Comprehension of digital transformation through the prism of an organizational design and redesign framework

Robert Fabac
University of Zagreb
Faculty of Organization and Informatics
Pavlinska 2, 42000 Varaždin, Croatia
rfabac@foi.unizg.hr

Abstract. *When defining and explaining the phenomenon of digital transformation, a considerable part of the research is focused on technologies that characterize such projects or initiatives, while a relatively smaller body of work addresses the change or transformation in organizational terms. The broader context in which the digital transformation of an organization should be considered is the organization's design, i.e., redesign framework. Several established models of organizational design emphasize the connection between key components – strategy, structure, processes, human resources, leadership, and organizational culture. Digital transformation occurs in general within all the aforementioned aspects of an organization, with all the respective changes being interrelated. This paper provides an overview of the results of selected previous research in the field of digital transformation under the framework of organizational design and redesign.*

Keywords. Digital transformation, technology, organization design, redesign, organizational change

1 Introduction

Digital transformation is occurring due to the combined functioning of permanent mobile internet connections and the emergence of a wide range of new applications, products, and services, thus achieving a growing ecosystem of technologies and applications applied by individuals, companies, and the public sector. The range of DT technologies includes by consensus: big data & data analytics, cyber security solutions, robotics and automated machines, 3D printing, mobile services, new social media, cloud technologies, internet of things, artificial intelligence.

The difference between the previous understanding of IT-enabled organizational change (transformation) and digital transformation has been explored and explained by the authors (Wessel et al., 2021). The impetus for digital transformation (DT) is stronger and includes major "trends in society and industry" (Vial, 2019), (Hartl & Hess, 2017).

Digital transformation can be observed at the level of the whole society, as well as at the level of sectors, industries, organizations, teams, and individuals. The level of organization is relevant as in this paper the research questions are based on the concept of organizational design.

Digitization and digital transformation in modern organizations is a kind of new paradigm that dominates the ambition to achieve better performance and competitive advantage. Previous recent research on the impact of digital transformation on the organization has focused to a lesser extent on identifying changes in organizational design elements.

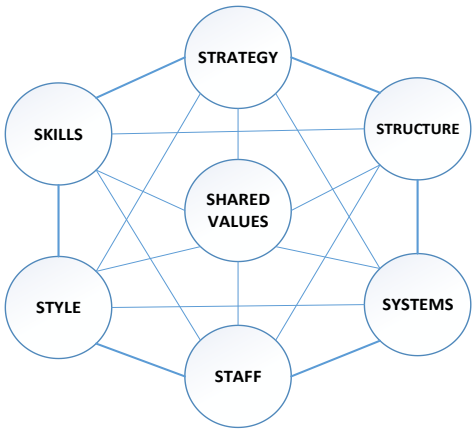

Figure 1. Organizational design model (McKinsey's 7S model)

The term organizational design refers to the presentation of the essence of an organization, and it represents a system of internal connections and relations within the organization. Well-known organizational models include key design components and their interrelation, so Jay Galbraith's design model includes the following elements: strategy, structure, processes, human resources, rewarding (e.g., in Galbraith, 2014).

The next established framework, McKinsey's 7S model (Figure 1), is slightly more complex and includes elements of organizational culture (values), leadership, and systems (e.g., in Cox et al., 2019).

Major organizational changes are traditionally seen through design changes, so by analogy, the effects of digital transformation can be expected in the domain of design. Technology is one of the main environmentally driven sources of organizational change. Therefore, when it comes to digital transformation it should be noted that many authors speak of the so-called "disruptive role of digital technology". Organizational change is accompanied by resistance to change. It is visible through the resistance of employees, but also due to barriers resulting from an inappropriate organizational design.

The next relevant design and redesign issue is the development of steps or phases of organizational change (e.g., steps in the OPTIMAL design model, by Cichocki & Irwin, 2011). Moreover, analyzing organizational design and change includes considering where organizational change is taking place in the organization (top-down approaches, etc.).

The paragraphs that follow provide a review of previous research, followed by a qualitative research based on the method of content analysis of selected research articles. The characteristics and implications of certain DT technologies on the elements of organizational design are identified. This is followed by the discussion of the results and the conclusions.

2 Literature review

At the level of global competition and development, it is worth mentioning the European Commission document "Digital Transformation Scoreboard" which contains data and analysis regarding the adoption of digital technologies in business activities within the EU (EU, 2018). EU countries are comparing their performance in terms of digital technology integration.

The analysis of cases of digital transformation, i.e., technologies implementation in some papers leads to the determination of specificities regarding the impact on design, although the authors use the same term digital transformation to identify impacts on the following comprehensive categories: change/innovation of business model (Verhoef et al., 2021), (Frank et al., 2019); core business change (Hess et al., 2016); business and social transformation (Löbbecke & Picot, 2015); value creation, value proposition and customer interaction (Pousttchi et al., 2019).

The basic organizational dimensions affected by digital transformation, according to the authors (Kaufman & Horton, 2015) are the following: "external" (customer experience); "internal" (business operations and decision making) and "holistic" (the entire organization). According to the definition of the author (Ismail et al., 2017) the DT process is "aimed at achieving a competitive advantage, applying more digital technologies and making changes in the business dimensions, including the business model, customer experience and operations, and simultaneously impacting people (including their skills talent and culture) and networks."

The influence of certain characteristic DT technologies on organizational elements are recorded in the works of the authors (Bilgeri et al., 2017), (Brous, et al., 2020) with regards to IoT technology; then by the authors (Al-Sai & Abualigah, 2017), (Dremel et al., 2017), (Pappas et al., 2018) for big data (BD) and data analytics; then in the papers on artificial intelligence (AI) (Fountaine et al., 2019), (Robert et al., 2020), (Dimitrov, 2016); and research (Ahuja et al., 2012), (Marston et al., 2011), (Gangwar, 2017) for cloud computing (CC).

The phases and frameworks of digital transformation as a specific type of organizational change have been recorded by the authors (Verhoef et al., 2021), (Van Veldhoven & Vanthienen, 2021), (Kaufman & Horton, 2015).

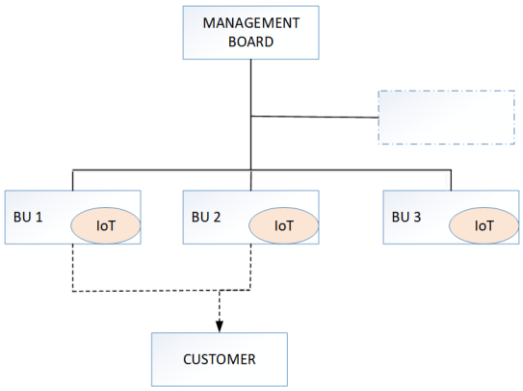

Figure 2. Illustration of possible changes in the organizational structure due to the introduction of IoT (by analogy with Bilgeri et al., 2017)

At the same time, some studies have identified effects related to changes in the elements of organizational design. Changes due to the implementation of digital transformation are reported among others in the following papers: for business processes (Hess et al., 2016), (Mergel et al., 2019); for human potentials, (Schuchmann & Seufert, 2015), (Pousttchi et al., 2019); for strategy (Kane et al., 2015), for structure (Verhoef et al., 2021), (Hess et al., 2016), (Bilgeri et al., 2017), (Ricciardi et al., 2019); for organizational culture (Kane et al., 2016); for leadership (Ricciardi et al., 2019).

The *research gap* is related to the fact that the very notion of digital transformation emphasizes organizational transformation, while this transformation is not comprehensively explained by researching digital transformation initiatives but is only partially explained in some papers. This research should contribute to identifying the overall impact of

DT technologies on individual parts of the design that undergo change. Based on the established gap and based on the above research contributions, we pose the following research questions:

RQ1. *Are there impacts of digital transformation technologies on all components of an organization's design?*

RQ2. *What are the impacts of individual digital transformation technologies on the characteristic components of an organization's design?*

The methodology applied in this paper is qualitative content analysis, including the analysis of described cases in selected papers.

3 Research

Considering the above previous research, further analysis regarding the effects of individual technologies has been conducted. New quality and contribution have been achieved based on the insight into the influences of certain technologies on certain design elements.

Papers were obtained by searching Scopus, WOS and Google Scholar databases, and using queries adapted to interactive pairs "technology-element design" (Tables 1 and 2). Searching by the keyword model (e.g., Internet of things impact organizational structure) resulted in the collection of papers that were further selected. For the final selection of about 40 papers from which the results, findings, claims have been drawn, the relevant data on their citation or acceptance have been also used.

3.1 Digital transformation strategy and impact of technologies

Two Deloitte and MIT studies signed by the authors (Kane et al., 2015) and (Kane et al., 2016) provide a valuable contribution. The very title of the 2015 article points to the importance of shifting the focus in DT projects from technology to DT strategy whose impact is crucial to project success. According to their research, in organizations with lower digital maturity, more than 50% of respondents cite a "lack of strategy" in DT, as one of the top-three barriers to implementation. The contribution of these studies is evident in the analysis of the concept of effective digital culture as well as in the elaboration of the concept of "digital congruence".

Regarding characteristic DT technologies, IoT technology means networked electronic devices that can communicate with each other thanks to software and sensors. When implementing IoT digital transformation, the organizational structure experiences changes in such way as to introduce new departments (organizational units), as discussed (Bilgeri et al., 2017) by analyzing the effects of IoT implementation on "large manufacturing companies' overall organizational structure". Moreover, especially relating to IoT implementation, a "cross-business unit (BU)" model of collaboration, i.e., cooperation is achieved in organizations at a higher level. The application of IoT solutions in health care has been explored by (Alraja et al, 2019). They highlight the issues of security, privacy, and familiarity. The authors (Brous, et al., 2020) point out three key benefits expected as a result of IoT adoption in organizations: Big Data, openness and connectivity.

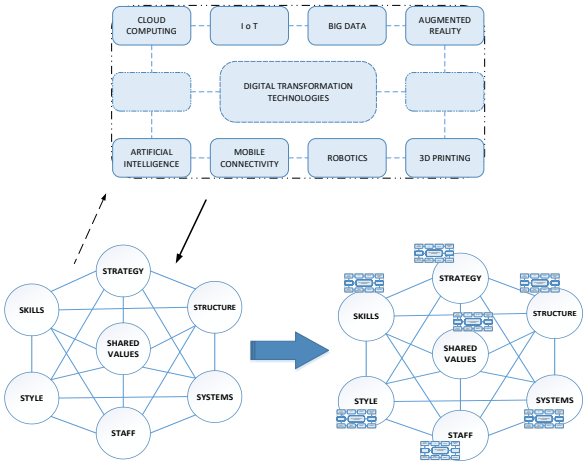

Figure 3. Illustration of the impact of DT technologies on organizational design elements

A valuable consideration of AI initiatives is provided by the paper (Fountaine et al., 2019), which establishes, among other things, that "AI-enabled companies divide key roles between a *hub* and *spokes*". The responsibilities of the *hub* as a central group of analysts include AI policies, standards, and processes, and among other things, attracting talent and formulating training strategies. A *spoke* is a business unit or function that includes a manager as the AI product owner. Responsibilities include overseeing executive teams (Fountaine et al., 2019, p. 8). The authors (Robert et al, 2020), noting a growing use of artificial intelligence systems for HR management, started considering the task of designing a "Fair AI for Managing Employees". In highlighting this topic, a clear reference to AI and human potential issues is made.

Several works of authors who have researched cloud computing are listed in the tables, in addition to their separate contributions, such as (Gangwar, 2017) and (Marston et al., 2011).

The experience of implementing Big Data in the German car industry has been handled by Dremel et al. (2017). In doing so, they establish three stages of evolution "…of AUDI towards Big Data Analytics - advancing, enabling, and leveraging" (Dremel et al., 2017). The authors (Al-Sai & Abualigah, 2017) consider Big Data opportunities in the public sector. The authors (Roden et al., 2017) have conducted research on the successful application of the Big Data

system in globally successful companies (Royal Philips, eBay, Walmart, Volkswagen).

3.2 Design elements influenced by DT

When considering organizational design elements we should highlight business processes because they probably represent the most common object of DT initiatives (e.g., in Mergel, et al., 2019). Among numerous studies, the paper (Hess et al., 2016) is worth mentioning. It gives the example of the German company Ravensburger, which going from the traditional core business (analog games and books) entered the market "e-book & online gaming". In doing so, the company identified the need to strengthen competencies and abilities – staff training and hiring new people.

In the paper (Schuchmann & Seufert, 2015), the authors identify and analyze the way knowledge is acquired by individuals, teams, and organizations in the banking sector during digital transformation and changing roles and tasks of employees and managers.

A number of articles demonstrate the importance of the values and attributes of the organizational culture (OC) for the success of the digital transformation endeavor. In their paper (Hartl & Hess, 2017) the authors ask the research question about values crucial for a successful digital transformation. To get the answers, they conducted a Delphi study with the participation of a number of experts and academics close to various industries. The results of the ranking of organizational values crucial for DT success put the variables "Openness towards change" and "Customer centricity" in the first place. The analysis using the Competing Values Framework shows the importance of values that are far from the Hierarchy and Market points, and close to the Clan culture, and especially to the Adhocracy culture variant.

4 Discussion

The first consideration we make concerns the readiness of the organization to implement digital transformation, given the peculiarities of the existing organizational design (Table 1). The key conclusions of the individual selected studies, i.e., abstracts have been transferred to the tables below. Certain observations in Table 1 are analogous to those in the model of traditional organizational change (resistance to change; aspect of organizational learning) and similar to the requirement of successful DT - trends in the design of modern organizations generally follow versions of the "shallower" hierarchy and structure with less rigid formalisms (less reporting, rules, bureaucratic requirements, etc.).

Table 2 contains the qualifications, describes the effects of digital transformation during the implementation and after the implementation of individual technologies. It should be noted that for each pair (technology - design element) there is a characteristic observation concerning the relevant changes. With respect to the research questions, the given Tables 1 and 2 provide the required answers.

Table 1. Preparation for DT and early stage of DT

	Digital transformation initiatives
Design	"As IT takes over many coordination and control responsibilities from hierarchy, traditional hierarchical views of organizational form become incomplete" (alternatives to the traditional structural forms, in Zammuto et al., 2007); overcoming of barriers to DT (Vogelsang et al., 2019)
Strategy	Formulation of a digital strategy and its incorporation into higher-level strategies (Kane et al., 2016); Desirable establishment of DT governance structures (Chanias et al., 2019)
Structure	Bearing in mind the creation of a more agile structure (Kane et al., 2016, p. 15); Identify the existing "skillset" as the organizational resource management capability required to create and deliver value through DT (e.g., for Big Data in Pigni et al., 2016)
Processes	Defining existing processes before implementing DT; Support for process digitization (e.g., implementation of ERP and CRM systems); Preparation for process optimization (e.g., using Big Data) (Hess et al., 2016)
People	Note the importance of the so-called "change skills" (Kane et al., 2016, p. 11); Occurrence of fears - overcoming resistance to DT changes (Mugge et al, 2020)
Leadership	Leaders need to understand digital technologies and their capabilities; In organizations with low digital maturity, there is a low percentage of leaders who have sufficient digital skills (Kane et al, 2015); in preparation for DT, it is necessary to hold meetings and workshops across departmental boundaries, for managers and leaders (e.g., AssetCo., from Chanias et al., 2019)
Culture and values	Preparation for DT by building a "digital culture"; The problem of the absence of a culture of experimentation (Kane et al., 2016, p. 14); The existing "mindset", the issue of organization's willingness to invest in DT initiatives (e.g., Pigni et al., 2016)

For **RQ1** (*Are there impacts of digital transformation technologies on all components of an organization's design?)* The answer to this question is positive. Digital transformation and the application of technologies (IoT, AI, BD, CC) through the transformation process affect all elements of the organization's design. The second research question (**RQ2**) is: *What are the impacts of individual digital transformation technologies on the characteristic components of an organization's design*? The answer to this question can be found in the descriptions given in Tables 1 and 2.

Table 2. Impacts and changes during and after DT initiatives

	Structure	**Strategy**	**Processes**	**People**	**Leadership**	**Culture and values**
DT in general	Consider developing the required level of "digital congruence - culture, people, structure, and tasks aligned" (Kane et al., 2016, p. 4); Strengthening cross-functional collaboration and multidisciplinary networks in the organization	The content of the DT strategy must meet the requirements of the business level and functional level (Ismail et al., 2017); Formulate a strategy that will include digital resources and through DT lead to better performance	New requirements due to the creation of "related products"; In DT processes are transformed and only sometimes optimized (Vial, 2019); AI and Big Data can enable advanced - automated, decision-making processes (Loebbecke & Picot 2015)	Changing roles and tasks, employee learning; Developing new skills; "DT requires employees to depend more heavily on their analytical skills to solve new problems " (Dremel et al. 2017); possible occurrence of resistance to DT (Svahn et al., 2017)	Leaders must learn; A new understanding of the topic: how to run a business; New leadership roles to respond to technology challenges (e.g., position chief digital officer, in Vial, 2019)	Among the most important values that affect the success of DT are: openness towards change, customer centricity, innovation, agility, willingness to learn (Hartl & Hess, 2017)
IoT	New departments; Cooperation across the borders of organizational units; "Issue of scalability in terms of both connected products as well as related services" (Saarikko, p. 670)	Application of IoT as a great potential for newcomers; In practice, only some organizations have an IoT security strategy that needs to change given the number of cyberattacks on IoT devices (Lee, 2020)	Improving healthcare processes by establishing remote IoT as a monitoring and intelligent care system; Reducing costs and resources with greater customer satisfaction; Improving educational processes (Bagheri & Movahed, 2016).	Request for new skills and roles (IoT data manipulation, privacy assurance); Decision making in terms of IoT data generation; Possible improvement of interaction with customers / clients	Collection of large amounts of data and new data: influence on decision-making; User concerns about privacy; The need to "improve the security and privacy levels embedded in IoT devices and applications" (Alraja et al., 2019)	Doubts due to the benefits and risks of introducing IoT in the organization; potentially greater transparency of the organization (Brous, et al., 2020)
Big Data (BD)	Centralization and creation of "analytics-as-a-service" in the company;	BD and analytics by generating information provide an opportunity for decision	The benefits of applying BD in decision-making processes, planning in the supply chain,	Skills and experts challenges for organization; Creating a team of experts; BUs	Danger of losing control in the domain; Reduced reliance on experience; Responsibility	Developing a data-driven culture within organizations; Promoting a climate of organizational

	New jobs related to Big Data	makers to respond promptly, when performing agile changes (Mikalef et al., 2016)	communicating with customers (Matthies et al., 2017, p. 13); Application of BD in workforce deployment processes, based on predictions	flexible in terms of technology usage and analytics competencies	in achieving digital maturity (Mugge et al, 2020)	learning (Pappas et al., 2018, p. 489)
Cloud computing (CC)	The risk that customer data and other confidential data could reach across national borders	CC offers advantages: lowers the cost of entry for smaller firms; CC provide a quick access to hardware resources, with no capital investments (Marston et al., 2011)	Some CC enablers help customers to manage the processes they have outsourced to cloud providers (Marston et al., 2011, p. 180)	Organizational human resources (IT staff with skills and knowledge related to cloud services) have a positive effect on cloud computing usage. (Gangwar, 2017)	The importance of informing leaders about aspects of CC, knowledge of reliability and security issues, and understanding human-based issues related to CC	OC of openness regarding new procedures and methods in doing business, a culture that encourages innovation has a positive effect on the use of CC (Gangwar, 2017)
AI	"AI-enabled companies key roles: a "Hub" (AI teams) and a "Spokes" (teams close to users)" (Fountaine et al., 2019); New jobs like Digital Health Advisors: "consumer-oriented, associated with the data store and the AI engines" (Dimitrov, 2016)	Behind AI initiatives should be a strategy that considers the bigger picture and allows the elaboration of AI opportunities.	"AI fairness - employing AI to automate existing procedures rather than employing AI to create new procedures – based on consistency and transparency - to support processes for fair decision making" (Robert et al., 2020, p. 13)	In some AI organizations "automatically assigning workers to tasks and also evaluating their work" (Robert et al., 2020), (Dhir & Chhabra, 2019); AI development requires cross-functional teams and multidisciplinarity (Fountaine et al., 2019)	Leaders must make an effort to overcome cultural and organizational barriers faced by AI initiatives (Fountaine et al., 2019); The key role of leadership in digital maturity processes (Mugge et al, 2020)	Concepts in supporting AI fairness: "transparency (AI visible and known), explainability (describing AI to the employees), visualization (information to employees by images), voice" (Robert et al., 2020, p. 26)

In response to **RQ2** we point out that unlike changes in design components in traditional initiatives, DT causes requirements and changes such as: *digital congruence, scalability, analytics-as-a-service, analytical teams, networks (structure); DT strategy, AI strategy IoT security, opportunities for small businesses (strategy); process transformation, IoT remote care, agile decision making, AI fairness, outsourced processes management (processes); new digital skills, data analytics competencies, work in cross functional teams, new jobs, change skills (people); digital officer, care about security and privacy, less reliance on experience, efforts in achieving digital maturity (leadership); learning orientation, transparency, agility, data-driven culture, customer centricity (culture and values).*

5 Concluding remarks

Digital transformation is a social and technological phenomenon that modern organizations are hastily

embracing for the sake of improving performance and gaining a competitive advantage. The notion of transformation in such initiatives refers to organizational changes or transformations. It is a common interpretation that DT denotes a change that primarily concerns the business model. In this paper, we investigated the impact of DT technologies on organizational design and its components: strategy, structure, processes, people, leadership, and organizational culture. In addressing the research questions, it has been determined that the main technologies of the DT process (Cloud Computing, IoT, AI, Big Data) have a characteristic impact on all components of organizational design. In future research, we intend to pay more attention to the investigation of DT cases, possibly based on relevant personal experience, with the peculiarities of "as-is" variants of organizational design and with emphasis on research topics such as: barriers to DT implementation, enablers of DT, the roles of technology experts and company executives, risk reduction strategies in implementing DT initiatives.

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