smooth implementation of initiatives, therefore, planned behavior theory is very important. It is useful in predicting behaviors in more specific and complicated contexts. Unfortunately, there remains some deficiency in the explanatory power of these theories following the literature review. There is remains a need for further study.

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Cybersecurity and Strategic Management

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Abstract

Against the backdrop of rapidly evolving technologies and increasingly complex communications networks, cybersecurity is becoming a key aspect of strategic planning. Protecting information, financial, reputational and other assets from increasingly frequent and sophisticated cyberattacks depends on the ability to develop and continually update a comprehensive, proactive approach that takes into account a wide range of factors. The state of national cybersecurity has become one of the key indicators of the level of development along with «classic» indicators (GDP, etc.). The recently emerged research area of «cybersecurity economics» is constantly being enriched with new knowledge and approaches.

The article analyzes the risks to the cybersecurity system at different levels and the main measures to strengthen it, and assesses the dynamics of management trends. Key competencies relevant for professionals in this field are outlined.

Keywords: cybersecurity; intelligence; strategic management; risk management; bibliometrics analysis

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Introduction

As more and more businesses move their operations online, cybercriminals are beginning to stake their claim in the digital realm, which imposes high costs on the economy.[1] Cybersecurity emerged as a countermeasure to protect the online environment from cyberattacks, damage, improper use, and economic espionage. The perception of cybersecurity has shifted from being just an "IT issue" alone to being a "strategic management issue" and a "techno-legal management issue" due to the ever-increasing sophistication of cybercrime in its attack approaches and techniques (Mantha, García de Soto, 2021). Even though technology is developing rapidly, humans are still the primary actors and play a vital role in controlling the process of securing a country from attacks and threats. We cannot fully depend on technology because of its drawbacks such as false decision, lack of transparency, or overreliance. Cybersecurity is in line with the goals of Society 5.0, a strategic model initiated in Japan that focuses on balancing humanity and technology. A 5.0 society is an "intelligence society" in which physical space and cyberspace are highly intertwined. Both Industry 4.0 and Society 5.0 are related ideas that talk about how cutting-edge technologies are used in business and in society as a whole. Society 5.0 calls for a deeper integration of technology to create a human-centered society that addresses social issues and creates new economic value. Industry 4.0, on the other hand, focuses on digitizing and automating manufacturing processes. Balancing social and societal problems is a complex and ongoing challenge that requires a multifaceted approach. The first solution to be concerned with is stakeholder engagement. Engaging with stakeholders, including customers, employees, investors, and community groups, can help organizations understand the social and societal issues that matter to them. Overall, balancing social and societal problems requires a comprehensive approach that considers the impact of an organization's actions on a wide range of stakeholders.

Previous studies analyzed the relationship between cybersecurity and management but focused on the era of Industry 4.0, cyber-physical systems, enterprises, and public policy implications (Alahmari, Duncan 2020; Kharchenko et al. 2019; Kure et al., 2018). However, this study will try to emphasize the relationship between cybersecurity in management and Society 5.0. In addition, the inclusion of new technologies in cyberspace, such as artificial intelligence (AI), machine learning (ML), data analytics, cloud computing, quantum cryptography, and the Internet of Things (IoT), has made cybersecurity a complex domain that requires more in-depth research in order to keep up with the growth of cybercrime (Sobb et al., 2020). As a result of ongoing trends and difficulties, the global market for cybersecurity has expanded dramatically, and it is anticipated that it will reach approximately 259 billion USD by 2025 (Dhawan et al., 2021). The nature of research into cybersecurity technologies, systems, and concerns has shifted to become more interdisciplinary and international in scope since the national threats mostly come from outside the impacted countries. In a broader sense, the following are some of the areas that fall under the theme of cybersecurity research: management; critical infrastructure; risk assessment; risk management; economics; investments; information services; public works; decision-making; human resources; and education. When searching for prior research on cybersecurity in management through the Scopus database, it becomes clear that the body of written work in this field is experiencing rapid expansion. Therefore, the author has constructed the following research questions:

1. What is the relationship between the keywords of cybersecurity and management in terms of co-occurrence?
2. What are the dynamics of the concept in the field of cybersecurity?

Methods

This study employed a quantitative method by using the bibliometrics analysis technique. This study's analysis and mining process would draw on the Scopus database as one of the most extensive reputable databases (Mongeon, Paul-Hus, 2016). For the search strategy, the author divided the keywords into two topics. The first keyword typed in the Scopus database was relevant to "Cybersecurity". Afterward, it was followed by the "management" keyword in the next topic. Before the filter was applied, the search results revealed that there were 3,285 documents. However, since the author was only interested in the advancement of cybersecurity in management from articles and because the language was filtered into English, the authors additionally focused by narrowing the keywords in the final articles of a journal to tighten the results. The final result was 780 articles found in the Scopus database. The following keywords were constructed to explore the data through the aforementioned database on the of August 23, 2022 and gained 780 articles from Scopus:

(TITLE-ABS-KEY ("cybersecurity") AND TITLE-ABS-KEY (management*)) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "english")) AND (LIMIT-TO (SRCTYPE , "j"))*

In this analysis, the chosen number of documents was five, and the result of thresholds was 314 out of 5,663

[1] The term "cybercrime" refers to a broad category of online offenses that includes breaking into information systems, spreading computer viruses, stealing identity information, stealing political and industrial secrets, spreading misinformation, and attempting to influence global opinions and election results. Cyberattacks may employ various techniques, including viruses, worms, botnets, ransomware, and social engineering. Individuals who commit crimes online may do so as part of a more extensive, more coordinated operation, as is the case of institutions that support cyberattacks or states that sponsor cyberattacks.

keywords. Similar to the co-occurrence network analysis, this quantitative analysis will deeply analyze the evolution of thematic words used since the first study related to "cybersecurity" and "management".

In the method section, the data will be refined using software named Openrefine to filter and unite similar terminology but with different spellings. Furthermore, the data visualization will use VOSviewer, R programming, and Draw.io to highlight the results. Through the VOSviewer visualization process, the author found some similar words which could be united into one terminology. Table 1 gives a list of words that have been associated.

The next section will portray the scope of keywords related to cybersecurity in management based on co-occurrence, thematic evolution, publication distribution, and co-citation analysis to decipher the research development contributions.

Table 1. **Thesaurus in VOSviewer**

Label	Replace by
Cybersecurity	Cyber security
Cyber-attacks	Cyber attacks
IoT	Internet of things (IoT)
humans	human

Source: authors.

Results

Co-occurrence analysis (network analysis)

The following visualization describes the clusters related to cybersecurity, which are divided into seven clusters based on colors such as yellow, sea blue, dark blue, green, purple, orange, and red. The author observed from Figure 1 that the term "cybersecurity" is widely spread in the yellow and red clusters, with the highest number of items. Based on the figure, the keyword "Cybersecurity" is highly and closely linked with "Network security." "Cybersecurity" occurred up to 532 times, and "network security" reached 172 occurrences. Along with the co-occurrence result, the total link strength of "Cybersecurity" was also the highest, up to 2,930, and the total link strength of "network security" was up to 1,334. The aforementioned clusters were connected by many interesting links to other keywords such as: investments, human, critical infrastructure, information services, decision-making, public policy, risk management, and economics. It provided sophisticated previous research about risk management in cybersecurity. With the previous research, every country and scientist agrees that a cybersecurity management model is needed to secure critical infrastructures such as internet voting systems, banking systems, and energy infrastructure. There is no role model for the cybersecurity management paradigm, yet many governments recognize the need to secure their essential resources (Katsikeas et al., 2021).

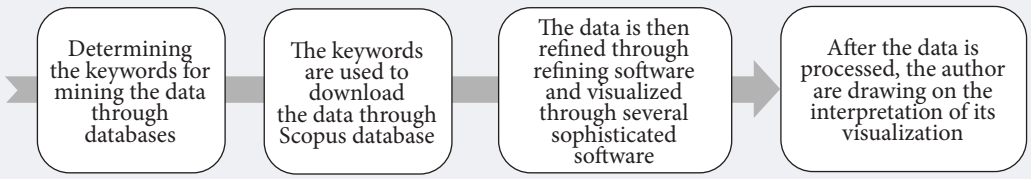
To this end, the keyword "cybersecurity" was also highly linked to "human," which will relate to human management in handling cybersecurity. The role of human management in handling cybersecurity is focused on the decisions on how to handle cyber threats in the right way. Over 39% of security concerns are tied to the human element, and 95% of successful cyberattacks are generated by human error, mostly insider threats. Lack of user understanding of cyber risks is a severe cybersecurity issue (Alsharif et al., 2021). However, the author will also highlight other keywords.

Thematic Evolution of Cybersecurity in Management

This study will analyze the keywords' trends based on co-occurrence and thematic evolution in the field of cybersecurity in management. The authors were analyzed with thematic evolution visualization and three field plots of visualization. It stated that the words' evolution mainly occurred in computer security, cybersecurity, and electric power transmission networks, and the themes correlate to computer security, female, human, network security, automation, cybersecurity, information systems, and air traffic control.

In conformity with the results, the authors could found that cybersecurity is now related to automation, computer security, information systems, and network security. The relationship between cybersecurity (1999-2019) and cybersecurity (2020-2022) in the Scopus database resulted from several words such as cybersecurity, cyber threats, personal computing, Internet of Things, risk perception, security management, resource allocation, and complex networks that had up to 203 occurrences. These relationships show the development of technology in line with that

Figure 1. **Bibliometric Process**



Source: authors.

of cybersecurity (Marcantoni et al., 2022; Morgan et al., 2022).

The discussions of Cybersecurity issues started around 1980.[2] The first article in Scopus related to cybersecurity was published in 1999 and continued hitherto. Furthermore, cybersecurity is in tandem with the term "security management". Cybersecurity management is concerned with reducing uncertainties and managing risks perceived by a security system (Mouti et al., 2022). One of the key objectives of cybersecurity management is to reduce uncertainties associated with security risks. This involves identifying potential risks, evaluating the likelihood of their occurrence, and assessing the potential impact on the organization. By doing so, cybersecurity managers can prioritize risks and allocate resources to those areas that are most vulnerable or likely to be targeted by attackers.

Another important aspect of cybersecurity management is risk management. This involves developing strategies to manage risks associated with cybersecurity threats. Risk management strategies can include implementing security controls, such as firewalls, antivirus software, and intrusion detection systems, to prevent or detect security breaches. It can also include developing incident response plans to ensure that the organization can respond effectively to a security incident.

Based on the findings of the three field plots, also known as a Sankey diagram the most influential authors, the most popular additional keywords, and the most influential affiliations are illustrated. Based on the Scopus database, this graph demonstrates a sequence of links between data in a flow. It describes the association between the strongest and heaviest linkages between factors such as journals, keywords, and the most influential or relevant researchers in the field. Liu Z., Wang I., and Masacci F. were the individuals who had the most vital links to the keyword "cybersecurity," which is notable. These three authors all have contributions in the same second heavier link; one of those contributions has the keyword "risk management." The connection between "cybersecurity" and De Montfort University is the most robust one, which suggests that the university is responsible for the vast majority of publications that contain this keyword. It is something that can be seen by following the flow from the keyword field to the section of the journal. Because of this, it is possible to track the growth of cybersecurity research by using the primary bibliometric findings, which served as the basis for a literature analysis that zeroed in on the most significant concerns. Additionally, the bibliometric data revealed increased interest in studying cybersecurity and risk management strategies to protect against cyberattacks.

Discussion

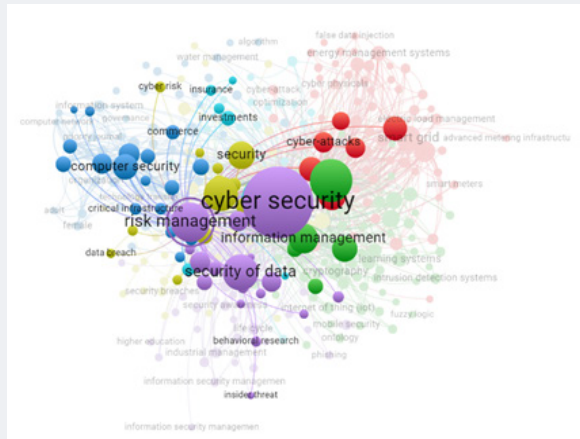
This section will draw on the discussions of the resulting analysis of the most contemporary issues concerning cybersecurity and management.

The prior results slightly illustrated the relationship between cybersecurity and strategic management, including investments, human capital, critical infrastructure, information services, decision-making, and economics.

Cybersecurity and Investments

A country's investments in cybersecurity are crucial given that cyberattacks could come physically or digitally (Li, Liu, 2021). Currently, most economic, commercial, cultural, social, and governmental activities and interactions of countries at all levels, including individuals, non-governmental organizations, government, and governmental institutions, are carried out in cyberspace. These activities and interactions can be dissected into several categories: commercial, cultural, social, and economic (Aghajani, Ghadimi, 2018). The focus of national security in investments is on optimizing the work units and how the country could secure itself from a cyberattack. This issue inspired the creation of a particular unit for handling cybersecurity as a crucial investment. Before the establishment of cybersecurity units, the prevention of cyberattacks were the responsibility of an intelligence agency within a firm's technology department. Nevertheless, technology departments and cybersecurity units often compete against one another given that technology units are only responsible for resolving technological issues while cybersecurity workers must counter some technological decisions for the sake of security.

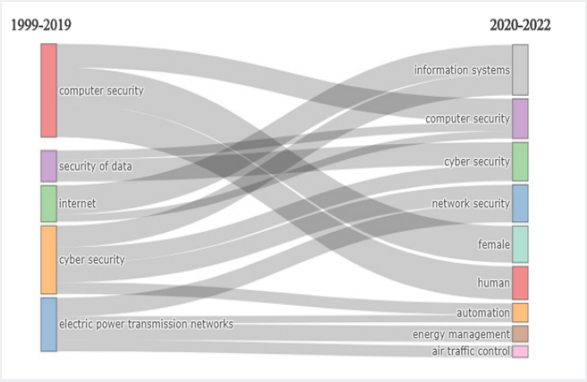
Figure 2. **Risk Management Co-occurrence Analysis**



Source: authors.

[2] https://blog.avast.com/history-of-cybersecurity-avast, accessed 14.06.2023.

Figure 3. **Thematic evolution map and three fields plot**



Source: authors.

Another reason for establishing cybersecurity departments is the spread of fake news in society, especially in political contexts. Fake news are a critical element and can severely impact diverse entities including cities and even countries' positions on the global stage. Various approaches are available to collect and identify fake news (Dutta et al., 2023). Primary research stated that the rise of fake news began with digital sources and social media (Alsuliman et al., 2022; Isa et al., 2022). Many studies have been developed on methods to improve rumor classification, particularly misinformation detection on social media, with promising results in recent years.

Cybersecurity has seven pillars of cyber resilience: patient, persistent, preserving, proactive, predictive, preventive, and pre-emptive (Carayannis et al., 2021). Preventive and pre-emptive measures are critical cornerstones of cyber resilience. Both attempt to mitigate cyber threats and secure an organization's essential assets and systems, but their approaches differ. Preventive measures are intended to keep cyberattacks from happening in the first place. These procedures seek to detect vulnerabilities and put into place security safeguards to keep cybercriminals from abusing them. Firewalls, access controls, encryption, and antivirus software are examples of preventive measures. These techniques contribute to reducing the attack surface and making it more difficult for cybercriminals to breach an organization's defenses.

Pre-emptive measures are intended to anticipate and prevent cyberattacks before they occur. These are more proactive methods that entail taking action based on intelligence and threat assessments. Threat hunting, penetration testing, and vulnerability assessments are examples of pre-emptive approaches. These techniques assist firms in identifying and mitigating possible vulnerabilities before cybercriminals may exploit them. In summary, preventative measures are intended to avert assaults, whereas pre-emptive measures are intended to anticipate and prevent attacks before they occur.

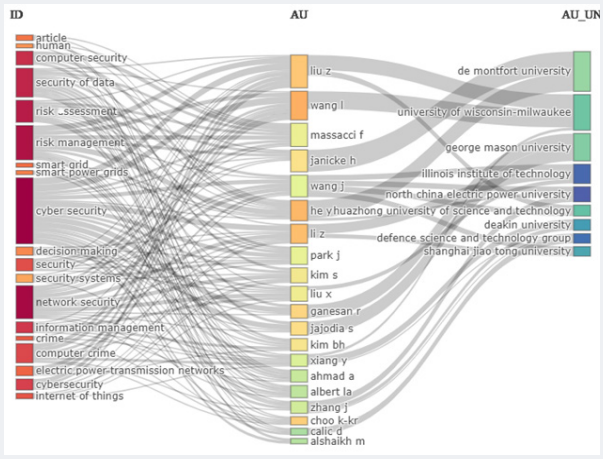
The implementation of ambidextrous cybersecurity involves balancing the need for strong cybersecurity defenses with the need for agility and flexibility in responding to cyber threats. This can be achieved by incorporating the seven pillars (7Ps) of cyber resilience into an organization's cybersecurity strategy. To implement ambidextrous cybersecurity, organizations should first assess their current cybersecurity posture and identify areas where they may be vulnerable to cyber threats. They should then develop a comprehensive cybersecurity strategy that incorporates both defensive and adaptive measures, using the 7Ps framework as a guide. Table 2 lists some key steps to implementing ambidextrous cybersecurity.

Table 2. **Key Steps to Implementing Ambidextrous Cybersecurity**

Action	Description
Develop a risk management plan.	This involves identifying critical assets, systems, and data, and assessing the risks associated with them. This information can be used to develop a risk management plan and prioritize cybersecurity investments.
Implement security controls.	This involves implementing security controls, such as firewalls, access controls, and encryption, to prevent or mitigate cyber threats. This pillar focuses on protecting critical assets and systems from unauthorized access or use.
Implement monitoring and detection tools.	This involves implementing tools and processes to detect cybersecurity incidents as they occur. This can include intrusion detection systems, security monitoring tools, and incident response plans.
Develop an incident response plan.	This pillar focuses on developing and implementing an incident response plan to contain, mitigate, and recover from cybersecurity incidents. This involves developing procedures for responding to incidents, such as isolating affected systems, preserving evidence, and notifying relevant stakeholders.
Develop a recovery plan.	This involves developing a recovery plan to restore systems and data following a cybersecurity incident. This may involve restoring data from backups, rebuilding systems, or implementing new security controls to prevent future incidents.
Continuously assess and update cybersecurity strategies.	This pillar focuses on continually assessing and updating cybersecurity strategies to address new and emerging threats. This may involve updating risk management plans, implementing new security controls, or providing employee training to address new threats.
Develop a communication plan.	This involves developing a communication plan to inform stakeholders about cybersecurity incidents, risks, and responses. This may involve communicating with employees, customers, partners, and regulators to ensure that they are aware of cybersecurity risks and measures in place to address them.

Source: authors.

Figure 4. **Three field plots**



Source: authors.

Previously the police department of cybersecurity and corporate security services prevented the development of the majority of cyberattacks. However, the main focus of police agencies is on the function of repressive prevention or law enforcement, yet in cybersecurity, intelligence will focus on pre-emptive function (Kopotun et al., 2020). Therefore, the cybersecurity department is a part of strategy to secure a national against all attacks.[3]

Cybersecurity and Human Resources

The strong connections between cybersecurity and human resources are fundamental (Mitrofanova et al., 2017). The rising digitization of most technologies we use in our personal and professional life makes cyberattacks a hazard for governments or corporations and ordinary people. It is common practice to consider humans the weakest link in the cybersecurity chain. It is because any technical security solution is still susceptible to failures caused by human mistakes (Gratian et al., 2018). Human resources in cybersecurity must master not only technology, including software or hardware, but also cyberspace and cyberculture and should be trained under the intelligence agency (Pollini et al., 2022). Meanwhile, the recruiting procedure used in national cybersecurity intelligence agencies is considered too academically oriented. It places a greater emphasis on academic qualifications than on the overall quality of a candidate. The requirements of human resources who work with cybersecurity are a bachelor's degree, especially in informatics. However, since the era's development, human resource requirements have expanded to the soft skills of visual communication design, culture studies, and media studies that require the staff to combine some skills and academic backgrounds (Furnell, Bishop 2020; Scanlan et al., 2020). Figure 5 presents the overview of the skills required for intelligence staff in the cybersecurity department.

In the recruitment process of cybersecurity staff, the phases of tests are various, starting from medical check-ups, academic tests, competence tests, psychological tests, and ideological mental tests. It will then relate to the training after being recruited as cybersecurity staff. The following examples are the summary of intelligence education focusing on cybersecurity (AlDaajeh et al., 2022; Stephanidis, Eds, 2020):

- Strengthening intelligence's mental and moral resilience
- Basic knowledge about intelligence gathering
- Relevant materials and activities related to intelligence gathering
- Scanning cyber threats and ensuring cybersecurity
- Knowledge integration between report progress and research

Human resources can contribute significantly to cybersecurity by educating themselves and raising awareness, recruiting and hiring qualified personnel, creating effective policies and procedures, ensuring compliance, and participating in incident response. By working together, human resources and cybersecurity teams can create a robust cybersecurity culture that helps prevent cyber attacks and safeguard critical infrastructure.

Cybersecurity and Critical Infrastructure

Even though the public and private sectors spend millions of dollars a year on technologies, security software, and hardware devices that will raise the level of cybersecurity within their companies, these companies are still susceptible to cyberattacks. The primary issue with the current state of affairs is that computer network security is still typically regarded as a technical component or piece of technology that can be readily installed within an organization. That implementation will guarantee computer network security. This mentality needs to shift since, in today's world, ensuring network security involves more than just using the appropriate technologies (Limba et al., 2017).

Modern Industrial Control Systems (ICS) manages many vital activities worldwide. A typical ICS incorporates computerized devices, control systems, and networking appliances to manage industrial processes over broad geographic areas. ICS supports vital na-

[3] Indonesia already has a framework and policy in place for cybersecurity, which are managed by government agencies and the official community. Cybersecurity policies are coordinated by the Ministry of Communications and Information Technology (MCI). The Information Security Coordination Team, the Directorate of Information Security, and the Indonesia Security Incident Response Team on Internet Infrastructure are three government bodies involved in cybersecurity in Indonesia (ID-SIRTII).

Table 3. **Some applications of cybersecurity for protecting vital infrastructure**

Application	Description
Stopping cyber assaults	Cyberattacks can damage critical infrastructure systems and create widespread outages, jeopardizing individual and community safety and security. Cybersecurity measures can assist in avoiding these attacks by identifying vulnerabilities and putting mitigation measures in place.
Ensure system availability	To protect the safety and well-being of individuals and communities, critical infrastructure systems must be available and operational at all times. Cybersecurity measures can assist in ensuring that systems are available and secure against cyber threats.
Safeguarding sensitive data	Vital infrastructure systems frequently contain sensitive data that hackers value, such as personal information and intellectual property. Cybersecurity measures can help safeguard this information against illegal access and disclosure.
Regulation compliance	Critical infrastructure systems are subject to a variety of regulations, including the NIST Cybersecurity Framework, which provides guidance for implementing cybersecurity safeguards to protect critical infrastructure systems. In the case of a cyber attack or other cybersecurity issue, a well-designed incident response plan can help guarantee that critical infrastructure systems are safeguarded and the incident's impact is reduced.

Source: authors.

tional infrastructures like water treatment, energy production, and transportation. A successful attack can shut down this infrastructure, causing industrial stoppages or safety issues for people, the environment, and assets. Similarly, operating a process when the infrastructure is under assault or corrupted has potentially catastrophic safety implications (Catota et al., 2019; Firoozjaei et al., 2022). Hence, a country must develop a good critical infrastructure for security, such as building advanced laboratories (de Soto et al., 2022). In this case, Cyber-Physical Systems (CPS) are the world's critical infrastructure and could affect human life in the future. In recent years, CPS has seen a rise in connections, which has raised cybersecurity concerns. Aside from classic information system vulnerabilities, CPS has new issues due to heterogeneous devices and protocols and stringent reliability requirements (Michalec et al., 2022).

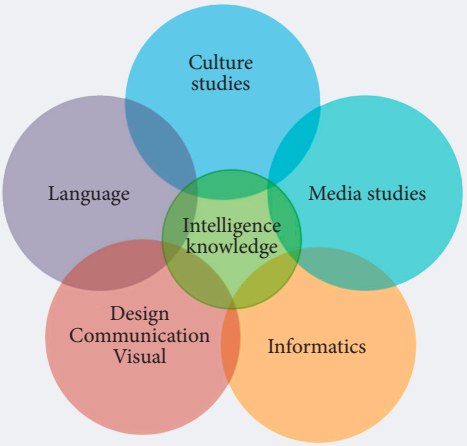
The critical infrastructure could be formed as laboratories for practice, intelligence school and training, qualified departments and materials, and cyber-physical systems (Qi et al., 2018; Quincozes et al., 2022). In developing the critical infrastructure, establishing a new school department, innovative campus, and medical intelligence could strengthen national security from cyberattacks or national threats. Therefore, the development of critical infrastructure needs a system of Public-Private Partnership (PPP) to mitigate the risks against critical infrastructure and manage the quality of the infrastructure. Critical infrastructure is also related to how governments and private businesses understand their roles in raising the degree of national cybersecurity. It has been found that there is a disjunction between what each side expects from the other side in building advanced national security (Carr, 2016; Watanabe, 2019).

Cybersecurity is vital for safeguarding critical infrastructure against cyber assaults. Critical infrastructure refers to physical and digital systems that are necessary for civilization to function, such as power grids, transportation systems, water supply systems, and communication networks. These systems are interrelated and interdependent, and disturbances in one can have serious consequences in others. Table 3 provides some examples of how cybersecurity might help secure vital infrastructure:

Cybersecurity and Information Services

IT implementation in most areas of the state, economy, and society offers various opportunities for automating management operations and increasing the efficiency and quality of rendered services (Boiko et al., 2019; Rahiman et al., 2021). A lack of awareness of reverse socio-technical dangers can lead to an unsuspecting employee leaking critical corporate data or compromising information security. Even though programmed systems can detect phishing emails and websites, they are not 100% accurate (Mantha, García de Soto, 2021). Technological solutions will not guard against cyber dangers or attacks like phishing. Hence, companies must implement procedures to protect individuals from phishing risks, attacks, and promote strategies to raise awareness. Information and data security awareness help prevent social engineering attacks. Information and data security management need to maintain constant vigilance (Rajan et al., 2021).

Figure 5. **Skills Needed for Cyber Security Staff**



Source: authors.

Table 4. **Steps of filtering information by using artificial intelligence to decide the final information**

Step	Description
Collecting information	The intelligence staff gained information from two sides: available information from any sources such as social media, media, news, and societal issues and closed information from its agents or intelligence members (Hautamaki, Kokkonen 2020). It should be noted that intelligence information must have three patent prerequisites: fast, precise, and accurate.
Artificial intelligence	An artificial intelligence machine will then process it to learn and make decisions from the collected data.
Expert judgments	The decision-making function of information processing is considered and filtered by the experts before identifying the final information.
Situational awareness	Given the ever-increasing complexity of the dynamics of cyber threats, it is currently more complicated than it has ever been for enterprises to acquire in-depth insights into their current state of cybersecurity. As a result, businesses rely on Cyber Situational Awareness (CSA) to assist them in gaining a deeper insight into the dangers posed by cyber events and the consequences these threats may pose (Jiang et al., 2022). Situational awareness is one of the re-checking phases of information. The head of intelligence will analyze the current urgent situation. If the information that has been determined to not be urgent or is possibly inaccurate, the information processing will be refined through a similar process.

Source: authors.

Cybersecurity and Decision-Making

Research has found that decision-making based on artificial intelligence impacts cybersecurity (Zyoud, Fuchs-Hanusch, 2017). Intelligence experts use behavioral decision theory to improve intelligence and counterintelligence decision-making. Orthodox and behavioral decision theories also present the decision as a prioritization effort inside a demarcated problem space where the probability is of sum to one (Alemany et al., 2023; Misuri et al., 2019; Phillips, 2022). Based on the presented results, the information services are highly related to decision-making, situational awareness, information sharing, risk assessment, and artificial intelligence. The literature provides an overview of information processing in the cybersecurity field with several steps of filtering information by using artificial intelligence to identify critical information (Table 4).

Cybersecurity with Risk Management and Assessment

To this end, the relationship between cybersecurity and risk management and assessment is closely interlinked given both are relevant to protecting critical infrastructure and determining policy decisions. In planning infrastructure for cybersecurity, the head of intelligence examines the risk assessment and management strategies to design dynamics, intelligence applications, or education. Risk assessment methods are widely used to analyze possible future situations, especially in cyberattacks or threats such as in cyber-physical systems, cyber safety, human resource, and economic activities (Kure et al., 2018; Michalec et al., 2022; Mitrofanova et al., 2017b; Rosado et al., 2022).

One of the examples of the relationship between cybersecurity and risk assessment and management can be found in economics. Cyberspace indicators are a big part of the points used to measure a country's progress and GDP. The economics of cybersecurity analyzes cybersecurity challenges, such as PACS (Privacy and Cybersecurity) adoption. Most evaluations focus on cost-benefit trade-offs encountered by rational market participants, strategic behavior, and market outcomes regarding participant welfare. Cybersecurity risk assessment encompasses firms, customers, government, and adversaries. It also analyzes market mechanisms, market failures, and the economic impact of regulation on cybersecurity. Security risks drive cybersecurity economics (Jentzsch, 2018).

Risk management strategy could also defend against national threats that consist of conflicts that include multiple nation-states, political protesters, insider trading, and espionage that is supported by a hostile state. (McEvoy, Kowalski, 2019)

In analyzing and defeating cybersecurity risks, various risk management tools are applied.[4] These methods can be a further recommendation for further research related to cybersecurity and management in empirical research.

Conclusion

Cybersecurity is a crucial issue that must be addressed by all enterprises, regardless of size, industry, or location. In order to defend their assets, data, and reputation from the increasing frequency and sophistication of cyberattacks, organizations must adopt a comprehensive and proactive approach to cybersecurity. A successful cybersecurity strategy necessitates a comprehensive and unified strategy that incorporates people, procedures, and technology.

Our article analyzes the trends in the evolution of research on cybersecurity and its relationship to key aspects of strategic corporate management, including investments in infrastructure and human capital.

[4] For example, CRAMM (CCTA Risk Analysis and Management Method), OCTAVE Allegro methodology, Infosec Standard 1, FAIR (Factor Analysis of Information Risk), MEHARI (MEthod for Harmonized Analysis of RIsk), STRIDE (Spoofing, Tampering, Repudiation, Information Disclosure, Denial of Service, Elevation of privilege), SABSA (Risk), Attack Path Analysis, and IRAM (Information Risk Assessment Methodology).

It is shown that a key aspect of cybersecurity remains dealing with people as the most vulnerable link in the chain. Key areas of action include both training cybersecurity professionals with a wide range of universal competencies and informing ordinary users about potential cyber threats.

Cybersecurity is an ongoing process that requires regular monitoring, examination, and improvement. Companies must undertake regular risk assessments, identify vulnerabilities, and establish measures to limit cyberattack threats. This necessitates collaboration between several departments and parties, including IT, legal, human resources, and upper management. In conclusion, cybersecurity is a strategic concern that requires the focus and resources of companies at all levels. By adopting a proactive and comprehensive cybersecurity strategy, firms may reduce the likelihood of cyberattacks and safeguard their precious assets and reputation.

A limitation of this study is that it is focused on a specific review and the authors only use cybersecurity in a global context. Further, we restricted the language into English since we want to provide an overview of the previous research with a general understandable language. However, we recommend that the future studies analyze an expanded and larger body of research related to cybersecurity and strategic management so that the study will be more comprehensive and applicable to several contexts.

The authors declare no competing interests. The data of this research could be accessed through the Scopus database. For the approval, it does not need any approval as long as we have authorized access to the database. No informed consent was necessary in this research since this is a literature review.

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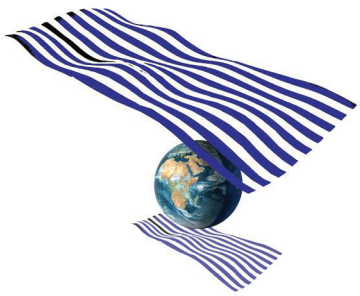

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