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Digital transformation as a catalyst for sustainability and open innovation

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A B S T R A C T

The work identifies the main interrelations between digital transformation, open innovation, and sustainability. While the interest of scientific communities in these concepts is growing, there are very few studies on the role of digital transformation in fostering open innovation and sustainability. This research aims to study the conceptual frameworks for digital transformation, open innovation, and sustainability and investigate whether and how digital transformation catalyzes sustainability and open innovation. A three-phase methodology is applied in this research. A literature overview was performed to demonstrate how the concepts and definitions of digital transformation evolved over the years and to create a digital transformation typology. To scope a body of existing literature and identify knowledge gaps, a scoping review was performed to establish underlying principles and conceptual frameworks for digital transformation, open innovation, sustainability, and their interrelations. A qualitative content analysis of the selected literature was conducted to answer the main research question and sub-questions. As a result of the research, the framework of the interrelations between digital transformation, open innovation, and sustainability was developed and confirmed, demonstrating that digital transformation is an enabling and fostering factor for sustainability and open innovation. At the same time, digital transformation may have a negative impact on sustainability, mainly affecting its environmental dimension.

1. Introduction

The importance of digitalization and digital transformation (DT) is an increasingly discussed topic among scientific researchers and practitioners in different fields. While the practitioners are interested in the practical implications and benefits of digital transformation for the business, the scientific world is in search of conceptualization of digital transformation and its interconnection and interrelation with business management, organization, sustainability, open innovation, and other concepts.

DT facilitates the improvement of the existing services, products, and processes and the introduction of new ones (Wu et al., 2021) to meet the fast-changing requirements of the market, thus ensuring sustainable development based on constant innovation (Ulas, 2019; Kim et al., 2021; Sia et al.). With the rapid diffusion of digital technologies, organizations are forced to look for new ways of working (Kraus et al., 2021) and towards the creation of new business models, value chains, and ecosystems (Wu et al., 2021; Ulas, 2019; Kim et al., 2021; Schallmo et al., 2017; Robertsone and Lapiņa, 2022; Prokhin, 2020; Dias et al., 2021; Ahmad et al., 2021) that, in return, adds to new value creation for the customers and consumers through customer involvement (Schallmo et al., 2017; Camarinha-Matos et al., 2019), customization of products and services, and new customer experience (Kopalle et al., 2019).

Digital transformation (DT) can be defined as a disruptive process where organizations change value-creating processes by adopting digital technologies in response to changes in the business environment (Vial, 2019). Digital transformation boosts innovation as it requires the acquisition of new knowledge and skills, calls for new forms of collaboration within the organizations and across industries, promotes the creation of new business models, and leads to the sustainable usage of organizational resources (Mayakova, 2019; Tabrizi et al., 2019; Armengaud et al., 2017). With the cultural and structural changes of the entire organization caused by digital transformation (Kraus et al., 2021; Singh and Hess, 2017; Hinings et al., 2018; Ivančić et al., 2019; Hanelt et al., 2020; Olsen Ti, 2020; Jones et al., 2021; Fischer et al., 2020; Schneider and Kokshagina, 2021), DT also catalyzes further transformations, such as the transformation of governance, HR, and IT functions in organizations (Sia et al.; Mergel et al., 2019; Trivedi and Pillai, 2020).

Innovation, on the other hand, drives changes and makes them a reality. Digital transformation is, by its nature, a fundamental change that completely revises how companies operate, design, develop, produce, sell their products, and provide services (Prokhin, 2020), therefore driven by innovation, making both concepts interrelated and interconnected. Innovation also is a collection of small but impactful ideas for continuous improvements that help the company become more efficient and sustainable. These improvement ideas can be generated inside the organization or borrowed from outside.

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Open innovation – a term first coined by Chesbrough is defined as ". . . the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough and Vanhaverbeke, 2006). In other words, open innovation is a business model of the organization not relying only on innovative internal capabilities but being open to the world in terms of usage of external resources to drive innovation (outside-in innovation processes) and being open to the market with new ideas (inside-out innovation processes) (Kraus et al., 2021).

Digital transformation removes borders and allows suppliers and customers to be integrated into innovation creation (Gassmann et al., 2010), where customers are a valuable source of ideas that might result in innovations (Oganisjana and Kozlovskis, 2019). Several research papers describe how digital transformation makes organizations implement changes in their processes, structure, and strategies to support open innovations (Urbinati et al., 2020; Mu and Wang, 2020), while other research shows that open innovation enhances the sustainability of organizations (Medne, 2019; Jeong et al., 2020) and is a core driver for environmental innovation resulting in a competitive advantage (Skordoulis et al., 2020). However, the current research on the interrelation between open innovation and digital transformations is scarce.

Since the 1970s, when humankind gradually started to understand that the way we exploit our planet is not going to be long-lasting, the issues of sustainability and sustainable development have been receiving significant attention from governmental and business institutions as well as from the scientific community all over the world.

The term "sustainability" originated from ecology, referring to "a state or condition that can be maintained over an indefinite period of time" (Du Pisani, 2006) and is closely related to sustainable development, first mentioned in 1987 Brundtland report "Our Common Future" by the World Commission on Environment and Development, where sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Glossary of summaries - EUR-Lex). The report emphasizes sustainability's social and economic dimensions and links environmental deterioration with indigence. The concept's core idea is balancing economic development with environmental protection and social equality and justice, which would require policy changes and alignment (Dalal-Clayton and Bass, 2002).

The roots of the sustainability concepts can be traced many centuries back in history. However, industrialization, population growth, and scarcity of resources bring out the fear that current and future generations may not be able to satisfy their needs, increasing its importance in modern society. The growing concern is about the impact of organizational activities in pursuing economic viability on the environment and society (Adams et al., 2014)., therefore economic, social, and environmental interests and considerations cannot be treated separately (Curran, 2009; Eizaguirre et al., 2019).

The word "sustainable' was used to describe a balance between ecological and economic stability aiming at satisfying the base needs of all people in a 1972 report called "Limits to growth" (Du Pisani, 2006). From a corporate perspective, sustainability is a balance between many economic, social, and environmental factors affecting the company and its performance that ensures sustainable development (Beltrami et al., 2021). In other studies, sustainability is defined as a philosophy, approach, or practice that guides and drives the development process toward achieving a sustainable level or state. It is also defined as the ability to allocate resources and make responsible decisions to achieve economic, social, and environmental objectives (Ozili, 2022).

In the current research, sustainability is considered the result of sustainable practices that secures the sustainable development of the companies. Sustainability practices, according to Curran (Curran, 2009), "allow for satisfactory outcomes for humans and the environment while fulfilling the social and economic needs of current and future generations.".

Many studies address the issues of sustainable performance and openness to innovation for organizations' growth and continuous development (Wu et al., 2021). Organizational focus on continuous improvement is directly related to its openness to innovation and the ability to develop sustainably (Medne, 2019). To survive and ensure sustainable development, companies and organizations need to improve their products, processes, and organizations continuously, remaining at the same time efficient and effective. When developing new products and services, companies can focus more on sustainable solutions and being environmentally friendly (Dias et al., 2021). Digitalization and digital transformation play crucial roles in these processes. Several studies demonstrate that digital transformation impacts different aspects of sustainable development and can be an enabler for sustainability (Feroz et al., 2021; Hrustek, 2020); however, these impacts require more comprehensive further research.

The main research question of the study is:

RQ: What is the role of digital transformation in fostering open innovation and sustainability?

To conduct the research in a structured way, the authors defined two research sub-questions:

RSQ 1: What are the interrelations between digital transformation and sustainability?

RSQ 2: What are the interrelations between digital transformation and open innovation?

The research design is demonstrated in Fig. 1.

The concepts and definitions of digital transformation were analyzed using a literature overview with the systematic search strategy, followed by a scoping review of the literature to clarify the interrelations between digital transformation, sustainability, and open innovation. Qualitative content analysis with open coding was carried out to confirm the conceptual framework developed based on the scoping review. Their wide application in the research determined the choice of methods. Combining the application of the selected methods, it was possible to develop and confirm the conceptual framework of the interrelation between digital transformation, sustainability, and open innovation.

The paper is organized as follows: after the Introduction, Section 2 describes the methodology chosen for the research. Section 3 presents the literature overview and scoping review results, the concepts identified, and the propositions put forward. Qualitative content analysis results are also presented in Section 3. Sections 4 and 5 present the discussion and conclusions, respectively.

2. Materials and methods

The overview of the literature to conceptualize digital transformation was performed from November 2021 to January 2022 using Scopus and Web of Science citation databases for the search and selection of the literature and Google Scholar as a complementary database. The authors have chosen a systematic search strategy to balance sensitivity and specificity (Bramer et al., 2018), considering the limited timeframe and the specific scope of the research. For the initial search, a combination of the words "digital transformation" mentioned only in the

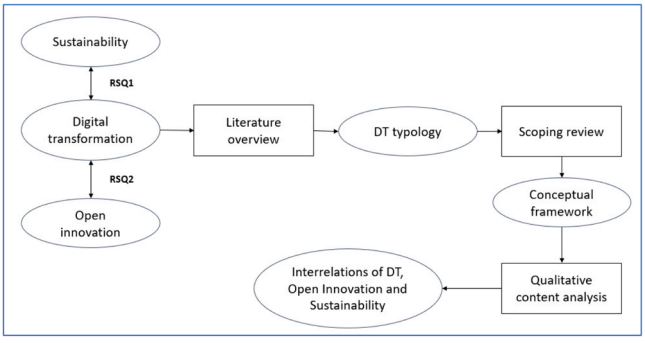


Fig. 1. Research design (created by authors).

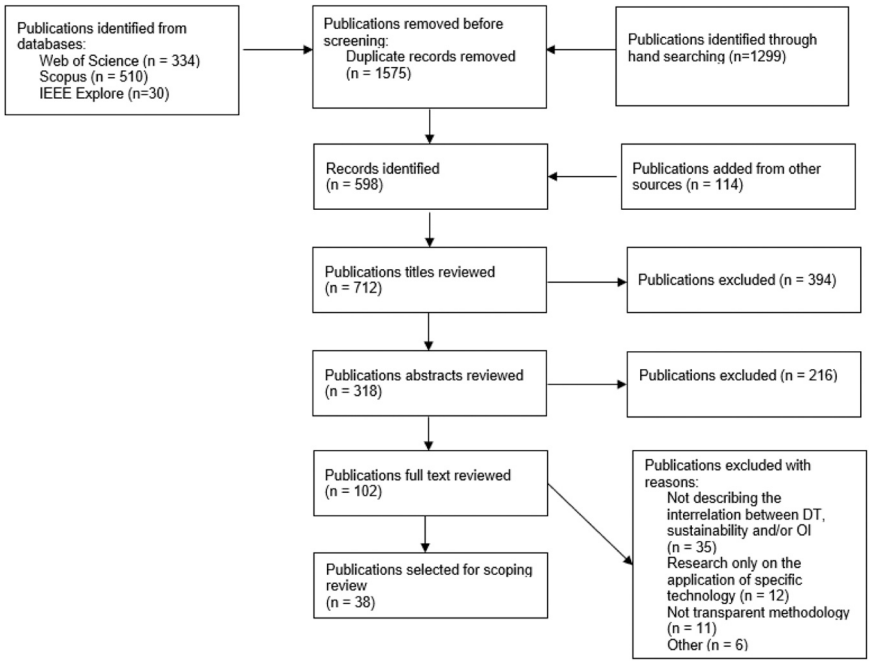


Fig. 2. Literature search, assessment and selection process (created by authors).

publication's name and only scientific articles in English or Russian languages were used.

A total of 54 literature sources were reviewed, and 27 articles containing digital transformation definitions were selected for the detailed analysis. The selection criteria were chosen based on the limited timeframe and considering that the digital transformation phenomenon is studied across several domains, e.g., technological, IT, business, and organizational, as well as in interdisciplinary research. The literature overview aims to define the most comprehensive terminology for explaining digital transformation. For this reason, the authors have chosen not to limit the scope of research by the discipline. The publications' timeframe was not limited to clarifying the first publications where the term "digital transformation" appeared. Then the definitions were classified, and the typology of definitions, together with other research results, are presented in the following sections of this paper.

In the second phase of the study, the authors conducted a scoping review of the literature to determine the relationship between the concepts of digital transformation, open innovation, and sustainability, the scope of the literature, and knowledge gaps. A scoping review is a tool to estimate what is already covered by a body of literature and the volume of studies available and to provide an overview (Munn et al., 2018). The investigation of research conduct can be added to the purpose of these reviews. Scoping reviews also aim at mapping definitions and the topic's conceptual boundaries (Lockwood et al., 2019).

In the third phase, qualitative content analysis with open coding was performed to derive the concepts from the data. Qualitative content analysis is a systematic method to convert text words into less content-related categories (Elo and Kyngäs, 2008).

The initial search for the scoping review was conducted in the selected databases Scopus, Web of Science, and IEEE Explore using the following combination of keywords "'digitalization" OR digitalisation OR “digital transformation” AND “sustainability” OR “open innovation”. Only publications in the English language in scientific journals and conference proceedings from various disciplines were considered. The digital transformation in the current research is reviewed in the context of an organization or enterprise. The authors did not limit the research to any particular study field. The authors have not limited the research to a specific time frame. Additionally, a manual search was performed in the selected journals: Technovation, Technological Forecasting and Social Change, Journal of Product Innovation Management, Innovation: Organization & Management, Journal of Open Innovation, International Journal of Renewable and Sustainable Energy, Sustainability, Energy for Sustainable Development, Agronomy for Sustainable Development, The International Journal of Environmental Sustainability, Sustainability Science.

The literature search, appraisal, and selection were performed from January 2022 to May 2022. The first search resulted in obtaining a total of 2173 publications, most of them being duplicates. After the removal of duplicates, 598 publications were considered for further analysis. The application of the "Berrypicking technique" (Bates, 1989) and the manual search of the works of Henry Chesbrough, Marcel Bogers, and Wim Vanhaverbeke led to the inclusion of 114 additional relevant publications. After the review of the title and abstract, another 610 publications were eliminated as irrelevant - not demonstrating the interrelations of digital transformation and open innovation and sustainability. The full text of the selected publications was analyzed to determine if they either examine the impact of digital transformation on sustainability and open innovation or an interrelation between those concepts.

After the quality assessment, 64 publications were eliminated for reasons: 35 articles were eliminated as not showing the interrelation between these concepts, 11 articles for not having a transparent methodology, 12 articles analyzed the impact of the application of a specific technology, such as Internet of Things or Big Data only, one article was related to the impact of digital transformation on sustainability in the light of COVID-19, and five articles researched digital transformation of the economy of a particular country. This resulted in 38 publications being eligible for a scoping review. Then the chosen articles were assessed for being relevant to the research question and grouped into themes.

The flowchart of the literature search, assessment and selection process is shown in Fig. 2.

After excluding 15 literature reviews, a further 23 articles containing empirical research relevant to the research questions were selected for qualitative content analysis. The qualitative content analysis was performed from June 2022 to October 2022 using NVivo 11 software.

The selected articles were analyzed, and the results were documented. The charting of data was performed using Microsoft 365 Excel

Table 1
Digital transformation typology.

DT perspective	Source	Type
Technological, organizational, and social changes	(Bikse et al., 2021; Jones et al., 2021; Olsen Ti, 2020; Van Veldhoven and Vanthienen, 2021)	Change
The adoption of digital technologies for the benefit of the organization	(Ebert and Duarte, 2018; Lee et al., 2021; Tijan et al., 2021; Westerman et al., 2011; Wu et al., 2021; Deloitte, 2017; OECD, n.d.)	Process
Customer-centric perspective - changes in customer relationships and value proposition	(Singh and Hess, 2017; Mergel et al., 2019; Kruszyńska-Fischbach et al., 2021)	Change
Business-centric perspective - product, process, and organizational change	(Camarinha-Matos et al., 2019; Hinings et al., 2018; Gong and Ribiere, 2020; Bican and Brem, 2020; Liu et al., 2021)	Change
Introduction of new business models	(Ahmad et al., 2021; Gökalp and Martinez, 2021; Kim et al., 2021; Tijan et al., 2021; Verhoef et al., 2019; KPMG, 2018)	Impact
Driver for the creation and operation in ecosystems	(Kim et al., 2021; Ahmad et al., 2021; Kopalle et al., 2019; Verhoef et al., 2019; Subramaniam et al., 2019)	Impact
Cultural and organizational change driven by technology	(Ivančić et al., 2019; Hanelt et al., 2020)	Change

application. The results include general information about the research – authors, study type, country of study, publication year, journal, and specific information related to the research questions, such as concepts, interrelations, and the main findings. Only the studies containing empirical research were selected for the qualitative content analysis. One researcher did the coding; the codes were reviewed and validated by the second researcher.

3. Results

3.1. Literature overview

The research on digital transformation is attracting the scientific community and industry attention, and the interest is growing year by year. The digital transformation topic attracts interest from academia and business across different sectors and industries.

The earliest publication from the Web of Science database where the term "digital transformation" is mentioned in the article's title is a journal article called "Digital Transformations of Time: The Aesthetics of the Internet" by Marlena Corcoran, dated 1996. The article describes DT in light of the interrelations between art and technology. The new technologies are transforming the esthetics of human perception of art, and experiencing art means not only enjoying a piece of artwork but also an action in time, a process itself where the attention is shifted to digital art activities from digital art objects (Corcoran, 1996).

The first publication in Scopus that mentions digital transformation as a transformation of an entire industry is "The digital transformation of health care" by Coile RC Jr, published in Physician Executive journal in 2000. In the article, the author sees digital transformation as a re-invention of the health industry and the provision of healthcare services enhanced by the Internet (Coile, 2000).

The first book describing the concept of digital transformation is "Digital transformation: the essentials of e-Business leadership" by Patel and Mccarthy, published by McGraw-Hill in 2000 (Trivedi and Pillai, 2020). However, the above publications do not offer a distinct definition of digital transformation. Among 54 reviewed information sources, 23 publications from 20 scientific peer-reviewed journals containing digital transformation definitions were selected for the detailed examination.

From the selected literature, the authors have collected the definitions of the term "digital transformation," shown in Table A1 in Appendix A.

Analyzing the definitions, it can be conjectured that digital transformation is viewed from different perspectives. The first definitions focus on the technological side, the adoption of digital technology to replace manual processes with digital ones, and the upgrade of technology (Westerman et al., 2011; Deloitte, 2017). It is also an innovation that changes the existing rules and structures (Hinings et al., 2018).

Some authors classify DT as a technological, organizational, and social change (Olsen Ti, 2020; Bikse et al., 2021). Van Veldhoven and Vanthienen (2021) proposed a digital transformation framework where DT was seen "as an interaction-driven perspective between business, society, and technology". Some researchers argue that DT is more related to the adoption of digital technology for organizational benefits (Hanelt et al., 2020), such as the creation of digital culture (Ivančić et al., 2019; Olsen Ti, 2020), increasing productivity and social welfare (Ebert and Duarte, 2018), or as a tool to create more value for companies (Verhoef et al., 2019). Other researchers see digital transformation as a continuous process (guided by innovation) of transformation of strategy, internal processes, and mindsets enabled by technologies (Jones et al., 2021; Liu et al., 2021) to improve a company's value proposition (Gong and Ribiere, 2020).

Digital transformation can also be viewed as a customer-centric change in the way how the value is delivered to the customer (Singh and Hess, 2017; Kruszyńska-Fischbach et al., 2021) or how their needs are identified and satisfied (Mergel et al., 2019); or a business-centric transformation of the organization, product, services, and business processes to meet fast-changing market requirements (Camarinha-Matos et al., 2019). Digital transformation also drives the creation and introduction of new business models (Kim et al., 2021; Ahmad et al., 2021; Bikse et al., 2021; Lee et al., 2021) and operations in ecosystems (Robertsone and Lapiņa, 2022; Kopalle et al., 2019). The authors have defined three digital transformation perspectives – impact, change, and the process. The typology of digital transformation is shown in Table 1.

Digital transformation driven by innovations (Hinings et al., 2018; Gong and Ribiere, 2020; Liu et al., 2021) triggers and catalyzes further innovations resulting in new organizational structures, services, processes, operating and business models (Ahmad et al., 2021; Camarinha-Matos et al., 2019; Gökalp and Martinez, 2021; Kim et al., 2021; Mergel et al., 2019; Tijan et al., 2021; Verhoef et al., 2019; KPMG, 2018). Digital transformation is seen as a holistic approach and interaction of technological, organizational, and human (society) elements (Bikse et al., 2021; Van Veldhoven and Vanthienen, 2021). However, although the existing literature on digital transformation considers its impact on sustainability, DT's contribution to sustainability and sustainable development is vaguely reflected in the definitions found, mainly in terms of economic sustainability impacting factors, like performance improvement and increase of productivity (Westerman et al., 2011; Ebert and Duarte, 2018). Only a few authors see digital transformation as an improvement of social welfare (Ebert and Duarte, 2018), the creation of new competencies (Olsen Ti, 2020), or the strategic leverage of key resources and capabilities (Gong and Ribiere, 2020).

Following the evolution of DT definitions, the focus was on adapting digital technologies for performance improvement and business transformation. From 2020, digital transformation is considered a fundamental change enabled by digital technologies that impacts and

Table 2
The number of publications by journal and year.

Journal	2019	2020	2021	2022	Total
2018 Proceedings of PICMET '18: Technology Management for Interconnected World	1				**1**
2020 IEEE 18th International Symposium on Intelligent Systems and Informatics (SISY)		1			**1**
2020 IEEE 22nd Conference on Business Informatics (CBI)		1			**1**
Amfiteatru Economic				1	**1**
Brazilian Journal of Operations & Production Management	1				**1**
British Food Journal				1	**1**
Business Strategy and the Environment			1		**1**
Entrepreneurship and Sustainability Issues		1	1		**2**
Innovation Organization & Management			1		**1**
International Journal of Innovation Science		1			**1**
IOP Conference Series: Earth and Environmental Science		1		1	**2**
Journal of Cleaner Production			2		**2**
Journal of Engineering and Technology Management				1	**1**
Journal of Open Innovation			2		**2**
Proceedings of the International Conference on Business Excellence	1				**1**
Public Management Review		1			**1**
SAGE Open			1		**1**
Smart and Sustainable Built Environment			1		**1**
Sustainability	1	3	5	1	**10**
Sustainable Production and Consumption				1	**1**
Technological Forecasting & Social Change			3	2	**5**
TOTAL	**4**	**9**	**17**	**8**	**38**

transforms whole organizations, business models, industries, and society. Digital transformation is undoubtedly based on and supported by adopting digital technologies and replacing manual processes with digital ones, further integrating customers, suppliers, and other stakeholders in the business processes, building new ecosystems and creating shared value. However, it is about more than just technology. The core idea of digital transformation is the change of culture and the mindset of people.

3.2. Scoping review

An analysis of the selected publication for the scoping review on an annual basis shows that the publications cover a period of four years, even though there was no time limitation set during the search process. The majority of the papers (n = 17) are dated 2021. The papers were sorted by the journals in which they were published. Table 2 demonstrates that the papers were published in 21 journals, the majority in journals Sustainability (n = 10) and Technological Forecasting & Social Change (n = 5).

The geographical distribution of the publications is shown in Fig. 3, demonstrating that the countries with the highest number of articles are Italy (n = 6) and Germany (n = 3).

The classification of methodology represented in Fig. 4 indicates that most studies (n = 10) were conceptual, followed by modeling (n = 6), secondary data analysis (n = 6), and survey (n = 5) as a method. Focus group discussion (n = 3), multiple case studies (n = 3), interviews (n = 2), simulation (n = 1), exploratory research (n = 1), and case study (n = 1) are also represented.

The selected publications represent various industries and sectors, as shown in Fig. 5. The "No specific" category contains literature reviews and empirical studies unrelated to any particular industry.

Among the selected publications, 63 % (n = 24) is the research related to digital transformation and sustainability interrelations, 24 % (n = 9) related to DT and open innovation relations, and only 13 % (n = 5) publications contain research on the interrelations between digital transformation, open innovation, and sustainability. The authors have also concluded that there is a minimal number of studies on the negative impact of digital transformation on sustainability.

After the analysis of the selected publications, the following relations have emerged (Table 3): in the majority of research (n = 26), digital transformation is identified as an enabler for sustainability, DT as an enabler of open innovation was recognized in seven research; also, in seven studies DT was identified as an open innovation driver. Open innovation being a driver for digital transformation, is represented in six research. At the same time, six research identify sustainability as a driving force for digital transformation.

According to Hajishirzi et al. (2022), digital transformation boosts sustainability in all three dimensions - economic, social, and environmental- through data-driven innovations that significantly impact customer engagement, resulting in an increased competitive advantage. Competitive advantage has a more significant positive impact on economic sustainability than social and environmental sustainability.

In the work of Yalina and Rozas (2020), digital transformation is viewed through a prism of the digital workplace, reshaping ways of working and changing mindsets for the benefit of environmental sustainability. However, there are also challenges for the organizations and employees - instability, unclarity of rights and obligations for employees and the organization as an employer, difficulties in disengaging from work, health issues, and social engagement problems.

Research by Ng and Ghobakhloo (2020) reveals that DT, in the context of Industry 4.0, positively impacts energy sustainability through the digitalization of the whole value chain, from suppliers to manufacturers to end customers. Technology is the driver for digital innovation through digital business models that, in return, contribute to digital transformation and digital entrepreneurship, thus ensuring continuous improvement (Bican and Brem, 2020). Digital transformation is fostered by external collaboration and influenced by the organization. DT contributes to the development of new business models based on open innovations, collaboration (Sraml Gonzalez and Gulbrandsen, 2021), and open-source digital platforms (Fukawa et al., 2021), with digital technologies being an enabling factor (Rocha et al., 2022).

Based on the scoping review, the authors put forward the following propositions:

P1: Digital transformation enables sustainability.
P2: Digital transformation drives open innovation.
P3: Digital transformation enables open innovation.
P4: Open innovation drives digital transformation.
P5: Sustainability drives digital transformation.
P6: Open innovation has a positive impact on sustainability.

Enablers are the factors that make things possible (Enabler. n.d.) and aid and support the processes once they are started. They are influencing but not determinant factors (OECD, 2009). Drivers are internal or external factors that motivate action (Khan, 2019), triggering

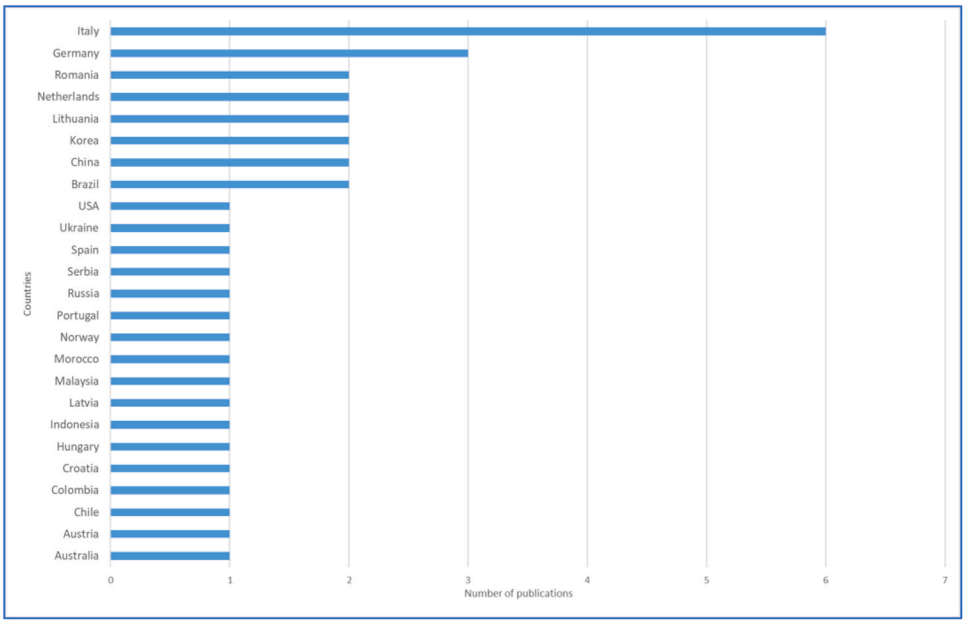


Fig. 3. The number of publications per country.

and shaping changes to the processes, organizations, or industries (OECD, 2009).

The need to sustain and develop makes companies continuously improve and innovate. In the current uncertain and ever-changing world, the traditional way of closed innovations is no longer an option. Fierce competition, increasing costs, and technological advancement force companies to look for collaboration outside the organizational boundaries (Kasperovica and Lace, 2021).

Qualitative content analysis with open coding was performed in the next step for the selected literature sources.

3.3. Literature content analysis

In the qualitative content analysis, 533 codes were derived from 23 scientific articles grouped into categories and themes. The themes related to the main theoretical framework and the frequencies are represented in Fig. 6.

The main findings of the qualitative content analysis of the selected literature sources are that digital transformation is an enabling and fostering factor for sustainability and open innovation. Digital transformation's contribution to economic and environmental sustainability is much more significant than social sustainability. This can be explained by the fact that the main drivers for digital transformation are consumers' needs and expectations (Camodeca and Almici, 2021; Kim et al., 2021; Llopis-Albert et al., 2021; Pînzaru et al., 2019) and competition (Farías and Cancino, 2021; Pînzaru et al., 2022; Rocha et al., 2022). The end consumers expectations, who are interested in a better and more personalized experience (Chu et al., 2019), are the main driver for the transformation of companies worldwide. The implementation of digital technologies ensures that experience. Consumers are also aware of products' environmental impact (Denicolai et al., 2021), therefore they are interested in sustainable purchasing and consumption, and ready to pay more for ethical products and organic labels (Bulovic and Čovic, 2019).

Digital transformation contributes to increasing material and resource efficiency, including energy resources (Beier et al., 2022), positively impacting economic and environmental sustainability. DT helps to increase the efficiency of operations and production (Ng and Ghobakhloo, 2020; Andriushchenko et al., 2020), reduce costs (Pînzaru et al., 2022; Rocha et al., 2022), increase productivity (Camodeca and

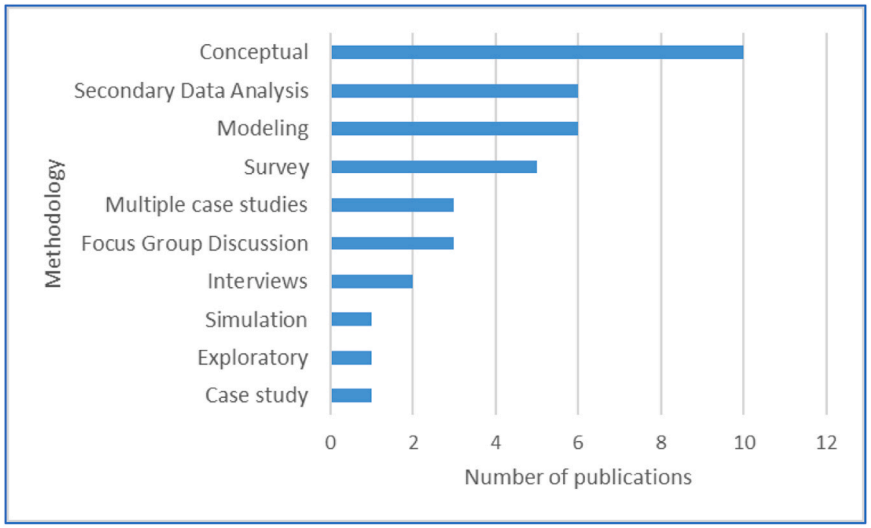


Fig. 4. The number of publications per methodology.

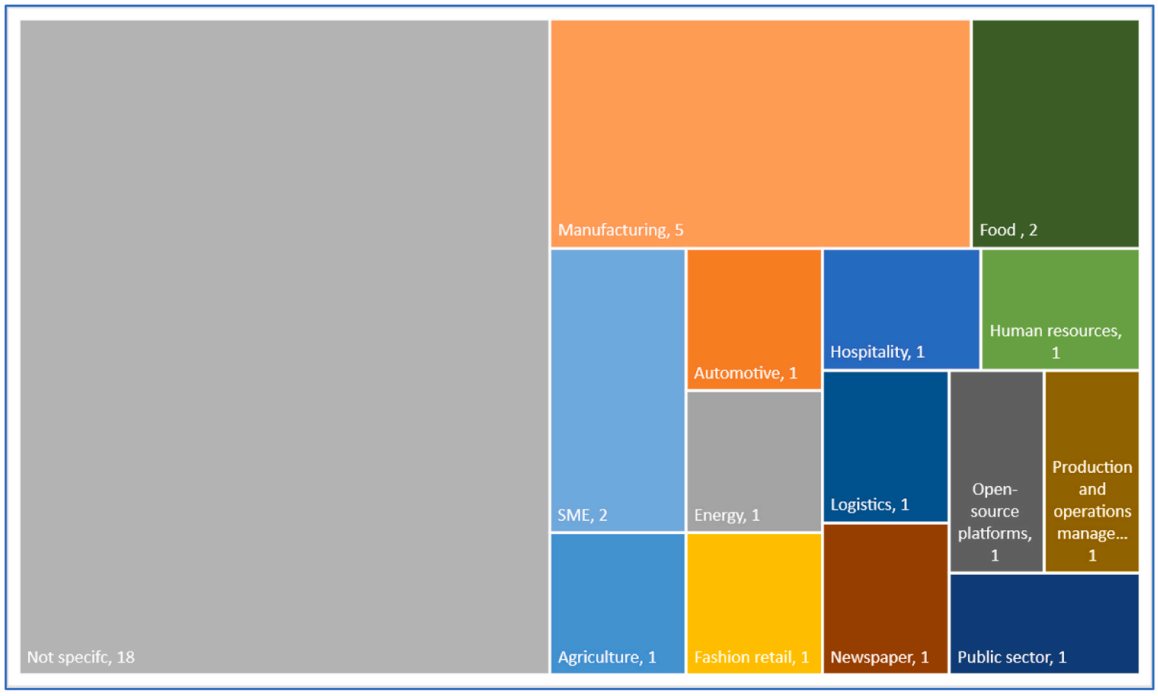


Fig. 5. The number of publications per industry or sector.

Almici, 2021; Denicolai et al., 2021), and improve the quality of products and services (Farías and Cancino, 2021; Ng and Ghobakhloo, 2020) as well as the speed and efficiency of new product development (Kasperovica and Lace, 2021; Chu et al., 2019).

Digital transformation, with its enabling technologies, aids companies in matching supply and demand and preventing surplus production (de Souza et al., 2021; Beier et al., 2022). Digital transformation increases the competitive advantage of companies by innovating their processes, products, services, and business models (Camodeca and Almici, 2021; Hajishirzi et al., 2022; Beier et al., 2022).

DT also facilitates collaboration and improves communication with customers, suppliers, and other stakeholders (Piccarozzi et al., 2022) and their integration into company activities, allowing them to communicate with each other and co-create value, thus contributing to business sustainability and enabling open innovation (Camodeca and Almici, 2021; Denicolai et al., 2021; Chu et al., 2019). Improved risk management, transparency, reputation, and overall company performance are other sustainability-enabling factors – the results of digital transformation (Pînzaru et al., 2022).

The other benefits are improved knowledge and skills of employees, making them more resilient to the changes in the labor market (Andriushchenko et al., 2020). Big Data, artificial intelligence (AI), and prescriptive and predictive analytics facilitate better decision-making (Camodeca and Almici, 2021; Denicolai et al., 2021; Kasperovica and Lace, 2021), allowing companies to react faster to changes and challenges (Chu et al., 2019), thus building resilience, a better understanding of customer needs (Pînzaru et al., 2022), enhances innovation (Chu et al., 2019), and support social and environmental management of the companies (Beier et al., 2022).

The previous research also emphasizes the role of technology and digital transformation in achieving Sustainable Development Goals (SDGs) (Camodeca and Almici, 2021). Digital transformation and digital technologies play an increasingly significant role in reaching environmental sustainability, starting from efficient use of resources (Bulovic and Čovic, 2019; Yalina and Rozas, 2020), integration of renewable energy from manufacturing (Beier et al., 2022), the introduction of circular manufacturing processes leading to a circular economy, sustainable consumption and production models (Camodeca and Almici, 2021; Pînzaru et al., 2019), reducing waste and emissions (de Souza et al., 2021; Ng and Ghobakhloo, 2020), preventing surplus production and using transportation modes more efficiently (Beier et al., 2022). AI and IoT technologies are widely used for supply chain

Table 3
The relationships identified in the research.

Relationship	Frequency	Sources
Digital transformation is an enabler of sustainability	26	(Beier et al., 2022; Beltrami et al., 2021; Bican and Brem, 2020; Camodeca and Almici, 2021; de Souza et al., 2021; Denicolai et al., 2021; El Hilali et al., 2020; Esses et al., 2021; Farías and Cancino, 2021; Felsberger and Reiner, 2020; Feroz et al., 2021; Ghobakhloo et al., 2021a, 2021b; Gomez-Trujillo and Gonzalez-Perez, 2021; Hajishirzi et al., 2022; Hrustek, 2020; Junge, 2019; Kasperovica and Lace, 2021; Ng and Ghobakhloo, 2020; Piccarozzi et al., 2022; Pînzaru et al., 2019, 2022; Schiavone et al., 2022; Yalina and Rozas, 2020; Bulovic and Čovic, 2019; Gils and van, Weigand, 2020)
Digital transformation is a driver of open innovation	7	(Bican and Brem, 2020; de Souza et al., 2021; Feroz et al., 2021; Fukawa et al., 2021; Kim et al., 2021; Rocha et al., 2022; Sraml Gonzalez and Gulbrandsen, 2021)
Digital transformation is an enabler of open innovation	7	(Kraus et al., 2021; Mu and Wang, 2020; Ghobakhloo et al., 2021b; Didenko et al., 2021; Mahdad et al., 2022; Chu et al., 2019; Andriushchenko et al., 2020)
Open innovation is a driver of digital transformation	6	(Kraus et al., 2021; Bican and Brem, 2020; El Hilali et al., 2020; Kasperovica and Lace, 2021; Rocha et al., 2022; Fukawa et al., 2021)
Sustainability is a driver of digital transformation	6	(Beltrami et al., 2021; Gomez-Trujillo and Gonzalez-Perez, 2021; Llopis-Albert et al., 2021; Piccarozzi et al., 2022; Pînzaru et al., 2022; Lammers et al., 2018)

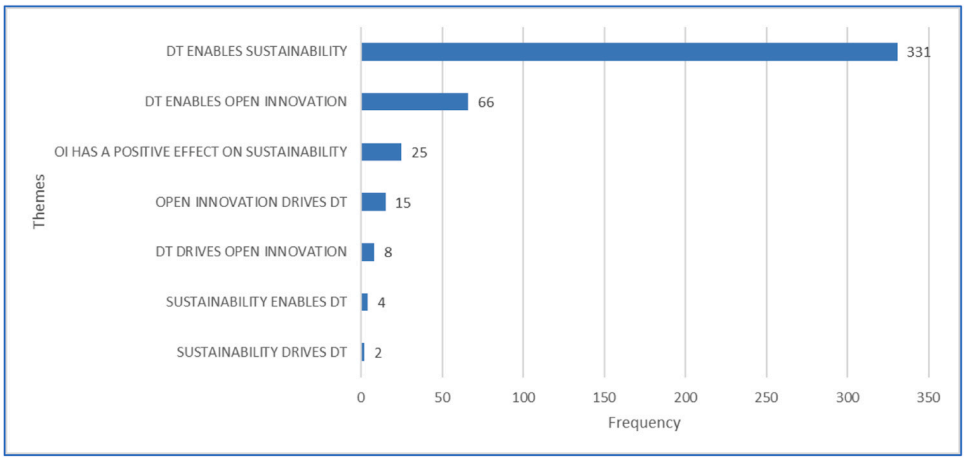


Fig. 6. The themes related to the main theoretical framework.

optimization (de Souza et al., 2021). Simulation and modeling technologies are used to improve environmental performance (Beier et al., 2022). AI is also employed for energy usage optimization (Denicolai et al., 2021). IoT, Big Data, cloud and mobile technologies, and social networking are transforming traditional approaches to environmental management (Pînzaru et al., 2022).

In terms of social sustainability, digital transformation contribution is only evolving, and the research on DT's impact on social sustainability is insufficient. Digital transformation improves employees' well-being by allowing them to have good working conditions (Farías and Cancino, 2021), maintain work-life balance, and improve their performance, positively impacting employees' satisfaction and loyalty (Yalina and Rozas, 2020; Pînzaru et al., 2022). By supporting employees' well-being and enhancing environmental performance, digital transformation significantly impacts communities' economic and social development (Farías and Cancino, 2021). Digital transformation helps to reduce inequality and discrimination, ensures accessibility of services, such as public services, health, and education (Camodeca and Almici, 2021; Didenko et al., 2021), and generally improves the quality of life (Andriushchenko et al., 2020).

However, despite the many benefits digital transformation brings to organizations and society, the research also demonstrates its negative impact on sustainability. Concerns about high energy consumption caused by certain digital technologies, large carbon footprint, limited recycling opportunities, and e-waste (Camodeca and Almici, 2021; Denicolai et al., 2021; Yalina and Rozas, 2020) require more research and attention. Some scholars are unified in the opinion that digital technologies may have a mixed impact on environmental and social sustainability (Pînzaru et al., 2022; Andriushchenko et al., 2020) and that the relationship between digital transformation and sustainability is unclear (Camodeca and Almici, 2021; Esses et al., 2021).

Digital divide (Kim et al., 2021; Denicolai et al., 2021), dependence on digital systems (Llopis-Albert et al., 2021), issues concerning cybersecurity and privacy, internet addiction, and information manipulation (Camodeca and Almici, 2021) may hinder economic and social development. The emergence of new business models and market participants caused by digital transformation threatens the sustainability of incumbent companies and their business practices (Sraml Gonzalez and Gulbrandsen, 2021).

Digital transformation is also an enabler for open innovation, supporting and promoting strategic collaborations with suppliers, customers, and external partners (Chu et al., 2019; Andriushchenko et al., 2020), and their integration (Denicolai et al., 2021), creation of new complementary technologies, products, and services (Fukawa et al., 2021), accessibility and development of new markets together with partners (Denicolai et al., 2021; Farías and Cancino, 2021; Kasperovica and Lace, 2021) allowing distribution of product via different channels (Bulovic and Čovic, 2019) and realization of new marketing strategies (Chu et al., 2019).

At the same time, digital transformation drives open innovation by driving the international expansion of companies (Denicolai et al., 2021), expanding the range of commercialization of research and development (Didenko et al., 2021), and pushing innovations out of company boundaries into collaborative networks (Rocha et al., 2022) through Industry 4.0 technologies (Fukawa et al., 2021). The lack of internal digital capacities forces companies to look for them outside and bring them in, collaborate with external organizations, and recruit specialists from outside companies with the necessary knowledge and skills (Rocha et al., 2022).

In turn, in the reviewed literature, the authors have found confirmation of open innovation driving digital transformation. First of all, the collaboration with external partners fosters the creation of new digital collaboration tools like digital platforms (Fukawa et al., 2021) and other digital solutions, digital discoveries, and digital innovations (Rocha et al., 2022) that, in turn, drive digital transformation (Camodeca and Almici, 2021; Andriushchenko et al., 2020). Intellectual potential and IT capabilities obtained by companies as a part of the open innovation process (Rocha et al., 2022) are the core drivers of digital transformation (Chu et al., 2019; Andriushchenko et al., 2020).

The current study also demonstrates the positive effect open innovation has on sustainability. Although the initial aim of the research was to investigate the impact of digital transformation on open innovation and sustainability, and the interrelations of open innovation and sustainability were not in the scope, the authors consider these are important findings. Open innovation undoubtedly improves the competitive advantage of the companies by enhancing their capabilities, boosting innovation (Bulovic and Čovic, 2019; Mahdad et al., 2022), which is one of the key sustainability drivers (El Hilali et al., 2020), contributing to market growth and increasing the attractiveness of the products as the consumers compliment from larger users and producers networks (Fukawa et al., 2021). Open innovation strengthens company sustainability efforts involving stakeholders in environmental activities of the companies (El Hilali et al., 2020), adopting new business models, increasing opportunities entering new markets, and allowing risk- and resource-sharing (Mahdad et al., 2022). Collaboration and partnership also allow data-sharing, resulting in economic and social gains (Kasperovica and Lace, 2021).

Although the concept of sustainability being a digital transformation driver was formed during the scoping review, very little evidence (n = 2) was found during the qualitative content analysis of empirical studies. The research of (Pînzaru et al., 2022) states that sustainability drives digital transformation and contributes to forming new digital business models. In particular, internal sustainability factors such as culture, continuous improvement, business development trends, and

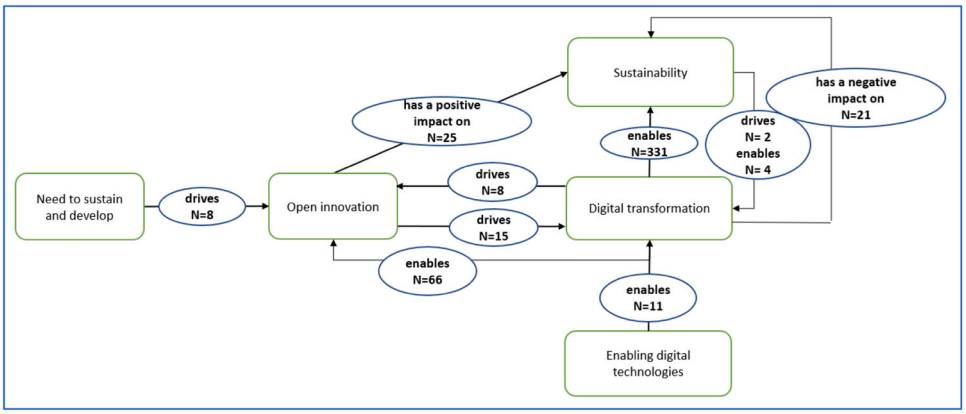


Fig. 7. Conceptual framework of the interrelated elements supported by qualitative content analysis.

the assessment of current business models greatly influence digital transformation, supplemented by external factors such as regulatory compliance, business partners' expectations, and competition. The authors also found that some scholars see sustainability as a digital transformation enabler (n = 4), especially for companies where the digital business is not a core one (Denicolai et al., 2021). The other research states that the extent of digital transformation depends on the level of economic and social development (Esses et al., 2021).

Based on the scoping review, the propositions, and the results of qualitative content analysis, the authors propose the following conceptual framework shown in Fig. 7 that summarizes the main theoretical constructs.

Qualitative content analysis results also confirm (n = 11) that digital tools and technologies play an enabling role in digital transformation.

Within this study, the authors have identified additional open innovation, sustainability, and digital transformation drivers, shown in Table 4.

As it can be seen, competition is the driver for all three concepts. Contrary to other research where legislation is one of the critical drivers for sustainability and the adoption of sustainable practices (Kim and Lee, 2014; Lozano, 2013), the legislation in current research is the driver for digital transformation while not being among sustainability drivers.

4. Discussion

As a result of the literature overview, digital transformation is defined as a continuous process enabled by digital technologies and leading to certain changes and improvements; a change by itself transforming the whole organization and the ways a value is created and delivered, or an impact resulting in the creation of new business models and operation in ecosystems. The authors have defined three digital transformation perspectives – impact, change, and the process as shown in Table 1. The suggested typology is in line with the previous research, stating: "In general, "digital transformation" is used as a term to describe the process, impact, and change in the use of new digital technologies" (Karekla et al., 2021).

In today's rapidly changing operational environment, to survive and ensure sustainable development, companies and organizations should be more agile in responding to customer needs; they need to continuously increase their efficiency, improve quality, apply innovative technologies and solutions, improve their processes and organizational culture, develop existing products and services and offer new ones to the market, that is, to innovate. Closed innovation is no longer an option, as under this model, the development of research projects is limited by the organization's knowledge base. Internal decisions can stop some potentially successful projects. The research projects can enter an organization via the internal knowledge base and exit to the market only. On the contrary, open innovation allows research projects to enter and exist in many different ways using different channels, making using internal and external knowledge in the organization more efficacious (Chesbrough, 2012).

Open innovation accelerates the launch of new products and services to the market and creates new commercial opportunities utilizing the knowledge exchange between the parties (Enkel et al., 2009). Organizations need external knowledge and resources to create ideas. To get this knowledge and resources, organizations share their ideas via digital platforms (Fukawa et al., 2021) and other technologies that power the creation of new digital ecosystems (Jeong et al., 2020). Organizations require digital platforms and data processing services to build data capabilities (Camodeca and Almici, 2021). The interdependencies of the parties within the ecosystem form the basis of the organization's business model.

Open innovation fosters the development of new technologies for collaboration (Didenko et al., 2021) that, in return, enable digital transformation (Chu et al., 2019; Ebert and Duarte, 2018; Ivančić et al., 2019; Pînzaru et al., 2019; Prokhin, 2020; Robertsone and Lapiņa, 2022). As previous studies show, these innovations also have a positive impact on sustainability (El Hilali et al., 2020), which is in line with the works of Swan and Solow, who each individually contributed to the

Table 4
Drivers of open innovation, sustainability, and digital transformation.

Category	Frequency	Category	Frequency	Category	Frequency
OPEN INNOVATION DRIVERS	11	SUSTAINABILITY DRIVERS	13	DIGITAL TRANSFORMATION DRIVERS	26
Competition	1	Continuous improvement	1	Data	1
Dissemination of new knowledge	2	Employees expectations	1	Innovation	1
Need to sustain and develop	8	Consumers expectations	6	Competition	6
		Other stakeholders' expectations	1	Consumer expectations	10
		Competition	3	Legislation	3
		Resource scarcity	1	New challenges	4
				Other stakeholders' expectations	1

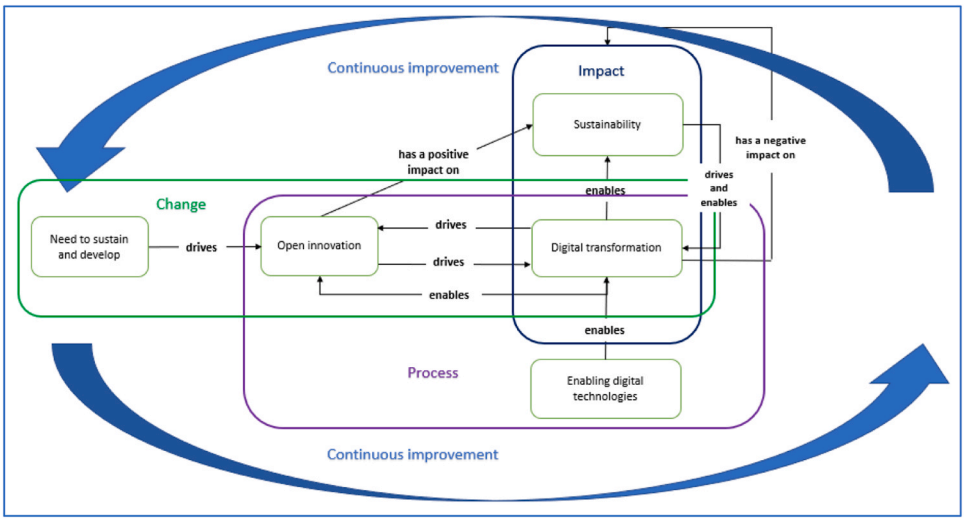


Fig. 8. The interrelation between Digital Transformation, Sustainability, and Open Innovation.

development of an economic growth model that forms the foundation of neoclassical growth theory stating that technology is one of three driving forces for long-run growth (Dimand and Spencer, 2009). However, not all companies can benefit from open innovation, as suggested in the research by Fukawa et al. (2021).

In response to the challenges the companies are facing, they implement digital innovations (Pînzaru et al., 2019), leading to the digital transformation that changes all aspects of the organization resulting in the development of new products, services, systems, platforms, and business models that, in return boosts innovation further (Robertsone and Lapiņa, 2022). Open innovation is needed to align the requirements of different business models and to get and share knowledge (Didenko et al., 2021) for value creation meeting new requirements of customers, stakeholders, and producers (Hrustek, 2020).

The digital transformation itself is the result of technological innovations (Bican and Brem, 2020) fostering the sustainable development of organizations (Beltrami et al., 2021; Hinings et al., 2018) yet at the same time being pushed by it (Bulovic and Čovic, 2019). Although some previous research shows that sustainability may serve as a digital transformation driver (Pînzaru et al., 2022) or enabler (Denicolai et al., 2021; Esses et al., 2021), such shreds of evidence are still being determined, and more research is needed on the impact of sustainability on digital transformation.

Digital transformation contributes to achieving Sustainable Development Goals (Camodeca and Almici, 2021). Previous studies identified the positive impact of digital transformation on all three pillars of sustainability; however, it is more evident in evaluating sustainability's economic and environmental aspects (Ghobakhloo et al., 2021a; Piccarozzi et al., 2022). Digital transformation has many benefits for the organization, thus increasing competitive advantage that has a significant positive impact on economic sustainability (Robertsone and Lapiņa, 2022; Bulovic and Čovic, 2019)., although another researcher argues that “competition is not a driver to reach sustainability during digital transformation” (El Hilali et al., 2020).

Energy sustainability is ensured by deploying renewable energy in production, reducing carbon emissions, more efficient energy usage, data processing for effective decision-making, and developing new business models (Ng and Ghobakhloo, 2020). Environmental sustainability through digital transformation is ensured by resource consumption improvement and material efficiency (Beltrami et al., 2021). During a digital transformation, customer-centricity, data, and innovation are the key drivers of sustainability.

Open innovation contributes to reaching sustainability through customer involvement (El Hilali et al., 2020). Technology-driven innovations are critical determinants of economic growth toward sustainability (Bican and Brem, 2020). The technologies that enable digital transformation have a different impact on sustainability; some technologies, like additive manufacturing, contribute to economic and environmental sustainability by reducing time to market leading to customer satisfaction, offering lighter-weight products, and minimizing resource consumption and waste, thus ensuring environmental sustainability (Ghobakhloo et al., 2021a). On the other hand, some technologies require high energy consumption, produce a carbon footprint, and have limitations in terms of recycling (Camodeca and Almici, 2021; Denicolai et al., 2021). Although technology is an enabler of digital transformation and is a common element in all DT concepts and frameworks, the authors conclude that digital transformation is not only about the adoption of digital technologies but more about embracing change affecting all aspects of business, organization, and society, strategy and culture, value proposition, customers involvement, resulting in the development of new operating and business models. New business models further foster digitalization and transformation by maximizing innovation and effectiveness (Tijan et al., 2021).

Digital transformation as a process enables sustainability. DT enables and drives open innovation. DT is also a change needed for organizations to sustain and develop. DT leads to introducing new business models and operating in new ecosystems – the impact leading to sustainability and further driving open innovation. The interrelation between digital transformation and its three perspectives, sustainability, and open innovation, is represented in Fig. 8.

As the current research shows, digital transformation is the driving and enabling force for open innovation and an enabler for sustainability. This is in line with the previous research stating that digital transformation can be a tool for creating sustainability and contributing to achieving SDGs (Camodeca and Almici, 2021). Lack of internal digital capabilities drives companies to look for these capabilities and collaborate outside-in (Rocha et al., 2022; Andriushchenko et al., 2020), creating the necessary infrastructure, like digital platforms and sharing resources (Didenko et al., 2021; Chu et al., 2019). Open innovation practices like alliances between companies, collaboration with universities, and even coopetition drive digital transformation further, offering new ways to create and deliver value (Fukawa et al., 2021). To survive and develop sustainably, organizations must continuously improve through innovations that drive digital transformation and fosters the development of new digital tools, technologies, and platforms. However, the negative impact of digital transformation on sustainability shall not be forgotten. More research and attention need to be put in this direction.

5. Conclusions

In the first part of the research, the typology of digital transformation was created. In the second part of the research, the authors have identified the main themes of the research on the interrelation of digital transformation, open innovation, and sustainability. In the third part, the theoretical propositions were confirmed by the results of qualitative content analysis.

To be sustainable, companies must constantly improve their performance, efficiency, and productivity and offer their customers new products, services, and experiences. In other words, they need to innovate. Digital transformation is an innovation that adopts digital technologies to completely change how companies operate, satisfy their stakeholders, and deliver value and social welfare. Digital transformation is seen as a process, a change, and an impact.

Digital transformation positively impacts the economic development of companies and societies through more efficient usage of resources and elimination of waste, offering opportunities to simplify and optimize business processes, thus lowering costs. DT contributes to developing new business models and ecosystems, including circular economy and cross-industry collaboration, allowing companies to respond faster to the demands of constantly changing market needs, increasing income generation, adding value to the economy, and fostering the development of innovation culture.

Digital technologies play a crucial role in improving companies' environmental and social performance, working conditions, employees' well-being and satisfaction, and quality of life in general. Digital solutions for energy efficiency monitoring, economical and efficient usage of water and other resources, and the development of new manufacturing methods and materials based on advanced technologies that are more environmentally friendly are just a few examples of the digital transformation potential toward environmental sustainability.

In the social sphere, digital transformation presents multiple opportunities to increase the affordability and accessibility of many services for broader population segments regardless of their location and social status and at much lower costs, e.g., education, public and health services.

Digital transformation, with its enabling technologies, offers an array of opportunities for sustainable practices leading to sustainable development, open innovation, and a much better future for us, humans, and our planet.

CRediT authorship contribution statement

Galina Robertsone: Conceptualization, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Visualization. **Inga Lapiņa:** Methodology, Validation, Resources, Supervision, Project administration, Writing - review & editing.

Institutional Review Board Statement

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Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

Appendix A

See Appendix Table A1.

Table A1
Digital transformation definitions.

Year	Definition	Source
2011	“Digital transformation (DT) – the use of technology to radically improve performance or reach of enterprises.”	(Westerman et al., 2011)
2017	“The digital transformation now underway will remove the organizational silos by bundling all digital activities together and transforming the whole organization to become a more customer-centric, digitally savvy enterprise.”	(Singh and Hess, 2017)
2017	“For the rest of us, digital transformation refers to the adoption of digital technology to transform services or businesses. This is achieved by replacing manual (non-digital) processes with digital ones or replacing outdated digital technology with upgraded digital technology.”	(Deloitte, 2017)
2018	“…the combined effects of several digital innovations bringing about novel actors (and actor constellations), structures, practices, values, and beliefs that change, threaten, replace or complement existing rules of the game within organizations and fields.”	(Hinings et al., 2018)
2018	"Digital Transformation (DX) is about adopting disruptive technologies to increase productivity, value creation, and social welfare."	(Ebert and Duarte, 2018)
2018	“Digital Transformation stands for ongoing changes to business models, business processes and operations as well as customer interaction in connection with new information and communication technologies.”	(KPMG, 2018)
2019	“…a change in how a firm employs digital technologies, to develop a new digital business model that helps to create and appropriate more value for the firm.”	(Verhoef et al., 2019)
2019	“Digital transformation can be comprehended as a continuous process of climbing the scale of digital maturity by employing digital and other technologies along with organizational practices to create a digital culture.”	(Ivančić et al., 2019)
2019	“Digital ecosystems, however, are powered by new digital technologies that have transformed the very nature and scope of traditional interdependencies. Some firms have already embraced these changes. Others, still accustomed to competing within traditional industry structures, need to adapt to new ecosystems driven by new digital technologies. This effort is commonly referred to as digital transformation.”	(Subramaniam et al., 2019)
2019	“The transformation towards the extensive adoption of digital technologies to create/modify business services, processes, culture, and customer involvement/experiences to meet fast-changing business and market requirements is known as “digital transformation.”	(Camarinha-Matos et al., 2019)
2019	“Digital transformation is a holistic effort to revise core processes and services of government beyond the traditional digitization efforts. It evolves along a continuum of transition from analog to digital to a full stack review of policies, current processes, and user needs and results in a complete revision of the existing and the creation of new digital services.”	(Mergel et al., 2019)

(*continued on next page*)

Table A1 (*continued*)

Year	Definition	Source
2020	"…we define DT as organizational change that is triggered and shaped by the widespread diffusion of digital technologies."	(Hanelt et al., 2020)
2020	"A fundamental change process, enabled by the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity and redefine its value proposition for its stakeholders."	(Gong and Ribiere, 2020)
2020	"Digital transformation refers to the leveraging of industrial internet of things (IoT) technologies, software, services, and expertize to expand digital intelligence throughout a workforce, as well as augment workflows and processes to create new efficiencies and competencies that effect cultural and behavioral change within a company."	(Olsen Ti, 2020)
2020	"Significant change of an existing environment due to transferring major processes to digital solutions. Outcome of Digital interplay as underlying process, contingent internally (organization) and externally (cooperation) while embracing profound change and implications."	(Bican and Brem, 2020)
2021	"Digital transformation (DT) includes three main elements: technological, organizational, and social. In order to ensure digital transformation, it requires maintaining the holistic approach to ensuring the implementation of all the above-mentioned elements—digital technologies and organizational solutions together with the human element."	(Bikse et al., 2021)
2021	"Digital Transformation: the disruptive technological achievement bringing new business and operating models."	(Gökalp and Martinez, 2021)
2021	"We define DT as the continuously increasing interaction between digital technologies, business, and society, which results in transformational effects and increases the change process' velocity, scope, and impact."	(Van Veldhoven and Vanthienen, 2021)
2021	"This study proposes to define DT as a process that aims to improve an entity by triggering significant changes to its properties through combinations of digital capabilities, technologies, and platforms."	(Wu et al., 2021)
2021	"…digital transformation that is business-driven, technology-enabled, and innovation-guided process."	(Liu et al., 2021)
2021	"At a corporate level, digital transformation refers to significant change in firms' business models and the main fields of business overall based on performance in digitalization."	(Kim et al., 2021)
2021	"Digital transformation is the integration of digital technology into an entity's operational areas to fundamentally change the way the staff operates and deliver value to the patients."	(Kruszyńska-Fischbach et al., 2021)
2021	"Digital transformation (DT) is the process of combining digital technologies with sound business models to generate great value for enterprises."	(Lee et al., 2021)
2021	"DT may be defined as the use of new digital technologies (analytics or embedded devices) to enable business improvements or to innovate the business models in strategic, tactical and operational terms."	(Tijan et al., 2021)
2021	"Digital transformation is less about adding technology to the production line and more about changing all aspects of the business from processes to culture starting with the pervasive mindsets held by individuals and as a collective organization."	(Jones et al., 2021)
2021	"Digital transformation is the most widely recognized phase and describes a business change that leads to the development of new business models that may be revolutionary to the organizations or industry."	(Ahmad et al., 2021)
n.d.	"Digital Transformation refers to a process of adoption of digital tools and methods by an organization, typically those that have either not been including the digital factor as part of their core activities or have not kept up with the pace of change in digital technologies."	(OECD, n.d.)

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