Acta Catallactics

časopis za ekonomska i opšta društvena pitanja

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Časopis „Acta Catallactics, časopis za ekonomska i opšta društvena pitanja“ od autora očekuje najviše standarde integriteta u istraživanju. Radovi koji su primljeni za razmatranje za objavu u časopisu trebaju sadržavati dovoljno informacija kako bi svaki kvalificirani istraživač mogao ponoviti rezultate.

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Poštovani,

Pred Vama je osmi broj naučnog časopisa "Acta Catallactics, časopis za ekonomska i opšta društvena pitanja" koji je osnovan 2019. godine i izlazi dva puta godišnje u izdanju udruženja "Multi" i Visoke škole "Internacionalna poslovno-informaciona akademija" Tuzla. Nakon četiri godine djelovanja, sada već možemo navesti da je riječ o vrijednoj tradiciji izdavaštva, posebno razumijevajući da u Bosni i Hercegovini nema puno naučnih časopisa koji se bave tematikom ekonomskih i drugih društvenih pitanja.

"Acta Catallactics" je usmjeren prema naučnicima i stručnjacima koji se bave istraživanjem ekonomskih i opštih društvenih pitanja. Objavljuje radove koji doprinose teorijskom, metodološkim i empirijskim spoznajama u svim ekonomskim oblastima, kao i drugim oblastima koje pokrivaju društvene nauke. Radovi se mogu temeljiti na kvalitativnim i kvantita- tivnim analizama, mogu predstavljati sinteze dosadašnjih istraživanja i ukazivati na otvorena pitanja u izdvojenim područjima društvene i ekonomske prakse.

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Pozivam sve zainteresovane da pošalju svoje radove za novi broj časopisa koji izlazi krajem 2024. godine.

Svako dobro,
Admir Čavalić, MA,
glavni i odgovorni urednik

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Sadržaj

CROWD-BASED OPEN INNOVATION: MODELS, CHALLENGES, AND TRENDS

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Abstract

This article considers concepts, models, achieved results and emerging trends of the open innovation approach to organizing and conducting research and development activities in companies. The goal is to perform a comprehensive systematic analysis of literature that considers the open innovation models that focus on the collaboration of various stakeholders, including companies, academia, government, startups, individuals, and others, in the context of design and development of innovative digital services, through integration of crowdsourcing and DevOps. As a result, we propose a new framework for organizing open innovation activities using DevOps practices for digitals service development. Finally, we present examples of implementing crowd-based open innovation models in various contexts.

Key words: *Open Innovation, Crowdsourcing, DevOps, Digital Services.*

1. Introduction

Austrian economist Joseph Schumpeter (1883-1950) in the first half of the twentieth century was the first to recognize and define the concept of innovation theory. Throughout history, innovations have had a special contribution not only through the development of new products, services, and technologies but also through the progress of the entire society as a whole. As a result of the general social digital transformation, a digital economy was created, which is precisely based on innovation processes. In the conditions of market competition and the digital economy, the continuous implementation of innovation projects is necessary for the successful operation of a company. Constant

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innovative activities are necessary for a company to be competitive in the market. The main function of innovations is to introduce changes in the company that can increase its economy, effectiveness, and profitability, thus influencing the development and growth of the company (Curley & Salmelin, 2013). Digital transformation, which is innovative by its nature, brings radical changes in the organization and operations of a company. The development of various Industry 4.0 technologies, such as Internet of Things (hereinafter: IoT), big data, virtual reality and others, enabled the wider social community to define problems and offer solutions in many areas of social action (Bogdanović, et al., 2021).

According to the chronological classification of different models of innovation management (Trott, 2017), the sixth generation is represented by the open innovation model, which appeared in 2000 and continues today. Open innovation represents a model of combining internal and external ideas, intending to improve the development of new technologies.

The purpose of this article is to analyze and present an overview of the open innovation concepts and models in the context of digital transformation, with the focus on software development aspects, and propose a research and innovation platform that leverages DevOps concepts to support open innovation. In section 2 we present the main theoretical concepts of open innovation approach. Section 3 gives an overview of crowd-based open innovation models, with the focus on hackathons, startups and the role of DevOps. In section 4 we discuss the possibilities of creating a general model of crowd-based open innovation, based on the approaches in literature. Finally, section 5 presents examples of open innovation projects, followed by concluding remarks.

2. Open innovation - term and concept

The term Open Innovation was used for the first time in 2003 by Chesbrough (Chesbrough, 2003), in the paper "Open Innovation: A New Imperative for Creating and Profiting from Technology." He defined open innovation as the use of knowledge from the company and its environment, to speed up internal innovation processes with external knowledge and thus increase the market for existing internal innovations for their external placement (Chesbrough, 2012). Until the end of the 20th century, innovative activities in companies were limited by their borders. This means that those companies implemented innovative development projects exclusively under controlled conditions, with internal knowledge and resources, without any competition (Stanisavljević et al., 2023).

The closed innovation business model, due to the rising costs of technological development and the ever-shortening lifespan of new products, has faced declining efficiency (Dodgson et al., 2008). The previously closed and traditional innovation processes no longer gave the expected results (Dhal et al., 2018). This was influenced by the increased number of experts in various fields, then opportunities for capital inflow, as well as opportunities to reach innovative and high-quality solutions outside the company (Cruz & Astudillo, 2020).

The way out of the closed circle of ever-increasing costs and decreasing revenues was provided by a model of open innovation. The development of modern technologies, especially the IoT, has enabled companies to use knowledge from the immediate and wider social environment, from other companies, research organizations, educational institutions, local governments, and even directly from the citizens themselves (Santoro

et al., 2018; Wang et al., 2021). Accordingly, open innovation represents a "distributed innovation process based on the management of knowledge flows beyond the boundaries of the organization" (Chesbrough & Bogers, 2014; Bogers et al., 2018). Transparency, cooperation, clear goals, finding the right channels, commitment, and rewarding participants are key factors for the success of open innovation (Durst & Ståhle, 2013; Subtil de Oliveira et al., 2018).

In the past two decades, few studies have addressed the difficulties in implementing open innovation, intending to provide managers with guidelines for managing and managing these processes, to successfully implement open innovation. The European Commission promoted the Open Innovation 2.0 approach, which was based on innovation ecosystems, cooperation, and joint value creation, to integrate and synergize innovation processes (Curley & Salmelin, 2013; Lopes et al., 2021). The emergence of the "Industry 4.0" paradigm and the development of information technologies and IoT have created the conditions for today's innovation processes to represent the integration of knowledge from the fields of education, business, public and state administration, the civil sector, and individuals themselves. These activities aim to offer new, innovative services, as well as to open new markets (Hizam-Hanafiah & Soomro, 2021; Stojanović et al., 2021). The Industrial Technology Research Institute is just one of the international R&D organizations working on a platform-based open innovation model and its generation from idea to commercialization, to create social and economic value (Wang et al., 2021).

3. Analysis of the crowd-based business model of open innovation

Models of open innovation can be generally categorized in three groups: a) Outside-In; b) Inside-Out; c) Coupled. The Outside-in model includes the use of external knowledge and the taking over of other people's discoveries and their inclusion in internal innovation processes, while the Inside-out model is aimed at the placement of internally generated knowledge to other companies (Inauen et al., 2011). The integration of Outside-In and Inside-Out models represents the combined Coupled model (Chesbrough & Bogers, 2014; Bogers, 2012; Enkel et al., 2009; Gassmann et al., 2010), which includes two or more partners who, through joint activities, manage the development of an innovation from an idea to its commercialization outside of their organizational units (Bogers et al., 2012). The focus of further analysis is on the coupled models, which include multiple stakeholders, and span across the industry, academia, government, and society participation, through crowdsourcing.

The concept of open innovation in theory and practice is based on the crowdsourcing model, in which the source of knowledge is the "mass of individuals" (crowd), which leads to better, faster and more innovative solutions (Estellés-Arolas & González-Ladrón-de-Guevara, 2012). Crowdsourcing is most often used at the beginning of the innovation process, which is crucial for its successful implementation (Sarić et al., 2022; Stanisavljević et al., 2022). According to the definition of author Jeff Howe (Howe, 2008), crowdsourcing is a process by which a certain task in the form of an open call is transferred from specialized individuals to an undefined, large group of people outside the company. With the necessary conditions met, a community will almost always perform better than employees within a single company.

Digital transformation creates conditions for unifying the processes of creating innovations, developing and exploiting software for digital products and services, as well as processes related to market research and customer relations. In digital transformation, innovative processes are more diverse and it is not possible to realize them with a single model of innovation management. The crowdsourcing platform is just one of the digital platforms for open innovation, and includes crowdsourcing, crowdfunding, microwork, social product development and the sharing economy (Abhari et al., 2022). In theory, that model is known as the Crowd-based business model of open innovation. The application of this model of open innovation enables companies to find, in addition to resources within the company itself, sources of innovation and actors of the innovation process in the business environment, as well as among citizens. Digital platforms enable all actors in the innovation process to perform all their tasks remotely and efficiently (Aggeri & Segrestin, 2007). All citizens have the opportunity to get involved in the innovative process, whether for financial or other reasons (Saebi & Foss, 2015).

Numerous digital platforms have been developed for the crowd-based business model of open innovation. They provide digital services for the creation of innovations, most often in the form of a virtual environment. According to Hallerstede (Hallerstede, 2013), digital platforms for open innovation can be divided into:

- Innovation contests and competitions (Innovation Contest)
- Innovation Community
- Innovation Marketplaces
- Innovation Toolkits
- Technologies to support innovation (Innovation Technologies)

3. 1. Hackathons and student competitions

Student competitions and *hackathons* represent one approach to implementing the concept of open innovation in non-formal education. They were originally organized with the aim of participants developing prototype software solutions through intensive programming in a short period, over time they developed into different models of student competitions (Briscoe & Mulligan, 2014). Companies have already recognized the value of *hackathons* as an open model of innovation, where ideas and prototypes can be created by students and other participants. Numerous *hackathons* have recently been organized as virtual events, based on the cooperation and synergy of various international and cultural teams. The shortcoming of this model of open innovation is that the focus is only on the innovation capacities of educational institutions or technology transfer, and educational goals and learning outcomes are missing.

The improvement of engineering education can be achieved through open innovation and the implementation of project-based learning in formal education. Research conducted at the Department of e-business, Faculty of Organizational Sciences, University of Belgrade showed that both of these approaches to improving engineering education yield good results and have a positive effect on learning outcomes and students. Both approaches have been implemented for teaching and learning IT education subjects, namely Blockchain technologies and IoT (Ćirković et al., 2023).

Project-based learning is already widespread and recognized as a method for developing innovative competencies in engineers. However, the disadvantage of project-based learning for open innovation is that the results obtained from the classroom often do not reach potential investors, consumers, or the market (Awuor et al., 2022).

3. 2. Startups

Startup companies are a powerful engine of open innovation. Startup companies are essentially open organizations, necessarily involved in innovation processes (Spender et al., 2017). In stimulating the growth and success of startup companies, open innovation plays a key role, as a unique challenge and opportunity. Thanks to external knowledge, resources, and networks, startup companies can accelerate their innovation processes, reduce risks and gain a competitive advantage in dynamic markets. They can use a variety of open innovation strategies, including collaboration with industry leaders and research institutions. Startups can use open innovation to fuel their growth and achieve long-term success (Budiyono, 2023). In the literature, the application of open innovation in startup companies is a relatively unexplored field, and research dealing with collaborative innovation between startups and large companies is practically non-existent. Open innovation for startups has advantages, and startup managers with experience working in or with large companies can skillfully deal with a larger partner in the innovation network (Usman & Vanhaverbeke, 2017).

3. 3. DevOps model for development management

Open innovation platforms have emerged as software solutions to facilitate collaboration between different participants in an open innovation initiative (Cruz & Astudillo, 2020). The *DevOps* model for software development management combined with the Crowd-based open innovation management model represents an integrated model for open innovation. The crowd-based business model of open innovation includes research of potential markets, new ideas, creation of innovations, services, and implementation of prototypes. In a situation where companies are in the process of digital transformation, and their products and services are digital, the DevOps software development management model is necessary for conceptual design, testing, commercialization, and exploitation of digital products and services.

A wide set of stakeholders is involved in the functioning of open innovation platforms. Platform providers are companies that implement and maintain it, and provide technical support, innovative services, legal security, and monetary compensation for the services provided. The users of the platform, on the other hand, are other companies, entrepreneurs, freelancers, public administration, the academic community, the civil sector, and citizens (Bogdanović et al., 2023).

4. Open innovation using DevOps and Crowdsourcing

Thanks to the development of IoT and social networks, instead of traditional open innovation we increasingly have Internet-based innovation. Online environments create opportunities for different ideas, products, and services. Through public sharing, open innovation and knowledge management can be linked. In this way, companies speed up their work, reduce risk and, thanks to open innovation platforms, reach innovative resources.

For a long time, triple helix was the dominant model of innovation, as an approach that focuses on the interactions between industry, academia and government (Leydesdorff, 2000). Lately, the focus is shifting to quadruple and quintuple innovation models, which add knowledge society and natural environment (Carayannis & Campbell, 2010). An illustration of the quintuple helix model of innovation is presented in Figure 1.

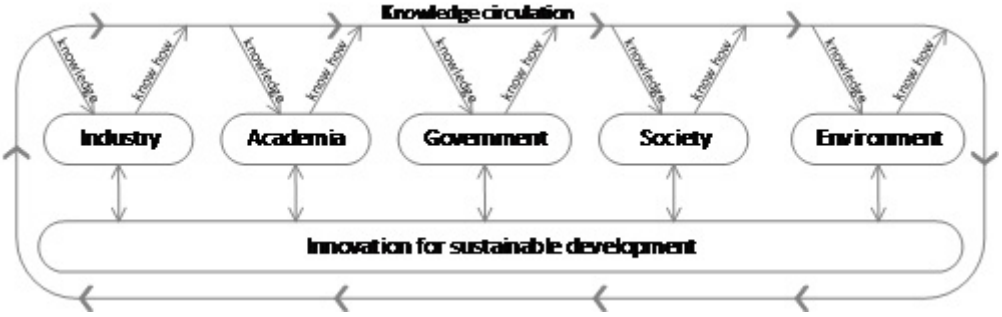

Figure 1. Quintuple helix model of innovation, based on (Carayannis et al. 2012)

However, the development of modern digital products and services is based on integration of new approaches to innovation with modern product development and software development concepts and models, such as DevOps (Bogdanović et al., 2023). Open innovation models in this context are various, and hard to be presented with one comprehensive model of innovation management. As one attempt to integrate open innovation models with modern software development approaches based on DevOps, we present an integrated model that includes a crowd-based model of open innovation management based on the chain-interactive model from the literature, DevOps approach to software development, and quintuple helix elements (Figure 2). The proposed approach is founded on crowd-based models, which rely on the participation of a large number of stakeholders, including stakeholders from macroenvironment, such as industry, academia, government, citizens and environment, as well as stakeholders from microenvironment, such as suppliers, consultants, consumers, distributors, competitors, to jointly develop sustainable solutions. In all phases, the company relies not only on internal resources and knowledge, but communications with the relevant stakeholders through a set of interfaces and communication shannels. The DevOps phases of software development correspond to phases of innovation process, as shown in the figure. Many of the innovations require some kind of software development, and thus the lifecycle of the innovative product or service has to be in line with the lifecycle of the software that serves it. Innovation outcomes may come in various areas or forms, including new products or services, new business models, new marketing strategies or techniques, or any kind of organizational innovation.

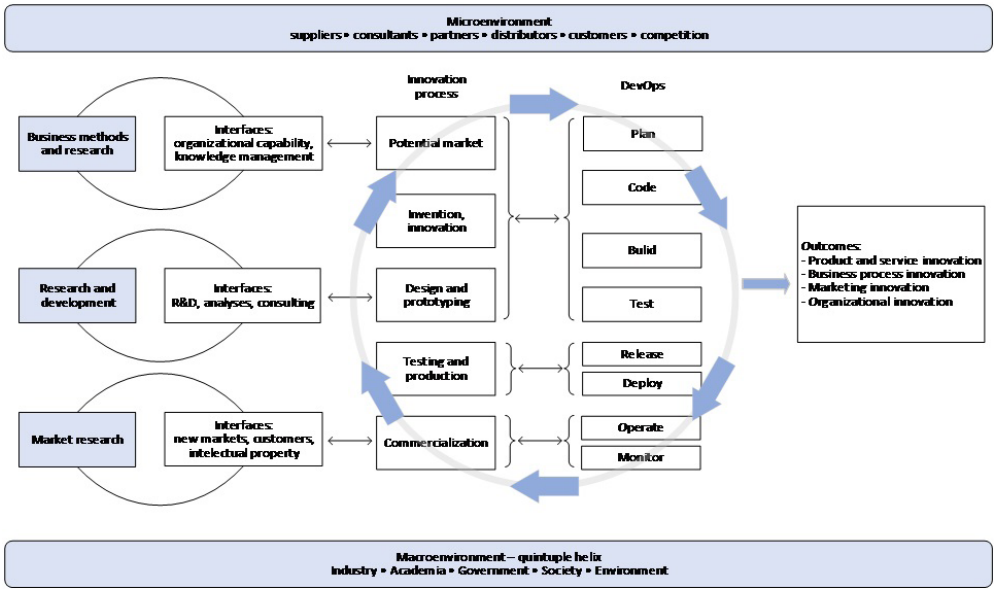

Figure 2. An integrated model for managing crowd-based open innovation with DevOps, based on (Caraça et al., 2007) (Carayannis et al. 2012) (Bogdanović et al., 2023)

5. Examples of crowd-based open innovations

Open innovations are applied in a wide variety of fields, and the best results are achieved precisely in cases of intersectoral cooperation. Thus, for example, railways and the railway industry, as complex and multidisciplinary systems, are particularly suitable for the application of the open innovation model. In European and global railway companies, the application of the open innovation model was "an original, efficient, and high-quality response to existing problems" (Dodgson et al., 2015; Thurner & Gershman, 2014; Hanley et al., 2022).

Only in the past few years have there been numerous examples of this. "Alstom", an international company for the production of high-speed trains, has solved the problem of fallen and withered leaves, which caused adhesion between the rails and the wheels of the train, by applying open innovation ("Open Innovation in Railway: Example of AlstomTM | ideXlab"). As many as 38 companies from Great Britain and France applied to the open call of the Eurotunnel, which connects these two countries under the English Channel, with innovative proposals for improving the maintenance of railway rolling stock ("CPC and Eurotunnel Invite SMEs to Provide Railway Innovation Solutions"). Indian Railways received online over 100 thousand innovative proposals on the topic of future innovations in business ("Improving Indian Railways with Open Innovation"). The Rail Activation project, which was funded by the European Union's Horizon 2020 research and innovation program, was implemented by the Spanish railway industry association Mafex, which brings together 90 companies. The main goal of this project was to motivate and direct small and medium-sized enterprises from the railway industry to undertake workplace innovations, as part of the open innovation ecosystem. It is the first project of its kind in the railway sector (RailActivation project website http://railactivation.eu/).

When it comes to Serbian railways, an open innovation project was organized with students of the Faculty of Organizational Sciences of the University of Belgrade, to propose solutions for increasing the safety of railway traffic, based on IoT, through DevOps and crowdsourcing (Stanisavljević et al., 2023). The project included around 50 students working on solving real problems identified within the Serbian railways, both by developing new digital products and software.

Open innovation models are also increasingly present in the field of telecommunications, as telecommunications companies face market demands and find new opportunities to attract new subscribers with innovative products and services. In the period from 1985 to 2002, the mobile phone manufacturer Nokia combined various concepts related to cooperation strategies in research and development, applying the concept of open innovation in mobile telephony (Dittrich & Duysters, 2007). Such is the situation with telecom operators in Serbia, who have recognized the need to move from traditional to the concept of open innovation. These innovations are usually oriented towards smart city services based on the development of IoT technologies, cloud computing, software-defined networks, and blockchain. The development of the crowdsourcing model enabled telco companies in Serbia to include customers in the open innovation system, to better design and develop services adapted to their needs (Sarić et al., 2022).

Governments are increasingly focusing their efforts on encouraging innovation within small and medium-sized enterprises. Thanks to this, cooperation between the Government, industry, and universities is gaining importance in the agenda of policy makers, to enable open innovation in small and medium-sized enterprises (Bertello et al., 2022). Open innovation had a particularly significant role in fostering the business model of small and medium-sized enterprises during the Covid-19 pandemic (Jabeen et al., 2023). The implementation of a digital *hackathon* in Sweden, in response to the Covid-19 pandemic by applying the model of open innovation through crowdsourcing, has led to a significant growth of the digital health community in this country (Temiz, 2021).

And while many studies dealt with open innovation in large organizations, some authors analyzed eleven open innovation projects in SMEs in four European regions and found a wide range of primary and secondary stakeholders, with different levels of power and dependence, used in these projects (Albats et al., 2020). A typical example is IBM, which, despite promising assumptions, failed to make a significant profit from Watson Health, as a general-purpose technology, because, given its characteristics, the approach to its market entry was too closed. The authors of the study that analyzed this example suggest that the very concept of open innovation would improve the appropriation of value from general-purpose technology (Yang et al., 2022).

The authors also studied open innovation at Sri Lankan universities and their cooperation with industry, to improve innovation through knowledge and technology transfer (Weerasinghe & Dedunu, 2021). Open innovation platforms are applied in tourism, where stakeholders communicate with each other, reach agreements and jointly solve problems through the platform, using predominantly constructive styles of interaction (Lalicic, 2018). Open innovations also play a significant role in social enterprises, bearing in mind that they simultaneously realize their planned social mission, but also profit, which is proven by the example of four leading social enterprises in the field of education in Indonesia (Harsanto et al., 2022). Also, open innovation contributes to a sustainable, circular economy (Jesus & Jugend, 2023), and Procter & Gamble, with its "Connect and

Grow" strategy, implemented organizational and technological changes based on the model of open innovation (Dodgson et al., 2006). and open innovation is also applied in the pharmaceutical industry (Schuhmacher et al., 2013). The authors also deal with the risks that open innovation within companies entails, primarily due to aligned managerial motives and asymmetry among different stakeholders (Shaikh & Randhawa, 2022).

Innovations are crucial for the growth and development of a company's business and its competitiveness in the market. Open innovation is expressed through three different processes: acquisition of external technology; external exploitation of technology (outbound innovation); and merged innovation (Bigliardi et al., 2020). Acceptance and implementation of the open innovation model depend to a large extent on the organizational culture, knowledge, attitudes, and rewards of employees, which was confirmed by research that included 528 employees from 28 different industries in 37, mostly European countries (Alassaf et al., 2020).

6. Conclusion

The increasing adoption of the open innovation model has brought with it the need to adapt the business strategies of companies to new business conditions. To make strategic sense of innovation communities, ecosystems, networks, and their implications for competitive advantage, a new approach to strategy is needed - open strategy (Chesbrough & Appleyard, 2007). An increasing number of European companies are adopting the open innovation model as a way to innovate and make better use of their business environment. Based on the experiences of 31 large European companies that are considered innovation leaders according to the annual "SEP Europes Corporate Startup Stars" ranking, corporate cooperation models and approaches are continuously developing, and companies and innovation drivers jointly open and develop their innovation projects for mutual benefit (Onetti, 2021).

From the experiences in practice, it is clear that companies that wish to ensure sustainable development need to expand their innovation capabilities in line with the quintuple helix model, include a large number of internal and external stakeholders, and create an environment for continuous improvement and innovation. When the innovation is based on IT services or includes digital transformation, DevOps principles can be of use, and support continuous innovation with continuous software development.

Future research will be organized in several directions: 1) more details about the readiness of software companies to embrace open innovation concepts beyond open source software need to be obtained; in this context, they can take the role of organizers of open innovation projects, but can also take a more proactive role in participating in crowd-based open innovation projects organized by other companies; 2) further analyses of alignment of open innovation models with DevOps is needed; although their lifecycles are compatible, more experiences from practice are needed, especially when coordination between a large number of participants is required; 3) empowering companies to embrace open innovation model is needed; although internal stakeholders frequently recognize the potential, top-management support is not always present, nor is this innovation model recognized as a strategic priority; 4) finally, is in needed to study in more details the relationships and models to integrate all the identified components of quintuple helix

in an effective and productive way, and support crowd-based innovations for sustainable development through organizational models and technological infrastructures.

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L&D TOOLS AND SOLUTIONS: USE IN THE POST-PANDEMIC WORKPLACE ENVIRONMENT

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Abstract

Digital transformation and COVID-19 pandemic brought many changes in the business world, thus affecting learning and development (L&D) processes and activities. L&D activities are carried out within a company to ensure an environment in which employees and the company will develop, improve and grow. The aim of this paper is to examine which L&D tools and solutions can be used in the post-pandemic workplace environment. The tools and solutions presented in the paper can be a guideline for the responsible managers in terms of the available software, as well as their advantages and disadvantages.

Key words: *Learning and Development, Learning Tools, Post-Pandemic, Knowledge Management.*

1. Introduction

The rapid development of technology has brought many changes in the business world even before the COVID-19 pandemic. In the context of learning and development (L&D), "these changes have transformed the role of learning and development professionals, with a new emphasis on supporting self-managed learning through facilitation, coaching and mentoring and on developing in themselves and others the skills of working effectively in online and virtual environments" (Arney, 2017). The pandemic has caused many changes in various areas of business, thus affecting L&D processes and activities. As pointed out in the report of World Economic Forum (2021): "half of all employees around the world will need reskilling by 2025 – and that number does not include all the people who are currently not in employment."

Learning and development activities in the workplace environment can be organized on many levels, including individual level, groups or teams, organization-wide and it is

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often self-managed and directed (Arney, 2017). But knowledge itself is not enough for the success of a company, instead the ability to apply the gained knowledge and knowledge diffusion is the key for success (Drewniak & Posadzinska, 2020).

2. Importance of L&D

L&D activities are gaining more and more importance among knowledge management practitioners and theorists (Drewniak & Posadzinska, 2020). These activities are a foundation for building people resources and for gaining competitive advantage (Arney, 2017).

Learning and development can be seen as the cycle presented in Figure 1.

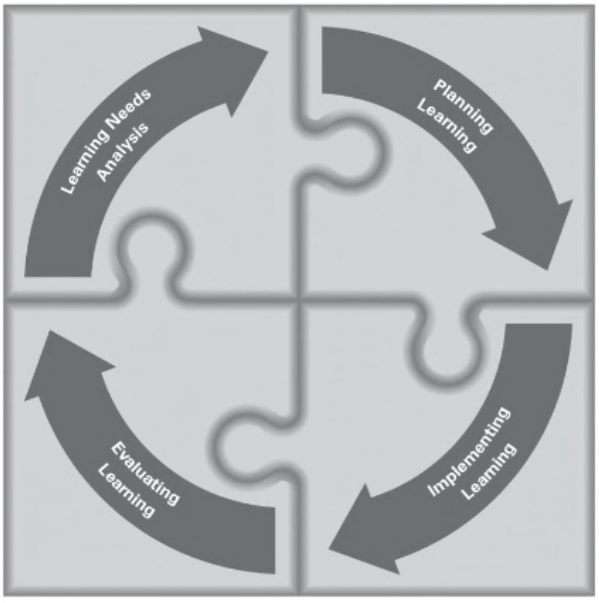

Figure 1. The learning and development cycle
Source: Fee (2011)

This cycle can serve as a framework for understanding employee learning and development activities. It tells us that a responsible manager should (Fee, 2011):

- identify and analyze the learning needs for the job and the required skills of employees or teams;
- use that analysis to plan, design and prepare a learning intervention;
- implement the learning intervention and
- assess and review the effectiveness of the learning intervention.

Although evaluation is usually the final stage of the L&D cycle, it should be planned from the beginning. It can be seen as the main part of the learning and development process where organizations assess the value of L&D interventions (Arney, 2017).

Workplace learning takes many forms. Learning builds skills and knowledge but also motivates people. Learning motivates employees and provides companies with the workforce needed to follow all new trends and such companies are ready for all future challenges. Study research done by MindTools for Business from 2020 shows that the

number one motivation for employees to learn at work is "To do their job faster and better", followed by "General career progression" (Mind Tools for Business, 2021).

During pandemic and post-pandemic, organizations began embracing different online learning forms as well as encouraging employees to develop skills. It is often organized as self-paced learning. Some of the steps the organizations need to take in the post-pandemic era include (Palmer, 2022):

- Let go of "command and control" - in the post-pandemic era, the top-down approach has no significant results. Instead, it is advised that the company identifies the skills and knowledge that they believe are critical to the success of individual employees as well as the company as a whole, and provide employees with guidance in acquiring those skills and knowledge. Today it often refers to communication skills, problem solving, empathy, etc.
- Track, recognize and reward - it is important for companies to find a balance between allowing employees to choose their own learning path and monitoring their progress. Responsible managers can use platforms to monitor employee progress, and it is recommended to organize face-to-face or online meetings about upskilling and reskilling goals.
- Optimize learning conditions - employees need uninterrupted time for learning, but it is necessary not to overload employees with too many tasks. Good communication within the company is crucial in order to build a strong culture of continuous learning.

Below are presented the most important tools and solutions that can be used in different phases of L&D in the post-pandemic workplace environment.

3. L&D tools and solutions

Various companies provide training and development programs to provide their employees with the improvement and advancement of their skills and knowledge. Orientation, management skills, and operational skills of employees are essential parts of a quality training program for employees (Jehanzeb & Bashir, 2013). These are the basics of any employee development program. The main task is to gain knowledge, cooperation skills, inventive thinking and resolving problems (Kottke, 1999).

According to Drewniak & Posadzinska (2020), the typical solutions to gain knowledge are:

- Training and workshops - they are considered classic tools. Workshops are suitable for smaller groups with focus on the practical part. They are usually used to gain specific knowledge or skills. Training is a broader concept and it combines workshops with theoretical parts.
- Online learning platforms - they enable implementation of various types of learning models and they are suitable for complex management of training processes.
- Knowledge bases - sometimes referred to as knowledge pills. They are a collection of documents and articles about a certain field.
- Business simulations and gamification - usually a very interesting form of learning. They rely on computer games and role-playing games to stimulate participation of employees.

Employees who follow new trends and continuously gain knowledge in their fields can respond faster to different challenges and maintain a positive company reputation (Platt, n.d.). Some of the tools that can provide companies with training that will help employees be as productive as possible are (Platt, n.d.):

- Learning Management System (LMS),
- Video conferencing tools,
- Microlearning platforms,
- Content creation tools and
- Knowledge repositories.

3. 1. Learning Management System (LMS)

A LMS framework enables organizations an access to the pre-stored training content in the form of lectures, videos, podcasts, e-books and other instructional resources accessible by all registered users from any place and at any time (Ilyas, Kadir, & Adnan, 2017). LMS is a software tool that, in addition to recognizing what training a team needs, also monitors progress achieved during training.

LMS is convenient and user friendly and supports all learning requirements of a modern organization. It supports various modules that can be shared, and has a centralized library, which can be accessed by all users. It can also contain analysis tools and reports that are programmed and customized.

Benefits of LMS are that LMS makes learning simple, provides unlimited access to e-learning materials, consolidates all training information, reduces learning costs, enables tracking and saves time. In addition to the mentioned advantages, when it comes to LMS we must also take into consideration administrative costs and setup time. It should be noted that implementation of LMS may take some time and it requires IT and programming knowledge (GoGuardian Team, 2021).

LMS in the post-pandemic workplace environment can bring (McAvoy, 2022):

- Increased learner engagement and retention - employees can assess their current level of knowledge and identify what they need to learn, set learning goals and choose different resources that will help them achieve those goals.
- Easing administrative burden and evaluation of learning - analysis of results in real time and automation of administration gives L&D staff more time to focus on higher-level tasks.
- Solving company-wide needs - all departments have fast and easy access to the latest information and training materials.

There are a lot of LMS platforms to choose from. Every of those platforms has its own strengths and weaknesses. Forbs Advisor analyzed the best LMS options and they are: Absorb, Cheaper Learning LMS, TalentLMS, iSpring, Docebo, D2L, Canvas LMS, Edmodo LMS and Moodle LMS (Henning & Main, 2023).

3. 2. Video conferencing tools

"Video conferencing software is software that allows two or more people to emulate a person-to-person meeting over the internet using real-time, multidirectional video and audio streaming." (BigCommerce, n.d.).

Video conferencing software enables online communication for all types of meetings or seminars, with the option of screen sharing or recording. It is used to improve collaboration. Employees can use video conferencing tools to host or attend virtual meetings with other employees, company partners or clients, regardless of where the participants are physically located.

Video conferencing tools must enable the following:

- Online video and audio communication,
- Giving the hosts the opportunity to invite participants to the conversation,
- Chat capability and screen sharing and
- Possibility of recording.

Benefits of video conferencing in the post-COVID era is that these communication tools are affordable and adaptable across industries. Video conferencing solutions can be used for any type of business. Video conferencing ensures the safety of workforce while improving collaboration (Bemer, 2022). Some of the issues corporate video conferencing can address, especially for large enterprises, are (Pappas, 2022):

- Low employee engagement,
- Limited peer-based support,
- No L&D team communication,
- Lack of employee feedback,
- High L&D costs etc.

Some of the most used video conferencing tools are: Microsoft Teams, Google Meet, Google Workspace, Zoom, BlueJeans Meetings, Skype, Webex Meetings, GoTo Meeting, Webex App, Slack, TeamViewer Remote, Amazon Chime etc.

3. 3. Microlearning platforms

Microlearning refers to relatively small, focused learning of units consisting of condensed learning activities (usually one to ten minutes), available on multiple devices. Microlearning lessons are designed for skill-based training, learning, and education and it is a multi-platform tool that can be applied to educate a large number of users (Shail, 2019).

Microlearning platforms must provide: content delivery and tracking, assessment and practicing, content storing and management as well as ease of administration. On the basis of these factors, the positive effects of the microlearning platforms can be measured. Some of the best microlearning platforms are: CodeofTalent, EdApp, 7apsMicrolearning, Axonify, TovutiLMS and Arist (G2, 2023).

Essence of microlearning is described across seven dimensions: requiring a short-time engagement; carrying less content; potentially being drawn from course elements; scattered form; coherent and self-contained; media-rich; and supportive of various learning approaches (Wang, Towey, Yuk-kwan & Gill, 2021). Several benefits of using microlearning have been reported, including: greater retention of concepts; better engagement for learners; improving learners motivation; engaging in collaborative learning; and improving learning ability and performance (Wang et al., 2021).

The outbreak of COVID has had a severe impact on businesses at large. Microlearning in the post-COVID period offered ways in which companies can offer services effectively for broader training initiatives and performance support. Assets used in microlearning are compact, and modalities are easily embedded with the training content, making them more interesting for the employees to assimilate information.

As regards to L&D, microlearning strategies are helpful and effective, since microlearning is flexible and it offers various learning formats and ease of delivery. Microlearning also offers the flexibility to create impactful learning pathways for employees to achieve their goals, by mixing and matching training content (Integra, 2020).

3. 4. Content creation tools

Content creation tools have emerged as something to describe digitally enabled cultural producers who create and circulate content on social media platforms, driven by an entrepreneurial spirit and desire to generate their own 'media brands' (Arriagada & Ibáñez, 2020).

Pandemic led to what we have today, over 50 million content creators, which include social media influencers, bloggers, and videographers who utilize software and financial tools that assist in their growth and monetization (Bogliari, 2021). This population is now recognized as the Creator Economy and it is one of the fastest growing economies to date (Bogliari, 2021).

L&D teams are looking for new ways to do things. They're taking a more sustainable approach to learning and development by deputizing content creation and empowering anyone from the organization to share their expertise (Markovic, 2022). Some of the steps that need to be taken in terms of content creation for more efficient L&D include (Markovic, 2022):

- Build a foundation for collaborative content creation,
- Remove barriers to access,
- Enable knowledge sharing and
- Lean into technology.

Content creator platforms that are popular today are: Grin, Creator & Co, LTK, Impact, Upfluence, Aspire, Klear and Stellar.

3. 5. Knowledge Repositories

"Knowledge repositories are online databases that continuously collect and organize a company's knowledge assets. These are also referred to as knowledge management repositories." (Capacity, 2019). These platforms allow storage, organization, collaboration and knowledge creation.

Knowledge repositories help organizations connect people with information and expertise globally via online searchable libraries, discussion forums and other elements. They provide a central location to collect, contribute and share digital learning resources for use in instructional design and content development for both traditional and non-traditional learning environments. They have become an integral part of corporate-wide knowledge management programs and a valuable stimulant of social and informal learning activities (TrainingIndustry, n.d.).

There are several key features of effective digital knowledge repositories:

- Centralization,
- Content management,
- Cost savings,
- Access control and
- Record management.

The best organizational knowledge repositories to help self-learning of employees are: EdApp, Confluence, Helpjuice, Nuclino, Guru, Trainual, Bloomfire, Document360, Knowmax and Slite.

4. Conclusion

Pandemic COVID-19 brought many profound business changes. In the post-pandemic era, many employees prefer to work online or in a hybrid model. For such employees, it is necessary to find appropriate tools for learning and development activities. This paper presents the importance of L&D, as well as the most significant tools and solutions for implementing L&D activities in today's business environment. Presented tools and solutions can be used in different stages of L&D activities. Those tools and solutions include LMS, microlearning platforms, video conferencing tools, content creation tools and knowledge repositories.

It remains questionable whether L&D will continue to develop fully online and self-paced or whether it will incorporate once again traditional forms of learning and development. The direction in which it will develop further will certainly depend on the needs of the company, its size and resources.

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IMPACT OF MACROECONOMIC FACTORS ON STOCK MARKET INDICES: EMPIRICAL EVIDENCE FROM GERMANY AND MALAYSIA

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Abstract

This study investigates the impact of the exchange rate, Federal Funds rate (FFR), inflation (CPI), industrial production index (IPI), and CBOE market volatility index (VIX)on stock market indices in both a developed and a developing economy. The research provides empirical evidence regarding the relationship between these macroeconomic factors and stock market performance, shedding light on their influence in different economic contexts. Using comprehensive datasets from the selected economies, the study employs econometric techniques such as regression analysis to examine the effects of these factors on stock market indices. Data for the study is obtained from the International Monetary Fund database and investing.com. Data spans from January 2015 to August 2022. The findings suggest that the exchange rate has a statistically significant impact on stock market returns in both countries, while the CBOE market volatility index (VIX) has a statistically significant impact on stock market returns in Germany. The other observed macroeconomic variables did not show a significant impact on stock market returns in the observed countries. The results provide valuable insights for investors, policymakers, and market participants, enabling them to make informed decisions and develop effective risk management strategies.

Key words: *Stock market, macroeconomic factors, developed economy, developing economy, regression analysis.*

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1. Introduction

A stock exchange, also known as a stock market or a bourse in continental Europe, is a regulated market for the selling and acquisition of assets such as stocks, bonds, and shares. In most nations, the stock exchange serves two purposes. It ensures the liquidity of securities as a ready market, encouraging consumers to put their resources into business investment. Second, it transfers capital among enterprises as a pricing mechanism by calculating prices that represent the genuine investment worth of a company's shares.

Economists and people involved in the financial sphere rely on stock market indexes. Long-term regularities that aid in understanding the behavior of financial participants, the growth of the economy, and international comparisons require consistent indices. Financial indices are also important for traders and investors looking for a quick and easy way to get a summary of what's going on in the stock market. To assess the performance of stock markets, a wide range of indexes have been developed throughout history. These components have exploded in popularity in recent years.

The stock market is an important part of a country's economy. It transfers investment funds from stock investors to stock borrowers, which is essential for a thriving economy. A stock market is essentially a market where securities (stocks, bonds, and other financial instruments) are traded.

As Djedović & Djedović (2018) state, in order to comprehend stock market reports, it is crucial to recognize that the prices of securities and other financial instruments in the long term correspond to economic and political fundamentals and trends. These fundamentals are external to the markets, encompassing economic and political factors that govern trends in specific securities, groups of securities, or even the entire market. Over the long term, these factors determine stock movements and impact the value of all financial instruments. Generally, stock prices tend to increase during favorable economic conditions and decrease when the economy is weak. Numerous factors can influence stock prices, some with immediate effects while others have long-term consequences. Examples of these fundamentals include changes in industrial production, inflation rates, and other similar factors (Djedović & Djedović, 2018). By understanding the underlying principles governing stock markets, we can explore the economic foundations that affect security prices. This paper aims to investigate the influence of external factors on the stock market in Germany and Malaysia, specifically focusing on inflation, industrial production, interest rates, exchange rates, and the CBOE market volatility index (VIX).

This research focuses on analyzing the relationship between the stock market index in Germany and Malaysia, including DAX (DE30) index representing the German stock market, and KLSE (FTSE Malaysia KLCI) representing the Malaysian stock market, and macroeconomic variables from January 2015 to August 2022.

The objective of this study is to examine the existence and nature of the relationship between key factors that have historically influenced conventional indices both regionally and globally, and the DAX and KLCE indexes representing Germany and Malaysia. Specifically, the research aims to determine the extent of influence that macroeconomic factors have on the indexes.

The significance of this study is manifold. It provides valuable insights for policymakers to comprehend the impact of their policies on the DAX and KLSE indexes. It also assists

investors in understanding how the market may respond to changes in macroeconomic factors. Lastly, researchers can utilize the findings to assess policy impacts and predict future movements of the DAX and KLSE indexes.

In the following sections of the study presented is a relevant literature review which is a base for the model development. Furthermore, provided is information regarding the data and methodology used in the study. In the last sections, presented are the results and the main conclusions of the study.

2. Literature review

Previous studies have examined the relationship between stock market returns and macroeconomic variables. These studies have demonstrated significant connections between stock markets and macroeconomic variables across different countries (Djedovic & Djedovic, 2018). "While the association between stock markets and economic activities is evident regardless of causality, a standardized set of macroeconomic variables has yet to be established. The selection of macroeconomic variables to explore the determinants of the stock market tends to vary slightly among studies. However, Abdul Rahman et al. (2009) suggest that inflation rates, money growth, interest rates, industrial production, reserves, and exchange rates are the most common significant factors in explaining stock market movements" (Djedović & Djedović, 2018).

In the following paragraphs presented are the relevant macroeconomic variables that potentially have an impact on stock market indices, as well as the empirical evidence regarding this relationship. This section is based on past relevant study work completed by different researchers for various nations and time periods.

2. 1. Stock market indices and the macroeconomic indicators

"While the association between the stock market and economic activities is quite obvious regardless of its causality direction, a standardized set of macroeconomic variables is not found. Macroeconomic variables selected to examine the determinants of the stock market tend to be slightly different in various studies. However, Abdul Rahman et al. (2009) suggest that the rate of inflation, money growth, interest rates, industrial production, reserves, and exchange rates are the most popular significant factors in explaining the stock market movement" (Djedović & Djedović, 2018).

As Abdul Rahman et al. (2009) suggests that there are several studies that determine factors affecting stock prices such as studies by Sadorsky (2003), Ibrahim and Aziz (2002), Mavrides (2000), and Chen (2003).

2. 2. Interest rate (Federal Funds Rate) and stock market indices

Bartram (2002) mentions that there are several ways through which interest rates affect the performance of companies. Furthermore, Martinez-Moya et al. (2013) mention

this relationship as well and argue that "the interest rate influences both the future cash flows for companies and the discount rate to value these companies and, hence, the stock price of the company".

Due to the importance of interest rates in shaping the stock prices of the companies, besides domestic monetary variables, we included in the study a foreign interest rate, namely US Federal Funds Rate (FFR), to capture international influence on both stock markets. Due to some econometric limitations, domestic interest rates are not included in the study.

In the study conducted by Mohd. Yusof and Abd. Majid (2007) on the Malaysian stock market, it is found that the Federal funds rate has a significant direct impact on the Malaysian stock market behavior.

Chebbi and Derbali (2019) empirically investigated the impact of US monetary policy surprises on the volatility of stock market returns for euro-area countries. They found a significant response of volatility to an expected component of the target rate change. Furthermore, they highlight homogeneity in the responsiveness of European stock markets to US news announcements.

There are also different studies that investigate the relationship between domestic interest rates and stock markets. We highlight a few of them. Misra, P. (2018) investigated the relationship between the Indian stock market index (BSE Sensex) and macroeconomic indices. Data used for research is from April 1999 to March 2017. The results of their study suggest that there is a long-run impact of interest rates on the stock market index.

Furthermore, Ahmed (2008) researched the impact and nature of relationships between key macroeconomic indicators and the stock market index in India. Data reference is for the period March 1995 to March 2007, on a quarterly basis. It is concluded that stock prices in India lead economic activities except for interest rate movement. Results imply that interest rate serves a leading role in the stock index movement.

Adam and Tweneboah (2008b) tested for cointegration between macroeconomic indices and the stock index in Ghana. The assaying is on time intervals from January 1991 to April 2007 based on quarterly data. The article found that macroeconomic variables and stock prices in Ghana are cointegrated, implying a long-term link. The VECM analysis reveals that interest rates have a considerable impact on the stock market.

N. Apergis and S. Eleftheriou (2002) conducted an empirical investigation on the link between stock prices, inflation, and interest rates in Greece from the year 1988 to 1999. Monthly data on stock prices, as assessed by the ASE stock price general index, is used in the empirical analysis. The results show that interest rates and stock prices are favorably associated, although this relationship is statistically negligible.

2. 3. CPI – Inflation and stock market indices

The findings of N. Apergis and S. Eleftheriou (2002) support the theory that stock prices and inflation are related. Despite the strong association that the literature claims, empirical evidence obtained in their analysis show that stock values in ASE follow inflation rather than nominal interest rate fluctuations. The findings show that continuously decreasing inflation tends to lead to a real increase in stock values because lower inflation means lower risk to the economy.

Furthermore, the Vector Error Correction Model (VECM) applied by Misra (2018) demonstrates that inflation and BSE Sensex have a long-run causal relationship as well as a short-run causal relationship between inflation and the BSE Sensex stock index.

Floros (2008) investigated the link between stock returns and inflation in his study. For the period from 1988 to 2002, he used monthly data from the Athens Stock Exchange Price Index and the Greek Consumer Price Index to test this association. A set of equations adding lagged inflation values shows a negative but not significant influence of lagged inflation on stock returns. Furthermore, by using the Johansen cointegration test the results of a study conducted by Floros (2008) found show that there is no long-run link between stock returns and inflation.

In her study, Shiblee (2009) examined the impact of inflation, GDP, unemployment, and money supply on the stock price of the industrial sector. The research was based on the New York Stock Exchange from the period of 1994 to 2007. She found that inflation is expected to have a minor impact on the stock market index.

Ibbotson G. and Chen P. (2001) estimated the long-run stock market returns in the real economy. Annual historical stock returns are decomposed into supply components such as inflation and GDP per capita from the years 1926 to 2000. The results show that nominal earnings growth including inflation account for most of the return of the stock market.

2. 4. Index of Industrial Production (IPI) and stock market indices

McMillan (2016) presented research that investigates predictability and stock market returns forecasting using twenty-five variables. The data is collected on a quarterly basis throughout the sample period, which runs from January 1973 to April 2014. The results show that in the key group of variables that predict changes in expected returns is GDP acceleration. Furthermore, Misra (2018) suggested that the Index of Industrial production has a long-run impact on the BSE Sensex.

Boubakari A. and Jin D. (2010) used time series data from five Euronext economies to investigate the causation link between the stock market and economic growth over the period from January 1995 to April 2008. The Granger causality test was performed to determine whether there was a causal link between stock market indexes and economic growth (GDP and FDI). The study's findings imply that the stock market and economic growth are linked in some nations where the stock market is liquid and active. The causative link is opposed in nations with a small and less liquid stock market.

In their study, Paramati R. and Gupta R. (2013) conducted a study for the period from April 1996 to March 2009, using the monthly Index of Industrial Production (IIP) and quarterly Gross Domestic Product (GDP) data. The monthly results demonstrate a bidirectional association between IIP and stock prices (BSE and NSE), but the quarterly data show that there is a unidirectional relationship between NSE and GDP, which goes from GDP to NSE.

2. 5. Exchange rate and stock market indices

In his work, Rasiah R. (2010) examines the long-run correlations and short-run dynamic interactions between the stock market and key macroeconomic factors in Malaysia from January 1980 to December 2006. The cointegration test and the vector error correction model show that real stock returns and the real exchange rate have positive long-run connections. Furthermore, Misra, P. (2018) suggests that there is a long-run impact of the exchange rate, on the BSE Sensex index.

T. Siddiqui and Y. Abdullah (2015) researched how to anticipate stock values using predictable patterns. The study's variables include the USD-INR exchange rate, crude oil prices, and key stock indexes in the United States the Eurozone, China, and Japan. Daily data from January 2004 to December 2013 is used in the study. The stock exchange data from international stock markets allow for overnight changes in market sentiment. Also, the correlations between macroeconomic conditions and stock return were established by Adam and Tweneboah (2008b). According to the findings, exchange rates have a small impact on stock price movements.

2. 6. CBOE market volatility index (VIX) and stock market indices

As a proxy for market volatility, the CBOE market volatility index (VIX) is used. "The implied volatility index is the trademark of the Chicago board options exchange and is introduced in 1993 and in 2003 modified" (Thielen 2016).

Nazlioglu et. al (2015) investigated the impact of VIX on the Islamic stock Markets and conventional stock markets. Study results suggest that the conventional stock market is sensitive to the VIX index in both positive and negative directions due to uncertainty and fear, and this is a regular behavior in these cases.

"Delisle et al. (2011) and Van Ahn Mai et al (2015) conclude that the rise of the VIX is negatively related to future stock returns, but there is no relation between the fall of the VIX and future stock returns. They conclude that 'VIX innovations are a priced risk factor only when VIX rises, and not when it declines" (Thielen, 2016).

Sarwar and Khan (2017) found that increases in VIX lead to significant immediate and delayed declines in emerging market returns in all periods. Furthermore, the study conducted by Sarwar (2012) focuses on VIX-returns analysis. The results suggest a strong negative contemporaneous relation between daily changes in VIX and U.S. stock market returns. This relation is stronger when VIX is higher and more volatile. The results also show that there is a similar relationship between VIX and equity returns in China, Brazil, and India in the specific periods.

3. Data and Methodology

Using comprehensive datasets from the selected economies, the study will employ econometric techniques such as regression analysis to examine the effects of these factors on stock market indices. Data for the study is obtained from the International monetary

fund database, the Federal Statistical Office of Germany, the Central Bank of Malaysia, the Federal Reserve's database, and investing.com on a monthly basis, spanning from January 2015 to August 2022. The data will be statistically analyzed using Microsoft Excel and EViews software. Ordinary Least Squares Regression will be used to study the relationship. All necessary diagnostics tests including normality, serial correlation, and heteroscedasticity will be run.

As introduced previously testing will use data from Germany as a developed and Malaysia as a developing country.

The data utilized for the investigation will be derived from secondary sources. The main source for macroeconomic data used for Germany and its indicators is the Federal Statistical Office of Germany. Macroeconomic data for Malaysia is collected from the Central Bank of Malaysia.

The multiple regression econometric models used in the study, which include the following variables, can be expressed as:

Stock Market Index growth (Germany) = β0 + β1 * dExchange rate + β2 * Industrial Production Index growth + β3 * CPIgrowth + β4 * VIX + β5 * dFederal Reserves Rate + β6 * VIXgrowth index + ε

Stock Market Index growth (Malaysia) = β0 + β1 * dExchange rate + β2 * Industrial Production Index growth + β3 * CPIgrowth + β4 * VIX + β5 * dFederal Reserves Rate + β6 * VIXgrowth index + ε

In the models:

- Stock Market Index represents the dependent variable, which is the value of the stock market index being predicted.
- Exchange rate is an independent variable that denotes the foreign exchange rate.
- Industrial Production Index (used as a proxy for GDP) is an independent variable that measures industrial production.
- CPI growth is an independent variable representing the inflation rate.
- CBOE market volatility index (VIX) is an independent variable that represents the Volatility Index, which measures the expected market volatility.
- Federal Reserves Rate is an independent variable indicating the interest rate set by the U.S. Federal Reserve.

β0, β1, β2, β3, β4, β5, and β6 are the regression coefficients that represent the impact of each independent variable on the dependent variable. ε represents the error term in the model, accounting for the unexplained variation not captured by the included independent factors.

The growth rate of the series is estimated by subtracting the value at time t - 1 from the series value at time t and dividing it by the series value at time t as shown in Eq. (1), where Gt is the growth rate at time t, Bt is the series value at time t and Bt-1 is the series value at time t - 1.

Equation 1.

$$\boldsymbol{G_t} = \frac{B_t - B_{t-1}}{B_{t-1}} x100$$

4. Results

In the following parts presented are the results of the study. Ordinary least squares regression analysis was applied to examine the effects of the set of independent variables influencing the stock market return in developed and developing economies, represented respectively by Germany and Malaysia.

4. 1. Descriptive statistics

Table 1 presents the summary statistics of the key variables in this study related to Germany.

Table 1. Descriptive statistics - Germany

	DAX_INDEX	CPI	EXCHANGE_RATE	FEDFUNDS	IPI	VIX
Mean	12358.91	112.3903	101.8722	0.840652	108.2982	18.88152
Median	12311.9	111.7202	101.9307	0.4	108.8778	16.37
Maximum	15884.86	127.3739	104.3858	2.42	126.2699	53.54
Minimum	9495.4	105.6088	98.29645	0.05	77.20127	9.51
Std. Dev.	1606.179	4.967424	1.407191	0.827915	8.536214	7.637585
Skewness	0.455496	1.218237	-0.280809	0.68467	-0.69801	1.657591
Kurtosis	2.636128	4.243303	2.397838	1.956247	4.344654	6.78436

Source: Authors' calculation

Table 2 presents the summary statistics of the key variables in this study related to Malaysia.

Table 2. Descriptive statistics - Malaysia

	KLCI_INDEX	CPI	EXCHANGE_RATE	FEDFUNDS	IPI	VIX
Mean	1647.626	119.6261	5.774567	0.840652	110.9744	18.88152
Median	1651.655	120.5	5.807268	0.4	112.1224	16.37
Maximum	1870.37	128.2	6.189792	2.42	130.7784	53.54
Minimum	1350.89	109.9	5.016211	0.05	77.00413	9.51
Std. Dev.	110.4841	4.016391	0.224588	0.827915	8.970241	7.637585
Skewness	-0.062051	-0.369997	-1.661173	0.68467	-0.60207	1.657591
Kurtosis	2.651337	2.747373	6.262275	1.956247	4.310105	6.78436

Source: Authors' calculation

4. 2. Unit root tests

Table 1 and Table 2 present the results of Augmented Dickey-Fuller unit root tests for the variables used in the research models for Germany and Malaysia. The results showed that all variables are stationary at the level, meaning that they do not have unit roots.

Table 3. Unit root tests - Germany

	Test Statistics	
Variables	Level	1st Difference
DAX GROWTH[1]	-10,0172*	
DEXCHANGE[1]	-8,675*	
DFED[1]	-3,737*	
INFLATION[1]	-4,0666*	
IPIGROWTH	-10,97599*	
VIXGROWTH	-12,259*	

*Note: [1] Indicates Augmented Dickey-Fuller test, * indicates the series is stationary at 5% significance level*

Table 4. Unit root tests - Malaysia

	Test Statistics	
Variables	Level	1st Difference
KLCI GROWTH[1]	-10,46*	
INFLATION[1]	-7,240*	
DFED[1]	-3,737*	
DEXCHANGE[1]	-8,974*	
IPIGROWTH	-13,074*	
VIXGROWTH	-12,259*	

*Note: [1] Indicates Augmented Dickey-Fuller test, * indicates the series is stationary at 5% significance level*

4. 3. Residual Diagnostics

In the following Tables presented are the results of the residual diagnostics for the research models. Namely, the results of the residual diagnostics are covering the Normality test, Serial correlation LM test, and Heteroscedasticity tests for Germany and Malaysia.

The normality of distribution is tested using the Jarque-Bera test. As shown in Figure 1 (Germany) the estimated model using EViews software shows JB=3.746, with a probability of 0.153, pointing to the conclusion that on any commonly used significance level, we do not reject the null hypothesis on the normality of distribution of relation errors. Furthermore, as shown in Figure 2 (Malaysia) the estimated model using EViews software shows JB=4.160, with a probability of 0.1248, pointing to the conclusion that on any commonly used significance level, we do not reject the null hypothesis on the normality of distribution of relation errors.

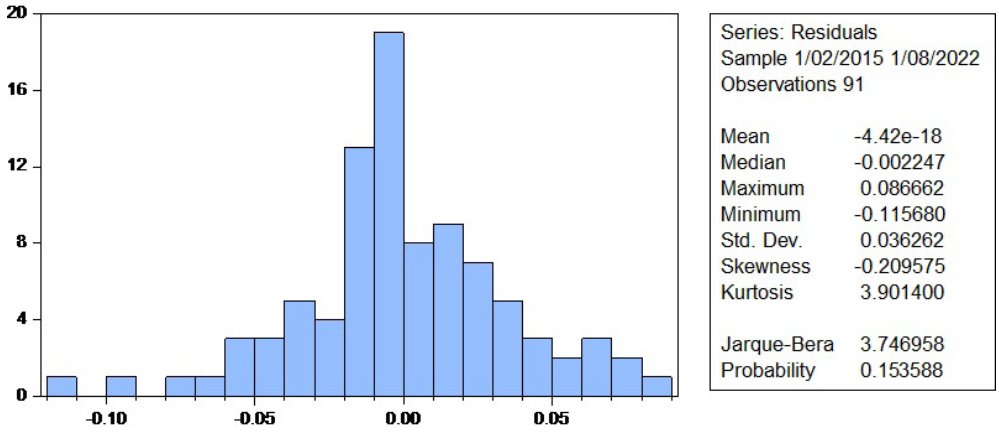

Figure 1. Results of the Jarque-Bera Test - Germany

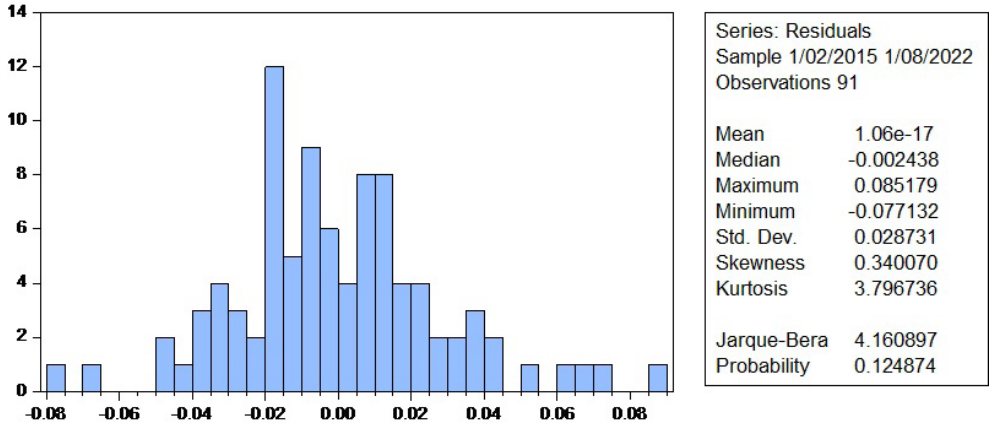

Figure 2. Results of the Jarque-Bera Test - Malaysia

Autocorrelation has been tested using the Breusch-Godfrey LM test for autocorrelation (Tables 3 and 4). With a level of significance of 5%, we can confirm the null hypothesis stating there is no autocorrelation in the models that can be accepted.

Table 5. Results of the Breusch-Godfrey LM Test for Autocorrelation -Germany

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.478050	Prob. F(2,83)	0.2340
Obs*R-squared	3.129563	Prob. Chi-Square(2)	0.2091

Table 6. Results of the Breusch-Godfrey LM Test for Autocorrelation -Malaysia

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.366117	Prob. F(2,83)	0.6945
Obs*R-squared	0.795790	Prob. Chi-Square(2)	0.6717

To address the potential heteroscedasticity problem that is common in time series, we have conducted a Breusch-Pagan-Godfrey Heteroscedasticity test using EViews software. The results of the test are presented in Tables 5 and 6. The null hypothesis assumes homoskedasticity. Given that the probabilities are all greater than 0.05, shown in Table 5 for Germany, and that the probabilities of Malaysia shown in Table 6, are also greater than 0.05, we do not reject the null hypothesis and conclude that the variances are homoscedastic for each model.

Table 7. Results of Breusch-Pagan-Godfrey Heteroscedasticity test – Germany

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.776799	Prob. F(5,85)	0.5691
Obs*R-squared	3.976458	Prob. Chi-Square(5)	0.5528
Scaled explained SS	5.033025	Prob. Chi-Square(5)	0.4119

Table 8. Results of Breusch-Pagan-Godfrey Heteroscedasticity test – Malaysia

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.390376	Prob. F(5,85)	0.2361
Obs*R-squared	6.879914	Prob. Chi-Square(5)	0.2297
Scaled explained SS	8.393819	Prob. Chi-Square(5)	0.1358

Thus, all the presumptions have been confirmed, and the results of the regression model including the economic determinants of stock market returns can be used to conclude the German and Malaysian case.

Table 9. The summary output of the regression model – Germany

Dependent Variable: DAXGROWTH
Method: Least Squares
Date: 04/28/23 Time: 16:46
Sample (adjusted): 1/02/2015 1/08/2022
Included observations: 91 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEXCH	-0.023947	0.006951	-3.445195	0.0009
DFED	-0.020916	0.023067	-0.906740	0.3671
INFLATION	1.245149	0.886250	1.404962	0.1637
IPIGROWTH	-0.068113	0.041114	-1.656674	0.1013
VIXGROWTH	-0.108061	0.012947	-8.346389	0.0000
C	0.005659	0.004377	1.292854	0.1996

R-squared	0.512867	Mean dependent var	0.003353
Adjusted R-squared	0.484212	S.D. dependent var	0.051955
S.E. of regression	0.037313	Akaike info criterion	-3.675272
Sum squared resid	0.118344	Schwarz criterion	-3.509721
Log likelihood	173.2249	Hannan-Quinn criter.	-3.608483
F-statistic	17.89806	Durbin-Watson stat	2.324306
Prob(F-statistic)	0.000000		

Regression estimates of economic determinants of stock market index return (DAX) in Germany show a statistically significant impact of exchange rate and VIX growth rate on stock market index return in Germany. Federal Funds Rate, inflation, and IPI growth did not show a statistically significant impact on stock market index (DAX) return in Germany. Both the exchange rate and VIX growth rate have a negative coefficient. The F-statistic equals 17.898 with a corresponding empirical significance level of 0,000, thus showing that the regression model is statistically significant at 5% significance.

Table 10. The summary output of the regression model – Malaysia

Dependent Variable: KLCIGROWTH
Method: Least Squares
Date: 05/10/23 Time: 13:20
Sample (adjusted): 1/02/2015 1/08/2022
Included observations: 91 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPIGROWTH	-0.191280	0.651205	-0.293732	0.7697
DFED	0.025207	0.019236	1.310412	0.1936
DEXCH	-0.084392	0.030308	-2.784505	0.0066
IPIGROWTH	-0.000709	0.000405	-1.750589	0.0836
VIXGROWTH	-0.000534	0.000453	-1.178108	0.2420
C	0.086743	0.042404	2.045656	0.0439

R-squared	0.163419	Mean dependent var	-0.001309
Adjusted R-squared	0.114209	S.D. dependent var	0.031412
S.E. of regression	0.029564	Akaike info criterion	-4.140853
Sum squared resid	0.074293	Schwarz criterion	-3.975301
Log likelihood	194.4088	Hannan-Quinn criter.	-4.074063
F-statistic	3.320817	Durbin-Watson stat	2.160599
Prob(F-statistic)	0.008680		

Regression estimates of economic determinants of stock market index return (KLCI) in Malaysia show a statistically negative significant impact of exchange rate on stock market index return in Germany at a 5% significance level. Furthermore, regression estimates of economic determinants of stock market index return (KLCI) in Malaysia show a statistically negative significant impact of IPI growth on stock market index return in Malaysia at a 10% significance level. However, Federal Funds Rate, inflation, and VIX growth did not show a statistically significant impact on the stock market index (KLCI) return in Malaysia. Both the exchange rate and IPI growth rate have a negative coefficient. The F-statistic equals 3.32 with a corresponding empirical significance level of 0.00868, showing that the regression model is statistically significant at 5% significance.

The results of the study show that for both countries and indices that are investigated, the exchange rates have a significant negative impact on stock market returns. However, the coefficients are very low. It should be taken into consideration that the exchange rate is the price of a unit of a given currency in relation to other currencies. "The performance and profitability of industries and companies that are major exporters or heavy users of imports are considerably affected by the exchange rate against major currencies of the world" (Osamwonyi, 2003). Therefore, it is not unexpected that the exchange rate has a significant impact on the stock market returns.

Furthermore, economic theory asserts that the exchange rate is an important variable in developing a comprehensive understanding of the behavior of stock prices and index movements. Maysami et al. (2004) state that the "depreciation of countries' currencies will lead to an increase in demand for their exports and thereby increasing cash flows to the country, assuming that the demand for exports is sufficiently elastic". This can be one of the reasons for having a significant and negative influence of exchange rates on stock market returns in both countries. Study results are in line with the results of several other studies that found a significant impact of exchange rate on stock market returns (Maysami and Sims (2002, 2001a, 2001b)).

The results also suggest that the CBOE market volatility index (VIX) has a statistically significant impact on stock market return in Germany, while in Malaysia it is not the case. The reasoning for this difference might be that the German stock market is more interconnected with the global markets and that reflections of the fear or implied volatility which is represented by the CBOE market volatility index (VIX) are easily transmitted to the German stock market, while the Malaysian stock market is immune to these effects since Malaysian linkage with the international and western economies is weaker. The results can be beneficial for the investors when creating their investment portfolios, as well as for the stock market trading timing in the observed countries and corresponding indices.

5. Conclusion

In this study, a review of relevant literature related to determinants of stock market returns was presented, as well as empirical evidence from Germany and Malaysia. Potential determinants of stock market returns used in this study include the industrial production index (IPI) as a proxy for GDP, exchange rate, inflation rate, implied volatility index (VIX), and federal funds rate. For the purpose of the study, monthly basis data, spanning from January 2015 to August 2022 is collected from several sources including the International monetary fund database, the Federal Statistical Office of Germany, the Central Bank of Malaysia, the Federal Reserve's database, and investing.com.

The data is statistically analyzed using Microsoft Excel and EViews software. Ordinary Least Squares Regression is used to study relationships.

The results of the empirical analysis confirmed that the exchange rate has a statistically significant negative impact at 5% significance on stock market returns in both countries, which is also in line with the abovementioned empirical literature and the theory. On the other side, the implied volatility index (VIX) has a statistically significant impact at 5% significance on stock market returns in Germany, while the impact in Malaysia is insignificant. It is expected that VIX has an impact, in both countries, however, the level of openness and interconnectedness of the Malaysian market to the world markets could be a reason for the insignificant result. While in Germany, considered a developed economy, this impact is transmitted smoothly.

The rest of the results, related to the other macroeconomic variables used in the research model, namely inflation rate, federal funds rate, and industrial production index did not show a statistically significant impact at 5% significance on the stock market returns in the two observed countries.

The main limitations of this study is that only two stock market indices were taken into consideration when exploring the determinants of stock market returns, and that the data used for the study spans from 2015 to 2022. A larger number of observations, as well as the usage of more indices from different countries, would provide a better ground for more comprehensive conclusions. Furthermore, the R-squared value of the econometric model in the Malaysian case is quite low, suggesting that other variables should be included in the model, to strengthen the analysis and the model itself. Therefore, it is advisable to analyze more countries and indices, increasing the number of observations and reconsidering the econometric models, by eventually adding additional explanatory variables.

The results can be beneficial for the investors when creating their investment portfolios, as well as for the stock market trading timing in the observed countries and corresponding indices.

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IS COMPOSABLE ENTERPRISE THE KEY TO DIGITAL TRANSFORMATION?

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Abstract

Using computers and other digital devices is now standard practice in most businesses. Business and personal communication, execution of business tasks, and finding solutions to various business and social challenges are all made possible by digital technology. The digital future of business offers nearly infinite potential for the creation of value for companies. The proliferation of clouds, the increasing number of networked devices, and the increasing number of requirements at the network's edge are all factors in the development of modern business infrastructures. However, the way business is conducted is being forever altered by digitalization. Organizations are rethinking their architecture strategies and adopting a more modular approach to keep up with the rapid pace of technological advancement. That allows them to construct, assemble, and reassemble essential elements of their businesses with lightning speed, allowing them to capitalize on opportunities as they arise and adapt to threats as they arise without succumbing to their effects. In order to facilitate growth and change, composable businesses are built from modular components that can be easily swapped out. The paper's main goal is to investigate whether transformation to the composable enterprise is the best road to its effective digital transformation. According to the findings of a critical review of recently published works, developing a composable enterprise architecture necessitates close collaboration among many parties because it removes traditional barriers between business and IT, allowing businesses to provide clients with more personalized application experiences.

***Key words**: Composable Enterprise, Digital Transformation, Modular Components.*

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1. Introduction

The rapid advancement of information and communication technology (ICT) and globalization has created an environment where businesses of all sizes are forced to adapt quickly or risk being left behind. In addition to facilitating regular professional and personal communication, work completion, entertainment, and problem-solving, digital technology also helps address a wide range of societal and business issues. Cloud computing, artificial intelligence (AI), Big data analytics, blockchain, augmented and virtual reality, the Internet of Things (IoT), robotics, etc., are at the forefront of this digital transformation, which the COVID-19 epidemic has further accelerated in both business and society.

In the literature and practice, the terms digital transformation and digitalization are frequently used interchangeably. Some researchers, however, have sought to differentiate between the two (Bockshecker et al., 2018). As defined by Parida et al. (2019, p. 12), digitalization is the "application of digital technology to innovate a business model and generate new income streams and value-producing opportunities in industrial ecosystems." Digitalization provides chances for businesses to increase internal efficiency (processes), introduce brand-new products and services, and/or create whole new business models (Parviainen et al., 2017). Vial (2019) defines "digital transformation" as "a process that tries to better an entity by triggering major changes to its features using combinations of information, computation, communication, and networking technologies."

According to these definitions, "digitalization" refers to incorporating digital elements into a company's business model, products, and services. In contrast, "digital transformation" refers to the more all-encompassing process of adapting an entire company to work with digitalization.

Achieving a successful digital transformation necessitates close alignment of four dimensions (Matt et al., 2015):

1) technology use, including a company's perspective on the use of cutting-edge technologies and readiness for the use of new technologies;
2) value creation shifts associated with technology adoption;
3) structural shifts related to the incorporation of new digital activities into existing organizational structures; and
4) financial aspects can act as a driver or result of the transformation.

Most essential, businesses must have standardized procedures and knowledge management to successfully undergo digital transformation (Berman, 2012). Investments in digital technologies might not necessarily provide positive returns. Several studies suggest that organizational capabilities, such as organizational learning (Tippins et al., 2003), leadership style (Seah et al., 2010; Verdú -Jover et al., 2014), and an adaptive organizational culture (Alos-Simo et al., 2017), are more important than technical knowledge for achieving success. Operational processes, resources, and internal and external users should all be a part of the transformation (Henriette et al., 2015). According to Lenka et al. (2017), investing in hardware with smart subcomponents (such as sensors, digital user interfaces, and software applications) is a common first step in the process of digital transformation. Connectivity is the next step, including ports, antennas, software,

and Internet protocols. Analytic capability, the third step, refers to using development rules, business logic, and algorithms to convert massive amounts of data into predictive insights and directions for action.

Digital transformation offers companies practically limitless opportunities to generate business value. The potential for data-driven business strategies and information products is stronger than ever, and data and analytics have emerged as key drivers of company strategy.

The cloud, networked devices, and requirements at the network's periphery are all growing trends in enterprise infrastructures. Leaders in cloud and edge infrastructure and operations (I&O) need to be creative with regard to network security, workload deployments, and edge infrastructure extension.

Problems with visibility and monitoring/management arise when working with cloud-native applications. Digital business transformation initiatives are at risk if I&O leaders are unable to utilize machine learning (ML) and artificial intelligence (AI) technology to comprehend the relationships and performance of dispersed systems (Lindner, 2022).

Business processes do not end at the application boundary. The benefits afforded by digital technology have become essential differentiators, especially as the world recovers from the pandemic and other disruptive market issues. Companies that can take advantage of enormous volumes of data are proving to be more agile and resilient. In order to better respond to business shifts, organizations must adopt a portfolio of applications that are more easily created, disassembled, and extended (Lindner, 2022).

As the rate of upheaval and unpredictability rises, businesses must adapt by placing greater emphasis on business design and architecting composability across numerous interrelated perspectives. Its structure must be designed using modular components to transform a company into a composable business. The modular design provides the flexibility for the business to reorganize and refocus as required in response to external (or internal) variables like a change in client values or a disruption in the supply chain or materials (Panetta, 2020).

Those in charge of corporate architecture and technological innovation need to start paying more attention to business design and architecting composability across numerous connected perspectives if they want to succeed.

The aim of this paper is to research whether transformation to the composable enterprise is the best road to its effective digital transformation.

The paper is structured as follows. After an introduction, the next section explains composable enterprise, its principles, and its fundamental characteristics. The section that follows discusses the bond between composable enterprise and digital transformation. The paper comes to a close with a conclusion, challenges, and next steps.

2. Composable enterprise

As a result of technological advancements, business processes are becoming more adaptable, and workflows and applications are less likely to collapse under the pressure of innovation or other outside influences. Today, it is crucial for businesses to be able to quickly modify their workflows and the technologies that support them in response to shifting market conditions. Companies that switched to cloud computing no longer had to

worry about maintaining their own servers, data centers, or apps. The following stage is composability.

Composability is a paradigm of system architecture that facilitates the construction of complex systems from modular, independently operating parts. That facilitates the assembly of novel systems from preexisting parts. The primary goal of composability is to take a whole technology stack and turn it into a single, fluid work environment. That is accomplished by having workflows bounce between applications without forcing the user to go between applications (WalkMe, 2023) manually.

The ability to innovate and quickly adjust to shifting business needs is at the heart of "composability," including a company's culture, technology, and processes. In business, composability refers to a modular structure that allows for easy reorientation and restructuring (Quixy, 2023).

Business architectures in the digital age must be prepared for uncertainty and ongoing change. The composable enterprise prioritizes flexibility over efficiency. There is no longer a single use case or purpose for which a system, process, or worker exists. Digital disruptors are increasingly sweeping away the calcified, creaking corporate systems and processes that have been ingrained in firms for decades. Markets are shifting, and customer expectations are rising due to the rise of online and app-based businesses enabled by cloud computing, open application programming interfaces (APIs), data analytics, mobile devices, social media, and the Internet of Things. To truly deliver value, composability, a close relative of integration, requires in-depth familiarity with the stakeholders and their business demands (Abbiati et al., 2021).

Composable enterprises are connected businesses with business processes enabled by cloud and API services obtained and leveraged from external suppliers or through internal data centers. Composable enterprises can grow in scope by developing digital skills that can be used by third parties (Forbes, 2015).

According to Gartner, a composable enterprise is "an organization that delivers business outcomes and adapts to the pace of business change. It does this through the assembly and combination of packaged business capabilities (PBCs).PBCs are application building blocks that have been purchased or developed." (Gaughan et al., 2020).

Composable enterprise refers to using software components that can be swapped out for one another to construct, innovate, and modify corporate processes in response to internal and external changes. Simply put, it facilitates the growth and adaptation of businesses. With the help of extensive stakeholder cooperation, businesses may build a composable enterprise architecture that blurs the lines between business and IT to provide customers with more individualized application experiences.

2. 1. Core principles of composability

Converting a business to a composable business requires enterprises to keep up with technological innovation, rethink their architecture strategies, and adopt a more modular approach, maximizing their ability to build, assemble, and reassemble core business elements to quickly seize market opportunities and respond to disruptors and threats while maintaining resilience.

The Gartner concept of composable business is based on four fundamental principles (Panetta, 2020):

- Discovery
- Modularity
- Orchestration
- Autonomy

Discovery is the process of learning about and using new design possibilities and parts so that modifications may be directed, tracked, and kept safe. The firm must be able to easily find and comprehend each part in a catalog or marketplace (Natis, 2023). A solid inventory of Packaged Business Capabilities (PBAs) that aligns with the company's vision is provided by Enterprise Architecture's catalog of Business Capabilities aligned with IT assets. Companies can adapt more quickly to the ever-increasing rate of change in the business world by adhering to this principle (Panetta, 2020).

Modularity is the practice of dividing a domain into independently scalable and change-manageable parts. When it comes to IT, modularity means having the freedom to rearrange components as needed. Business models are the source of modularity. The principle of autonomy will force the modularity of the component to be determined by the business (Natis, 2023). Because each team or component needs to be self-sufficient and has input into its own output, they will voice a desire for modularity. That idea guarantees increased adaptability using structural alterations.

Orchestration is the process of prescribing and negotiating interactions between components in order to facilitate recomposition and formation. Connectivity between components is standardized and based on patterns, and each part of the system has clearly stated capabilities articulated through services (Natis, 2023). Each item is handled by a process that orchestrates how the pieces fit together within the PBC, assisting in standardization. That principle assures improved leadership because leaders must rethink their business models and include application procurement, implementation, and maintenance in their growth strategies (Panetta, 2020).

Autonomy describes the practice of keeping individual parts of a system from being overly reliant on one another. The notion of autonomy, which is based on business demands, drives the modularity of the component; therefore, the two concepts go hand in hand (Natis, 2023). That principle is essential for maintaining resilience (Panetta, 2020). When it comes to preparing for disruptions in resources and processes, business continuity plans are specifically tailored to solve the difficulties encountered in the past. The danger of using outdated business models is something they fail to see. Maintaining smooth operations requires a business plan that can withstand interference from the outside world.

As these principles of composable business are put into practice, a composable enterprise emerges. Since a composable enterprise architecture eliminates conventional boundaries between business and IT, it enables enterprises to give customers more tailored application experiences, but this requires close collaboration across numerous stakeholders. The composable business principles are essential for businesses to thrive during periods of upheaval.

2. 2. Building blocks of the composable enterprise

To make an enterprise composable, its structure must be designed using modular, easily swapped-out components. These building pieces can be thought of as Lego bricks that can be stacked, rearranged, and even thrown away as needed (Quixy, 2023). That allows companies to break down cumbersome old applications into smaller, more manageable pieces. Figure 1 shows the three essential components of a composable business as described by Gartner (Panetta, 2020):

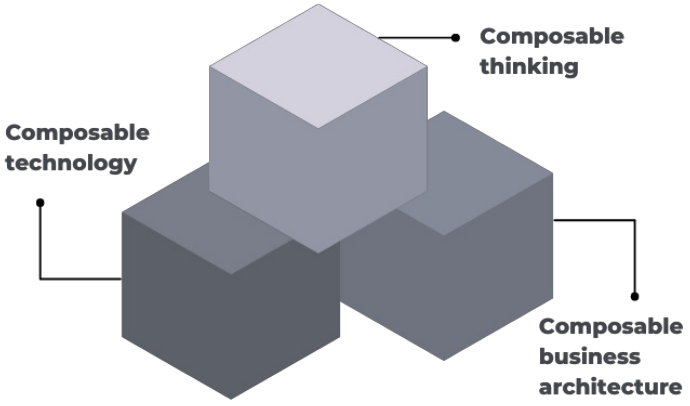

Figure 1. Building blocks of composable business (Quixy, 2023)

1) Composable thinking
2) Composable business architecture
3) Composable technologies

The composable way of thinking promotes the belief that "anything is composable". Composable thinking paves the door for a quicker, more adaptable approach to meeting ever-evolving consumer demands. The information inside and outside the company is encouraged to be shared and sought. Enterprises can be directed in what to compose and when to produce it by combining composable thinking with the ideas of modularity, autonomy, orchestration, and discovery.

Composable business architecture strengthens organizational adaptability and resilience. If companies' structural capacities are enhanced, they can modify and reinvent their products and services. Thanks to the compositional nature of a business architecture's structural capabilities, enterprises are given tools to design their operations. Using a composable business design requires careful consideration of the following (Quixy, 2023):

- The composable business architecture has three dimensions: engagement, technology, and capability.
- Composable business architecture supplements the preexisting business architecture rather than replacing it. Organizations can use it as a lens and a guide for making technology investment decisions and launching new business activities to help them reap the benefits of digital acceleration.
- It is not a business model but can help companies prepare for digital acceleration.

- It's not a formal structure, but it can pave the way for spontaneous groups to develop and work together.
- Industry-specific business architectures can be gradually updated with the help of the composable business architecture's individual building blocks. Doing it all at once is neither desirable nor required.

Enterprise architects must prioritize IT and business alignment to create a composable design. It offers a fresh perspective on figuring out how everything already fits together. Enterprise architects include flexibility in design as they switch to composability, allowing businesses to prepare for various scenarios. Gartner predicts that businesses will adopt a platform for creating and modifying application experiences that brings together high-end and low-code composition capabilities accessible to IT and business users alike. Unlike traditional applications, the composed application experience can be recomposed on demand if the user's role or best practices change (Sabourin, 2020).

Packaged business capabilities (PBCs), as the primary composable architectural components that make this possible, are shown in Figure 2. They reflect a clearly defined business capability that business users understand and are packaged for automated use (Free, 2021). When designing applications, it is crucial to think about what will be on the inside and what will be on the outside as the components are broken down, and the boundaries are defined. Connecting the various IT components (such as PBCs) together is the key, and application programming interfaces (APIs) are the means to accomplish this. While not everything needs to be a PBC, rising connectedness is anticipated generally.

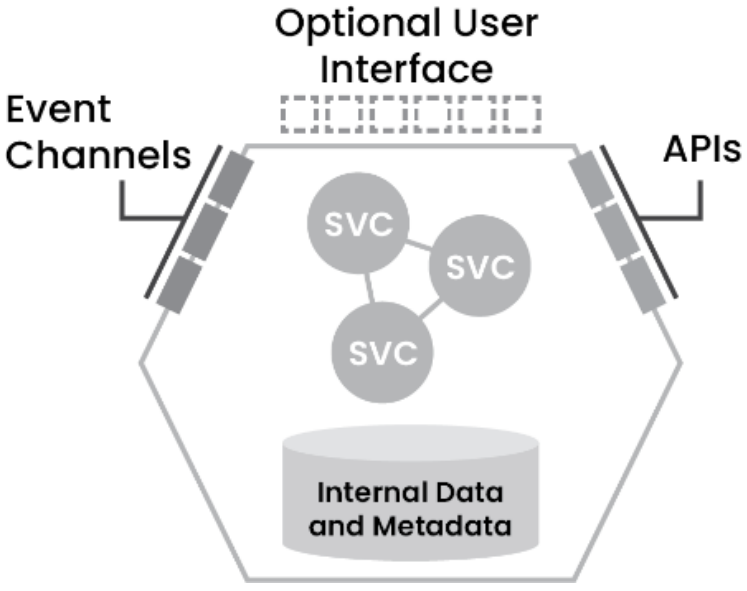

Figure 2. PBC - Packaged business capability (Free, 2021)

The internal data and metadata needed to carry out business requirements must be included in PBCs since they are software components that implement well-defined and autonomous business capabilities. A composable application results from multiple PBCs being stitched together and, potentially, front-ended with a user interface. These individual applications can then be combined into portfolios of business capabilities. The "glue" that connects these PBCs (Figure 2) can be APIs or Event Channels. Without knowing the inner workings of each other's code, applications can communicate with one another through

APIs (RedHat, 2022). An application programming interface (API) serves as a conduit via which two applications can share information and interact with one another.

An API is developed before a composable application is implemented, and the means through which it will be provided are specified. Developers start the development process by discussing the API with prospective clients. They begin developing the actual app by making use cases and API prototypes. This approach to creating apps is known as "API-First development." In API-First Development, APIs are built before applications, which is a paradigm shift in the API design process that represents the company's goals and aspirations (Lameriks, 2018).

Composable technologies are the tools of the present and the future. The technology's interrelated pieces propel the goals of product design and the idea of composability. Agility and adaptability are of paramount importance. It promotes enterprise-wide transparency, openness, and increased connectivity and reuse (Quixy, 2023).

Any company that values swift, risk-free, and efficient transformation will profit from application composition. However, not every business has the same sense of urgency or level of readiness regarding composability. Leaders in the fields of business application and software development should adjust their strategies accordingly. In today's business world, flexibility is crucial for survival. Enterprises should change their software architecture to one based on modular, interoperable components and application programming interfaces (APIs) and their corporate structure to one based on self-governing, geographically dispersed teams capable of producing high-quality results quickly. In that way, they manage and standardize growth democratically.

3. Digital transformation and composable enterprise

Leveraging new technologies to their full potential is more important than ever as businesses anticipate the technical and economic changes that the future may bring. Companies can boost their growth rates and introduce innovations to their processes with the help of digital transformation. A digital business model that involves a gradual shift to an innovative activity foundation and an adjustment to the digital ecosystem in which the organization operates should be developed in tandem with digital business transformations. Some fundamental features of the digital transformation of businesses are (Bochulia, 2021):

1) Evaluation of risks and threats. During the decision-making process for a company's digital transformation, it's essential to identify the proportion of activity revenue that could be jeopardized by adopting digital innovation and abandoning a tried-and-true business model.

2) 2. Digital skills acquisition. They are implementing widespread changes in employee training and upgrading the company's software and hardware to help employees gain the digital skills necessary to complete a company's digital transformation and guarantee its continued digital development.

3) Determining the optimal version of a new model. Parameter estimation for various digital business models aims to select the one that offers the best overall risk/reward profile for implementing digital transformations. The organization can settle on a

course of action, adopt an existing model, or create its own variant based on one of the traditional digital business models.

4) Defining the source of digital competence. The survival and growth of each company depend on a set of fundamental skills.

5) Evaluating readiness for digital partnership. The digital partnership ensures more transparency and access to more information, both organized and unstructured, which alters the standard method of interacting with one's internal and external surroundings. When making the shift to building new information ties, businesses must determine whether or not they are prepared to make digital partnerships.

6) Ensuring the development of digital culture. Securing the enterprise's transition to digital operations by creating a company-wide digital culture and disseminating information about its benefits to employees at all levels of management.

Business leaders today regard digital transformation as the catalyst for a whole new way of thinking about what it means to be in business in the current world. Time is of the essence in digital transformation, as are the iterative modifications to the original program of digital change that must be made in accordance with their guiding principles. By focusing on these fundamental elements, fine-tuning the changes program, and taking steps to strengthen the organization, the business finds a stable footing in its chosen digital transformation direction.

3. 1. Digital transformation benefits and challenges

Understanding the benefits and challenges of digital transformation is essential for taking leadership of digital transformation. That includes having a thorough familiarity with the new systems and processes that are driving new enterprises, as well as how they interact and what they are capable of providing.

Key benefits of digital transformation can be synthesized from literature (Khin & Ho, 2019; Hai, 2021; Shofawati, 2019; Kraus et al., 2022; Morze & Strutynska, 2021; Thales, 2023) as follows:

- Increasing customer satisfaction. Never before have consumers had such lofty anticipations. Customers, on the one hand, want businesses to cater to their specific requirements. Conversely, they prefer automation to manual intervention for things like software access, updates, and deactivation/reactivation. The ability to apply powerful digital tools and methods, such as automated procedures, is an obvious benefit of digitalization in business. Improved client satisfaction is a direct result of these digitalized procedures.
- Driving data-based insights. Companies will be able to collect and analyze data that may be turned into profitable insights thanks to digital transformation. In the past, businesses may not have collected and utilized data at all, or it may have been dispersed across a number of unconnected platforms. Strong data collecting, centralized data storage, and the development of tools to evaluate and translate data into knowledge that encourages informed business decision-making will all be made possible by digital transformation.

- Enabling software monetization. It is common knowledge nowadays that organizations may maximize their return on investment (ROI) and make the transition from a product-centric to a software-centric focus by monetizing their proprietary software.
- Enabling high-quality user experience. Companies that place a premium on creating value understand that they are not just selling their customers a product but an experience. Through the use of automation, artificial intelligence (AI), and self-service technologies, digital transformation makes it possible to create stunning, effortless user experiences.
- Encouraging collaboration and improving communication. Businesses today require a digital platform that fosters internal communication and cooperation across all departments to increase creativity and production. When an organization undergoes a digital transformation, inefficient ways of communicating and sharing ideas are eliminated, as are unnecessary steps and delays. Businesses that digitize their internal communications will see gains in efficiency, accountability, and innovation, giving them a competitive edge.
- Increasing agility. Most enterprises now realize that adaptability and the capacity for change are crucial for surviving the current era of rapid digital transformation. The products they use, the sources of income they can count on, and the needs of their customers have all shifted significantly over the past few years. The enterprise will be able to foresee problems and prepare for them with the help of a digital business environment, ensuring their continued success.
- Limiting human error. Eliminating time-consuming and error-prone manual data entry and human inefficiencies is a significant pro of digital operations. Compared to manual processes, which are prone to human mistakes, digital ones are intrinsically more streamlined and secure.
- Encouraging an environment of employee excellence. Having support from upper management is crucial for a smooth digital transformation. The enterprise must foster an environment where all employees are convinced that the digitalization of business processes would be beneficial. The enterprise should invest in the digital education of its employees if it wants to win their support. Namely, the company's best resource is its talented workforce.
- Increasing operational efficiency. Integrating with back-end systems, automating delivery procedures and product updates, enabling cross-device activation, managing various product versions, and more allow the business to streamline manual processes and cut expenses. The organization will be able to save time and money by switching to digital business procedures, and employee frustration will decrease.
- Enabling future digital growth. All subsequent corporate expansion may be traced back to the initial act of digital transformation. A lack of investment in digital business transformation will result in the company's rapid obsolescence. The shift to digital is inevitable. The organization needs to undergo significant changes if it is to weather the global digital tsunami. After that happens, the organization can reap the full benefits of digital transformation for years to come.

Although digital transformation brings significant advantages, its implementation may encounter barriers and challenges. According to the literature (Cichosz et al., 2020; Checchinato et al., 2021; Vogelsang et al., 2019; Matt et al., 2020), the main challenges and barriers to digital transformation can be grouped as follow:

- Human - insufficient digital skills of employees, shortages of IT specialists on the external labor market, internal resistance to change, lack of managers' knowledge about how to accomplish change
- Technological - Technology and digital divides between cities and rural areas and developed and developing nations limit the scaling-up of digitalization, IT security issues, and lack of access to a stable Internet connection.
- Financial - a lack of appropriate financing possibilities and financial resources for the upfront cost of investments in new technologies.
- Organizational - Organizational inflexibility/ unwillingness to change (typified by hard-to-change organizational routines, processes, and traditional ethos of the organization). The business model of the firm is perceived underpinned by face-to-face interactions. Productivity is being undermined by employee stress brought about by the intensification of work.
- Legal - national laws and regulations can create hostile conditions for new technologies adoption,
- Environmental - lack of government support for digitalization, underdeveloped education system or poorly designed education system towards digitalization and limited government skill formation initiative on digitalization, Lack of government investment in infrastructure

3. 2. Nexus between composable enterprise and digital transformation

Digital transformation entails not only embracing digital technologies but also redesigning business procedures to accommodate the rapid development of technology and utilizing applications to continuously improve business processes.

In general, enterprises are hesitant to abandon the solutions they have been using for years for financial reasons (investment in equipment, software, and employee training) and apprehension about new, untested technology. The composable architecture allows enterprises to maximize earlier IT expenditures while also benefiting from the introduction of new solutions by combining existing and new solutions (internal and external) through a layer of a unique composition platform and an integrated data layer.

Although digital transformation is widely regarded as one of the primary drivers of composable enterprise success, its impact is reciprocal. Building a composable enterprise accelerates the digital transformation process in reverse. Precisely, the benefits of developing a composable enterprise overlap with the benefits of digital transformation, which amplifies the effect of digital transformation (Table 1).

Table 1. The bond between digital transformation and composable enterprise

Digital transformation	Composable enterprise
Increasing customer satisfaction	Because traditional barriers between business and IT are removed with a composable enterprise architecture, businesses may provide customers with individualized application experiences.
Driving Data-Based insights	Enterprises can manage and integrate infrastructure components with a single, unified API. It enables a versatile network, which is essential in today's data centers. That allows businesses to leverage massive amounts of data to become more adaptable and resilient.
Enabling software monetization	The composable architecture allows enterprises to maximize earlier IT expenditures while also benefiting from the introduction of new solutions by combining existing and new solutions (internal and external) through a layer of a unique composition platform and an integrated data layer.
Enabling high-quality user experience	The composable organization has the ability to design and test limitless experiences to acquire high-quality user experience because every aspect of its software may be extended and altered to match a range of usages and consumer wants.
Encouraging collaboration and improving communication	Teams in a composable organization rely heavily on integration and cooperation when developing software products. To ensure continuous integration across the board, the company requires a platform that acts as a marketplace for teams to share and discover components, facilitates consumption and integration, and simplifies upgrades and changes.
Increase agility	The rapid delivery provided by autonomous teams in a composable enterprise enables the business to meet its customers' needs and outperform its rivals. With component-driven software, teams can easily divide features into incremental releases that can be sent to production more frequently.
Limiting human error	The application of intelligent software makes a composable infrastructure smarter than conventional infrastructure. A composable system can scan for setup mistakes and find accessible resources. As an added bonus, it suggests ways to address these issues.
Encouraging an environment of employee excellence	Since product teams have extensive industry expertise, they can gain a competitive edge if they are allowed to release frequently without being slowed down by coordinating with other groups.
Increasing operational efficiency	A more adaptable and responsive infrastructure is available for any business. Since resources can be rearranged on the fly, applications and services can be distributed more quickly.
Enabling future digital growth	Scaling up or down is simple because businesses may add or remove resources as needed. The platforms' utilization can be scaled up at the business's desired rate, allowing the underlying infrastructure to keep up with its rapid expansion.

Developing and implementing composable enterprises, like digital transformation, may confront impediments and challenges. The following three issues are related to the composable enterprise and stem from its underlying philosophy (Santiago, 2020; WalkMe, 2023):

- Finding the proper middle ground for an application scope - A packaged application in a modular enterprise must be functionally specified. It's loosely connected, reusable, and self-contained, but the scope of work must be constrained inside

a well-thought-out single business capability. It's easier said than done, but it's basically a mini-app. The packed application may have several APIs and entities but must adhere to 'business capability boundaries.' It can scale dynamically and independently; a single business unit or team maintains a packaged application.

- The barrier in innovation teams - Developers and IT positions within a business unit are becoming more common. Every year, an increasing number of businesses embrace the decentralized structure on the people side by forming an 'innovation team' within their line-of-business teams. That is unquestionably a positive step forward. However, linguistic barriers and user-friendliness issues develop due to internal and external alignment. Outside of the team, developers still rely on technical advice and expertise for enterprise-wide frameworks and best practices. Product managers and other business roles aren't working closely enough with developers to create product functionality and an end-to-end user experience. There is still a significant amount of practice disconnect in this type of team; the extent of disconnect may be judged by the quality of applications produced by the team.
- Managing complexity - A composable enterprise promotes a distributed system design to enable rapid development and faster innovation through decentralization, including software and application stack independence amongst teams. However, the role of lifecycle management has not been diminished — maintain/manage/operate or governance as one of the cycles. Governance is a vital concern for a modular enterprise, which includes interoperability, orchestration, security, and analytics. It is critical to have a visibility platform to handle data interactions amongst packaged apps in real-time and offline.

While composability is not a brand new approach to business and software (architecture) development, its unique viewpoint on how components work together makes composable enterprise design so exciting. It's a novel approach to organizing and integrating its parts (APIs, PBCs) with modern technologies like the cloud, SaaS, iPaaS, and AI. Teams and organizations should keep democratization at the forefront of the project at all times as they move through each stage of the composable business journey. The organization's technological infrastructure is secondary in importance to the overall change. Success requires the interplay of people, culture, and policies. Organizational maturity and adaptability determine the rate of change. The world of consumption is changing at an unprecedented rate, and a genuinely composable organization is one that is ready for disruption, can deliver experiences at the speed of customer demand, and actively leads innovation.

4. Conclusion

Leveraging new technologies to their full potential is more important than ever as businesses anticipate the technical and economic changes that the future may bring. Enterprises can boost their growth rates and introduce innovations to their processes with the help of digital transformation. A comprehensive understanding of the new systems and processes driving new enterprises, including how they interact and what they are capable

of producing, is essential for those who want to take the reins on digital transformation. As a result of digital interaction and analytical decision-making, this change will yield more than just efficiency and reduced processing costs. Creating a digital business model that involves a gradual shift to an inventive activity foundation and an adjustment to the digital ecosystem of business should go hand in hand with any digital transformation.

A two-way link between digital transformation and the composability approach is often considered a company's reaction to digital transformation. Establishing a composable enterprise rests on digital transformation, and vice versa; the latter strongly influences the former.

The paper shows how digital transformation can have a multiplicative effect by combining it with the benefits of creating a composable organization. Thus, it was determined that, given the current state of technology, the best path to a successful digital transformation is the transition to a composable enterprise.

With composability, businesses can build flexible, robust workflows without relying on a small pool of expertise to accommodate change. By allowing for composability in applications, providers can offer consumers the ability to customize apps or services for their unique use cases, and businesses can free up developers to focus on revenue-generating projects rather than retooling their IT infrastructure. Workflows and the technologies that allow them must be flexible enough to quickly adjust to changing business needs.

The advantages of the composable enterprise (PBC, cloud, APIs, SaaS, etc.) also pose the most significant obstacles to its expansion and widespread acceptance. An awareness of the process of establishing PBCs and APIs, as well as mutual understanding between members of fusion teams composed of business context experts and technology experts, may be crucial to the success of developing composable enterprises. It is impossible to definitively establish which level of granularity to use or even how to describe a business capability that should be packaged in PBC without first understanding the characteristics of the business environment. That is the greatest obstacle facing this corporate architecture and a critical factor in determining its future.

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