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Quels sont les types d'interactions entre transformation numérique et résilience ?

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Résumé :

De nombreux événements récents (COVID 19, guerre, etc.) ont créé de nombreux défis pour l'humanité en général et le système d'information en particulier. Ces contraintes ont mis l'accent sur l'importance de la résilience des systèmes et sa relation avec la transformation et la numérisation. Dans cet article, nous présentons une revue de la littérature sur les différents types d'interactions entre la transformation numérique (TN) et la résilience. Cette étude se compose de 72 articles publiés entre 2010 et 2021 dans des revues liées à la recherche en systèmes d'information (SI). Les résultats montrent qu'il existe de nombreuses dimensions de la TN et de la résilience. Sur cette base, nous avons étudié les interactions entre les différentes dimensions pour clarifier leurs contributions dans le management des SI. Une liste complète de références est présentée. Cet examen va fournir une source à toute personne intéressée par l'influence mutuelle entre le TN et la résilience.

Mots clés :

Résilience, transformation numérique, dimensions, interactions, influences.



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Abstract:

Many recent events (COVID 19, war, etc.) have created many challenges for humans in general and information systems in particular. This constraint did put the accent on the importance of system resilience and its relation to transformation and digitalization. In this article, we present a review of the literature on the different types of interactions between digital transformation (DT) and resilience. This study consists of 72 articles published between 2010 and 2021 in journals related to information systems (IS) research. The results show that there are many dimensions of DT and resilience. Based on this, we did study the interactions between the different dimensions to improve IS management. A complete list of references is presented. This review will provide a source for anyone interested in the mutual influence between DT and resilience.

Keywords:

Resilience, Digital transformation, dimensions, interactions, influences.

1. Introduction

During the first years of the twenty-first century, globalization and information systems did radically change the face of business and organization. After some years of experience, we can notice that there is a growing discussion about the resilience of these systems. Following the recent events also (the COVID repercussions, the Suez Canal obstruction in March 2021 by the Ever-Given container ship, etc.), the IS community did focus more on this subject.

For numerous businesses, many of the nice to have information system (IS) functionalities have become a must-have. We can notice that organizations that have been aware of the IS potentialities have demonstrated better resilience against exogenous shocks due to COVID19 (Pee et al., 2021).

Despite the growing importance of resilience, we can find researchers that invoke the lack of research on this subject. Floetgen et al (2021) did notice that although the nature of COVID19 heralds the need to develop resilience on a broader scale, only a few papers explore how information systems affect the resilience of a higher-level system or explain the organizational resilience building. This phenomenon is aggravated by the lack of empirical investigation and real-world examples, the limited conceptualization of resilience in information systems, and the limited testing of dimensions in practice (Heeks & Ospina, 2019).

Floetgen et al., (2021) also stated that recently there have been calls for papers to tackle the research gap in understanding resilience using information technology. These citations do justify the importance of our studies to better understand these concepts.

Furthermore, we notice that during the 21st century, firms' interest is growing in both the resilience (World Bank, 2013) and the transformation of information and communication technology (World Bank, 2016). Yet, to date, there has been little connection in theory or practice between these two trends (Heeks & Ospina, 2019). With our paper, we contribute to fulfilling this gap by providing the types of links existing between resilience and digital transformation. We answer the following research question: what are the types of interactions between resilience and digital transformation?

We intend to contribute to the managerial and theoretical literature by providing more details on the dimensions and studying the relations between them.

This paper will be organized as follows, we will start by highlighting definitions of DT and resilience. Following this part, we did explain the research methodology. We will then get our results as a literature review. Next, we will present a discussion of these findings, the discussion will be focused on the possible improvement of our literature review results and the possible new research streams. Finally, we will have a conclusion with the possible application fields of this study.

2. Theoretical background

2.1 Digital transformation: definition

For several years, a rich body of IS literature has explored transformation (Baiyere et al., 2021). To introduce digital transformation, we did retain a unified definition. Gong & Ribiere, (2021) did answer the question of a unified interpretation. In their paper, they did define DT as a fundamental change process, enabled by the innovative use of digital

technologies accompanied by the strategic leverage of key resources and capabilities, aiming to improve an entity and redefine its value proposition for its stakeholders.

In the literature, we do also find other papers with specific definitions. As an example of DT interpretation, we do find a conceptual definition as a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies. Vial (2019) also describes DT as a process wherein organizations. The role of this transformation is to respond to the changes taking place in their environment by using digital technologies to alter their value creation processes.

2.2 Resilience: Definition

From our readings, we do retain an interpretation of resilience in the information system field. In this domain, resilience presents the capability of a system to anticipate risk, avoid potential losses and quickly recover from disturbances (Floetgen et al, 2021).

In our literature review, we did notice that resilience is an emerging topic in various disciplines such as ecology, psychology, engineering, management, and information systems. We do find a different definition of resilience depending on the field.

In a managerial context, Müller et al (2013) associate resilience with an organization's capacity to continue its mission despite disruption through mindfulness, resourceful agility, elastic infrastructures, and recoverability.

From an engineering perspective: resilience is a combination of technical design features, such as fault tolerance and dependability, with organizational features such as mindfulness, training, and decentralized decision-making.

In this information system field, resilience has been adopted at different levels of analysis, such as the organizational, group, and community levels. In the IT context. We see resilience as a platform that orchestrates an autonomous ecosystem of actors through socio-technical means (McIntyre et al., 2020).

3. Research Methodology

We did choose the scoping review as a type of literature review. This type is explained by Paré et al (2015) to examine the extent, range, and nature of research activities, determine the value of undertaking a full systematic review or identify research gaps in the extant literature. In our case, in response to our research question, we will need to focus on the breadth of coverage of the literature to identify the dimensions of DT and resilience and clarify the interactions between these dimensions.

To fulfill this goal, we conducted an in-depth review of the literature in several stages. As a guiding line, we did follow the method explained by Webster & Watson (2002). They did recommend a structured approach to determine the source material for the review. The first step is to select the papers with the major contributions. These papers are present in the leading journals. For this step, we did identify the senior scholars' basket of journals and the financial time - fifty journals, to guarantee the quality of the scientific publications.

Also, we restricted selection only to papers between the years 2010 and 2021 to tackle only the recent research trends in the field. We did use the keywords “Digital transformation” and “Resilience” to search the full text of the papers that contains the two words at the same time. To get our list of papers, we did use EBSCO-HOST as a search engine and the “Business source complete” as a database. This research did get us 258 papers between 2010 and 2021. To better target the relevant papers from this list, we did a review of the title and the abstract for each paper and we removed articles that weren't related to our focus. Then we did a full-text review to get our final group of articles. After this step, we did get 52 papers.

As a second step, we did a “go backward” analysis by reviewing the citations for the articles identified in step one to determine prior articles we should consider. Complementary, we did a “go forward” analysis by using the Web of science to identify articles citing the key papers identified in the previous steps. As a result, we did gather other 20 papers that were useful to our studies and we did use them in the elaboration of this document.

As a result of our search, we did gather 72 documents.

Then to analyze these documents, we did follow the grounded theory methodology. We did use the three-coding strategies: open coding, axial coding, and selective coding (Gasson & Waters, 2013).

As a first step, we start with open coding. It's an analytical process of generating higher-abstraction level dimensions. To justify our choices, we did record the most used vocabulary by the different researchers that did help us to indicate the different higher abstraction dimensions (annex A).

As a second step, we used axial coding to develop further the dimensions and relate them to their possible sub-dimensions (annex B).

We did end this analysis with selective coding where the dimensions and sub-dimensions are integrated and refined.

When the dimensions do begin to emerge, we did engage in a “comparative analysis” continuously comparing our primary result with the new paper’s findings. In annex C, you can find all the papers that we did use. In this annex also, we did indicate the dimensions treated by each document.

4. Findings

4.1 Digital transformation: dimensions

Through the literature review that we conduct, we could identify four dimensions of DT (technical, structural, cultural, and environmental dimensions) and six sub-dimensions. Figure 1 does resume our different findings. Following this figure, we will provide explanations and examples for each dimension and sub-dimension.

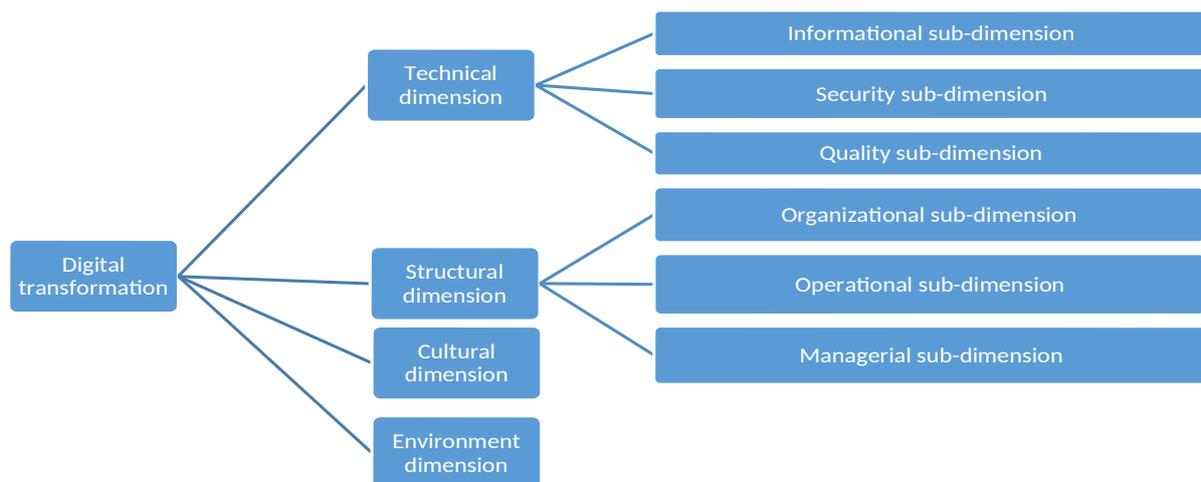


Figure 1 : list of the dimensions and sub-dimensions related to digital transformation

As we're studying information systems, we will start by discussing the technical dimension. As the speed of technological change is accelerating with new digital capabilities being rolled out yearly (Nadkarni & Prügl, 2021), this dimension will be the main actor in the transformation of IS. In the literature, we do find three sub-dimensions: informational, security, and quality.

We can notice worldwide a growing movement of digitalization and connectivity. This movement does lead to an enormous quantity of data and companies do need to appropriate this database for monetization purposes. Governments are also seeking access to them in support of public services. In the informational sub-dimensions, we do treat mainly this growing data volume with many management methods and tools. Commercial datafication practices are being employed by a few dominant digital platform companies originating in the United States or China. More popular technologies are also used like artificial intelligence (AI), machine learning techniques, and data analytics. Accompanying these developments is a debate about the societal benefits, the harmful consequences, and the appropriate policy responses (Mansell, 2021).

For security sub-dimensions, we can find some papers that do emphasize the importance and the challenges of this part. This transformation imposes new designs. Designing information systems for cyber-security poses additional challenges to IS compared to completely novel applications since they contain technical components and traditional action patterns inherent to the legacy systems from which they emerge (Brandt et al., 2018). As an example, of the security issues, Bélanger & Crossler (2011) discussed the Information privacy challenges and breaches. Privacy refers to the desire of individuals and companies to have some control over their data. The precise also that 85 percent of companies in 2007 experienced a privacy breach, among them, 63 percent reported multiple breaches. The majority of the reporting companies stated that they spent their time reacting to privacy breaches as opposed to being proactive in their attempts to prevent them.

An essential component also is the quality sub-dimension. This part deals with the service provided (implementation) and the product itself (architecture, the coding language used, the technology used, design, etc.). Tim et al., (2021) define service quality as the difference between customers' expectations for service performance and the service received in reality.

During the process of digital transformation, we need to consider the customer requirements and ensure the conformity of our quality by measurable standards.

As an example of this sub-dimension, Yang et al., (2011) did explain the extension of external customer satisfaction through the IT-based Customer Relationship Management systems (CRM) paradigm and the merging of Employee Relationship Management systems (ERM). They did find that employee satisfaction with the ERM system is largely a function of system quality perceptions and the application usefulness. They believe that high-quality systems implementations and the usefulness of the functions will produce high degrees of employee satisfaction with ERM systems. This highlights the critical role of accurate assessments for user function and quality requirements.

As a second dimension, we have the structure of DT. This dimension deals with the organizational and managerial parts of a DT project. As sub-dimensions, we did find three components: organizational, operational, and managerial.

Starting with the organizational sub-dimension, transformation is broadly considered to be a strategic necessity to achieve favorable or superior levels of organizational performance (Baiyere et al., 2021). This transformation requires the implementation of a new reflection, the design of new processes, and the consideration of the organizational inertia that characterizes organizational structures and prevents their transformation (Besson & Rowe, 2012). A formalized organization is a key component to the success of any transformation process. This part needs to be aligned with the managerial strategy and will influence the operational tasks. As Ahlstrom et al (2020) cited, after the 2008 financial crisis, there was an installation of a new normal to guarantee organizational efficiency. This transformation, even if it was in small actions on one side of the globe, can have a major impact on organizations on the other side of the globe.

One of the major structural problems in the IS project is the operational responsibilities and changes. DT brings solutions to these problems. Hastig & Sodhi, (2020) state supply chain traceability as an example of operational challenges. In our modern market, there is an operational problem in supply chain traceability to check ethical production, compliance with sanctions, or product safety. Current production unities have limited knowledge of the source (components or raw materials) of the goods they manufacture or sell, so they seek visibility into the supply chain. Operations management (OM) experts are focusing on transparency, visibility, and traceability in the supply chain (Sodhi & Tang, 2019). We do find many IT-based systems for achieving supply-chain traceability using technologies like blockchain (Sodhi & Tang, 2019).

Hastig & Sodhi, (2020) State also in their paper that DT will influence many operational business requirements: curbing unlawful practices, achieving sustainability, improving operational efficiency, increasing supply-chain coordination, and sensing market trends.

As a structural sub-dimension also, we can find the managerial part. This sub-dimension contains a lot of problems like leadership, strategy, governance, etc. (Hanelt et al. 2020). In the strategy component, for example, we have the value creation of the firm, the scope of the firm, the business model, etc. We're here siting some examples related to the managerial sub-dimension:

- For the value creation of the firm, organizations are continuously experiencing internal transformations that change how they create value and structure their processes. Vial,

(2019), argues that DT went a step further by using digital technology to redefine its conception of the value offered by the firm.

- For the change of the scope of the firm. As Baiyere et al., (2021) affirmed, this is particularly meaningful for DT since formulating strategies or value propositions typically calls into question the existing identity of an organization.
- For the business model, current research defines DT as the use of digital technologies to improve business outcomes, technologies-driven changes in core business processes, and automation of tasks. Revenue models, product offerings, and sales practices were envisioned to change the entire organization, with digital technology being at the core of this change. (Baiyere et al., 2021.)

For the other dimensions of DT, we can find the cultural aspects. This part treats mainly the information-technology adoption by the users. Bala & Venkatesh, (2015) do notice that information technology (IT) implementation is a major organizational change event that will disrupt an employee's work environment. In their paper, the team develops a model of technology adaptation behaviors that employees perform to cope with a new IT system. They did use the "technology adaptation behaviors" as a link between IT implementation and employee job outcomes.

Bala & Venkatesh, (2015) do indicate that employee resistance remains a major challenge for organizations implementing ITs.

In the cultural dimension also, we have organizational learning and creativity. The recognition of impositions and reconciliations that occur during the transformation process highlights that transformation activities impose changes on the work practices, which, if not attended to, may derail the entire transformation agenda. These impositions on work practices then activate reconciliation actions that subsequently refine the transformation activities (Baiyere et al., 2021). This transformation can lead to organizational learning of new adaptation ways and can affect the creativity of the organizational members.

As a fourth dimension, we did identify the influence of the environment. As an example, we can find the regulation influence. A Lot of criticism of many "big tech" companies regarding their digital technologies and services policy. There is a growing debate about how datafication activities should be regulated. Consumers are persistently obliged to adjust to the shocks of technological change in the digital infrastructure (the internet, fixed and mobile communication) and in-service applications (social media, electronic commerce, search engines, and data analytics) with no guarantee about the use of their data. (Mansell, 2021).

Another aspect also of the regulation is the taxation of the digital platform companies. With human populations facing health, unemployment, and environmental crises, there is a need to ensure that countries have a sustainable tax base. Given the quick rise of big digital companies, there is a movement toward taxes specifically targeting the large digital platform. (Mansell, 2021).

4.2 Resilience: Dimensions

If we go deep into the literature, we can enumerate these dimensions of resilience: structural, cultural, and technical resilience. In the following figure 2, we did resume our different findings. Following this figure, we will provide explanations and examples for each dimension and sub-dimension.

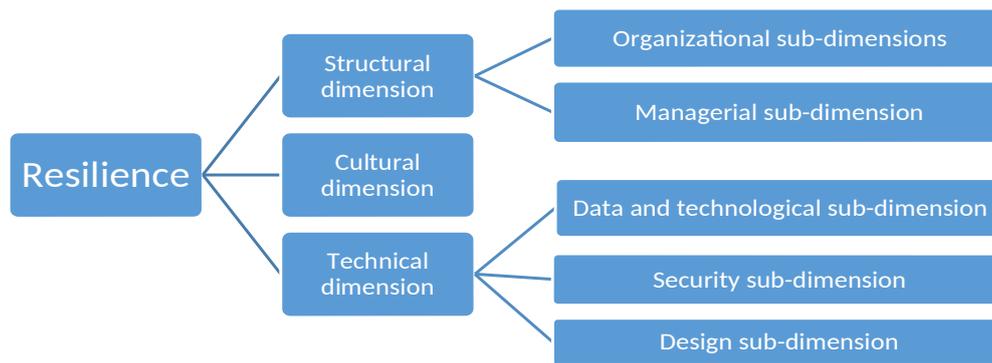


Figure 2: The List of Dimensions Related to Resilience

As a first resilience dimension, we did identify a structural part. We did find two sub-dimensions: organization and management (the strategy and the orientation of the companies).

On an organizational level, resilience has evolved from responses to external threats. Resilience was presented as reliability in the processes, adaptivity of the business models, and robustness in the design principles to reduce organizational vulnerabilities. Currently, the focus has shifted toward an internal perspective of resilience, dealing with the reliability of processes and avoiding failures (Floetgen et al., 2021).

The concept of the “resilient organization” has gained popularity as a concept that might aid companies to survive and thrive in difficult or volatile economic times. Questions have been raised concerning the characteristics of such structures, and how best to help firms when there are threats to their well-being and even to their existence (Riolfi & Savicki, 2003).

On a managerial level, resilience does also transform the business model of the firms. Despite the drawbacks of COVID19, some mobility platforms haven't been resilient enough to survive the crisis but are thriving. For example, GoTOglobabl, GreenCar, and Meituan have reported a significant increase in users and trips and already exceeded their set pre-lockdown business objectives of growth and profitability. Mobility service platforms have capitalized on their platform-based nature to respond to the crisis (Floetgen et al., 2021).

In the same context, DesJardine et al., (2019) do affirm that resilient organizations maintain stability in the face of general environmental disturbances. Strategic practices contribute to organizational resilience. Strategic practices create interdependencies among stakeholders, which builds stability. As well, strategic practices encourage interdependencies among diverse actors, which builds flexibility. The balance between stability and flexibility is a hallmark of resilience.

As a second dimension, we did identify the cultural aspects. The cultural resilience dimension includes the social adoption of the users. Tim et al., (2021) in their paper, did explain digital social innovation (DSI). The DSI can be defined as the novel use of digital technology to address major societal challenges.

Information systems (IS) research has shed light on various DSI initiatives and their impact on sustainable development. From improving health and well-being to promoting environmental sustainability and civic engagement, existing DSI research has painted an optimistic picture of resilience and sustainability in the face of societal challenges.

As an example of this cultural dimension, much existing research examines how e-commerce adoption led to business value creation and evolve the social resilience of the users. Tim et al., (2021) in their paper did explain how e-commerce can be adopted to bring sustainable development among marginalized communities. They did justify this with a case study of an early and large e-commerce community in rural China. This example does explain the impact of information systems on social resilience and changing the cultural aspects of the population.

Finally, we did identify a technical dimension. We did identify three sub-dimensions related to technical issues: data and technologies, design resilience, and security challenges.

For the resilience design sub-dimension, the recent pandemic has pointed out the importance of a resilient IS design. There is a growing need to be informed by possible functionalities and technologies that do improve the system resilience. As an example, during the COVID 19 crisis, many of the nice-to-have IS functionalities have become must-haves. In response to the pandemic, technology has raised privacy and resilience concerns. (Pee et al., 2021).

Related to the technical dimension, we have data challenges. Heeks & Ospina (2019) did describe three notions of the data and technological resilience:

- The resilience of an information system input system (RISIS): in this case, resilience is the property of some precursor system that acts as an information system input.
- The resilience of an information system (RIS): the information system itself and its resilience are here the focus of analysis (the resilience of the technology uses, the data, etc.).
- The resilience of an information system outcome system (RISOS): this research looks at the impact of information systems on the resilience of others, and wider systems that the IS support.

As a final sub-dimension of technological resilience, Ray (2018) in his book presents the security challenges. He explains that the networks resilient are the processes that quickly identify and limit the activities of unauthorized actors. They're networks that are architected to minimize the potential for damage. Most importantly, they have the ability to resume essential operations quickly after sustaining a disabling cyber-attack. As cyber threats become more persistent, more sophisticated, and more pernicious, we must take a proactive approach to achieve this digital resilience.

In this second part of the finding, we did discuss the different dimensions and sub-dimensions related to the resilience.

4.3 The types of interactions between the resilience and digital transformations dimensions:

As a result of our literature review, we advance that there are many types of interactions and mutual influences between these dimensions. We have a possible simple relation (a one-to-one relation: from the DT to the resilience dimensions or from the resilience to the DT dimensions). Also, we have a possible complex relation (a mutual influence between many dimensions of DT and resilience).

4.3.1 Simple relation: DT affects the resilience

For the simple relations, we can notice—by definition—that resilience is a characteristic of the system. Sakurai & Chughtai (2020) did affirm that resilience is defined as a system's

capacity to rebound to its original state, which suggests that resilience is a property of a system. On the other hand, as Baiyere et al. (2021) confirm, the DT is a transformation of the system (Vial, 2019).

So, there is a cause-effect relationship (the DT is transforming the resilience of the system). With this logic, resilience is a consequence of the IS transformation. We can apply this principle to the different dimensions, for example, we can see that a change in the organizational sub-dimension of the DT will affect the resilience organizational sub-dimension.

4.3.2 Simple Relation: Resilience affects the DT

As a simple relation also, resilience can trigger the process of DT. In our modern economy, we have to keep up with the challenges. So, it's the resilience that is pushing the firms for adapting an urgent DT process to prevent losses in upcoming crisis. In this case, we need to consider the requirements of the system resilience while we do a DT project.

As an example of that, Floetgen et al. (2021) did cite the mobility platforms that did utilize their platform ecosystem to pivot out of the crisis-related limitations. During the crisis, there was a shortage of human transportation services. To overcome this, "BlaBlaCar" for example, did use the existing platforms to transport other objects (like medicine, food, etc.). This decision demonstrates the resilience characteristic of the existing platform that did help to absorb the first shock of the business disruption.

After this first wave, "BlaBlaCar" has successfully introduced a new platform through which communities can support one another with grocery shopping during COVID-19. This explains the effect of the managerial resilience (business model) constraint on the business model DT. "BlaBlaCar" company did face a constraint that did affect its business model resilience, so it did use the digital transformation and built a new platform to overcome this.

4.3.3 Complex Relation: mutual influence between DT and resilience

For the complex relations, we can notice a sequence of changes (for example, a dimension of resilience could trigger a change in a DT dimension, and this modification could affect another dimension). As examples of these relations, Taghipour & Merimi (2021) did cite that the COVID-19 health crisis proves the vulnerability of the entire industrial and food supply system. They did also report that many companies did face Supply Chain disruptions due to the pandemic. These citations present some examples of organizational resilience.

If we go further in the same article, Taghipour & Merimi (2021) cite the digital transformation design (the quality sub-dimension) as a consequence of this organizational disruption. The operation and supply chain management (OSCM) responses to such pandemics should include making universal supply chains readier and more integrated for digitalization (World Economic Forum, 2020). Digitization of scientific committees could strengthen and improve quality in the face of pandemic-related disruptions. This goal could be reached by prioritizing the design of a model for managing ecological phenomena under any circumstances. This design challenge can include dimensions like operational management, operational research, network theories like Markov chains, Bayesian networks, ecological modeling, network theory, simulation, optimization, etc. Derrouiche & Lamouri (2020) also believe that the gradual shift to Supply Chain 4.0 fulfills the promise of a more autonomous and flexible enterprise for organizations seeking productivity.

Furthermore, Taghipour & Merimi (2021) cite that a possible consequence of this design digital transformation change will be a technical challenge that we could qualify as a technical resilience. In the same paper, the authors did indicate that 70% of governments had approached projects related to digital change. They did also specify that the general use of data between suppliers, companies, and customers will have evolved considerably. Excellent communication will therefore allow for simplification and fluidity of the information sharing between the different parties and the logistic flows. This challenge can be considered as a technical resilience related to data.

As we can see in this example, in the same article we do follow the cause and consequences relation between the organizational resilience, the DT design concept, and the technical resilience challenge.

In the same article also, we can find an example of resilience that can trigger many DT transformations. A resilient organization can lead to a design DT change (the same as before), but this time, it can lead to managerial DT change. Taghipour & Merimi (2021) explain that due to the pandemic, 90% of companies are changing their business model exploring a “direct to Customer” model to cope with the arrival of new competitors, and among them, 40% have already opted for an omnichannel rather than multi-channel approach. While more complex to implement, it's also the approach that best improves the customer experience and leads to an immediate “strong impact” in areas such as production, warehousing, transport, or customer service. This business model transformation will trigger a design transformation to apply the new approach. Figure 3 does schematize this process of the relation between the different dimensions.

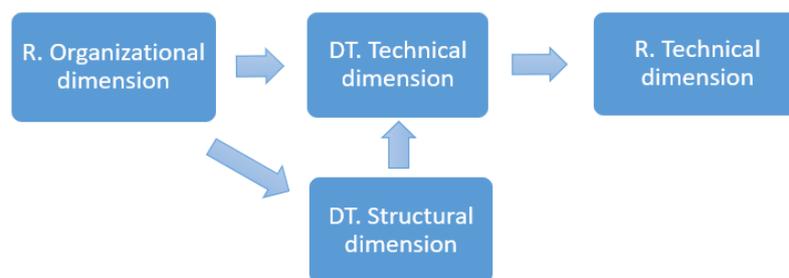


Figure 3: the relation between different dimensions of DT and resilience

Another example will also be the document of Narayandas et al (2020). In this paper, the writers presented the lessons from Chinese companies’ responses to COVID-19. We can notice the links between organizational resilience during the first wave and the managerial & organizational DT. Furthermore, the transition between cultural resilience did trigger a design resilience and did lead to a quality DT.

In annex C, we have many other examples of complex relations like the papers of Heeks & Ospina (2019) (the mutual relations between the informational Dt and the technological resilience) and the paper of Ciarli et al (2021) (the relation between quality DT, managerial DT, and cultural DT).

In this third part of the findings, we did identify for the literature two types of the relations between DT and resilience dimensions and sub-dimensions.

In the following figure 4, we did resume our findings.

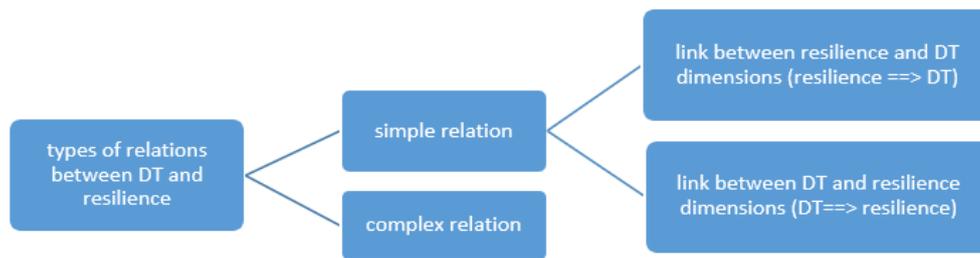


Figure 4: types of relations between DT and resilience

5. Discussion

The goal of this paper is to identify the type of links between resilience and DT dimensions and sub-dimensions.

In this literature review, we did deduce two families of interactions: simple and complex.

These interactions are critical in the study of the system's reactions to a crisis. It gives more visibility to managers in times of catastrophe. If you have an emergency, your system will react with a resilience type (because the resilience is a characteristic of the system) or a transformation type, then there will be a triggering of some other dimensions through the time.

A very interesting future gap will be the qualification of the interaction's nature: we can qualify a positive or negative mutual influence. As an example, in this document, we did indicate the challenges that do face the employees in adopting the new IS (Tim et al.,2021). This resistance to the change is present in the cultural resilience dimension and can lead to a DT cultural dimension. In this case, we're not sure if this reaction will have a good or bad influence on the process. Some users will adapt quickly to the new methods and we will have good operational efficiency, some other users will reject this transformation and we won't have an efficient process.

One of the potential research streams will also be the study of real examples and checking the possible and the impossible types of interactions. A large study could elaborate an empirical model of links between resilience and DT dimensions. This model will be more certain and will present a reference to the managers to guide the change in their systems. This study can help us to understand the dynamics of complex interactions. We can treat examples of dynamics like feedback cycles, vicious circles, etc.

To go further, we can apply these principles to some areas of expertise to qualify if we have some differences or specifications depending on the studied field. In this paper, we did take some examples from the supply network as it was one of the major areas that did face many resilience issues and DT projects lately (due to the multiple threats during the COVID crises, the geopolitical threats due to the Chinese New silk road project, the multiple trade taxes threats between the trump administration and the Chinese government, etc.).

6. Conclusion

In this paper, we did start with the importance and the definition of DT and resilience. Furthermore, we did introduce resilience and DT dimensions and sub-dimensions and we did

discuss the types of mutual interactions between them. From our studying of the papers, we did distinguish two types: the simple and the complex relations.

Although this review can't claim to be exhaustive, it does present several implications. We did try to present the importance of the DT and resilience for managers and IS research community. Through this work, we do aim to make a contribution to the research community through highlighting the mutual interactions as a subject of interest and study. Also, this interest by the researchers will influence the managerial community by presenting some awareness and clarifications that could boost their DT projects.

Our paper did present a literature review that can lead us to some limitations. We did present in the discussion section some points that could be the subject of a future paper.

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Annexes

Annex A: List of the most used vocabulary for the dimensions

DT & Resilience	Vocabulary	Dimensions
Digital transformation	Digital transformation (DT), digital technology, organizational transformation (OT), IT enhancement, adoption, improvement, IT Change.	Technical
		Structural
		Cultural
		Environment
Resilience	Flexibility, resilience, adaptation, variation, bouncing back, new normal, endure, to cope with external shocks, agility, continuity and recovery, bounce forward, adjusting,	Structural
		Technical
		Cultural

Annex B: List of the most used vocabulary for the sub-dimensions

DT & Resilience	Dimensions	Sub-dimensions	Vocabulary
Digital transformation	Technical	Informational	Cloud innovation adjustments, information and communication technologies for development (ICT4D), blockchain, traceability, technology maturity, technical innovation (artificial intelligence, 5G mobile networks, machine learning, machine learning, etc.), datafication, data management (database, data lake, etc.), infrastructure, open-source software, scalability
		Security	Security management, cyber-physical systems, security policy, firewall, protection, security technologies (virtual private network VPN, virus, breach, malware, ransomware, Trojan horse, worm, bot, spyware, DDOS, Rootkit, phishing, BYOD, encryption, deep fake, white/black hat, dark web, etc.), privacy, protocol,
		Quality	System design, IT development, IT modules, technical legacy, conceptualize, design science, Execution, implementation, testing, business requirements, quality testing, audit, IS architecture, normalization, systems lifecycle.
	Structural	Organizational	Organization, IT-enabled organizational transformation, new organizational identity, work load, team organizations, support organization, administrative controls, best practices, virtual organization.
		Operational	practice theory, IT implements, operational rules, operational benefits, agility, rapidity, continuity, performance, production, availability,

		Managerial	IT strategies, digital strategy, opportunity and threats, strategic benefits, longer-term change, 4th industrial revolution, e-government, e-learning, management information systems (MIS), strategic information system, roadmap,
	Cultural	/	Training, employee management, opportunity and threats, socio-ecological systems, knowledge management systems, learning management system (LMS),
	Environment	/	Tax, social and financial practices, law texts, techno-economic, economic power, societal benefits, social and political harms, Taxation adjustments, geographic information system (GIS)
Resilience	Structural	Organizational	Reconciliation, organizational adaptation, organizational resilience, Rapidity, Self-organization, Adjusting to the digital, task force, crisis management team, virtual organization
		Managerial	post adoptive IT, strategic and tactical practices, challenges, constraint, short-term shocks, Resilient BPM, processing controls
	Technical	Data and technological	Technology adaptation, control variables, IT resilience, e-resilience, Resilience of an information system input system (RISIS), Resilience of an information system (RIS), Resilience of an information system outcome system (RISOS), data colonialism, data management (database, data lake, etc.), infrastructure, scalability
		Security	Cybersecurity, time to recovery, security policy, safety-critical, information security and risk management (ISRM), protection, risk management, security technologies, data security controls, hacker, privacy, protocol
		Design	System design, design interface, conceptualization of resilience, deliver solutions, systems lifecycle
	Cultural	/	Technology adaptation behavior, Employees engagement, cognitive appraisals, user adaptation to IT, community resilience, human system, socio-ecological systems, Adjusting to the digital

Annex C: A list of the dimensions and sub-dimensions treated by all the papers.

Reference	Digital transformation				Resilience			the relation between DT and resilience dimensions and sub-dimensions
	DT technical	DT structural	DT cultural	DT environment	Resilience Structural	Resilience Cultural	Resilience Technical	
Baiyere et al.2021	No	Yes (organizational, managerial)	Yes	No	Yes (Structural)	No	No	Yes (DT: organizational - managerial>> Resilience: organizational - managerial)
Brandt et al. 2018	Yes (Security)	No	No	No	No	No	Yes (Security)	Yes (resilience: technical>> DT technical)
Bala & Venkatesh 2015	No	No	Yes	No	No	Yes	No	Yes (DT: cultural>> Resilience: cultural)
DesJardine et al, 2019	No	No	No	No	Yes (managerial)	Yes	No	Yes (Resilience: managerial - organizational>> Resilience: Cutural)
Derrouiche, & Lamouri 2020	No	Yes (organizational)	No	No	No	No	No	No
Floetgen & al 2021	Yes (organizational, managerial)	No	No	No	Yes (organizational, managerial)	No	No	Yes (Resilience: Managerial - Organizational>> DT: Managerial - Organizational)
Heeks & Ospina 2019	Yes (informational)	No	No	No	No	No	Yes (Data and technology)	Yes (DT: Informational>> Resilience: Data and technology) Yes (DT: Data and technology>> Resilience: Informational)
Hastig & Sodhi 2020	Yes (quality)	Yes (operational)	Yes	No	No	No	No	Yes (DT: Operational>> DT Quality) Yes (DT: Operational>> DT Cultural)
Müller et al. 2013	No	No	No	No	Yes (managerial)	No	No	No
McIntyre et al. 2020	No	Yes (managerial)	No	No	No	No	No	No
Mansell, R. (2021).	Yes (Informational)	No	No	Yes	No	No	No	Yes (DT: Informational>> DT: environment)
Reference	digital transformation				resilience			the relation between DT and resilience

	DT technical	DT structural	DT cultural	DT environment	Resilience Structural	Resilience Cultural	Resilience Technical	dimensions and sub-dimensions
Pee et al 2021	No	No	No	No	No	No	Yes (design)	No
Rioli & Savicki 2003	No	No	No	No	Yes (organizational)	No	No	No
Ray (2018),	No	Yes (Security)	No	No	No	No	Yes (Security, Design)	Yes (Resilience: Security, Design>> DT Security)
Sakurai & Chughtai 2020	No	No	No	No	No	Yes	No	No
Sodhi & Tang, 2019	Yes (Informational)	Yes (operational)	No	No	No	No	No	Yes (DT: operational>> DT: Informational)
Taghipour, A., & Merimi, M. (2021).	Yes (quality)	Yes (organizational)	No	No	Yes (organizational)	No	Yes (data and technology)	Yes (resilience: organizational>> DT quality) Yes (resilience: organizational>> DT organizational) Yes (DT organizational>> DT quality) Yes (DT quality>> DT data and technology)
Tim & al. 2021	Yes (quality)	No	No	No	No	Yes	No	Yes (DT: quality>> Resilience: Cultural)
Vial, G. (2019).	No	Yes (managerial)	No	No	No	No	No	No
World B (2013)	No	No	No	No	No	Yes	No	No
World B (2016)	Yes (quality)	No	No	No	No	No	No	No
WEF (2020).	Yes (quality)	No	No	No	No	Yes	No	Yes (DT: quality>> Resilience: Cultural)
Yang et al 2011	Yes (quality)	No	No	No	No	Yes	No	Yes (DT: quality>> Resilience: Cultural)
Wendy et al. 2011	No	Yes (organizational)	No	No	No	No	No	No
Narayandas et al.2020	Yes (quality)	Yes (organizational, managerial, operational)	Yes	No	Yes (organizational)	Yes	Yes (Security, Design)	Yes (DT: organizational, managerial, operational>> Resilience: organizational) Yes (DT: quality>> Resilience: Security, Design) Yes (Resilience: Cultural>> DT Cultural) Yes (Resilience: Cultural>> Resilience: Design>> DT quality)

Reference	digital transformation				resilience			the relation between DT and resilience dimensions and sub-dimensions
	DT technical	DT structural	DT cultural	DT environment	Resilience Structural	Resilience Cultural	Resilience Technical	
Adner & Kapoor 2017	Yes (quality)	Yes (managerial)	No	No	No	No	No	Yes (DT: managerial>> DT: quality) Yes (DT: quality>> DT: managerial)
Curşeu et al2021	Yes (quality)	No	Yes	No	No	No	No	Yes (DT: quality>> DT: Cultural)
Gorli et al 2015	No	Yes (organizational)	Yes	No	No	No	No	Yes (DT: organizational>> DT: Cultural) Yes (DT: Cultural>> DT: organizational)
Fenwick 2012	No	No	Yes	No	No	Yes	No	Yes (Resilience: Cultural>> DT Cultural)
Pavlou & El Sawy 2010	Yes (quality)	Yes (organizational, managerial, operational)	Yes	No	No	No	No	Yes (DT: quality>> DT: organizational, managerial, operational) Yes (DT: quality>> DT: Cultural)
Tan & salo 2021	Yes (quality)	No	Yes	No	No	No	No	Yes (DT: quality>> DT: Cultural)
Levine et al 2018	No	No	No	No	Yes (managerial)	Yes	No	Yes (DT: managerial>> DT: Cultural)
Li et al. 2021	No	No	No	No	Yes (managerial, organizational)	Yes	Yes (Security, data and technology)	Yes (Resilience: managerial>> Resilience: Cultural) Yes (Resilience: managerial>> Resilience: Security - data and technology)
Bartlett & morse 2021	No	No	No	No	Yes (managerial, organizational)	Yes	No	Yes (Resilience: managerial - organizational>> Resilience: Cultural)
Kano et al 2020	No	Yes (organizational)	No	No	No	No	No	No
Sajko et al, 2021	No	No	No	No	Yes (managerial, organizational)	Yes	No	Yes (Resilience: managerial - organizational>> Resilience: Cultural)
Kazan et al 2018	Yes (quality, Informational, Security)	No	No	No	No	No	No	No
Clemons et al 2017	Yes (quality, Informational)	Yes (managerial)	No	No	No	No	No	Yes (DT: quality, Informational>> DT: managerial)
Tallon et al., 2013	Yes (Informational)	Yes (managerial)	No	No	No	No	No	Yes (DT: Informational>> DT: managerial)
Firk et al. 2021	No	Yes (organizational)	Yes	No	No	No	No	Yes (DT: Cultural>> DT: organizational)

Reference	digital transformation				resilience			the relation between DT and resilience dimensions and sub-dimensions
	DT technical	DT structural	DT cultural	DT environment	Resilience Structural	Resilience Cultural	Resilience Technical	
Ambos et al.2022	No	Yes (organizational)	No	No	No	No	No	No
George et al. 2020	No	No	No	No	Yes (organizational)	No	Yes (data and technology)	Yes (Resilience: organizational>> Resilience: data and technology)
Ahlstom et al 2020	Yes (quality)	Yes (organizational)	Yes	No	No	No	No	Yes (DT: managerial>> DT: quality) Yes (DT: managerial>> DT: Cultural)
Wickert 2021	No	No	Yes	No	No	No	No	No
Lieberman 2021	No	No	Yes	No	No	Yes	No	Yes (DT: Cultural>> Resilience: Cultural)
Zuojun & yiqi 2020	No	No	No	No	Yes (managerial, organizational)	No	Yes (data and technology)	Yes (Resilience: managerial - organizational>> Resilience: data and tech)
Lu et al. 2017	No	Yes (operational)	No	No	No	No	No	No
Thomaz et al 2020	Yes (technical)	No	Yes	No	No	No	No	Yes (DT: technical>> DT: Cultural)
Song et al 2020	No	Yes (organizational, managerial, operational)	No	No	No	No	No	No
Hasija et al 2020	Yes (quality, Informational, Security)	No	Yes	No	No	No	No	Yes (DT: technical>> DT: Cultural)
Benner and Ranganathan 2013	Yes (quality, Informational, Security)	Yes (organizational, managerial, operational)	No	No	No	No	No	Yes (DT: technical>> DT: Structural)
Mak & max 2021	Yes (quality, Informational, Security)	Yes (organizational, managerial, operational)	No	No	No	No	No	Yes (DT: technical>> DT: Structural)
Roth and Zheng, 2021	No	Yes (managerial)	No	No	Yes (managerial)	No	No	Yes (resilience: managerial>> DT: managerial)
Qi & Shen 2019	Yes (quality)	Yes (organizational)	No	No	No	No	No	Yes (DT: quality>> DT: organizational)
Gaimon &	No	No	Yes	No	No	No	No	No

Ramachandran 2021								
Reference	Digital transformation				resilience			the relation between DT and resilience dimensions and sub-dimensions
	DT technical	DT structural	DT cultural	DT environment	Resilience Structural	Resilience Cultural	Resilience Technical	
Ciarli et al 2021	Yes (quality)	Yes (managerial)	Yes	No	No	No	No	Yes (DT: quality>> DT: managerial) Yes (DT: quality>> DT: cultural)
Scott et al 2017	Yes (quality)	Yes (managerial)	No	No	No	No	No	Yes (DT: quality>> DT: managerial)
Delgado & mills 2020	No	Yes (organizational, managerial)	No	No	No	No	No	No
Suluk & Kammerlander 2021	Yes (quality)	Yes (managerial)	No	No	No	No	No	Yes (DT: quality>> DT: managerial)
Prommegger et al 2021	No	Yes (organizational)	No	No	No	No	Yes (Data and technology)	Yes (Resilience: Data and technology>> DT: organizational)
Kohli & melville 2019	Yes (quality)	Yes (managerial)	No	No	No	No	No	Yes (DT: quality>> DT: managerial)
Qureshi et al 2021	No	No	Yes	No	No	Yes	No	Yes (DT: Cultural>> Resilience: Cultural)
Georgia et al 2013	Yes (quality)	Yes (organization)	No	No	No	No	No	Yes (DT: quality>> DT: organizational)
Henfridsson et al 2014	No	Yes (organizational)	No	No	No	No	No	No
Clarke 2019	Yes (quality)	Yes (managerial)	No	No	No	No	No	Yes (DT: quality>> DT: managerial)
Eismann et al 2021	No	No	Yes	No	No	No	No	No
Connolly et al 2010	Yes (quality)	Yes (managerial)	No	No	No	No	No	Yes (DT: quality>> DT: managerial)
Lanzolla et al 2020	Yes (quality)	Yes (managerial)	No	No	No	No	No	Yes (DT: quality>> DT: managerial)
Xue et al., (2013)	Yes (quality)	Yes (operational)	No	No	No	No	No	Yes (DT: quality>> DT: operational)
Datta 2017	No	No	No	No	Yes (managerial, organizational)	Yes	Yes (Data and technology)	Yes (Resilience: managerial - organizational>> Resilience: data and technology) Yes (Resilience: cultural>> Resilience: data)
Bélanger & Crossler 2011	Yes (security)	No	No	No	No	No	No	No
Derrouiche & Lamouri 2020	Yes (quality)	Yes (structural)	No	No	No	No	No	Yes (DT: quality>> DT: managerial, organizational, operational)