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Digital Sustainability Model A New Approach in Business Model Innovation

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Abstract

Objective: Although one of the most significant business challenges is in the field of financial and economic issues, the businesses during the last few years have faced two other new challenges including the requirements of sustainability, as well as the proper and timely use of digital transformation tools. For this reason, businesses should emphasize the challenges of social, environmental, and digital transformation aspects in addition to sustainable economic profitability challenges to consider these issues as the main challenges of their business model. However, businesses need new dynamic capabilities with the changes posed by new challenges. Such inner capabilities focus on digital sustainability and evolution. With the onset of the COVID-19 disease, the need for attention and acceleration of the creation and development of such capabilities in businesses became completely apparent.
Method: The research method was of mixed type based on six research methods of Meta-Synthesis, Thematic Analysis, Interpretive-Structural Model, Cognitive Rating Cluster Map, DEMATEL, and Analytic Network Process.
Results: The model proposed in this study included three approaches, three aspects, seven dimensions, and 19 components. Based on quantitative modeling, its seven main dimensions were considered in three aspects as "digital/sustainable direction", digital/sustainable execution", and "digital/sustainable results".
Conclusion: Three dynamic digital /sustainable capabilities such as sensing opportunities and threats, seizing opportunities, transforming, as well as new dimensions called "digital scouting", "sustainable computing" and "sustainable engagement were presented in the digital sustainability model.

Keywords: "Digital Sustainability", "Business Model Innovation", "Dynamic Capabilities"

1. Introduction

Digital sustainability in a broad sense can be defined as "organizational activities which seek to advance the goals of sustainable development by using the technologies which create, use, transfer or store electronic data" [1]. On the other hand, the theoretical analysis between the digital aspects of human life and more sustainable concerns for humanity and Earth as well as the way digital technologies and processes of functional catalysts are realized to achieve the 2030 goals of the United Nations for everyday life is of great importance. Digital technologies have had a significant effect on innovation and transformation, on the environment, people's lives, society, and economy. Digital technologies have changed the ways to communicate, study, work, interact and even look for friends, relationships, and love. Thus, it is critical to consider the effect of the digital transformation on individuals and in the broader social, economic, and environmental context [2].
Thus, the current very dynamic and rapid business environment has made organizations move towards innovation and continuous change quickly. Such dynamics and changes have been derived from two significant factors such as "sustainability and digitalization" [3]. In this regard, the two main challenges considered as the main drivers of the creation and necessity of innovation in business models include the business sustainability strategy which emphasizes environmental and social factors along with the economic factor [4,5], and the digital developments resulting from the digitalization of the business environment and the creation of new opportunities from the use of digital technologies [3, 4, 6].
Sustainability: Sustainability is the business issue of the 21st century [7]. According to Brundtland, "sustainable development is a development which meets its current needs without endangering the ability of future generations" [8]. Based on the urgent call of the United Nations for the realization of sustainable development goals, businesses should submit their social and environmental reports alongside financial reports. This issue has become more significant, especially after the environmental disasters, as well as the significance of public health [9, 10]. To realize the strategy of sustainability and the principles of sustainable development, the significance of sustainable business in the first and second decades of the 21st century has been increasingly regarded [11]. Sustainability is one of the critical challenges that businesses face today; In this regard, businesses should have an appropriate response to social and environmental issues along with economic issues to their stakeholders [12,13]. To gain a sustainable competitive advantage, organizations have considered

the compatibility of their products and services for protecting the environment and improving the health and well-being of people and society as their main priorities [14]. Thus, considering the maximum short-term profitability towards creating long-term values for all stakeholders can result in the creation of a sustainable business model. Such organizations aim to change their business model fundamentally to pay special attention to social and environmental issues, as well as economic issues [12,15]. Currently, sustainable business development is the focus of business researchers and policymakers and is the main focus of academic centers. Supporting sustainable business is increasing by the supporters seeking to eliminate the negative environmental effects of production and consumption systems (natural resources and energy) as well as considering societal challenges (welfare, public health, and well-being [16]. Regarding the ambiguities related to sustainability, managers often have ambiguities on how to turn their businesses into sustainability, how to have long-term profitability in their sustainable business models, as well as social and environmental issues [5, 17,18]. Based on statistics, 90% of millennial or Y generation people (at the age of 20 or early 30 in the US) spend more than 180 billion dollars per year to move towards brands that consider more social and environmental responsibilities [19].

Digitalization: One of the effects of digitalization is that a highly dynamic and changeable environment has led businesses towards innovation and constant changes. It seems that sustainability management in the digital environment has been of axial importance to planners and policymakers, considering a wide range of new opportunities ahead for businesses as new information technologies in combination with sustainability [3]. The business environment for businesses has been influenced by digital transformations during the past decade. As a result, the focus on innovation in the business model has grown rapidly [20]. Digitalization has affected all parts of society, especially economies. Now, businesses have the opportunity to apply new digital technologies such as social networks, mobile phones, big data, IOT, and Blockchain as well as artificial intelligence and cloud computing to completely change their businesses [21, 22]. During the last decade, a new concept has been introduced as the concept of "digital transformation" due to the widespread development of technology [23]. In this regard, businesses and organizations are undergoing an inclusive and influential transformation of digital transformation [24]. Digital transformation is defined as the use of new digital technologies for significant advances in business such as enhancing the customer experience, simplifying performance, or creating new business models." Successful companies (e.g., Apple) can open new ways to create value for the customer with the help of new technologies [21]. In general, digital transformation can be defined as the refinement (adaptation) of business models, resulting from the rapid changes in technological advances and innovations which change the behaviors of customers and society [23]. For this reason, the use of digital technologies and digitalization has been highly effective in re-creation and innovation in the business models of organizations [25].

The technologies of the digital era have had a profound effect on the business model by deconstructing all industries. Digital technologies have resulted in disruptive innovations in the business model [27,26]. It should be noted that while the depth and speed of innovation have increased unprecedented speed and complexity after digital transformations, new technologies rarely change businesses unless there is an innovation in the past business models which adapts new technologies to the market needs [17]. Digital transformation is "an organizational transformation which integrates digital technologies and business processes into the digital economy" [21]. Thus, organizations should create new digital values in the business model based on these technologies [26]. In the digital era, the success of many traditional businesses has depended on the appropriate and timely use of digital tools and technologies and this has become a major challenge for many organizations. For this reason, businesses large and small have considered the innovation of business models based on new digital technologies as a top priority [28]. However, just adding a digital element or tool to the existing business does not cause a fundamental change to the business model. Technology is only a factor of empowerment and not a goal; Thus, new digital technologies and tools are accelerating and can drive business model innovation [27]. In addition, consumer behavior is changing in response to the digital revolution. Market data indicated that consumers move their purchases to online shops and the multiplicity of digital calls with the help of digital technology tools such as social networks, mobile, artificial intelligence, play a key role in customer choice affecting both online and offline sales [6]. Thus, the rapid development of digital technologies and the resulting innovation have changed the behaviors of customers and people [23].

Based on the conducted studies, one of the effective factors in achieving faster sustainable development can be the use of the capacity of digital technologies [13]. To innovate the business model of organizations, it is necessary to evaluate the interaction and alignment between digitization measures related to sustainability [29, 7, 13, 14].

However, with what capabilities and how can organizations drive their business towards digital sustainability? Indeed, how social and environmental factors are regarded alongside economic factors and have the necessary dynamism in the face of rapid digital changes are ambiguous [17,30]. Furthermore, a business model may lose its sustainability over time despite achieving sustainability. Thus, it is necessary for organizations to constantly make internal changes for creating integration within or flexibility with their environment. Therefore, the sustainability of business models depends on the dynamic capabilities of a business [31]. Teece (2017) argued that the ability to manage the development and -re-creation of business models is a primary foundation of dynamic capabilities. This is true not only for the initial design of the business model but also for the replacement and transformation of model elements that change over time [32]. Even dynamic capabilities can accelerate and facilitate innovation for business models in organizations [33].

Unlike normal capabilities, which are mostly used in the approaches related to a monotonous and calm environment and are focused on converting resources into a value proposition, value creation, and value capture, dynamic capabilities are in charge of resetting and converting available static resources, knowledge, and competencies into "innovative products and processes" due to changes in the external environment [34]. Thus, success in creating a business model requires the creation of a set of dynamic capabilities which enable organizations to recreate the elements of their business models in line with their changing environment [35]. Studies have indicated that the presence of dynamic capabilities in organizations helps the better use of digital transformation opportunities [36]; To achieve sustainable business model innovation in the digital era, it is necessary to evaluate the way of using the dynamic capabilities of organizations [31]. In addition, innovation in business models is the output of their dynamic capabilities. In this case, managers should identify the capabilities required by their business and, if necessary, review or re-innovate their business models for gaining a competitive advantage [31, 37].

Numerous studies have been performed on the subjects of digital sustainability, business model innovation, and dynamic capabilities. However, none of them has been considered fully and has not become a comprehensive model. Thus, providing a model which can be a good model for the success of digital sustainability is the main objective of this study. Accordingly, the objectives of this study are as follows:

1- Identifying the key elements for providing a digital business sustainability model such as: "digital sustainability", "business model innovation" and "dynamic capabilities".
2- Providing a thorough and integrated model of sustainable digital business based on dynamic capabilities.

2. Review of the literature

In this section, first, the theories related to the main elements and dimensions of the subject are evaluated. Then, the definitions and descriptions of each of these elements and dimensions are presented. Although the main approach used in this study was related to the theory of dynamic capabilities, this theory was originated from the theories of Resource-Based View (RBV), Knowledge-Based View (KBV), and Network Theory (NT) [38,39,40]. Theories related to digitalization included Digital Transformation (DT), Resource-Based View (RBV), and Dynamic Capabilities Theory (DCT) [43, 41, 42]. Theories related to sustainability included Strategic Choice Theory, Social Network Theory (SNT), Resource-Based View (RBV), Social Network Theory (SNT) (46, 45, 44). Theories related to the business model included Dynamic Capabilities Theory (DCT), Resource-Based View (RBV), Business Strategy, Strategic Theory & Network Theory (NT) [29, 40, 47, 45, 44, 48, 49]

In summary, the approach used in this study was dynamic capabilities originated from source-based theory and created a network theory.

Digital Sustainability - Business Model Innovation (DS-BMI)

Digital sustainability refers to a business activity that seeks to advance the goals of sustainable development through the creative use of digital technologies that create, use, and transfer electronic data sources [50; 51].

Digital sustainability can be broadly defined as electronic tools, systems, devices, sources of production, storage, and use of data in business models to create social and environmental value using the leverage method [52, 51].

The acquisition model consists of value proposition [53, 15, 27], value creation, value delivery, and value capture components [25, 29, 15]. Despite the extensive literature on the business model, it is not yet clear what drives business model innovation [54, 55]. The ideas on the conceptualization of a "sustainable business model" seem highly diverse [12]. Sustainability issues have increased over the past ten years [56]. The growth of problems due to the depletion of water

resources, air pollution, low indicators of human development, low economic growth, and climate change have completely confused policymakers, experts, and researchers [57]. Today, with the advent of social disasters such as the COVID-19 and the resulting financial crises, as well as natural disasters such as bad weather, organizations have to revise their business model more than ever to create the maximum shared value for all their stakeholders. To achieve this goal, businesses should innovate in their business models [9]. Sustainable business model innovation means creating an exclusively new business model or changing the current business model components to eliminate sustainability issues for stakeholders for creating a sustainable long-term competitive advantage [55]. In previous studies, sustainable business model innovation has been introduced as an appropriate solution to achieve competitive advantage while solving social and environmental problems. It refers to a change in the way of doing business by taking into account serious concerns about social challenges and the environment in the main measures of business. Thus, sustainable business model innovation can be regarded as a determining factor for improving the positive effects and reducing negative effects on the environment and society. For this purpose, it is necessary to change the value proposition, value network, and value acquisition [15]., Hence a business should seriously seek to create positive value for society and the environment and also optimize value for itself and a wider network of stakeholders, such as the general public as stakeholders [15]. A sustainable business model should pay attention to all components of sustainability. To consider all three sectors of social, environmental, and economic, Osterwalder's nine-element three-layer business canvas can be used; In this case, a three-layer model can be designed in which each economic, social and environmental sector is used in one layer [16, 9, 8, 58, 59]. In a simpler form, the three layers of economic, social, and environmental can be regarded only in the value proposition of Osterwalder's business [60].

Digital transformation is changing the way small and medium-sized enterprises create and capture value [61]. The digital transformation and innovation in the resulting business model have mainly put pressure on consumer expectations and behaviors, as well as traditional companies, resulting in the disruption of countless markets [6]. The concept of digital transformation has appeared during the last two decades due to the growth and development of digital tools and the widespread effect of digital technologies on businesses so that digital transformation can be regarded as a new paradigm in the way of doing business, leading to the re-creation or innovation of business processes and models, as well as changes in consumer social behaviors and improvement of customer experience [32]. Thus, one of the applications of digital technologies in businesses is to change people's lifestyles to protect the environment and reduce pollution (water, soil, and air) as well as to create equality and social justice by providing equal and transparent access to limited resources on Earth [17]. Since digital technology can be used for the feasibility and improvement of performance, a combination of IT capabilities with sustainability goals can bring about positive
changes in terms of economic, environmental, and social benefits [3].

Digital Sustainability- Business Model Innovation-Dynamic Capabilities (DS-BMI-DC)

Dynamic capability theory has been presented as an approach to creating the concept of innovating in the business model [40]. Dynamic capabilities are based on innovation and can provide the ability to create, expand and modify the company's main resources. Dynamic capabilities are comprised of three main parts: (1) sensing opportunities and threats, (2) seizing opportunities, and (3) transforming and reconfiguring the organization’s business model based on the internal resources of the organization. Due to the destructive nature of digitalization, it is possible to use the dynamic capabilities framework as a powerful lens for evaluating digital transformations in the business environment to move from the traditional approach to digitalization [21]. Specifically, it has been reported that companies should build strong dynamic capabilities to create, implement and rapidly transform business models to be relevant in the emerging digital economy. Gaining a competitive advantage in a rapidly changing world in terms of technology and meeting social and environmental needs is only probable by creating and strengthening the internal capabilities of businesses. Dynamic capabilities are the result of a combination of management, learning, and restructuring processes.

For this purpose, businesses must analyze the environment to identify new changes and restructure themselves with what may lead to a competitive advantage in the environment [38]. For Teece (2007) dynamic capabilities include the capabilities of "sensing the measures of changes, seizing, and obtaining values and finally transforming" which are necessary for designing, deploying, and innovating the business model. According to Teece (2018), the creation of dynamic capabilities helps to identify opportunities, provide resources that help to develop, review parts of the business model, change the structure and organizational culture [62]. Thus, businesses need to focus on using their domestic

dynamic capabilities for digital transformation and innovation in their business models [32].

3. Research Methodology

This qualitative and quantitative study was conducted with the help of six methods of Meta-synthesis, Thematic analysis, Interpretive-structural modeling, Cognitive rating cluster map, DEMATEL analysis, and Analytic network process.

Meta-synthesis is considered as an integrative method for qualitative synthesis which is applied to integrate, evaluate, and interpret the findings of multiple qualitative studies to transform individual findings into conceptualizations and interpretations [63]. Qualitative meta-synthesis is applied for reviewing qualitative studies systematically with a common focus. Scholars can reanalyze and interpret current qualitative studies through this method to produce new findings [64].

Thematic analysis refers to a qualitative research method that has been extensively applied in knowledge and research questions. According to Braun and Clarke, six phases were executed in the thematic analysis: (1) introducing one's data, (2) creating initial codes, (3) searching for themes, (4) reviewing the themes, (5) defining and naming the themes, and (6) generating the report [65].

The ISM (Interpretive structural model) is a mathematical methodology aimed at identifying the interrelation between complicated factors clearly or explaining a problem. If it is a complex relationship, it will not be easy to analyze the interrelation between the factors accurately. The ISM can explain a complicated interrelation between factors explicitly in a hierarchy [66].

The implementation steps of this method are as follows:

1. The factors are identified appropriately for analyzing the value using a literature review and systematic meetings
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3. A structural self-interaction matrix (SSIM) that can represent results through properly defined factors is created.
4. A reachability matrix (RM) is composed of the SSIM, and approves a transition matrix. The RM is turned into a binary matrix through 0 and 1. The transition rule of the conceptual relationship in the factor is that, if factor S is related to factor D and factor D is related to factor F, then factor S will be the main assumption of ISM, being related to factor F.
5. Based on the results of the fourth step, the RM is categorized step by step.
6. A directional graph is drawn according to the staged matrices and removes the transition relationship from the RM. Furthermore, directional graphs are changed into the ISM-based model to change the nodes between each factor of the directional graph [66].

MICMAC Analysis (Matrix of Cross-Impact Matrix Multiplication Applied to Classification): In MICMAC analysis, factors are classified into four clusters regarding the driving power and dependence power. Such clusters include Cluster I: Autonomous Factors—factors which are relatively cut off from the system and have poor or no dependency on other factors; Cluster II: Dependent Factors—cluster II factors are mainly dependent on other factors; Cluster III: Linkage factors—the connecting factors that are unstable and have the most effect on others; and Cluster IV: Independent Factors— such factors have a poor effect on other factors and should be highly considered due to the strong key factors [67].

Cognitive mapping refers to a "technique that captures an individual's attitude on a special issue in a graphical representation" [68]. Cognitive mapping involves diagraming individual mental models on a topic, creating graphical representations that show breadth and depth of understanding [69]. It lets participants show their understanding of the phenomenon in a multi-dimensional and individually special way, using a mixture of words, phrases, relationships, and ideas that are associated with describing the phenomenon and being limited only by the participant's ability to transfer ideas through their written, inventive, and verbal skills. The cognitive mapping method in this study uses a low-directed technique with minimal instructions allowing participants' discretion as they select how to identify and organize the concepts, they consider to be significant to the subject [68].

DEMATEL refers to a comprehensive analytic method for deriving the causal relationships in aspects or criteria related to a decision-making problem [70]. DEMATEL method is used in solving complex problems according to the management and determines the criteria, requiring more focus. The DEMATEL uses the structural modeling technique to find the relationship among the criteria in a system using a digraph. Such a digraph helps in evaluating and identifying the causal relationship between the criteria and makes the decision based on the expert's judgment [71]. The formulating steps of the classical DEMATEL are summarized as follows: Step 1: generating the group direct-influence matrix Z. Step 2: establishing the normalized direct-influence matrix X. Step 3: building the total-influence matrix T. Step 4: generating the influential relation map (IRM). Step 5: having a net influence matrix. Step 6: calculating the importance weights for criteria [72]. The ISM

method was used for describing the relationship among different factors through a multi-level hierarchical structure, creating the complicated relationships clear, and prioritizing the selected factors. The use of DEMATEL helped the researchers to measure the interactive effects of the factors selected quantitatively [73]. The DEMATEL method develops a cause-and-effect diagram according to a mathematic formulation. Furthermore, this relationship is applied as an initial dataset for the ANP method [74].

Many multiple criteria decisions making (MCDM) methods have been created during the past few decades. Analytic network process (ANP) is one of the most famous methods for deriving the weights related to an MCDM problem. The ANP provides a more realistic solution of weights to complicated MCDM problems with feedback and influence relationships inside the structure of decision problems by considering the dependency of aspects and, criteria. Although the ANP can derive more realistic solutions compared to traditional MCDM methods which assume independency among aspects and criteria, the analytic process based on the ANP is highly insignificant. Numerous iterations of questionnaire collections are normally needed for studying opinions from experts. A structure of the decision problem should be made before using the ANP through the methods such as Interpretive Structural Modelling (ISM) or DEMATEL. Then, the pairwise comparisons of the significance versus each criterion and weight can be derived according to another iteration of the questionnaire [70].

Decision-Making Trial and Evaluation Laboratory—Analytic Network Process (DEMATEL-ANP) multi-criteria techniques are applied for determining the weight coefficients of evaluation criteria [74]. The DEMATEL technique is applied to create an influential network relation map (INRM), and it is expected that the DEMATEL based Analytic Network Process (DANP) obtains the influential weights through the basic concept of Analytic Network Process (ANP). Thus, the DEMATEL technique can be applied for creating an INRM for each criterion and dimension and improving the normalization process of the traditional ANP. The DANP refers to a suitable tool to involve interaction and interdependence among the dimensions and criteria that appear in the cases of real-world problems. Based on the concrete properties of objective affairs, the methodology can approve the interdependence of variables and attributes, creating a relationship that shows such properties with an essential system and evolutionary trend [75].

Results Discussion

Qualitative part:

By meta-synthesis method, first, the terms Digital Sustainability, Business Model Innovation, and Dynamic Capabilities during 01/01/2010 - 30/04/2021 were searched in the databases of Science Direct, Scopus, Web of Science, and ProQuest (specifically in Articles' title), and 282 articles were found. After eliminating the common items and three times screenings in the title, abstract, and content of 34 final articles were selected. After an accurate and in-depth review of each article, the primary and secondary codes were extracted. Then, the extracted final codes were classified based on the thematic method following the research subject.

Findings of the qualitative part

The results of the meta-synthesis and thematic analysis are summarized in "table 1".

Table 1- The sequence of links between approaches, aspects, dimensions, and components (in three parts A, B, C)

A) Approach 1: the ability to sense and recognize changes- drivers of digital sustainability value creation

Approach	Perspective	Dimension	Component	Reference
Digital Sustainability Sensing Capabilities	Direction (Digital/ Sustainable)	Sustainable Computing	Customer Behavior Changes (Digital/ Sustainable)	[76] [77] [78] [79] [49] [80] [81] [82] [29]
			Society Changes (Digital/ Sustainable)	[76] [77] [78] [81] [82] [29]
			Environmental Changes (Digital/ Sustainable)	[76] [77] [78] [82] [29]
		Digital Scouting	Industry 4.0	[83] [80] [81] [29]
			Digital Transformation	[76] [83] [79] [49] [80] [81] [29]

B) Approach 2: the ability to capture and seize opportunities - redesigning digital sustainability values

Approach	Perspective	Dimension	Component	Reference
Digital Sustainability Seizing Capabilities	Execution (Digital/ Sustainable)	Value Delivery	Customer Relationships	[55]; [84] [78] [81] [47]; [48]
			Channels (Networks)	[85] [86] [55]; [87] [88] [77] [84] [78] [91] [48]
			Customer Segments	[55] [84] [78] [81] [47]; [48]
		Value Creation	Key Activities	[55] [84] [78] [81] [47]; [48]
			Key Partners	[85] [86] [55]; [84] [78] [81] [47]; [48]
			Key Resources	[55]; [78] [81] [47]; [38]; [48]
		Value proposition	Products	[86] [8]; [58] [84] [90] [89] [78] [80] [81] [48] [92]
			Services	[44] [58] [84] [90] [89] [78] [79] [80] [81] [48] [92]

C) Approach 3: the ability to transform and reconfigure - creating new digital sustainability values

Approach	Perspective	Dimension	Component	Reference
Digital Sustainability Reconfiguring Capabilities	Results (Digital/ Sustainable)	Sustainable Engagement	Customer Engagement	[93] [87] [82]
			Social Engagement	[85] [87] [91] [82]
			Environmental Engagement	[85] [87] [91] [82]
		Value Capture	Economic Profit	[86] [94] [55] [95] [12] [84] [48] [29]
			Social Benefit	[86] [94] [55] [95] [12] [84] [29]
			Environmental Benefit	[86] [94] [55] [95] [12] [84] [29]

Quantitative part:

After finalizing the selected dimensions and elements in the qualitative part, the interpretive-structural modeling (ISM) method was used through the snowball sampling method, and 12 experts and specialists with doctoral and master's degrees who had knowledge and experience in the subject of the study were selected to complete the matrix questionnaires.

As indicated in "Table 2", the final seven dimensions and the symbol of each dimension are specified. Based on "tables 1 - 6" (Appendices), the steps of interpretive structural modeling were performed, and finally, the model in this step is displayed in "Figure 1".

Table 2- Codes used for the approved variables

Symbol	Dimension	Symbol	Dimension
BMI1	Digital Scouting	BMI5	Value Delivery
BMI2	Sustainable Computing	BMI6	Sustainable Engagement
BMI3	Value Proposition	BMI7	Value Capture
BMI4	Value Creation		

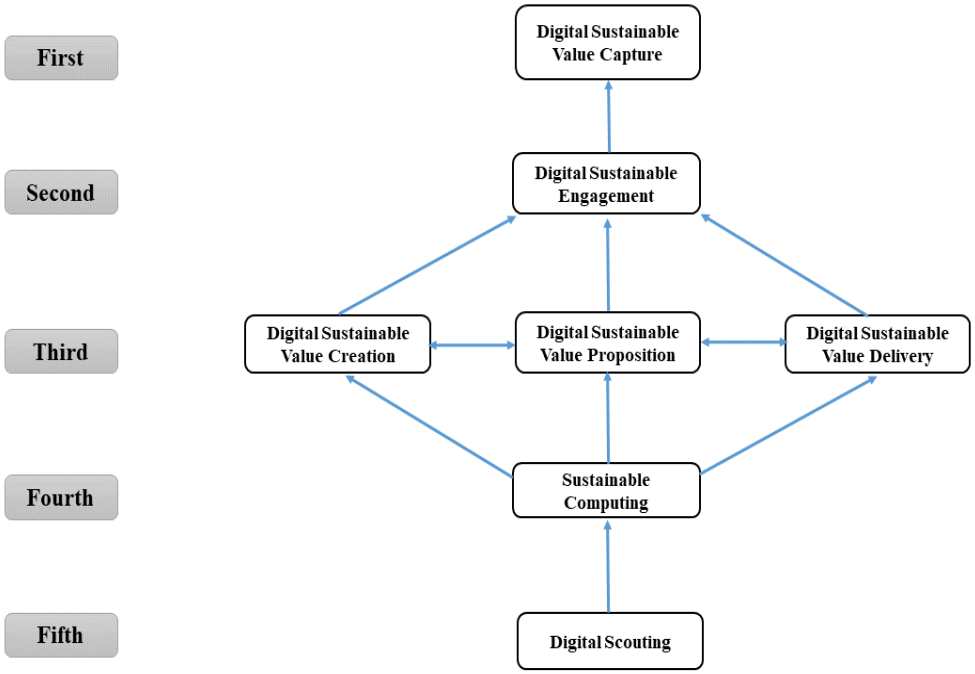

Figure (1) Interpretive structural model (ISM)

As displayed in "Figure 1", digital scouting is the first dimension of fashion that affects all other dimensions and then value capture is affected by all other dimensions.

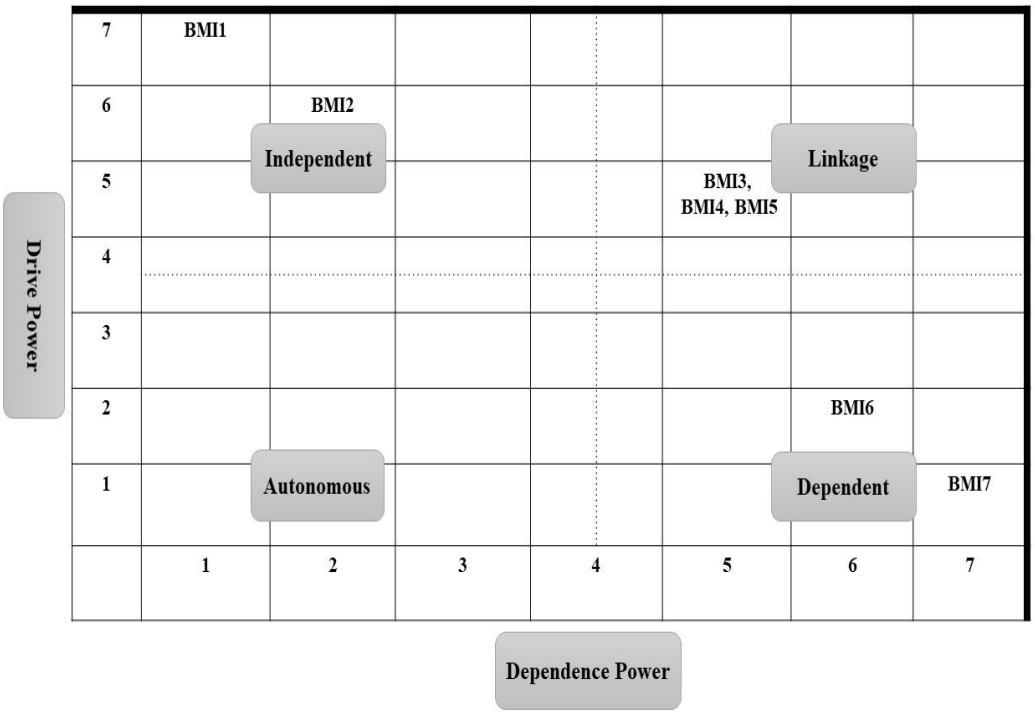

Figure (2) Matrix of Cross-Impact Matrix Multiplication Applied to Classification (MICMAC)

Based on "Figure 2", the most independent dimensions are BMI1 and BMI2 while the most dependent dimensions are BMI7 and BMI6.

Then, interpretive-structural modeling analysis was conducted using a cognitive rating cluster map and the final three aspects and components of the model with the opinion of experts were determined in accordance with "table 4".

Table 3- Group similarity matrix

Dimension	Symbol	BMI1	BMI2	BMI3	BMI4	BMI5	BMI6	BMI7
Digital Scouting	BMI1	12	12	0	0	1	0	0
Sustainable Computing	BMI2	10	9	1	0	1	1	0
Value Proposition	BMI3	2	1	12	11	10	1	0
Value Creation	BMI4	0	0	11	10	12	0	1
Value Delivery	BMI5	0	0	10	12	9	1	1
Sustainable Engagement	BMI6	0	0	0	1	0	11	12
Value Capture	BMI7	0	0	0	0	0	12	12

Table 4- Cognitive Rating Cluster Map

Direction		**Execution**			**Results**	
Digital Scouting	Sustainable Computing	Value Proposition	Value Creation	Value Delivery	Sustainable Engagement	Value Capture

"Figure 3" is obtained according to the four steps of "tables 7 - 10" (Appendices), based on the DEMATEL method.

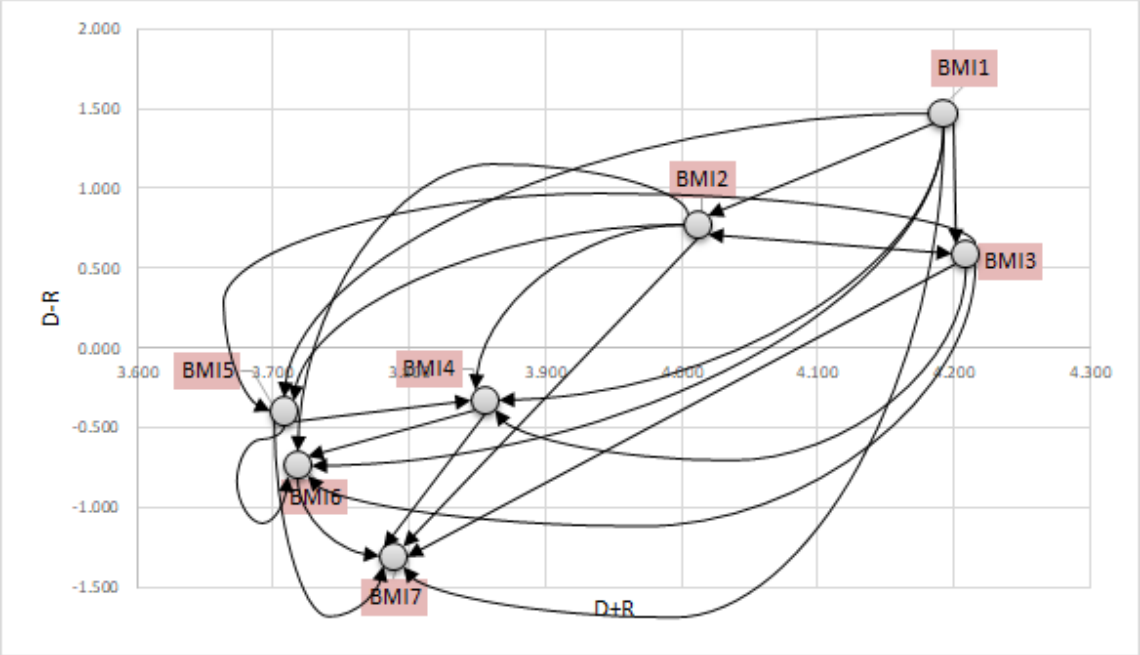

Figure (3) Diagraph showing the influential relationship between dimensions

Table 5- Full dimensional correlation matrix (T_D^{∞})

Symbol	D	E	R
D	0.256	0.399	0.447
E	0.220	0.260	0.356
R	0.163	0.207	0.212

Table 6-Degree of influences

Symbol	D	E	R
D	0.256	0.399	0.447
E	0.220	0.260	0.356
R	0.163	0.207	0.212

The coordinate axis was formed with the values D + R and D-R. The results are displayed in "Figure 4".

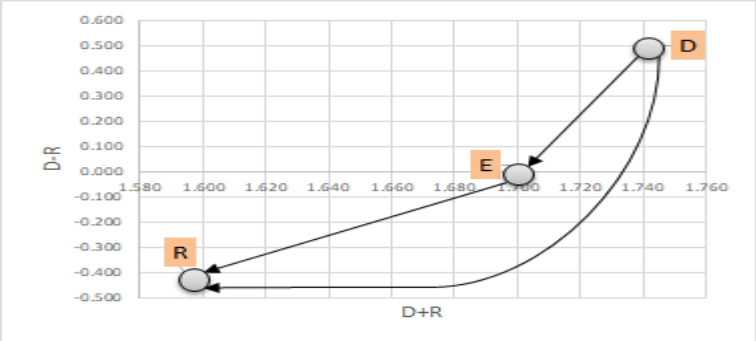

Figure (4) Causal diagram of the main factors

Table 7- Full dimensional correlation matrix (T_D^{∞}) Normalized

Symbol	D	E	R
D	0.232	0.263	0.279
E	0.362	0.311	0.355
R	0.405	0.426	0.365

Table 8 is obtained according to the four steps of "tables 11 - 14" (Appendices), based on ANP method

Table 8- Performance values combined with the influential weights of the dimension according to the DANP

RANK	FINAL WEIGHT (DIMENSION)	FINAL WEIGHT (DIMENSION /ASPECT)	DIMENSION	SYMBOL
3		0.262		(D)
4	0.1209	0.4624	Digital Scouting	BMI1
3	0.1406	0.5376	Sustainable Computing	BMI2
2		0.342		(E)
7	0.1062	0.3105	Value Proposition	BMI3
6	0.1177	0.3444	Value Creation	BMI4
5	0.1180	0.3451	Value Delivery	BMI5
1		0.397		(R)
2	0.1850	0.4666	Sustainable Engagement	BMI6
1	0.2115	0.5334	Value Capture	BMI7

Based on "table 8", aspect R (results) with a weight of 0.397 is ranked first, aspect E (execution) with a weight of 0.342 is ranked second and aspect D (orientation) with a weight of 0.262 is ranked third.

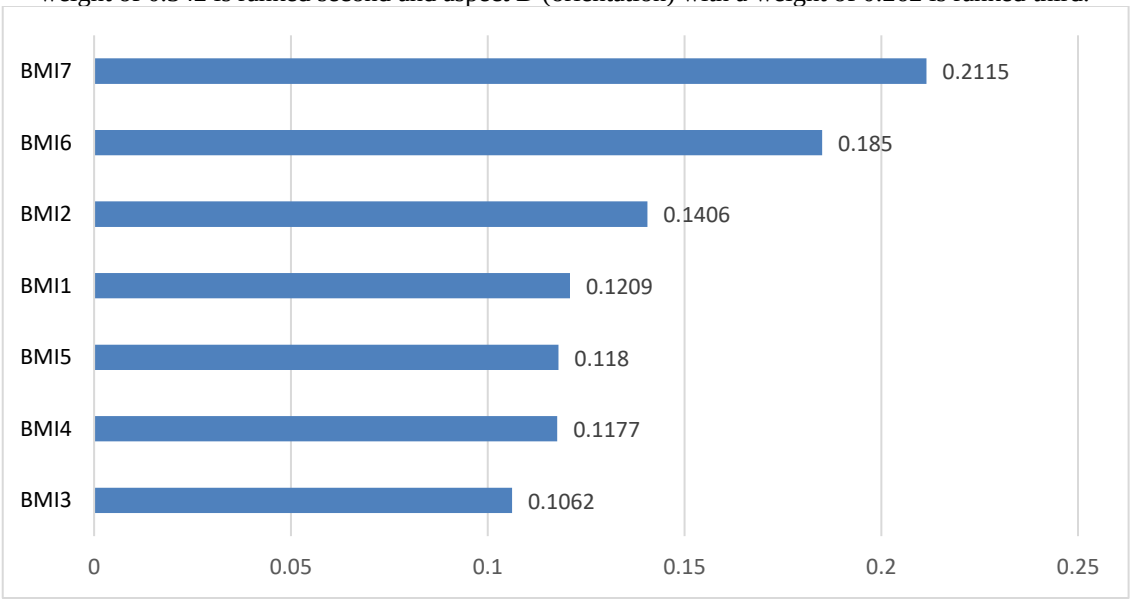

Figure (5) Final weight and rank of dimension

As shown in "Figure 5", most of the weight is related to value capture, followed by sustainable engagement and sustainable computing. The dimensions of digital scouting, value delivery, and similar value creation have almost the same weight while the value proposition is placed at the end with a short distance.

After discussing the experts, the score of each dimension was finalized as follows.

Table 9- Final score of each dimension

Symbol	BMI1	BMI2	BMI3	BMI4	BMI5	BMI6	BMI7
Dimension	Digital Scouting	Sustainable Computing	Value Proposition	Value Creation	Value Delivery	Sustainable Engagement	Value Capture
weight	0.120	0.140	0.110	0.115	0.115	0.185	0.215
Total weight	0.260		0.340			0.400	
aspect	Direction		Execution			Results	

The final model of digital sustainability

The final model in this study was based on three approaches, three aspects, and seven dimensions according to "Figure 6". The three approaches included 1-sensing the changes in the external environment, 2- the ability of proper and timely use of resources to seizing new values, and 3- reconfiguring the outer layer of the model.

The three aspects included 1-direction 2-execution 3-results (Sustainable/ digital). Further, seven dimensions were 1-Digital scouting 2- Sustainable Computing 3- Value proposition 4- Value creation 5- Value delivery 6- Sustainable Engagement, and 7- Value capture.

Figure (6) Digital Sustainability Model: Business Model Innovation & Dynamic Capabilities

4. Conclusions and suggestions

Today, the business environment is highly dynamic. Digital maturity and the use of digital innovation are essential for companies to successfully control the pressures of customers, competitors, and policymakers [3]. Previous capabilities were not sufficient for businesses to succeed in digital transformation and new capabilities were required [43]. Thus, businesses require dynamic digital capabilities for long-term success in digital transformation due to the digital era [6]. For this reason, the proposed model based on "Figure 6" includes the outer layer of dynamic capabilities. The creation and development of such new capabilities which are based on the requirements of sustainability and digital transformations affected by the digital era can lead to the success of businesses in new conditions. With the development of the theory of dynamic capabilities following table 10, new dynamic capabilities have been created in accordance with the concept of digital sustainability.

Table 10- Dynamic capabilities for digital sustainability

Dynamics	Sensing	Seizing	Reconfiguring
Digital Sustainability	Digital Sustainability Sensing Capabilities	Digital Sustainability Seizing Capabilities	Digital Sustainability Reconfiguring Capabilities
	Identifying opportunities and threats and sensing changes in the requirements of sustainability and digitalization is highly effective in terms of sustainable digital orientation. This capability is highly significant in determining and identifying the dimensions of 1- digital business scouting and 2- sustainable business computing.	The ability and use of internal business resources to capture and obtain new values are based on the factors of sustainability and digitalization and are highly effective in terms of sustainable digital implementation. This capability is highly significant in determining and identifying the dimensions of 1- value proposition 2- value creation and 3- value delivery.	Transformation to configure and restructure businesses is based on sustainability and digitalization factors and is highly effective in terms of sustainable digital results. This capability is highly significant in the dimensions of 1- sustainable engagement 2- capturing sustainable digital value.

With the help of new dynamic capabilities of digital sustainability, businesses can innovate their business model in line with the two main challenges of digital transformations and sustainability requirements. This process starts with the identification and sufficient understanding of environmental changes commensurate with these two fundamental challenges. Whether businesses can predict the extent to which digital transformations, as well as the social and environmental challenges with the economic challenge, can affect their business in the future. Based on the study of these two critical issues, the general directions of the business can be determined. This direction helps the business to prepare and formulate its long-term and short-term plans. After developing the plans, the business should enter the implementation phase. At this stage, the products and services which should be both in line with the transformations of the digital era and the sustainability requirements under the 2030 United Nations program are presented. How can such digital products and services with the aim of sustainability create digital and sustainable value for the business, how to transfer the created value to customers and stakeholders in such a way that we can use digital technologies and in this value delivery, what value is delivered to society and the environment, and finally, how businesses achieve sustainable digital results. Such results are intangible from the beginning, making it difficult and complex to measure and include a sustainable engagement, and then the tangible results are in the area of value capture. In addition, these results involve both direct customers and all other stakeholders. Direct customers and other stakeholders aim to pursue the results of digitalization in both the environmental and social areas. In this regard, sustainable digital businesses should measure the results of sustainability periodically. Due to digital transformations, businesses attempt to make the maximum use of digital tools and technologies in their business. However, they should move towards sustainability and meet the relevant requirements which can be challenging.

Thus, measuring the readiness of businesses with sustainability requirements is highly significant [96]; For this reason, it is proposed to develop significant

indicators of digital sustainability for measuring the readiness of businesses. Based on the proposed model, the highest score is related to the results. Thus, the development of indicators related to this section can lead to transparency and selection of the right path for businesses in the path of digital sustainability.

Furthermore, appropriate investment to create the appropriate conditions for business digitalization and use the opportunities ahead in all small and large organizations with the objective of sustainability and considering social and environmental requirements is very important [1]. As a result, it is suggested to analyze the relationship between business investment in the field of non-economic sustainability (social and environmental) with the economic field. The purpose is to measure the economic achievements in line with the investments made in the social and environmental fields since one of the concerns of businesses in difficult economic conditions is investing in ambiguous sustainability issues and it is necessary to conduct more accurate research.

References

[1] Wut, Tai Ming, Daisy Lee, Wai Man Ip, and Stephanie W. Lee. "Digital Sustainability in the Organization: Scale Development and Validation." *Sustainability* 13, no. 6 (2021): 3530.

[2] Sparviero, Sergio, and Massimo Ragnedda. "Towards digital sustainability: the long journey to the sustainable development goals 2030." *Digital Policy, Regulation and Governance* (2021).

[3] Vidmar, Doroteja, Marjeta Marolt, and Andreja Pucihar. "Information Technology for Business Sustainability: A Literature Review with Automated Content Analysis." *Sustainability* 13, no. 3 (2021): 1192.

[4] Romero, María Camila, Paola Lara, and Jorge Villalobos. "Evolution of the business model: Arriving at open business model dynamics." *Journal of Open Innovation: Technology, Market, and Complexity* 7, no. 1 (2021): 86.

[5] Jørgensen, Sveinung, and Lars Jacob Tynes Pedersen. *RESTART sustainable business model innovation*. Springer Nature, 2018.

[6] Verhoef, Peter C., Thijs Broekhuizen, Yakov Bart, Abhi Bhattacharya, John Qi Dong, Nicolai Fabian, and Michael Haenlein. "Digital transformation: A multidisciplinary reflection and research agenda." *Journal of Business Research* 122 (2021): 889-901.

[7] Lakshmi.R, Vasantha; Kennedy, Hanuman S. Sustainable Business Model: A Theoretical Framework for Manufacturing Firms. *International Journal of Business and Management Invention (IJBMI) (2018).* PP—01-04.

[8] Hossain, Mokter. "Frugal innovation and sustainable business models." *Technology in Society* 64 (2021): 101508.

[9] Geldres-Weiss, Valeska V., Nicolás Gambetta, Nathaniel P. Massa, and Skania L. Geldres-Weiss. "Materiality Matrix Use in Aligning and Determining a Firm's Sustainable Business Model Archetype and Triple Bottom Line Impact on Stakeholders." *Sustainability* 13, no. 3 (2021): 1065. [10] Czachorowski, Karen V. "Cleaning Up Our Act: Systems Engineering to Promote Business Model Innovation for the Offshore Exploration and Production Supply Chain Operations." *Sustainability* 13, no. 4 (2021): 2113.

[11] Szromek, Adam R. "The Sustainable Business Model of Spa Tourism Enterprise—Results of Research Carried Out in Poland." *Journal of Open Innovation: Technology, Market, and Complexity* 7, no. 1 (2021): 73.

[12] Geissdoerfer, Martin, Doroteya Vladimirova, and Steve Evans. "Sustainable business model innovation: A review." *Journal of cleaner production* 198 (2018): 401-416.

[13] Aluchna, Maria, and Boleslaw Rok. "Sustainable business models: The case of the collaborative economy." In *Sustainable business models*, pp. 41-62. Springer, Cham, 2018.

[14] Eikelenboom, Manon, and Gjalt de Jong. "The impact of dynamic capabilities on the sustainability performance of SMEs." *Journal of Cleaner Production* 235 (2019): 1360-1370.

[15] Bocken, Nancy, Frank Boons, and Brian Baldassarre. "Sustainable business model experimentation by understanding ecologies of business models." *Journal of Cleaner Production* 208 (2019): 1498-1512.

[16] Bergmann, Thorsten, and Hannes Utikal. "How to Support Start-Ups in Developing a Sustainable Business Model:

The Case of an European Social Impact Accelerator." *Sustainability* 13, no. 6 (2021): 3337.
[17] Brenner, Barbara. "Transformative sustainable business models in the light of the digital imperative—A global business economics perspective." *Sustainability* 10, no. 12 (2018): 4428.
[18] Clinton, Lindsay, and Ryan Whisnant. "Business model innovations for sustainability." In *Managing Sustainable Business*, pp. 463-503. Springer, Dordrecht, 2019.
[19] Radjou, Navi, and Jaideep Prabhu. *Frugal Innovation: How to do more with less*. The Economist, 2015.
[20] Djuraeva, Leyla. "Importance of the Innovative Business Models for the Future Success of the Company." In *SHS Web of Conferences*, vol. 100, p. 01013. EDP Sciences, 2021.
[21] Warner, Karl SR, and Maximilian Wäger. "Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal." *Long Range Planning* 52, no. 3 (2019): 326-349.
[22] Taing, Chhunleav, Nareth Duch, and Marady Phoeun. "The Impact of Digital Transformation on the Use of Banking Services at Banking Halls of ACLEDA Bank Plc." *Key Remarks from Managing Director of ACLEDA Institute of Business (AIB)*: 87.
[23] Kotarba, Marcin. "Digital transformation of business models." *Foundations of Management* 10, no. 1 (2018): 123-142.
[24] Ukko, Juhani, Mina Nasiri, Minna Saunila, and Tero Rantala. "Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance." *Journal of Cleaner Production* 236 (2019): 117626.
[25] Aagaard, Annabeth, Annabeth Aagaard, and Harrison. *Digital Business Models*. Cham: Springer International Publishing, 2019.
[26] Gupta, Sunil. *Driving digital strategy: A guide to reimagining your business*. Harvard Business Press, 2018.
[27] Johnson, Mark W. *Reinvent your business model: How to seize the white space for transformative growth*. Harvard Business Press, 2018.
[28] Tesch, Jan F., Tesch, and Rauscher. *Business Model Innovation in the Era of the Internet of Things*. Springer International Publishing, 2019.
[29] Parida, Vinit, David Sjödin, and Wiebke Reim. "Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises." *Sustainability* 11, no. 2 (2019): 391.
[30Leleux, Benoit, and Jan Van der Kaaij. *Winning sustainability strategies: Finding purpose, driving innovation and executing change*. Springer, 2018.
[31] Teece, David J. "Business models and dynamic capabilities." *Long range planning* 51, no. 1 (2018): 40-49.
[32] Fellenstein, Jonas, and Akilvenithan Umaganthan. "Digital Transformation: How enterprises build dynamic capabilities for business model innovation: A multiple-case study within the logistics and transportation industry." (2019).
[33] Lin, Ping, Xiaosan Zhang, Shuming Yan, and Qingquan Jiang. "Dynamic Capabilities and Business Model Innovation of Platform Enterprise: A Case Study of DiDi Taxi." *Scientific Programming* 2020 (2020).
[34] Clauss, Thomas, Michael Abebe, Chanchai Tangpong, and Marianne Hock. "Strategic agility, business model innovation, and firm performance: an empirical investigation." *IEEE transactions on engineering management* (2019).
[35] Inigo, Edurne A., Laura Albareda, and Paavo Ritala. "Business model innovation for sustainability: Exploring evolutionary and radical approaches through dynamic capabilities." *Industry and Innovation* 24, no. 5 (2017): 515-542.
[36] Obaya, Martín, Verónica Robert, Octavio Lerena, and Gabriel Yoguel. "Dynamic capabilities in the software and information services industry. A case-study analysis in Argentina from a business model perspective." *Innovation and Development* 10, no. 1 (2020): 89-116.
[37] Khodaei, Hanieh, and Roland Ortt. "Capturing dynamics in business model frameworks." *Journal of Open Innovation: Technology, Market, and Complexity* 5, no. 1 (2019): 8.
[38] Vicente, Afonso Ricardo Paloma, Marcos Ferasso, and Márcia Ramos May. "Dynamic capabilities development and

business model innovation: Evidences from IT industry in an emerging country." *International Journal of Business Innovation and Research* 17, no. 2 (2018): 226-248.
[39] Andresen, Florian. *Exploring Meso-Level Dynamic Capabilities to Address the Capability Rigidity Paradox: A Longitudinal Case Study Within the German Federal Armed Forces*. Springer Nature, 2020.
[40] Sniukas, Marc. *Business Model Innovation as a Dynamic Capability*. Springer International Publishing, 2020.
[41] Caputo, Andrea, Simone Pizzi, Massimiliano M. Pellegrini, and Marina Dabić. "Digitalization and business models: Where are we going? A science map of the field." *Journal of business research* 123 (2021): 489-501.
[42] Nadkarni, Swen, and Reinhard Prügl. "Digital transformation: a review, synthesis and opportunities for future research." *Management Review Quarterly* 71, no. 2 (2021): 233-341.
[43] Nwaiwu, Fortune. "Review and comparison of conceptual frameworks on digital business transformation." *Journal of Competitiveness* (2018).
[44] Hu, Haibo, Tao Huang, Yang Cheng, and Haitao Lu. "The evolution of sustainable business model innovation: Evidence from a sharing economy platform in China." *Sustainability* 11, no. 15 (2019): 4207.
[45] Lüdeke-Freund, Florian. "Sustainable entrepreneurship, innovation, and business models: Integrative framework and propositions for future research." *Business Strategy and the Environment* 29, no. 2 (2020): 665-681.
[46] Jabłoński, Adam. *Sustainable business models*. MDPI-Multidisciplinary Digital Publishing Institute, 2019.
[47] Čirjevskis, Andrejs. "The role of dynamic capabilities as drivers of business model innovation in mergers and acquisitions of technology-advanced firms." *Journal of Open Innovation: Technology, Market, and Complexity* 5, no. 1 (2019): 12.
[48] VoDoVoZ, ElIC, and MÁRCIa RaMos MaY. "Innovation in the Business Model from the perspective of Dynamic Capabilities: Bematech's case." *RAM. Revista de Administração Mackenzie* 18 (2017): 71-95.
[49] Ghezzi, Antonio, and Angelo Cavallo. "Agile business model innovation in digital entrepreneurship: Lean startup approaches." *Journal of business research* 110 (2020): 519-537. [50] George, Gerard, Ryan K. Merrill, and Simon JD Schillebeeckx. "Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development." *Entrepreneurship Theory and Practice* 45, no. 5 (2021): 999-1027.
[51] García-Jurado, Alejandro, José Javier Pérez-Barea, and Francisco Fernández-Navarro. "Towards Digital Sustainability: Profiles of Millennial Reviewers, Reputation Scores and Intrinsic Motivation Matter." *Sustainability* 13, no. 6 (2021): 3297.
[52] Gregori, Patrick, and Patrick Holzmann. "Digital sustainable entrepreneurship: A business model perspective on embedding digital technologies for social and environmental value creation." *Journal of Cleaner Production* 272 (2020): 122817.
[53] Li, Xiao, Jiarou Cao, Zhenggang Liu, and Xinggang Luo. "Sustainable business model based on digital twin platform network: The inspiration from haier's case study in China." *Sustainability* 12, no. 3 (2020): 936.
[55] Shakeel, Jawaria, Abbas Mardani, Abdoulmohammad Gholamzadeh Chofreh, Feybi Ariani Goni, and Jiří Jaromír Klemeš. "Anatomy of sustainable business model innovation." *Journal of Cleaner Production* 261 (2020): 121201.
[56] Goni, Feybi Ariani, Abdoulmohammad Gholamzadeh Chofreh, Muriati Mukhtar, Shahnorbanun Sahran, Syaimak Abdul Shukor, and Jiří Jaromír Klemeš. "Strategic alignment between sustainability and information systems: A case analysis in Malaysian public Higher Education Institutions." *Journal of Cleaner Production* 168 (2017): 263-270.
[57] Chofreh, Abdoulmohammad Gholamzadeh, Feybi Ariani Goni, and Jiří Jaromír Klemeš. "Sustainable enterprise resource planning systems implementation: A framework development." *Journal of cleaner production* 198 (2018): 1345-1354.
[58] Karlsson, Niklas PE, Maya Hoveskog, Fawzi Halila, and Marie Mattsson. "Early phases of the business model innovation process for sustainability: Addressing the

status quo of a Swedish biogas-producing farm cooperative." *Journal of Cleaner Production* 172 (2018): 2759-2772.
[59] Moratis, Lars, Frans Melissen, and Samuel O. Idowu. "Sustainable Business Models." *Principles, Promise, and Practice. Cham, Switzerland: Springer* (2018).
[60] Hernández-Chea, Roberto, Pratheeba Vimalnath, Nancy Bocken, Frank Tietze, and Elisabeth Eppinger. "Integrating intellectual property and sustainable business models: The SBM-IP canvas." *Sustainability* 12, no. 21 (2020): 8871.
[61] Bouwman, Harry, Shahrokh Nikou, and Mark de Reuver. "Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs?" *Telecommunications Policy* 43, no. 9 (2019): 101828.
[62] Muhic, Mirella, and Lars G. Bengtsson. "Dynamic capabilities triggered by cloud sourcing–a stage model." In *Academy of Management Proceedings*, vol. 2019, no. 1, p. 15991. Briarcliff Manor, NY 10510: Academy of Management, 2019.
[63] Peñarroya-Farell, Montserrat, and Francesc Miralles. "Business Model Dynamics from Interaction with Open Innovation." *Journal of Open Innovation: Technology, Market, and Complexity* 7, no. 1 (2021): 81.
[64] Gümüş, Sedat, Philip Hallinger, Ramazan Cansoy, and Mehmet Şükrü Bellibaş. "Instructional leadership in a centralized and competitive educational system: a qualitative meta-synthesis of research from Turkey." *Journal of Educational Administration* (2021).
[65] Mohd Salleh, Nurul Haqimin, Mahendrran Selvaduray, Jagan Jeevan, Abdul Hafaz Ngah, and Suhaiza Zailani. "Adaptation of Industrial Revolution 4.0 in a Seaport System." *Sustainability* 13, no. 19 (2021): 10667.
[66] Kim, Dosung, Yonghee Kim, and Namyong Lee. "A study on the interrelations of decision-making factors of information system (IS) upgrades for sustainable business using interpretive structural modeling and MICMAC analysis." *Sustainability* 10, no. 3 (2018): 872.
[67] Ahmad, Mahmood, Xiao-Wei Tang, Jiang-Nan Qiu, and Feezan Ahmad. "Interpretive structural modeling and MICMAC analysis for identifying and benchmarking significant factors of seismic soil liquefaction." *Applied Sciences* 9, no. 2 (2019): 233.
[68] Whyte, Patrina, and Geoffrey Lamberton. "Conceptualising Sustainability Using a Cognitive Mapping Method." *Sustainability* 12, no. 5 (2020): 1977.
[69] Petrun Sayers, Elizabeth L., Christopher A. Craig, Emily Skonicki, Grace Gahlon, Susan Gilbertz, and Song Feng. "Evaluating STEM-Based Sustainability Understanding: A Cognitive Mapping Approach." *Sustainability* 13, no. 14 (2021): 8074.
[70] Huang, Chi-Yo, Liang-Chieh Wang, Ying-Ting Kuo, and Wei-Ti Huang. "A Novel Analytic Framework of Technology Mining Using the Main Path Analysis and the Decision-Making Trial and Evaluation Laboratory-Based Analytic Network Process." *Mathematics* 9, no. 19 (2021): 2448.
[71] Manoharan, Shrinath, Venkata Sai Kumar Pulimi, Golam Kabir, and Syed Mithun Ali. "Contextual relationships among drivers and barriers to circular economy: An integrated ISM and DEMATEL approach." *Sustainable Operations and Computers* 3 (2022): 43-53.
[72] Si, Sheng-Li, Xiao-Yue You, Hu-Chen Liu, and Ping Zhang. "DEMATEL technique: A systematic review of the state-of-the-art literature on methodologies and applications." *Mathematical Problems in Engineering* 2018 (2018).
[73] Kamble, Sachin S., Angappa Gunasekaran, Harsh Parekh, and Sudhanshu Joshi. "Modeling the internet of things adoption barriers in food retail supply chains." *Journal of Retailing and Consumer Services* 48 (2019): 154-168.
[74] Gigović, Ljubomir, Dragan Pamučar, Zoran Bajić, and Milić Milićević. "The combination of expert judgment and GIS-MAIRCA analysis for the selection of sites for ammunition depots." *Sustainability* 8, no. 4 (2016): 372.
[75] Chiu, Wan-Yu, Gwo-Hshiung Tzeng, and Han-Lin Li. "A new hybrid MCDM model combining DANP with VIKOR to improve e-store business." *Knowledge-Based Systems* 37 (2013): 48-61.
[76] Gil-Gomez, Hermenegildo, Vicente Guerola-Navarro, Raul Oltra-Badenes, and

José Antonio Lozano-Quilis. "Customer relationship management: digital transformation and sustainable business model innovation." *Economic research-Ekonomska istraživanja* 33, no. 1 (2020): 2733-2750.
[77] Oskam, I., Bossink, B., & de Man, A. P. (2018). The interaction between network ties and business modeling: Case studies of sustainability-oriented innovations. *Journal of Cleaner Production*, *177*, 555-566.
[78] França, César Levy, Göran Broman, Karl-Henrik Robert, George Basile, and Louise Trygg. "An approach to business model innovation and design for strategic sustainable development." *Journal of Cleaner Production* 140 (2017): 155-166.
[79] Paiola, Marco, and Heiko Gebauer. "Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms." *Industrial Marketing Management* 89 (2020): 245-264.
[80] Frank, Alejandro G., Glauco HS Mendes, Néstor F. Ayala, and Antonio Ghezzi. "Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective." *Technological Forecasting and Social Change* 141 (2019): 341-351.
[81] Rachinger, Michael, Romana Rauter, Christiana Müller, Wolfgang Vorraber, and Eva Schirgi. "Digitalization and its influence on business model innovation." *Journal of Manufacturing Technology Management* (2018).
[82] De Silva, Muthu, Omar Al-Tabbaa, and Zaheer Khan. "Business model innovation by international social purpose organizations: The role of dynamic capabilities." *Journal of Business Research* 125 (2021): 733-749.
[83] Ranta, V., Aarikka-Stenroos, L., & Väisänen, J. M. (2021). Digital technologies catalyzing business model innovation for circular economy—multiple case study. *Resources, Conservation and Recycling*, *164*, 105155.
[84] Barth, Henrik, Per-Ola Ulvenblad, and Pia Ulvenblad. "Towards a conceptual framework of sustainable business model innovation in the agri-food sector: A systematic literature review." *Sustainability* 9, no. 9 (2017): 1620.
[85] Cantele, Silvia, Sara Moggi, and Bettina Campedelli. "Spreading sustainability innovation through the co-evolution of sustainable business models and partnerships." *Sustainability* 12, no. 3 (2020): 1190.
[86] Oskam, Inge, Bart Bossink, and Ard-Pieter de Man. "Valuing value in innovation ecosystems: How cross-sector actors overcome tensions in collaborative sustainable business model development." *Business & society* 60, no. 5 (2021): 1059-1091.
[87] Velter, M. G. E., Verena Bitzer, N. M. P. Bocken, and René Kemp. "Sustainable business model innovation: The role of boundary work for multi-stakeholder alignment." *Journal of Cleaner Production* 247 (2020): 119497.
[88] Madsen, Heather Louise. "Business model innovation and the global ecosystem for sustainable development." *Journal of Cleaner Production* 247 (2020): 119102.
[89] Baldassarre, Brian, Giulia Calabretta, N. M. P. Bocken, and Tomasz Jaskiewicz. "Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design." *Journal of cleaner production* 147 (2017): 175-186.
[90] Yang, Miying, Stephen Evans, Doroteya Vladimirova, and P. Rana. "Value uncaptured perspective for sustainable business model innovation." *Journal of Cleaner Production* 140 (2017): 1794-1804.
[91] Best, Bernadette, Kristel Miller, Rodney McAdam, and Sandra Moffett. "Mission or margin? Using dynamic capabilities to manage tensions in social purpose organisations' business model innovation." *Journal of Business Research* 125 (2021): 643-657.
[92] Bocken, Nancy MP, and Thijs HJ Geradts. "Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities." *Long Range Planning* 53, no. 4 (2020): 101950.
[93] Lüdeke-Freund, Florian, Sarah Carroux, Alexandre Joyce, Lorenzo Massa, and Henning Breuer. "The sustainable business model pattern taxonomy—45 patterns to support sustainability-oriented business model innovation." *Sustainable Production and Consumption* 15 (2018): 145-162.
[94] Barth, Henrik, Pia Ulvenblad, Per-Ola Ulvenblad, and Maya Hoveskog. "Unpacking sustainable business models in

the Swedish agricultural sector–the challenges of technological, social and organisational innovation." *Journal of Cleaner Production* 304 (2021): 127004.
[95] Pieroni, Marina PP, Tim C. McAloone, and Daniela CA Pigosso. "Business model innovation for circular economy and sustainability: A review of approaches." *Journal of cleaner production* 215 (2019): 198-216.
[96] Bican, P. M., & Brem, A. Digital Business Model, Digital Transformation, And Digital Entrepreneurship: Is There a Sustainable "Digital"? *Sustainability*, (2020). *12*(13), 5239.

Appendices:

Table 1. Symbols of the relations between variables in SSIM

Symbol	Relation	Symbol	Relation
X	two-way relationship between i and j	V	i lead to j
O	no relationship between i and j	A	j leads to i

Table 2. The structural self-interaction matrix

i	j	BMI1	BMI2	BMI3	BMI4	BMI5	BMI6	BMI7
BMI1	Digital Scouting		V	V	V	V	V	V
BMI2	Sustainable Computing			V	V	V	V	V
BMI3	Value Proposition				X	X	V	V
BMI4	Value Creation					X	V	V
BMI5	Value Delivery						V	V
BMI6	Sustainable Engagement							V
BMI7	Value Capture							

Table 3. Rules for the conversion of the entries of SSIM into quantitative values for the initial reachability matrix

Cell (i, j) of SSIM	Conversion rule
V	Place 1 in the cell (i, j) and 0 in the cell (j, i) of the reachability matrix.
A	Place 0 in the cell (i, j) and 1 in the cell (j, i) of the reachability matrix
X	Place 1 in the cell (i, j) and 1 in the cell (j, i) of the reachability matrix
O	Place 0 in the cell (i, j) and 0 in the cell (j, i) of the reachability matrix

Table 4. Reachability matrix of key elements

i	j	BMI1	BMI2	BMI3	BMI4	BMI5	BMI6	BMI7
BMI1	Digital Scouting	1	1	1	1	1	1	1
BMI2	Sustainable Computing	0	1	1	1	1	1	1
BMI3	Value Proposition	0	0	1	1	1	1	1
BMI4	Value Creation	0	0	1	1	1	1	1
BMI5	Value Delivery	0	0	1	1	1	1	1
BMI6	Sustainable Engagement	0	0	0	0	0	1	1
BMI7	Value Capture	0	0	0	0	0	0	1

Table 5. Level partitioning

No	Reachability Set	Prerequisite Set	Common Collection	Level
1	1,2,3,4,5,6,7	1	1	Fifth
2	2,3,5,4,6,7	1,2	2	Fourth
3	3,4,5,6,7	1,2,3,4,5	3,4,5	Third

4	3,4,5,6,7	1,2,3,4,5	3,4,5	Third
5	3,4,5,6,7	1,2,3,4,5	3,4,5	Third
6	6,7	1,2,3,4,5,6	6	Second
7	7	1,2,3,4,5,6,7	7	First

Table 6. Separation of drive power and dependence power

No	Symbol	Dimension	Drive Power	Dependence Power
1	BMI1	Digital Scouting	7	1
2	BMI2	Sustainable Computing	6	2
3	BMI3	Value Proposition	5	5
4	BMI4	Value Creation	5	5
5	BMI5	Value Delivery	5	5
6	BMI6	Sustainable Engagement	2	6
7	BMI7	Value Capture	1	7

Table 7. Direct communication matrix

Symbol	**BMI1**	**BMI2**	**BMI3**	**BMI4**	**BMI5**	**BMI6**	**BMI7**
BMI1	0	3.6	3.9	3.8	3.4	3.6	3.5
BMI2	2.3	0	3.1	3.6	3	3.1	3.1
BMI3	2.4	3.1	0	3.9	2.8	3	3.1
BMI4	1.2	1.4	1.6	0	3	3.2	3.4
BMI5	1.3	1.5	1.8	2.1	0	2.8	3
BMI6	1.5	1.3	1.5	1.4	2.3	0	3.3
BMI7	1.2	1.5	1.9	1.5	1.3	1.4	0

Table 8. Normalized direct-relation matrix

Symbol	**BMI1**	**BMI2**	**BMI3**	**BMI4**	**BMI5**	**BMI6**	**BMI7**
BMI1	0	0.165	0.179	0.174	0.156	0.165	0.161
BMI2	0.106	0	0.142	0.165	0.138	0.142	0.142
BMI3	0.110	0.142	0	0.179	0.128	0.138	0.142
BMI4	0.055	0.064	0.073	0	0.138	0.147	0.156
BMI5	0.060	0.069	0.083	0.096	0	0.128	0.138
BMI6	0.069	0.060	0.069	0.064	0.106	0	0.151
BMI7	0.055	0.069	0.087	0.069	0.060	0.064	0

Table 9. Total-influential dimensions of the matrix

Symbol	**BMI1**	**BMI2**	**BMI3**	**BMI4**	**BMI5**	**BMI6**	**BMI7**
BMI1	0.195	0.377	0.412	0.450	0.432	0.461	0.503

BMI2	0.258	0.195	0.340	0.394	0.370	0.392	0.431
BMI3	0.263	0.321	0.217	0.407	0.365	0.391	0.434
BMI4	0.171	0.200	0.224	0.177	0.301	0.322	0.361
BMI5	0.167	0.196	0.222	0.256	0.168	0.295	0.332
BMI6	0.165	0.178	0.199	0.215	0.248	0.164	0.324
BMI7	0.139	0.168	0.194	0.197	0.187	0.201	0.161

Table 10. Degree of influences

.Symbol	D	R	D+R	D-R
BMI1	2.830	1.358	4.188	1.472
BMI2	2.379	1.635	4.014	0.744
BMI3	2.396	1.808	4.205	0.588
BMI4	1.756	2.095	3.852	-0.339
BMI5	1.636	2.069	3.705	-0.433
BMI6	1.494	2.227	3.721	-0.733
BMI7	1.246	2.546	3.793	-1.300

Table 11. Complete communication matrix (Tc) Normalized

Symbol	**BMI1**	**BMI2**	**BMI3**	**BMI4**	**BMI5**	**BMI6**	**BMI7**
BMI1	0.341	0.659	0.318	0.348	0.334	0.478	0.522
BMI2	0.570	0.430	0.308	0.357	0.335	0.476	0.524
BMI3	0.450	0.550	0.220	0.411	0.369	0.474	0.526
BMI4	0.460	0.540	0.319	0.253	0.428	0.471	0.529
BMI5	0.460	0.540	0.344	0.396	0.260	0.471	0.529
BMI6	0.481	0.519	0.301	0.325	0.374	0.336	0.664
BMI7	0.453	0.547	0.335	0.341	0.324	0.556	0.444

Table 12. Unweighted supermatrix

Symbol	**BMI1**	**BMI2**	**BMI3**	**BMI4**	**BMI5**	**BMI6**	**BMI7**
BMI1	0.341	0.570	0.450	0.460	0.460	0.481	0.453
BMI2	0.659	0.430	0.550	0.540	0.540	0.519	0.547
BMI3	0.318	0.308	0.220	0.319	0.344	0.301	0.335
BMI4	0.348	0.357	0.411	0.253	0.396	0.325	0.341
BMI5	0.334	0.335	0.369	0.428	0.260	0.374	0.324
BMI6	0.478	0.476	0.474	0.471	0.471	0.336	0.556
BMI7	0.522	0.524	0.526	0.529	0.529	0.664	0.444

Table 13. The weighted supermatrix

Symbol	BMI1	BMI2	BMI3	BMI4	BMI5	BMI6	BMI7
BMI1	0.079	0.132	0.118	0.121	0.121	0.134	0.126
BMI2	0.153	0.100	0.145	0.142	0.142	0.145	0.153
BMI3	0.115	0.112	0.068	0.099	0.107	0.107	0.119
BMI4	0.126	0.129	0.128	0.079	0.123	0.115	0.121
BMI5	0.121	0.121	0.115	0.133	0.081	0.133	0.115
BMI6	0.194	0.193	0.202	0.201	0.201	0.123	0.203
BMI7	0.212	0.212	0.224	0.225	0.225	0.242	0.162

Table 14. Limit supermatrix

Symbol	BMI1	BMI2	BMI3	BMI4	BMI5	BMI6	BMI7
BMI1	0.1209	0.1209	0.1209	0.1209	0.1209	0.1209	0.1209
BMI2	0.1406	0.1406	0.1406	0.1406	0.1406	0.1406	0.1406
BMI3	0.1062	0.1062	0.1062	0.1062	0.1062	0.1062	0.1062
BMI4	0.1177	0.1177	0.1177	0.1177	0.1177	0.1177	0.1177
BMI5	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180
BMI6	0.1850	0.1850	0.1850	0.1850	0.1850	0.1850	0.1850
BMI7	0.2115	0.2115	0.2115	0.2115	0.2115	0.2115	0.2115