VILNIUS TECH
Vilnius Gediminas Technical University

14th International Scientific Conference "Business and Management 2024"
May 16–17, 2024, Vilnius, Lithuania

NEW TRENDS IN CONTEMPORARY ECONOMICS, BUSINESS AND MANAGEMENT

ISSN 2029-4441 / eISSN 2029-929X
eISBN 978-609-476-363-2
Article Number: bm.2024.1228
https://doi.org/10.3846/bm.2024.1228

V. NEW PERSPECTIVES ON MANAGEMENT AND RESILIENCE OF BUSINESS ORGANISATIONS https://vilniustech.lt/bm

ORGANISATIONAL RESILIENCE CONCEPTUAL MODEL: A SYSTEMS THINKING APPROACH

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Received 31 January 2024; accepted 18 April 2024

Abstract. With the challenges of the modern age, such as technological advancements (artificial intelligence, data analytics), complexity, and pandemics (COVID-19), resilient organisations must find better ways of surviving and ensuring sustainability. A gap exists in the literature on developing an organisational resilience framework and dimensions measurement model for the service industry aligned to digital transformation drivers. This paper identified organisational resilience components and dimensions to develop a conceptual Causal Loop Diagram (CLD) as a first step to establishing an organisational resilience framework. In this CLD, digital transformation drives environmental disruption that influences an organisation's stability and resilience. This is influenced by dynamic internal organisational and external environmental changes, amplified by technology, innovation, and customer needs and expectations. With these causal relationships, this initial model may be helpful in practice to assist organisations in making well-informed decisions about their resilience strategy and, therefore, the organisation's sustainability into the future.

Keywords: Causal Loop Diagram, digital transformation, organisational resilience, systems thinking.

JEL Classification: C52, L21, O14, O31, O32.

1. Introduction

Organisations in the 21st Century face challenges of understanding and working in a highly complex and uncertain environment. Accelerated and ever-increasing advancements in the science, technology, and innovation spaces drive this complex environment. Organisations are challenged by the increasing (exponential) rate of technological change (Sima et al., 2020). The challenges can affect the performance and disrupt the normal operations and the survival of the organisations. Research also indicates difficulties in measuring and understanding where most organisations' resilience to disruptions meets the expectations of surviving disruptions and environmental changes.

Rehak et al. (2018) define critical infrastructure systems resilience as the ability to absorb, adapt to, and/or rapidly recover from potential disruptions. The resilience of sociotechnical systems and critical infrastructure subsystems is a cyclic process of continuous improvement of prevention, absorption recovery and adaptation (Rehak et al., 2018). Vertical and horizontal integration of systems and organisations for the digital integration of infrastructure engineering is required throughout the value chain to meet the conditions of Industry 4.0 (Schumacher et al., 2016).

The Fourth Industrial Revolution (4IR) is the industrial era in which new technologies fuse the physical, digital, and biological worlds and impact all disciplines, economies and industries (Schwab, 2016; Schwab & Salai-Martín, 2017; World Economic Forum, 2017). The 4IR encompasses industrial automation, digitalisation, and services automation, creating competition in human labour markets (Lee et al., 2018; Lee et al., 2013). A gap exists in the literature on developing the organisational resilience framework and dimensions measurement model for the service industry that is aligned to the drivers of Digital Transformation (DT) of organisations (Bandara et al., 2019). It is an essential instrument for organisations to navigate the challenges posed by digital technology and innovation disruptions in their future operations and sustainability.

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Organisational resilience involves the management of uncertainty and unexpected events over time that will impact organisations in their normal operating conditions (Dong, 2023). Organisational resilience allows organisations to maintain functional operations in the face of ever-increasing disruption challenges in this 4IR. As the understanding of challenges organisations face is deepened, the definition of organisational resilience has evolved into a more strategic capability within the organisation's scope (Dong, 2023).

Rehak et al. (2018) have proposed that critical infrastructure resilience is a combination of technical resilience (comprised of robustness and recoverability) and Organisational Resilience (comprised of adaptability). Therefore, the model needs to include the impact of DT on sociotechnical and cyber-physical systems (CPS). These central systems will form the basis for the complex systems driving technology enhancement into the future.

This paper aims to create a conceptual model for evaluating and assessing Organisational Resilience, drawing from Systems Thinking (ST) methodologies. The dimensions for improved and sustainable Organisational Resilience and how resilience can be measured need to be analysed with the assistance of ST. A Systematic Literature Review (SLR) was implemented to identify the organisational resilience dimensions and their relationships from existing literature as the groundwork for this resilience measurement and assessment model. The framework offers a detailed depiction of the relationships among various dimensions and variables using a Causal Loop Diagram (CLD).

The proposed resilience measurement framework is designed to be a strategic tool that facilitates policy adjustments and serves as a validation simulation tool that considers the dynamic and intricate nature of organisational resilience dimensions. It also considers the impact of the volatile, uncertain, complex, and ambiguous (VUCA) environmental conditions organisations face.

The following section outlines the approach and methodology employed for the secondary data collection research method, aiming to improve understanding of the dimensions and interconnections in the existing literature. The subsequent section discusses the output of the SLR, focussing on the context in which numerous organisations encounter DT and how innovation will shape the survival prospects of organisations in the future.

The results section introduces the conceptual model developed in this study, which serves as a foundational basis for the next phase of data collection aimed at validating the model. Finally, the conclusion briefly outlines potential avenues for further research to advance the field of Organisational Resilience.

2. Literature review

Resilience

Resilience is derived from the English verb resile, derived from the Latin word *resilire*, which means to bounce back or return to a former state or original position (Tengblad & Oudhuis, 2019). The research on organisational resilience examines organisations' and employees' ability to handle crises, cope with traumatic changes, and deal with adverse and challenging situations (Tengblad & Oudhuis, 2019; Bhamra et al., 2011).

Resilience is a multifaceted, multidisciplinary, multidimensional and sociotechnical concept that is related to a variety of topics ranging from physical material properties to supply chain management, resulting in a diverse literature base (Burnard & Bhamra, 2011; Chen et al., 2021; Khan et al., 2019). Resilience has been studied for decades and across many contexts (Weick & Sutcliffe, 2007; Seville et al., 2008; Lengnick-Hall & Beck, 2003; McManus et al., 2008). Resilience has become a popular area of academic research and public discussion, and it is closely connected to complex systems theory (Meerow & Newell, 2015).

Given the depth of work in exploring organisational resilience, there still needs to be a greater understanding (Goldschmidt et al., 2019) of what the new digital and technological revolution will have on the survival of organisations in the future. The lack of measurement and assessment models for resilience necessitates researchers and practitioners to be able to measure the effect and impact of digital transformation programs on their organisations. In the literature, it is clear that resilient organisations have turned the organisational theory on its head by deploying more resources during disruptions, which is counterintuitive (Vogus & Sutcliffe, 2007). It is the research view that digital transformation is one way organisations can create future resilience, even though technological changes always introduce disruptions when implemented.

Organisational resilience

Many scholars have concluded that resilience is a philosophy about how organisations can face adversity, complexity, and uncertainty in the environment more proactively and responsibly, often even before crises occur (Tengblad & Oudhuis, 2019; Su & Junge, 2023; Goldschmidt et al., 2019). This research involves experts with diverse knowledge and experience to fully understand the concept of resilience, particularly organisational resilience. Therefore, organisational resilience is viewed as an organisation's ability to anticipate potential threats, cope effectively with adverse events and adapt to changing conditions. Organisational resilience depends on the ability of an organisation to reconfigure its resources, optimise processes, and reshape relationships to recover quickly from a disruption (Chen et al., 2021; Annarelli et al., 2020; Accenture, 2019).

Many scholars have listed capabilities and mechanisms that support organisational resilience, such as flexibility and redundancy, responsiveness, agility velocity, visibility, supply chain management and collaboration (Burnard & Bhamra, 2019; Duchek, 2020). Therefore, a framework for measuring organisational resilience must

consider capability dimensions as drivers of strengthening resilience. However, limited literature has demonstrated the analysis of resilience measurement for systems.

Digital transformation

DT is a process in which the "digital world" merges with the "physical world", forcing companies to manage radical change and shocks of the uncertainty of the business environment (Zhang et al., 2021). An organisation undergoing DT involves the integration of both internal and external resources through information, computing, communication, and connectivity technologies to reshape its corporate vision, strategy, organisational structure, processes, capabilities and organisational culture to adapt to the changing digital world (Vial, 2019; Skog, 2019; van Tonder et al., 2020; Zhang et al., 2021; Verina & Titko, 2019).

According to Vial (2019), DT has emerged as an essential strategic information systems phenomenon. This is generally seen as a sociotechnical system that stores, processes, manipulates and transfers information to effectively and efficiently serve its defined organisational task (Skog, 2019). Vial (2019) continues to identify disruptive digital technologies as disruptions that alter customer behaviour and expectations, change the computer landscape, and increase data availability (Vial, 2019). Therefore, DT is associated with changes in an organisation's infrastructure, products, services, business processes, business models and strategies, including interorganisational relationships in extended business networks (Gong et al., 2020; Chanias & Hess, 2016).

DT signifies the convergence of the digital and physical realms, compelling companies to navigate significant changes and the uncertainties of the business landscape (Zhang et al., 2021). In the process of DT, organisations merge internal and external resources through technologies encompassing information, computing, communication, and connectivity. This integration reshapes their corporate vision, strategy, organisational structure, processes, capabilities, and culture to adapt to the evolving digital landscape (Vial, 2019; Skog, 2019; van Tonder et al., 2020; Zhang et al., 2021; Verina & Titko, 2019).

DT require organisations to revamp their digital technologies to create new digital business models that generate added value (Verhoef et al., 2019; van Tonder et al., 2020). This multidisciplinarity encompasses changes in strategy, organisational structure, operational strategy, information technology, supply chain, and marketing (Verhoef et al., 2019). Three primary drivers propel DT: digital technology, digital competition, and digital customer behaviour. The DT journey unfolds in three pivotal phases: digitisation, digitalisation, and full-fledged DT (Verina & Titko, 2019; Fleron et al., 2021; He et al., 2021), representing the sequential steps Organisations must undertake to achieve a specific level of DT maturity. Organisational adaptation has been defined by Podsakoff et al. (2016), as cited by Sarta et al. (2020), as intentional decision-making undertaken by organisational members, leading to observable actions that aim to reduce the distance between an organisation and its economic and institutional environments (Sarta et al., 2020).

Systems thinking

The nature of organisational resilience is viewed as a dynamic phenomenon that is constantly changing based on nonlinear environmental changes that are always in flux. It is, therefore, intuitive that an organisational resilience model should reliably simulate the dynamics of the organisational interrelationship of all variables influencing the organisational system and its operations. System thinking is suitable for developing a robust model to establish a reliable simulation model. According to Verhoeff et al. (2018), systems thinking is a way to explain, understand and interpret complex and dynamic systems. Systems thinking is a cross-cutting concept that helps to deepen the understanding of the discipline of concern (Verhoeff et al., 2018; Shin et al., 2022).

System thinking is an essential skill in different research fields that can be used to develop dynamics models. According to Arnold and Wade (2017), systems thinking is defined as synergistic analytic skills used to improve the capability of identifying and understanding systems, predicting their behaviour, and devising modifications to them to produce desired effects. These skills work together as a system (Arnold & Wade, 2017).

Resilience, however, focuses on social and cultural factors within organisations which contribute to the organisations' ability to survive and potentially even thrive in times of crisis (Stephenson et al., 2010; Stephenson, 2010). The effectiveness and value of programs to build organisational resilience are much more difficult to measure. Therefore, an interdisciplinary research approach and practical application of theory should be utilised and emphasised to advance understanding and provide more targeted organisational resilience improvement programs. According to Dong (2023), organisational resilience is a complex and dynamic concept that requires systems thinking in the face of challenges and crises (Dong, 2023).

3. Research method

This research paper followed a SLR method for developing an Organisational Resilience conceptual model. The SLR was applied to identify the most critical dimensions influencing organisational resilience (Ruiz-Martin et al., 2018; Dong, 2023). The research followed a structured and rigorous approach to examining existing research and literature to inform the creation of a conceptual model (Xiao & Cao, 2017). Manual and thematic analysis used the N-squared correlation matrix to understand the interrelationship of main organisational resilience dimensions. The conceptual framework clarifies concepts, organises ideas, and identifies relationships with a graphical representation. The conceptual framework is

based on the literature review using the topics, concepts, phrases and theories related to the research question (Shikalepo, 2020; Evenseth et al., 2022). The SLR method assisted in investigating and exploring the main factors influencing organisational resilience and identifying the research gaps for better conceptualisation using system thinking.

The research process followed several significant steps, which are explained in the following sections. The first step was defining the research question related to analysing the current shortcomings in the resilience frameworks. A preliminary search for organisational resilience literature identified key issues and essential dimensions critical to measuring organisational resilience. This identified a gap in the methods and ways of measuring organisational resilience and the general measurement of resilience. There needs to be more consensus about the definitions and characteristics, dimensions, factors or attributes that are key in improving organisational resilience (Bhamra et al., 2011; Burnard & Bhamra, 2019; Braes & Brooks, 2011). Based on the preliminary literature search results, the main research question focused on investigating Organisational Resilience to identify dimensions for a robust measurement and an assessment model. This included how they are interrelated in a dynamic interaction to enhance or compromise resilience over time.

The second step was to define the scope of the research. The study's main interest was organisational resilience in management at the organisational level. Therefore, the study focused on the fields of management and business models, including engineering, given its role in DT. Some of the papers considered were socio-ecological, as most of the research on resilience has been done in this field. These were the foundation literature for understanding the resilience phenomenon and concepts. The literature on psychology, human resource management, finance and economics was discarded because the study in these fields is primarily focused on something other than the organisational level of resilience.

The SLR was conducted to establish the knowledge of the critical dimensions that influence Organisational Resilience and the dynamic interrelationship of the dimensions (Su & Junge, 2023). Several preliminary searches were done to scan the depth of the available literature on resilience and Organisational Resilience, revealing that some authors used enterprises and firms to indicate organisations. An organisation can be defined as "an organised group of people with a particular purpose such as business or government departments" (Ruiz-Martin et al., 2018); hence, companies and businesses were included in the search criteria for the research.

Many other authors also view business and organisations as systems; therefore, the word systems in the search options is used to search for additional literature. Systems can also refer to other systems, such as control systems, computer network systems or mechanical systems. Given that systems have several meanings, especially in engineering, the articles were included once the abstract was reviewed for the organisational resilience material. The preliminary literature scan also revealed that resilience is related to other concepts such as risk, reliability, disasters, redundancy, vulnerability, uncertainty, recovery, prevention, robustness or adaptation.

Therefore, in the final search, the enterprises and firms were included in the keywords on the article searches. The search keywords included *resilience*, *organisational resilience*, *capabilities*, *dimensions*, *resilience defining measures*, *engineering resilience*, *ecological resilience*, *digital transformation*, *and technology disruption*. The combination of search subjects also included *resilience assessment*, *system dynamics*, *systems thinking and organisational resilience*, *adaptive capacity and resilience*, *digital transformation and resilience*, *and complexity science*. Secondary literature data was collected using the Boolean search method in the interdisciplinary databases: Google Scholar, Scopus, Web of Science, ScienceDirect, Academia.edu, ResearchGate, and IEEE Xplore.

The search of the databases returned many articles that needed to be scanned for relevance once the abstracts were reviewed. More than 3000 documents published between the years 1973 and 2022 were located. The search included articles from conference papers, journal articles/papers, editorials, conference review notes, book chapters, review books, systematic reviews, published theses and short surveys. It was noted that Scopus has a more extensive coverage than Web of Science, even though it does not cover some journals. In addition, it provides more search filters. Scopus primarily provided papers in English belonging to the subject area of engineering (reliability engineering and system safety) or business, management, socio-ecological, and accounting.

In the fourth step, the exclusion criteria were defined, and the results were refined based on the paper's keywords and the analysis of the paper titles and abstract. Some documents in the search results did not include any keywords section. To avoid the issue of missing keywords, the abstract and title were considered to include the keywords. The paper with abstract and title without organisational resilience and management were also excluded from the final collection of the research. Some of the papers considered for inclusion were conference papers on organisational resilience. In the final analysis, 155 documents were selected for further detailed analysis to compile the systematic research paper.

In the ST approach and construct, it is recognised that multiple interdependencies within and between different organisations influence their abilities to respond and recover from disruptions in the operating environment (i.e., supply chains) (Seville et al., 2008). The ST approach allows focusing on socio-technological, political, and behavioural aspects and provides a basis for modelling these aspects into the endogenous structure. The literature review and analysis clarified the problem areas and complexity limitations that have constrained

research in developing a resilience framework. The ST methodology identified barriers to applying existing resilience frameworks available in the literature.

4. Results – conceptual framework

The paper developed the Organisational Resilience framework and evaluation model for organisations influenced by DT changes in the service sector. Table 1 indicates the categories of organisational resilience dimensions considered crucial from the SLR investigation outcomes. Organisations face substantial challenges due to the increased speed of societal and technological development, such as decreasing availability of natural resources, increasing energy prices, the advanced age of employees, and the globalisation of markets. Technological advancements impact service organisations as much as they do manufacturing organisations in the future. Technologies used for the manufacturing industry are ubiquitous. As such, they apply to the services industry sectors (Ganzarain & Errasti, 2016).

A Systemigram is typically used to communicate a system fundamental single complex problem in a graphical format or a net previously described in text (Mussante et al., 2011). Systemigram conveys stories about the whole system and articulates the problem considering the complete system perspective. The tool can be used to focus on the individual system components. A system diagram or Systemigram helps translate a system problem from a structured text into a storyboard-type diagram of the system's principal concept, actors, events, patterns and processes. The diagram is a network that is comprised of nodes, links, flows, inputs and outputs that fit on a single page. Nodes represent vital concepts and noun phrases specifying people, organisations, groups, artefacts and conditions (Blair et al., 2007).

Table 1. Organisational resilience dimensions and other key resilience concepts (source: Annarelli & Nonino, 2016; Xiao & Cao, 2017)

Dimensions for Organisational Resilience	References
Adaptability, Flexibility	Annarelli and Nonino, 2016
Agility	Annarelli and Nonino, 2016
Innovation, Creativity, Improvisation	Ma et al., 2018; Xiao and Cao, 2017
Recovery	Xiao and Cao, 2017
Redundancy, Robustness, and Reliability	Seville et al., 2008; Weick and Sutcliffe, 2007
Situational Awareness	McManus, 2008; Stephenson, 2010
Management of key vulnerabilities	McManus, 2008
Adaptive capacity	McManus, 2008; Stephenson, 2010

System Dynamics Modeling (SDM) describes complex and dynamic systems using qualitative/ conceptual and quantitative representations (Assumma et al., 2020). The qualitative modelling uses a causal loop diagram (CLD) tool. The CLD is a tool used to graphically represent the feedback loop structure of the system (Assumma

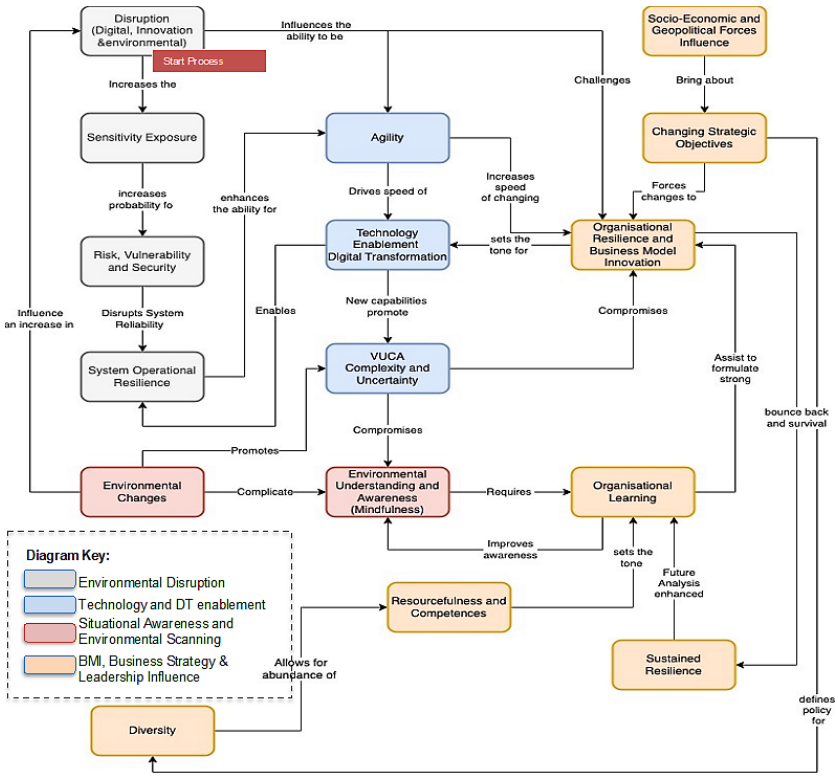

Figure 1. The organisational resilience dimensions interrelationship

et al., 2020). The CLD describes the primary mechanism of the system to define the causes of its dynamic behaviour over time. The transition from a Systemigram to a CLD requires converting the interrelationship of the organisational resilience dimensions into causal relationships that link the related feedback loops. The CLD considers the dynamic relationships of the dimensions and how the loops influence the entire system's behaviour over time.

Figure 1 shows the Organisational Resilience Dimensions Interrelationship model as a Systemigram. It shows the main dimensions and drivers of changes in Organisational Resilience when influenced and affected by disruptions. The identified dimensions and organisational resilience conceptualisation are based on the findings of the results from the SLR (Dong, 2023).

This is a graphical representation of the analysis of the SLR output. It provides the basis for identifying essential variables and the interrelationships between the system dimensions. The interactions in the components of a system are done through feedback loops, which means that a change or increase in an element affects the other interacting components.

The Systemigram starts from the Top left-hand corner, where Disruption impacts Organisational Risk and increases organisational vulnerability. Risk and vulnerability harm operating system reliability and operational resilience. Effective resilience management for a single organisation must be considered through the network of interdependent organisations for their survival from shocks and crises (Seville et al., 2008). That speaks to the way systems are integrated and how they work. The multi-organisational systems are interrelated, and their interactions influence each other in functioning, affecting the systems' complexity in uncertain environmental conditions. Therefore, developing a resilience measurement model is critical to understanding the relevant dimensions (Axmann & Harmoko, 2020).

Organisational Resilience combines capabilities, capacity, characteristics, outcomes, processes, behaviour, strategy or approach, type of performance, or a mix of the traits. These systems operate in complex and uncertain conditions that influence the systems and how they operate (Hillmann & Guenther, 2020). The organisational resilience framework and measurement model will be formulated using an iterative process of defining, selecting, and weighing the resilience model dimensions. The items will be developed using the system dynamics tools and techniques.

Organisational Resilience is a multidisciplinary concept developed across several sectors and disciplines (Marcucci et al., 2021). Many scholars approach resilience assessment using systems theory, specifically through complex adaptive systems. Systems theory does not have a single meaning but is generally an interdisciplinary study of complex systems in nature, science and society (Stolker, 2008). Therefore, ST will form part of the methodology. It is anticipated that system dynamics will be used to create and test the dynamics simulation of the proposed Organisational Resilience framework and evaluation model utilising scenario planning systems dynamic models.

Resilience for organisations is enhanced by their agility, which is improved by their ability to be innovative through digital technology. The DT improves organisational capabilities and promotes the ability of organisations to be more resilient. Innovation has a dual effect on the organisational system, increasing the complexity and uncertainty of the system. A single balancing loop brings a system stock back to its desired state. Several such loops provide resilience, operating through different mechanisms, at various time scales, and with redundancy, meaning one system component kicks into operation if another fails (Meadows, 2009).

The VUCA environment has influenced the organisation's environmental situational awareness. The influence of VUCA compromised the ability of the organisation to anticipate adverse conditions that will also compromise Organisational Resilience. Limnios et al. (2014) recognised that organisational resilience can be desirable or undesirable, depending on the system state. The resilience architecture framework forms the platform for integrating divergent research streams – organisational rigidity, dynamic capability and organisational ambidexterity. This is based on the fundamental basis that organisations start as flexible and fragile entities. They build resilience as they develop into well-structured and tactical organisations aiming to manage their competitive forces and environmental changes. Resilience has a dual manifestation of persistence, as either capacity for learning or resistance to change, and it is a target for situations (Limnios et al., 2014).

The changes in external conditions of the environment also complicate the situational awareness that is required by organisational leadership to have the ability to make strategic changes and also the ability to consider the Business Model Innovation (BMI) that will assist the organisation in weathering the changes external and internal to the organisation. The ability of an organisation to have a deep understanding of the situational condition requires a learning organisation. The advantages of the learning organisation are its resourcefulness and the availability of competence that supports the formulation of strategic, solid, and resilient business models that can withstand the complexity of the operating environment. Socio-economic and geopolitical forces have an increased ability to influence the changing strategic objectives of the organisations. These are the forces that can influence Organisational Resilience change. The changes in strategic objectives also affect the diversity policies adopted by the organisations, which drive the ability of the organisation to acquire the resources and competencies fundamental for the formulation of robust organisational resilience.

Many academics also defined ambidexterity as the ability to pursue innovation incrementally simultaneously and interrupt changes that will shock the organisation

(Aldianto et al., 2021; Zhang et al., 2021; Buliga et al., 2016). It is, therefore, essential to view innovation as a disruptive process that requires organisations to be resilient. According to Buliga et al. (2016), to increase Organisational Resilience, businesses must implement contextual ambidexterity to create an environment that cultivates both the robustness of business-as-usual activities and the adaptability toward new innovative activities. An exploitation strategy increases organisational robustness, and an exploration strategy increases organisational adaptability (Buliga et al., 2016).

Organisational Resilience in the context of engineering and core physics is viewed as the ability of the system to absorb disturbances and consecutively return to equilibrium. These approaches focus on robustness, efficiency and recovery or return to equilibrium rather than adaptive change. In most socio-ecological systems, literature resilience is approached from a positive construct. However, some researchers have highlighted that, unlike sustainability, resilience can be desirable or undesirable depending on the system state (Carpenter et al., 2001). Derissen et al. (2011) investigated the complex relationship between dynamic and normative sustainability concepts. They concluded that resilience could be more desirable and generally necessary for the sustainability of organisations. Resilience may manifest as offensive (adaptation) or defensive (resistance) to internal or external disturbances (Limnios et al., 2014).

Approaches to quantifying resilience stem from various meta-theoretical assumptions and views of resilience that are already prevalent in the resilience research community in the areas related to sociotechnical systems (Amir & Kant, 2018). Although quantitative methods are valuable for comparing resilience levels among various systems, the literature needs a conceptual theory of resilience in sociotechnical systems because systems' definitions and conceptualisations appear to be taken for granted and are lacking (Amir & Kant, 2018). The constructed dimensions interrelationship model in Figure 1 has been used as the basis for the formulation of the CLD that forms the foundation for the Organisational Resilience Conceptual model that will be taken further in the research in the development system dynamics model for building the Organisational Resilience measurement and assessment tool.

5. Discussion

The conceptual model has been developed using the CLD, which considers several organisational components crucial in the dynamics of the organisation as a system. The CLD has mapped out the system structure of the organisation and feedback loops of the organisation as a constantly changing system operating to resist disruptions from internal or external to the organisation. At the high level, starting from the left-hand side of Figure 2, the CLD indicates that the System's Operational Resilience is driven by robustness, recovery level and Redundancy, which positively impacts resilience and the system's sustainability. Continuous learning within the organisation has a delayed influence on organisations' digitisation, digitalisation and, therefore, DT.

DT is also the critical ingredient Of Organisational Resilience. Mangalaraj et al. (2022) indicate that DT is defined as a company-wide phenomenon in which the firm's core business model is reimagined using digital technologies. DT has positively impacted Organisational Resilience by improving the organisation's ability to perceive, integrate, coordinate, and rebuild the organisation during a crisis. As part of the advent of the Fourth Industrial Revolution (4IR) (van Tonder et al., 2020), DT can facilitate strategic Organisational Resilience (Mangalaraj et al., 2022; Zhang et al., 2021).

The CPS has emerged as a unifying name for systems where the computing and communication parts are tightly integrated during design time and operations. The idea of CPS promotes the critical drivers of implementing Industry 4.0, the foundation for the 4IR (Jazdi, 2014; Limnios & Mazzarol, 2011; Limnios et al., 2014). The CPSs are interconnected and integrated systems that provide new functionalities that improve quality of life. Industry 4.0 allows high flexibility in development, diagnostics, and maintenance, including operating automated systems (Jazdi, 2014). CPSs enable real-time internet-based communications and collaborations amongst value chain devices, systems, organisations and humans, enhancing situational awareness that supports organisational decision-making (Limnios & Mazzarol, 2011).

DT is all about disruption, and strategic adaptation to digital technologies leads to enterprise-wide transformation. The transformation is meant to improve value creation, operating efficiencies, organisational agility, and overall performance (Hurlburt, 2021). The 2020 Harvard Business Review, as cited by Hurlburt (2021), has concluded that DT is more about the talent and skilling of individuals than technology (Hurlburt, 2021).

DT is about harnessing technology using skilled talent. The article by Hurlburt (2021) emphasises that soft skills such as intellectual curiosity, the desire to learn (i.e., continuous learning), creativity, improvisation and flexibility (i.e., agility) are essential to innovative breakthroughs. The literature study by Buliga et al. (2016) showed that BMI is integral to the organisational response and corresponds with adaptation as a constitutive element of resilience (Buliga et al., 2016).

Organisations are open systems operating under conditions of substantial turbulence, risks (vulnerability and security), and uncertainty (complexity), and the organisations are seeking to balance stability and coherence with flexibility and change that will help to achieve high levels of efficacy and routine excellence (Carayannis et al., 2014). BMI must be premised on organisations innovating and exploiting their internal capabilities and resources to leverage organisational innovation strategies (Carayannis et al., 2014).

Business models constitute a plan's primary drivers and hold the key for decoding, understanding, and effectively communicating the strategy internally and externally to the organisational ecosystem (Carayannis et al., 2014). According to the research study by Carayannis et al. (2014), the application of BMI is required for organisational sustainability, resilience and intelligence. The BMI competencies incorporate resources, dynamic capabilities, and corporate entrepreneurship to develop competitive advantages and explore new opportunities to achieve Sustainable Enterprise Excellence (Carayannis et al., 2014).

Studies about resilience are well documented, and it is also well acknowledged that resilience is conceptualised as a dynamic and adaptive property of systems with multiple stable states that have evolved (Meerow & Newell, 2015). Several growing literature studies on resilience have concluded that the concept of resilience is referred to as a concept related to the absorption capacity of shock impact and the ability to recover to stable equilibrium and avoid the tipping point (Burnard & Bhamra, 2019).

The CLD in Figure 2 shows some loops with important variables influencing Organisational Resilience. The first loop that will be focused on is indicated in green. The CLD was constructed based on the literature review of all the identified Organisational Resilience dimensions.

The Disruption and Vulnerability loop: The initial stage of CLD analysis is the disruption trigger that influences organisations' resilience changes. The interrelation with perturbation and the stressors that occur due to environmental changes caused by environmental changes. The disruption (i.e., Digital, Innovation and Environment) influences the system vulnerabilities and increases the risk profile with the deterioration of organisational security. Figure 2 shows the reinforcement loops labelled (R8). Disruptions in the environment could be caused by environmental, economic, technological, social and/or political changes. The perturbation and stress interrelationships influence the exposure and sensitivity of the organisation's resiliency. This reinforcing loop drives an unfavourable influence on Organisational Resilience.

Operational System Resilience – Robustness, Reliability and Adaptability Loop: This CLD section is depicted by the bold blue-coloured arrows in Figure 2. The loop is complex, with several interactions with the essential variables for resilience. The exposure and sensitivity negatively influence the robustness and system redundancy of the organisation. The vulnerability and risk positively increase and drive the system's sensitivity and exposure factors. The robustness positively reinforces reliability and positively influences the system's operational resilience. The increase in resilience has, therefore, a positive effect on the recovery against organisational disruptions. Robustness positively affects the system's reliability and positively contributes to operational resilience. The increase in vulnerabilities also negatively influences the organisation's adaptive capacity. The adaptive capacity in the organisational systems' potential capacity to adapt to the vulnerabilities. Increased adaptive capacity positively reinforces the organisation's adaptability and flexibility. Adaptability drives increased system operational resilience. R1, R19, R15, R19, R13 and R16 indicate the Systems Operational Resilience interrelationship variables for robustness and adaptability. All the loops reinforce the System's Operational Resilience. The system's operational resilience improves organisational agility, reinforcing adaptive capacity organisation.

Technology for the Strategic Enablement – Digital Transformation loop: The loop shows that DT introduces new innovative technologies that are disruptive to the system. DT positively influences the transformability that prepares the organisation for its transformation. A time delay exists between the time it takes for innovative new technologies to shift the system capabilities and

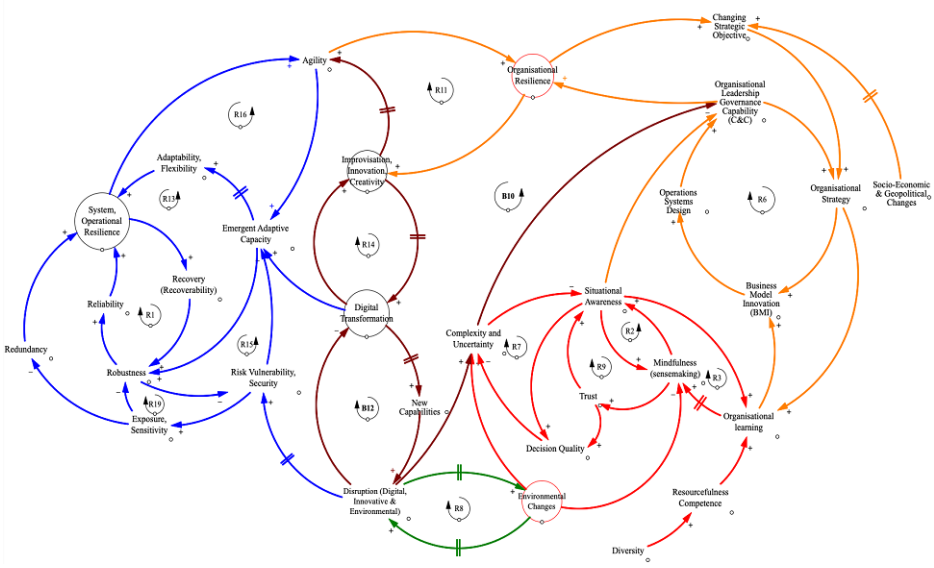

Figure 2. Organisational Resilience Conceptual Model using CLD

disruption. The loop indicated by (R14) shows variables that drive organisational innovation through DT. This process has the drive to improve Organisational Resilience through the innovation process of products. DT enables the organisation to build new capabilities that will, over time, create technological and Innovative disruptions (indicated by the balancing loop labelled B12 in Figure 2) through the system. DT has a dual impact on the system, given that organisations implementing DT can develop more innovative and creative solutions. The promotion of DT can also capacitate the organisation by increasing the Emergent Adaptive Capacity, which also drives the strengthening of System operational resilience loops.

Situational Awareness to Understand the Operating Environment Loop: Environmental changes influence uncertainty, and innovation adds complexity that impacts the organisation and its resilience. The impact of situational awareness as the driver of information collection and sensemaking of environmental scan assists with quality decision-making. Situational awareness is how organisations understand the operating environment and make well-informed decisions that help improve or advance organisational resilience. Trust in the decisions and quality decision-making is essential to the reinforcing loop for situation awareness. Situational awareness is also an integral component of organisational learning that drives the input of information utilised to consider new BMI and formulation of organisational strategy.

The VUCA environment harms the situational awareness within the organisation. Understanding volatility in the environment harms a better understanding of the operating situation, influencing organisational decision-making. An improvement in situational awareness positively influences expectations and sensemaking (mindfulness). The expectations have a positive impact on trust and, therefore, decision-making. The improvement in sensemaking has a positive impact on situational awareness. Situational awareness impacts command and control and influences the strategy and organisational design loop. The situational awareness loop is driven by several reinforcement loops depicted by R2, R3, R7, and R9.

Organisational Resilience, Business Model Innovation (BMI) and Strategy Loop: The fourth critical major loop component influences the organisational strategy and BMI, which is influenced by increased organisational leadership command and control and governance capabilities that drive a positive direction in formulating organisational strategy. An organisation's strategy affects an increase in BMI. Changes in BMI reinforce the positive direction of the operations system design. The operational system design influences leadership command and control, impacting Organisational Resilience. In return, Organisational Resilience positively influences Improvisation, innovation and creativity, which also has a delayed impact on organisational Agility over time.

Organisational command and control are influenced by leadership that uses the information gathered from situational awareness to make informed organisational strategies. Command and control have influenced the organisations' capability to improvise, innovate, and be creative based on the information analytics gathered from situational awareness. The organisational strategy influences the organisational learning culture, which also influences the innovation knowledge required in the business model innovation and the technical knowledge to improvise and innovate organisational systems.

The organisational culture is driven strongly by organisational learning and is developed over time. Hence, the delay required before organisational learning can be incorporated into an organisation's business decision-making culture and way of life. The Socio-economic and Geopolitical changes also influence the changes in organisational strategic objectives that act as input to organisational strategy formulation. These are critical drivers for an organisation to be resilient to adverse disruptions.

6. Conclusions

The paper's in-depth analysis of available literature on Organisational Resilience as a phenomenon identifies and confirms the principal dimensions and variables. A conceptual model of the interrelationship of Organisational Resilience elements was presented using ST with Systemigram and CLD. The CLD is the foundation of the model that is the basis for view for future research that will be used in developing an assessment and measurement resilience tool that uses system dynamics theory methodology. This has been divided into different components: disruption and vulnerability loop components, operational systems resilience, technology for the strategic enablement component (DT), organisational resilience, business model innovation, and strategy and situational awareness to understand the operating environment. The research concludes that organisational resilience dimensions are multifaceted.

According to the suggested working definition, resilience is an emergent quality related to the inherent and adaptable traits that permit an organisation to take a proactive approach to threat and risk mitigation (Burnard & Bhamra, 2011). Regarding the theory, the study offers insights into the fundamental dimensions and measurement variables for building and sustaining Organisational Resilience. The paper also lays the foundation for measuring resilience using the developed conceptual model through system dynamics as a novel and fresh measurement framework to explore further. Many scholars have frequently suggested that organisations should have the potential resilience to handle escalating problems. The research needs to reach a consensus on the concept of Organisational Resilience (assessment, measurement and implementation), even though the idea has been widely used in various fields and frequently discussed with different connotations (Annarelli & Nonino, 2016).

Refining the CLD and making it more reliable and robust will require engagement with several representatives from academia and industry, including government departments, where relevant primary data can be collected to refine and improve the validity and reliability of the proposed mental model (conceptual model). Engaging with the Expert SD stakeholders will also assist in making the conceptualisation of resilience more trustworthy and robust. According to Quinlan et al. (2016), the understanding of complex adaptive systems will always be partial and incomplete because of the dynamic nature of the system, and the imprecise measurement of imperfect system models is still valuable for understanding complex "wicket problems" (Quinlan et al., 2016). Based on the inaccurate and incomplete resilience assessment metrics, resilience measurement is expected to not be perfect; however, the expectation is that it will be helpful in practice to assist organisations in making well-informed decisions about their resilience and sustainability.

The main limitation of the conceptual model is that it requires verification and validation for the reliability and robustness of assessing organisational resilience. This will be achieved with further research to solicit expert knowledge on system thinking and system dynamics modelling that resembles reality.

Further research

Based on the insights gathered from the literature review, researchers formulate a conceptual framework for the Organisational Resilience model. This framework outlines the critical dimensions, components, and relationships the model will incorporate. It often draws on existing theories, models, and concepts from various disciplines such as management, engineering, psychology, and sociology. The next phase will involve resilience and system dynamics experts to validate and refine the conceptual model. The data collection will be conducted through Expert focus group structured interview sessions and processes. Post-model validation and refinement of the conceptual framework, a stock and flow dynamics model will be developed to build towards a simulation model for Organisational Resilience.

Validated and tested models can be used in real-world situations to test different policy scenarios and measure resilience over a long-term period. Future research will apply system dynamics to develop a robust model and simulation for measuring organisational resilience when considering policy changes or adjustments. Understanding complex adaptive systems will always be partial and incomplete because of the dynamic nature of the system and the imprecise measurement of imperfect system models (Quinlan et al., 2016). Based on the imprecise and incomplete resilience assessment metrics, resilience measurement is expected to be imperfect.

Acknowledgements

The authors would like to acknowledge all the people who have provided guidance and also questioned some of the thinking applied in producing this research. It has elevated the quality of the work that resulted in this paper being considered for the conference. The support that has been provided by the UP GSTM community has been invaluable to the production of this work.

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