



Digital transformation as a lever for entrepreneurial innovation in emerging business environments

التحول الرقمي كرافعة للابتكار الريادي في بيئات الأعمال الناشئة

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Abstract

This research aims to study the role of digital transformation as a lever for entrepreneurial innovation in emerging business environments by analyzing the relationship between the adoption of modern digital tools and the ability of entrepreneurs to develop innovative projects. Using structural equation modeling (SEM-PLS) with the SMARTPLS4 program, the sample included fifty (50) entrepreneurs. The results showed a strong positive relationship between the level of digital transformation and the level of entrepreneurial innovation, with a notable impact of the digital strategy that entrepreneurs should adopt. On the other hand, the study revealed a relative weakness in digital culture. Based on this, the study recommends the need to strengthen digital culture, expand the university's technological partnerships, encourage the use of smart analytics, and integrate digital transformation strategies into university business incubator programs.

JEL Classification Codes : L26 ; O36 ; M14 ; M13

Keywords

Innovation ;
entrepreneurship ;
digital
transformation ;
entrepreneurial
innovation ;
digital culture ;
startup .

الكلمات المفتاحية

الملخص

يهدف هذا البحث إلى دراسة دور التحول الرقمي كرافعة للابتكار الريادي في بيئات الأعمال الناشئة، وذلك من خلال تحليل العلاقة بين تبني الأدوات الرقمية الحديثة وقدرة رواد الأعمال على تطوير مشاريع مبتكرة. باستخدام النمذجة بالمعادلات البنائية (SEM-PLS) برنامج SMARTPLS4، حيث شملت العينة خمسين (50) رائد أعمال. أظهرت النتائج وجود علاقة إيجابية قوية بين مستوى التحول الرقمي ومستوى الابتكار الريادي، مع الأثر البارز للاستراتيجية الرقمية التي يجب أن يتبناها رواد الأعمال. بالمقابل، كشفت الدراسة عن ضعف نسبي في الثقافة الرقمية. وبناءً على ذلك، توصي الدراسة بضرورة تعزيز الثقافة الرقمية، وتوسيع الشراكات التكنولوجية للجامعة، وتشجيع استخدام التحليلات الذكية، إضافة إلى دمج استراتيجيات التحول الرقمي في برامج حاضنات الأعمال الجامعية.

تصنيف JEL : L26 ; O36 ; M14 ; M13

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I.INTRODUCTION:

Today's world is experiencing significant transformations as a result of the evolutions of digital technology, which began as a sector-specific technological advance but extended to various economic, social, and cultural aspects of life. Digital transformation became an indispensable option for companies' strategic orientations. It altered the nature of economic activities and institutions, restructuring them in line with imperatives that demand competitiveness driven by creativity and innovative thinking rather than traditional resource capabilities. In this context, entrepreneurship emerged as the locomotive of contemporary economies due to its ability to fuel creativity, generate jobs, and ensure sustainable development in response to increasing challenges.

While capital and financial resources remain important, they are no longer sufficient conditions for entrepreneurial success; today, entrepreneurship requires innovation to build, develop, and sustain projects. The digital evolution equipped entrepreneurs with mechanisms for developing innovative products and services and reaching markets at low costs within very short timeframes. Thus, digital technology opened up vast fields for growth, as it can provide tools for systems and network creation that facilitate quick learning processes. For many entrepreneurs, digital transformation is no longer just a technical and organizational advancement to optimize managerial and marketing tasks, but rather a driver of radical change in business models and structures.

Digitization tools based on artificial intelligence technologies, cloud computing, and data analytics are increasingly affecting entrepreneurial projects through two avenues: enhancing the operational and market capabilities of the projects themselves, and reconfiguring the business incubator system in a way that provides innovative solutions tailored to the needs of project holders. In this context, new technologies strengthen entrepreneurial projects' competitiveness by providing data for better decision-making, reducing project time and costs, ensuring a more efficient task assignment structure, and minimizing the reliance on subjective human judgment. Regarding the incubators' system, digitization allows for the creation of new and innovative channels of communication with the targeted audience to analyze needs more effectively and provide appropriate solutions.

Despite these positive prospects, digital transformation offered by the latest technologies comes with preconditions and challenges that question the degree of readiness of the environment—organizational structures, regulatory frameworks, human capital, and specific competencies—to withstand the impact of its rapid evolution. Also, "the digital transformation of business requires more than blindly adopting the latest technologies. Companies need to consider the impact of digitalization on their business strategy, organizational structure, culture, and human resources. Companies that fail to implement a well-thought-out strategy risk wasting resources on technologies that do not align with their goals or damaging existing functionalities related to their traditional value chain." Digital transformation is ascribed almost exclusively to the digitization of processes and services without a sound and alternate digital strategy, built around a long-term vision, making innovation necessary and ensuring its economic prospects. Knowing that innovation stands as the only tool, or at least essential input, that enhances the chances of businesses in both developed and emerging environments, including start-up projects, necessitates framing and adopting a

"digitization innovation" strategy. This means defining a vision that governs the use of digital technologies and their integration into the institution's strategy and objectives.

The previous considerations prompt us to put our research into action around digital entrepreneurship incubators. Entrepreneurship Incubators were an idea to create a haven for the new innovative idea and a real-world laboratory to build and test business-oriented plans for its application. They offer material support and moral support. Part of the service they render to project holders is to connect them with different actors who can assist them, provide them with training in one or more disciplines, and guide them toward leveraging innovation at various levels of activity. The question persists: To what extent do the incubators' digital transformation and its components influence positively the incubation process toward innovative projects? Surely, to what extent do the various expressions of digital transformation—ranging from digitizing tools to having a digital strategy for the projects or digitizing customer relationships—is positively enhancing innovation in the incubated projects?

Our study focuses on the Ain Temouchent incubator and aims to extend the perspective of analyzing the impact of digital transformation to see whether it might enhance this innovative capability and what specific components would contribute to achieving innovation or not attaining any significant effect that could rationally lead to developing the essential components of a defined strategy. Additionally, the study aims to identify forming groups of the influencing degree and examining not only groups that significantly affect innovation capability but also distinguishing the nature of the influence—whether direct success factors or conditional success factors, in which they need to be part or directly linked to a formulated strategy to achieve innovation capabilities. Hence, our study is important not only in enriching the theoretical network linking digitization and entrepreneurial innovation but also and primarily in proposing recommendations that decision-makers and incubator managers can use to build relevant strategies that help project holders enhance their chances of success and amplify their contributions to local and national economies.

Based on the above, we can pose the following main issue : what extent does digital transformation contribute as a lever for entrepreneurial innovation in emerging business startup environments?

1.Study hypotheses

- First hypothesis: Is there a statistically significant effect at the 5% significance level of the use of digitization on entrepreneurial innovation among project holders at the Ain Temouchent business incubator?

- Hypothesis two: Is there a statistically significant effect at the 5% significance level of digital strategy on entrepreneurial innovation among project holders at the Ain Temouchent business incubator?

- Hypothesis three : Is there a statistically significant effect at the 5% significance level of organizational and individual culture on entrepreneurial innovation among project holders at the Ain Temouchent business incubator?

- Fourth hypothesis: Is there a statistically significant effect at the 5% significance level of customer digitization and customer relationships on entrepreneurial innovation among project holders at the Ain Temouchent business incubator?

- Fifth hypothesis: Is there a statistically significant effect at the 5% significance level of network relationships on entrepreneurial innovation among project holders at the Ain Temouchent business incubator?

2. Research Importance

The importance of the study is evident in the following points :

- Enriching the literature on the relationship between digital transformation and entrepreneurship.
- Providing a knowledge framework that helps researchers understand the role of technology in entrepreneurial innovation.
- Highlighting the extent of digital transformation in the incubator under study and its contribution to promoting innovation and entrepreneurship.
- Enabling business incubators and accelerators to develop support programs based on technology and innovation.
- Understanding the effects of innovation and entrepreneurship in the era of digital transformation in business incubators.

3. Study objectives

Through studying this topic, we seek to achieve a number of objectives, including:

- Analyzing the concept of digital transformation and its role in reshaping emerging business environments.
- Studying the relationship between digital transformation and entrepreneurial innovation, and how it contributes to the development of new business models.
- Identify the challenges and obstacles faced by startups when adopting digital transformation strategies.
- Propose practical mechanisms and strategies to enhance the contribution of digital transformation to increasing competitiveness and innovation in emerging environments..

II. THEORETICAL FRAMEWORK :

In light of the rapid transformations the world is witnessing today, innovation, entrepreneurship, and digital transformation have become the most prominent pillars on which institutions and countries rely to achieve sustainable development and enhance competitiveness in a dynamic and constantly changing environment. Innovation, in its broadest sense, represents the process of developing ideas, services, and products in new ways and takes many forms, relying on different strategies. Entrepreneurship, on the other hand, is a key driver of economic and social growth, as it achieves the goals of creating opportunities and promoting innovation, despite the many challenges faced by entrepreneurs. On the other hand, digital transformation is an urgent necessity for monitoring technological development, through the integration of modern technologies into various processes with the aim of improving performance and increasing efficiency. Based on the importance of these concepts, this study seeks to analyse them and explain their interrelationship and role in achieving institutional and economic progress in our time.

1. The innovation

Innovation has several approaches and concepts, as follows:

A. The concept of innovation

-First definition (Joseph Schumpeter): This Austrian economist defined innovation as "the result of creating a new method or technique of production, as well as a change in all components of the product or how it is designed." (Lachmann, 2010)

-Second definition: "A new idea or behaviour by the management of an organisation within the sector, market or environment in which it operates." (Al-Sairfi, 2003)

-Tom Peters defines it as: "Dealing with something new, something that has not been chosen before. This expands innovation to its maximum limits because something new may be new to the company dealing with it but not to other companies, and dealing with something new may not mean innovating it within the company but may also mean purchasing it from others (overcoming an obstacle that was not innovated here) or imitating it." (Al-khasawneh, 2011)

From these definitions, we conclude that innovation is the process of creating and developing new or improved ideas, methods or products, including changes in product components, design, working methods, marketing or service delivery. Innovation also includes the introduction of new or improved tools and technologies within the organisation or in the market with the aim of achieving competitive advantage and economic and social success.

B.The importance of innovation

The importance of innovation lies in its ability to achieve the following: (Ferrah & Guenour, 2017)

- Developing and enhancing personal skills and interaction in group thinking through the use of brainstorming teams.

- Improving the quality of decisions made to address problems at the institutional level or in its various sectors and departments, in different technical, financial, marketing and social work environment areas.

- Innovation can lead to the launch of new products and services that better meet customer needs, which helps to achieve sustainable growth.

- Innovation contributes to the implementation of strategies to enhance and activate sales processes and increase revenue.

- Innovation can improve an organisation's internal processes, such as improving supply chains and developing production methods, leading to increased efficiency and resource savings.

- Innovation plays an important role in creating and enhancing an economic organisation's ability to compete in the market.

- Innovative organisations help stay ahead and compete with other companies by developing new products and services.

C.Innovation strategies

Innovation strategies are as follows: (Boiya, 2011)

-Proactive innovation strategy:

A proactive innovation strategy is a leading-edge strategy that involves influencing markets by developing and launching new products and creating new markets through these products. Building this strategy requires a strong ability to anticipate future developments in the environment and a greater ability to identify new and latent opportunities in the markets.

In fact, organisations pursue this strategy to take advantage of two key benefits: the first is strategic and technological, and the second is related to consumer purchasing behaviour.

The strategic advantage lies in the organization's technological progress and lead, as the first innovator is better able to control the developed or acquired technology and is better able to add improvements and developments.

In this case, it takes a considerable amount of time for competitors to imitate new products, which allows the innovator to take advantage of their benefits before competitors are able to do so. In all previous cases, subsequent competitors prefer to withdraw and not enter the market or to shift their focus to other markets.

The second advantage related to the impact on consumer purchasing behavior is that new products will in turn represent a rare and important resource for distributors who compete for them in order to increase their profits and maintain their customer relationships. In the event of the commercial success of a new product, distributors will work to distribute a subsequent/follow-up product in order to reduce their dependence on the manufacturing company and expand their profit margins. On the other hand, we find that the leading product enjoys the advantage of choosing the location and target market it creates through its choice of new physical and cognitive locations.

-Reactive strategy

A reactive strategy is the strategy adopted by a company to respond to threats and changes in its environment. It innovates its products after innovation appears elsewhere, such as when a new competing product appears that affects the market in which it operates.

This strategy aims primarily to adapt, adjust, and maintain the organization's position and market share. An organization that adopts such a strategy is expected to have marketing competencies on the one hand and be able to create new product lines or products on the other.

Despite the dominance of early innovators in the market, subsequent organizations can achieve some competitive advantages. The first innovator's knockout blow is only effective if it is quick and wins over a large number of customers, while the slow and limited spread of innovation may give the later innovator an opportunity to transfer the innovative ideas to other sectors, modify and adapt them to new customer groups, or imitate the new products more effectively. Similarly, in the case of radical innovations, the leading innovator cannot accurately determine all the characteristics of the new product, as customers themselves cannot do so, and the subsequent competitor benefits from the customers' experience of using the product. They also benefit from the mistakes and flaws of the product in its initial form, proposing a new or improved product based on market studies and recognizing the flaws and mistakes made by the "first movers." Later competitors also bear fewer risks and losses, as they only imitate successful products that have been accepted by customers. However, it should be noted that all these advantages are enjoyed by the first-mover competitors, not those who come later and have no room for differentiation in the market.

2.Basic concepts of entrepreneurship

Entrepreneurship is a modern concept that has gained increasing importance in recent years. It refers to the ability to explore opportunities, develop new ideas, and turn them into successful projects. Entrepreneurship is a key factor in driving the economy and creating job opportunities.

A.Definition of entrepreneurship

Some concepts related to entrepreneurship will be presented:

Entrepreneurship is defined as "a set of activities that focus on interest, provide opportunities, and meet needs and desires through creativity and the establishment of enterprises." (Al-Shimiri, 2022)

Entrepreneurship is also defined as "the process of utilizing a wide range of skills to achieve added value in a specific field of human activity, resulting in increased income or greater independence, as well as a sense of pride in the creative effort expended." (Al-Shimimri, 2022)

It **has** also been defined as "special situations that create economic and social wealth, characterized by a high degree of uncertainty, through which individuals enter into the realm of developing behaviors that depend rather on accepting change and risks collectively, taking initiative, and working individually." (Fadda, 2018)

From the above definitions, we conclude that **entrepreneurship** is a creative process that relies on investing skills and opportunities to establish projects or innovate solutions that meet the needs and desires of society, with the aim of achieving economic or social added value. Entrepreneurship is characterized by individual initiative, risk-taking, and the ability to change, which enhances independence and a sense of achievement.

B.The importance and objectives of entrepreneurship

Entrepreneurship is of great importance in many areas, especially in business organizations, and we summarize this importance as follows:(Khouli, 2023)

- Ability to change: There are entrepreneurs who have been able to change the reality in which they live.
- Self-confidence: Achieving goals makes a person confident in themselves and in their ability to achieve what they want.
- Moral wealth and self-satisfaction: This confidence enriches the individual and creates moral wealth and self-satisfaction through the skills and qualities that contribute to improvement in the field of work.
- Changing and improving an individual's behavior by doing what needs to be done or what they are skilled or talented at.

There are also many achievable entrepreneurial goals, the most important of which are listed below:(Al-Shimimari, 2022)

- Creating a general climate conducive to entrepreneurship at the institutional level.
- Working to establish new projects within the organization or new independent projects or units within the organization.
- Encouraging and developing initiatives presented by individuals working in the organization.
- Strategic renewal, in the sense of rethinking the organization's direction and opportunities.

There are other objectives, which are listed below:(Zhao & Collier, 2016)

- Time ownership: By allocating working hours, including organizing and adding extra hours, individuals choose entrepreneurship to control and organize their time.
- Achieving financial stability: One of the most important goals of an entrepreneur is to achieve a balance between expenses and income for their business and reach a point of financial stability.

C.Basics of Digital Transformation

Digital transformation is one of the most important modern trends witnessed by organizations in various sectors, as it contributes to improving efficiency and simplifying procedures through the use of digital technologies. With the acceleration of innovation, digital transformation has become a necessity for achieving competitiveness and sustainability.

3.Definition of digital transformation

First, let us refer to the term "digital transformation."

-Transformation: The verb "to transform" is derived from the Latin word "transformer" and means to change something and alter its nature, function, activity, and conditions to become something else. It encompasses many areas and various components, such as relationships, individuals, groups, teams, local communities, and political systems. (Baza, 2019)

-Digital: "Digitalization" is defined as a sophisticated reproduction process that enables the conversion of any type of document, regardless of its format, into a digital series. This technical work is accompanied by intellectual and administrative work to organize the information in order to index and schedule it and represent the content of the digitized text. (Saada, 2019)

Digital transformation is defined as the process of companies transitioning to a business model that relies on digital technologies to innovate products and services. Providing new channels of revenue and imposing them increases the value of their products. (Mahri, 2006).

Digital transformation is also defined as the use of technology to fundamentally improve an organization's performance. On the other hand, digital transformation involves the use of new digital technologies such as social media, mobile phones, analytics, and embedded devices to achieve developments in core business processes such as enhancing the customer experience, simplifying work processes, and innovating new business models. Digital transformation is also defined as " " (Boushi, 2019).

For organizations, digital transformation is the process of leveraging modern technologies to become more aware and flexible in their work and able to predict and plan for the future. With these characteristics, organizations can innovate and adapt more quickly to achieve the desired results from their use and move towards success. (Fari, 2021)

Through this definition, digital transformation can be defined as a strategic process that relies on the use of modern digital technologies to improve the performance of organizations and develop their operations and services by innovating new business models, enhancing the customer experience, and increasing operational efficiency. This transformation aims to enable organizations to adapt to change and achieve greater flexibility in forecasting and planning, thereby contributing to added value, increased revenues, and enhanced opportunities for success in an increasingly competitive environment.

1.The importance of digital transformation

One of the most important aspects of our current era is digital transformation, which is considered a fundamental factor. The importance of this transformation lies in:(European Commission, 2015)

- **Improving operational efficiency:** The adoption of digital transformation by organizations can lead to the improvement of their operations and increased efficiency through the use of digital technology.
- **Promoting innovation:** It encourages innovation and the development of new products and services to meet the needs of the modern market.
- **Expanding market access:** It contributes to opening up new investment opportunities and increasing the competitiveness of organizations.
- **Improving customer experience:** Enables a better and more personalized user experience, which contributes to increased brand loyalty.
- **• Increased production efficiency:** Contributes to improving employee productivity by providing technological tools that facilitate their tasks.

2. Dimensions of digital transformation

Digital transformation has several dimensions, which we summarize as follows:(Al-Haj, 2021)

- **Use of digital technologies :** the extent to which the organization is able to exploit information technology and its technological ambitions for the future
- **Digital strategy:** Digital transformation is a complex and ongoing task that can be disruptive if the person operationally responsible for the digital transformation strategy does not have sufficient experience in transformational projects directly. Therefore, it is important to define sufficient and clear responsibilities to determine and implement the digital transformation strategy.
- **Digitization of customers and customer relationships:** This dimension focuses on all aspects related to customer relationships and the extent to which digital transformation affects these relationships.
- **Organizational and individual culture :** Digital transformation can only succeed if it is supported by the people working in the organization. Therefore, leadership works to provide and create safe and healthy conditions for the workforce and to encourage all employees to grow, innovate, and achieve satisfactory results.
- **Network relationships:** The organization must interact extensively at a high level of speed and accuracy and be part of a network that includes suppliers, start-ups, governments, investors, and universities. The dimensions of digital transformation can also be challenged in the following elements:(European Commission, 2015)
- **Technical dimension :** The literature indicates that the technical components of the university's digital transformation are physical devices such as computers and their various accessories, educational software, and the communications and network infrastructure necessary for the use of e-learning and various applications. The focus is on digitizing the campus and rehabilitating the university's physical infrastructure, buildings, facilities, and classroom safety and security. This is achieved by providing the following components: technical equipment (computers, interactive screens, cameras, broadcasting and transmission equipment, smart classrooms with modern applications to handle increasing data, electronic security, digital training systems, high-speed internet, and appropriate virtual laboratories and labs).

- **Human dimension** : Human resources are one of the most important components of the digital transformation of universities because they are one of the most important means of coping with the pressures and challenges facing institutions. They are also one of the most prominent elements that lead societies to achieve progress and advancement in various fields. However, the shortage of individuals qualified to adapt to the digital environment is one of the issues that most countries suffer from, especially developing countries. The shortage of human resources qualified to deal with the digital age is an obstacle to modern technology. To implement digital transformation programs, a plan is needed to develop and nurture human competencies and capabilities within universities. This can be achieved by employing new competencies and capabilities with experience in transformation programs and by leveraging technological means.
- **Organizational dimension** : The digitization process requires comprehensive changes within the institution. This is not limited to technical equipment and the appointment of a technology manager but goes beyond that to include profound changes in information, sustainable strategic decisions, and an organizational culture that serves digital transformation. Openness and transparency in decision-making are essential, especially with regard to the introduction of new technologies. Personal initiative and innovation must be valued and encouraged, and a positive approach to dealing with mistakes must be developed, providing a basis for testing new technologies so that individuals can experience digital technologies in practice. (Khalil, 2022)

III. RESEARCH METHODOLOGY:

When using PLS-SEM, we benefit from the high degree of statistical power of this method compared to CB-SEM. This means that PLS-SEM is better able to identify relationships as significant when they are actually present in the model (Sarstedt & Mooi, 2018).

In order to obtain and analyze the results, we relied on data obtained from entrepreneurs incubated in the public incubator (Ain Temouchent University Business Incubator), based on a questionnaire that we prepared and distributed to the study sample.

A. Measurement tool

We may resort to using questionnaires to collect data, mainly because they are easy to implement (Sekaran, 2006). This method is also suitable for the current study because it allows data to be collected from a large sample, which helps the researcher to test the hypotheses proposed in the research and generalize the results.

B. Study population and sample

If the basic guidelines of sampling theory are not taken into account, questionable results will be obtained (Sarstedt & Mooi, 2018). In order to determine the required sample size, power analyses that take into account the model structure, the expected significance level, and the expected effect size must be used (Marcoulides & Chin, 2013).

The population of this study consists of more than 250 entrepreneurial students incubated at the Ain Temouchent University Business Incubator. In the context of this study, we relied on an electronic questionnaire as the main tool for data collection, where 50 questionnaires were monitored and answered correctly and acceptably.

C. Data preparation and verification

- Distribution assumptions:

Many researchers point out that the absence of distributional assumptions is the main reason for choosing PLS-SEM (Assaker & do Valle, 2015; Hair et al., 2012; Nitzl, 2016). Although this is a clear advantage of using PLS-SEM in social studies in particular, which mostly rely on non-normal data, given the sample size of over 30 items, the data can be considered normally distributed according to the theory of central limits.

The original, untransformed, and unmodified scores of the latent variables can also be used in the subsequent partial least squares (PLS) analysis in this study. The Kolmogorov-Smirnov test and the Shapiro-Wilks test were used to test the normality of the distribution by comparing the research data with a normal distribution with similar standard deviation and mean in the research sample (Mooi et al., 2017).

- Missing values

Data analysis was performed by examining data entry, data processing, and missing values. This was largely related to achieving some important insights into the characteristics of the data and its analysis (Hair et al., 2014). In fact, in data cleaning processes, the data being examined must be coded, standardized, and checked for missing values and answers in the returned survey questionnaires.

Regarding the treatment of missing values, SPSS provides an option that offers different methods such as mean, median, and linear trend. However, the imputation-maximization algorithm is the second-best method for replacing values in SPSS, especially when the number of missing points in the dataset is small (Little & Rubin, 2019). Therefore, the imputation-maximization algorithm was used in this study to handle missing values.

-Outliers

The data for all variables were examined using SPSS26. The data was identified by adopting a standard score, with a mean of 0 and a standard deviation of 1. However, if the extreme values in the data were of the fourth type (Hair et al., 2019) and there was no error in data entry or incorrect coding in the data, the researcher could retain them all.

D. Data Analysis for structural equation modeling

The first step in evaluating PLS-SEM results involves examining measurement models, which vary depending on reflective and constructivistic structures. If the measurement models meet the required criteria, we must then evaluate the structural model (Hair Jr. et al., 2017).

1.Evaluation of the measurement model

This stage can be divided into two steps, the first being consistency and the second being honesty:

In order to evaluate the measurement model, we must first examine the saturations of the indicators. Saturations higher than 0.70 are recommended, as they indicate that the construct explains more than 50 percent of the variance in the indicator, providing acceptable reliability for the items. This is also the case for this model, where all saturations are estimated at more than 0.7 according to Table 1.

Second, assessing internal consistency reliability, often done using Jöreskog's (1971) composite reliability. Higher values generally indicate higher levels of reliability. For example, reliability values between 0.60 and 0.70 are considered "acceptable in exploratory research," while values between 0.70 and 0.90 range from "satisfactory to good." However, values of 0.95 and above are questionable, as they indicate that items are redundant, which reduces the validity of the construct (Diamantopoulos et al., 2012; Drolet & Morrison, 2001).

Thirdly, Cronbach's alpha coefficient is another measure of internal consistency reliability that assumes similar thresholds but produces lower values than composite reliability. As shown in Table 1, all values range from 0.6 to 0.7 and sometimes higher, reflecting internal consistency, i.e., stability of the measurement tool.

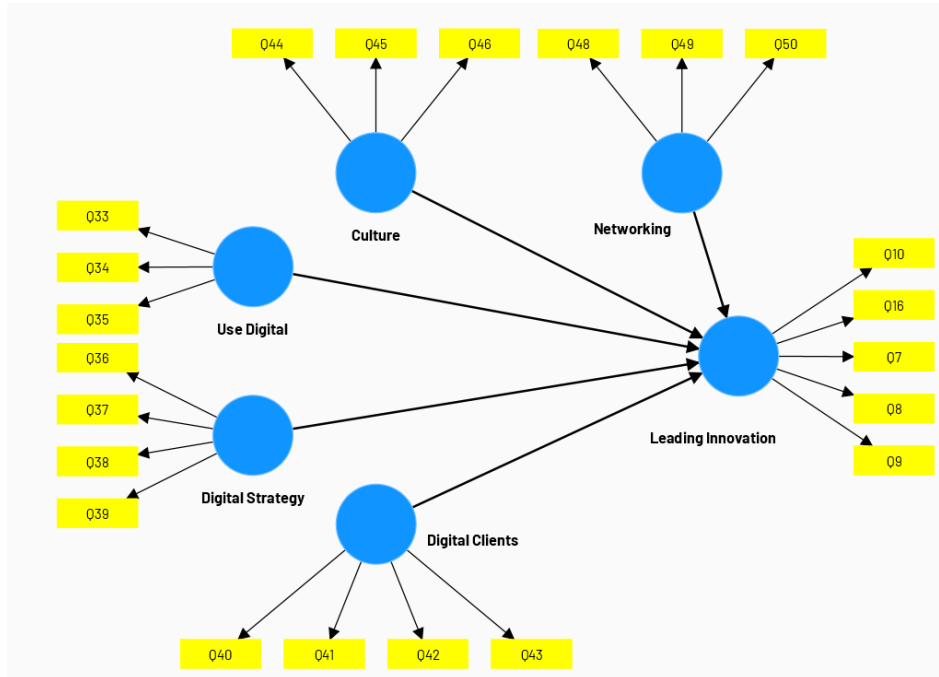
Table (01): Measurement model evaluation indicators

sVariable		Number Indices	Outer Loadings ≥0.70	Cronbach's alpha	rho_A	AVE
Digital Transformation	Culture	3	0,846 0,662 0,642	0,617	0,763	0,522
	Digital Clients	4	0,769 0,822 0,791 0,816	0,820	0,877	0,640
	Digital Strategy	4	0,797 0,873 0,673 0,660	0,814	0,840	0,571
	Networking	3	0,813 0,759 0,817	0,657	0,779	0,547
	Use Digital	3	0,734 0,891 0,761	0,737	0,840	0,637
	Leading Innovation	5	0,764 0,814 0,769	0,854	0,892	0,623

		0,726			
		0,866			

Source : Prepared by the researcher based on the outputs of the SmartPLS4 program

Figure (01): Research model after modification



Source: Prepared by the researcher based on SmartPLS4

As for validity, it can be divided into convergent validity and discriminant validity:

Assessing the convergent validity of each construct. It expresses the extent to which the construct explains the variance of its items. The measure used to assess the convergent validity of the construct is the average variance extracted (AVE) for all items in each construct. The minimum acceptable AVE is 0.50 or higher, indicating that the construct explains 50 percent or more of the variance among the items comprising the construct. This is consistent with the data for this model in round 01.

The assessment of discriminant validity, which is the extent to which the construct is empirically distinct from other constructs in the structural model. Fornell and Larcker (1981) proposed the traditional measure and suggested comparing the AVE for each construct with the square correlation coefficient between the constructs (as a measure of common variance) for the same construct and all other constructs measured reflexively in the structural model—the common variance of all constructs in the model should not be greater than their AVE. This is achieved in the model of this study, as shown in Figure(2).

Figure (02): Fornell-Larker test

	Culture	Digital Clients	Digital Strategy	Leading Innovation	Networking	Use Digital
Culture	0,723					
Digital Clients	0,610	0,800				
Digital Strategy	0,522	0,521	0,756			
Leading Innovation	0,479	0,638	0,660	0,789		
Networking	0,486	0,667	0,377	0,521	0,740	
Use Digital	0,541	0,547	0,764	0,573	0,454	0,798

Source: Prepared by the researcher using SmartPLS4 software.

To really check for discriminant validity, especially when the indicator loadings on the construct differ only slightly, Henseler et al. (2015) suggested the homogeneity-transitivity-modality-transitivity (HTMT) ratio for correlations. HTMT is defined as the average value of item correlations across structures (i.e., correlations of variance in traits and variance in methods) relative to the (geometric) mean of the average correlations for items measuring the same structure (i.e., correlations of similarity in traits and variance in methods). Discriminant validity issues arise when HTMT values are high. Therefore, when structures are more discriminant in theory, it is suggested to use a lower and more conservative threshold value, such as 0.85 (Henseler et al., 2015). This research confirmed that most values are less than 0.85.

2. Structural model evaluation

After verification and obtaining acceptable results for the measurement model, the next step in evaluating PLS-SEM results is to evaluate the structural model. Before evaluating structural relationships, multicollinearity must be examined to ensure that it does not affect the regression results. The scores of the latent variables of the external concepts are used to calculate the VIF values. VIF values greater than 5 indicate the possibility of multicollinearity between predictor concepts (). However, multicollinearity can also occur at VIF values less than 3 to 5 (Becker et al., 2015; Mason & Perreault Jr., 1991). Ideally, VIF values should be close to 3 or less. As in our research, all values are less than 3, so there is no multicollinearity.

Standard evaluation criteria to be taken into account include the coefficient of determination (R^2), which was 0.567, explaining 56.7 percent of the variation in entrepreneurial innovation as a result of the change brought about by digital transformation through its five dimensions (use of digitalization, digital strategy, customer digitalization, culture, and networking), which, according to Cohen, is a high level as it is greater than 35 percent.

■ Leading Innovation $R\text{-squared} = 0.567$ $R\text{-squared adjusted} = 0.517$

The f^2 effect size measure is somewhat greater than the path coefficient size. More precisely, the order of importance of the predictive structures in explaining a dependent structure in the structural model is often the same when comparing the path coefficient size and the f^2 effect size.

The effect size remains weak to moderate according to these values (0.02, 0.15, and 0.35), which are small, medium, and large for Cohen (1988).

Prediction accuracy can also be assessed in another way using the PLS path model, which calculates the Q^2 value (Geisser, 1974). This measure relies on a blindfold procedure that removes individual points in the data matrix, estimates the removed points using the mean, and estimates the model parameters (Rigdon, 2014; Sarstedt & Mooi, 2018). Thus, Q^2 is not a measure of out-

of-sample prediction but rather combines aspects of out-of-sample prediction and in-sample explanatory power (Sarstedt et al., 2017; Shmueli et al., 2016). Q^2 values must be greater than zero for a specific internal structure to indicate the predictive accuracy of the structural model for that structure. As a general rule, Q^2 values higher than 0, 0.25, and 0.5 indicate small, medium, and large predictive power for the PLS path model. The results indicate that most variables fall in the first domain, indicating a small predictive relationship, while entrepreneurial innovation in the larger domain indicates a large predictive relationship.

To evaluate the predictive power of the model when using PLSpredict, several predictive statistics can be used to measure the amount of prediction error.

We compare RMSE (or MAE) values with a simple benchmark. The recommended simple benchmark (generated by the PLSpredict method) uses a linear regression (LM) model to generate predictions for the manifest variables by performing a linear regression of each of the dependent construction indicators on the external latent variable indicators in the PLS path model (Danks & Ray, 2018). The smaller the PLS values, the smaller the LM values, and the greater the predictive power of the model, as is the case with our research.

3. Model fit quality

Goodness of fit (GoF) was used to assess the overall fit of the model. To measure the goodness of fit, PLS-SEM uses only one method, defined as the overall goodness of fit measure, introduced by Tenenhaus et al. (2008). Model fit is defined as the square root of the mean R^2 of the internal (reflective) latent variables multiplied by the mean cross-validation, or mean extracted variance (AVE) (Tenenhaus et al., 2005).

$$\blacksquare \text{ GoF} = \text{Racine } ((0.567)^2 \times (0.623)^2) = 0.353$$

Thus, the overall model fit quality was found to be at the threshold value of 0.36 for a well-fitting model. Thus, according to the criteria of Wetzels & Odekerken (2009), the result (0.353) showed that the model fit measure was large and appropriate for the validity of the PLS model.

IV. STUDY RESULTS (ANALYSIS AND DISCUSSION) :

According to Hair et al. (2014), the direct relationship will be expressed by the path amount, where we also rely on testing hypotheses by calculating the statistical significance of the paths to be tested as follows:

Table (02): Hypothesis testing results

	Original sample (O)	T statistics (O/STDEV)	P values	
Culture -> Leading Innovation	-0,022	0,134	0,894	Rejected
Digital Clients -> Leading Innovation	0,316	1,844	0,023	Accepted
Digital Strategy -> Leading Innovation	0,451	2,455	0,014	Accepted
Networking -> Leading Innovation	0,151	0,828	0,408	Rejected
Use Digital -> Leading Innovation	-0,001	0,007	0,995	Rejected

Source: Prepared by the researcher using SmartPLS4 software.

-First hypothesis: Is there a statistically significant effect at the 5% significance level of using digitalization on entrepreneurial innovation among project holders at the Ain Temouchent business incubator?

The results in Table (02) indicate that the statistical significance value for this hypothesis is 0.995, which is greater than 0.05, requiring the rejection of this hypothesis. In other words, the use of digitalization may not be the reason for the success of entrepreneurial innovation in the business environment. Other factors may also contribute to this.

-Hypothesis 2: Is there a statistically significant effect at the 5% significance level of the digital strategy on entrepreneurial innovation among project holders at the Ain Temouchent Business Incubator?

The results in Table (02) indicate that the statistical significance value for this hypothesis is 0.014, which is less than 0.05, requiring acceptance of this hypothesis. In other words, digital strategy plays a positive role in the success of entrepreneurial innovation in the business environment.

-Hypothesis 3: Is there a statistically significant effect at the 5% significance level of organizational and individual culture on entrepreneurial innovation among project holders at the Ain Temouchent Business Incubator?

The results in Table (02) indicate that the statistical significance value for this hypothesis is 0.894, which is greater than 0.05, requiring the rejection of this hypothesis. In other words, organizational and individual culture may not be a reason for the success of entrepreneurial innovation in the business environment. Other factors may contribute to this.

-Fourth hypothesis: Is there a statistically significant effect at the 5% significance level of customer digitization and their relationships on entrepreneurial innovation among project holders at the Ain Temouchent business incubator?

The results in Table (02) indicate that the statistical significance value for this hypothesis is 0.023, which is less than 0.05, requiring acceptance of this hypothesis. This means that customer digitization and customer relations are among the factors contributing to the success of entrepreneurial innovation in the business environment.

-Fifth hypothesis: Is there a statistically significant effect at the 5% significance level of network relationships on entrepreneurial innovation among project holders at the Ain Temouchent Business Incubator?

The results in Table (02) indicate that the statistical significance value for this hypothesis is 0.408, which is greater than 0.05, requiring the rejection of this hypothesis. In other words, network relationships may not be a reason for the success of entrepreneurial innovation in the business environment. Other factors may contribute to this.

The results of the study indicate a variation in the impact of digitization components on entrepreneurial innovation among project holders at the Ain Temouchent business incubator. It was found that the general use of digitalization was not statistically significant ($Sig=0.995$), which means that the mere use of digital tools does not necessarily guarantee the promotion of innovation, which is in line with what Youssef (2024) said: that digitalization needs a strategic and planning environment in order to become an added value. On the other hand, the results showed that having a

clear digital strategy had a positive and statistically significant effect ($\text{Sig}=0.014$), which confirms the findings of the study (Zott & Amit, 2017) that the use of digital technologies within an integrated strategy contributes to raising the level of creativity and innovation in start-ups. In terms of organizational and individual culture, the results showed no significant effect ($\text{Sig}=0.894$), indicating that culture alone is not enough unless it is translated into actual practices that support innovation, which is consistent with the study (Schein, 2010), which confirmed that organizational culture only has an impact when it is linked to clear leadership processes.

On the other hand, the results highlighted that digitizing customers and their relationships is one of the key factors for successful entrepreneurial innovation ($\text{Sig}=0.023$), as digital interaction with customers opens up new horizons for creativity and enhances the responsiveness of start-ups to market demands, as confirmed by a study (Verhoef et al., 2021), which linked digital transformation and consumer behavior in supporting innovation. As for network relationships, the results showed no direct impact ($\text{Sig}=0.408$), which is consistent with some studies, such as Hoang & Antoncic (2003), which showed that social networks do not contribute to innovation unless they are supported by clear mechanisms for knowledge sharing and partnership activation. Therefore, it can be said that success in the incubator environment depends primarily on the implementation of a digital strategy and customer digitization, while other factors remain secondary unless they are integrated into a comprehensive complementary framework.

V.CONCLUSION:

In conclusion, it can be said that the results of this study reflect the complex reality of the impact of digitization on entrepreneurial innovation in the business incubator environment. It has been found that digitization alone is not a sufficient factor for achieving entrepreneurial excellence, as the mere use of digital tools does not necessarily lead to the creation of new or sustainable innovation. Rather, the real value is manifested when digitization is part of an integrated digital strategy capable of directing resources and employing technology in a way that serves the objectives of startup projects. The results also showed that digitizing customers and their relationships is a fundamental pillar of supporting innovation, highlighting the importance of placing the customer at the heart of the innovation process through modern digital channels. In contrast, organizational and individual culture or network relationships did not have a statistically significant impact, indicating that these factors need supportive environments and clear activation mechanisms to become effective elements of entrepreneurial innovation. This conclusion confirms that innovation in the digital age is not the result of a single factor, but rather the outcome of a complementary interaction between digital strategies, customer orientation, and other organizational and network factors. Hence, the study opens the door for researchers and professionals to rethink how to formulate more comprehensive and effective digital strategies, with a focus on enhancing the customer experience as a key entry point for supporting entrepreneurship and innovation in the contemporary business environment.

-Recommendations

- Work on **developing digital infrastructure** (high-speed internet, data centers) to facilitate the adoption of technology by start-ups.

- Enact **flexible legislation and laws** that encourage innovation, protect digital intellectual property, and support e-commerce.
- Launch **national digital transformation programs** specifically targeted at start-ups and small and medium-sized enterprises.
- Invest in **intelligent data analysis** to understand the market and consumers and develop innovative products.
- Adopt **cloud technologies and** artificial intelligence to increase efficiency and reduce costs.
- Encourage a culture **of experimentation and continuous innovation** within work teams through mechanisms such as design thinking and lean startup.
- Integrating **digital skills and entrepreneurship** into university curricula and vocational training.
- Encourage applied scientific research in the fields of artificial intelligence, blockchain, and augmented reality to serve entrepreneurial projects.
- Spreading **a culture of digital transformation** among individuals and consumers to accelerate the acceptance of digital solutions.
- Encourage entrepreneurial innovation as a means **of creating new job opportunities** and achieving sustainable development.
- Support **digital community initiatives** that link technology and social entrepreneurship.

At the business incubator level, the following can be added:

- Providing advisory and technological services that help entrepreneurs adopt advanced digital solutions.
- Establishing partnerships between the private sector and universities to facilitate technology transfer to start-ups.
- Supporting start-ups through digital financing mechanisms such as crowdfunding platforms and venture capital.

VI. REFERENCES:

1. Al-Khasawneh, A. (2011). Managing creativity and innovation in business organizations.
2. Al-Haj, M. A. D. (2021). The importance of digital transformation for organizations in achieving effective strategic foresight. Ahmed Daraya University, Adrar.
3. Al-Shimimari, A. D. A. B. A. (2022). Business management: fundamentals, concepts, and contemporary applications. Al-Obeikan Publishing.
<https://books.google.dz/books?id=K8OVEAAAQBAJ>
4. Al-Sairfi, M. A. A. (2003). Pioneering Management. Dar Safaa Publishing and Distribution.
<https://books.google.dz/books?id=n298QgAACAAJ>
5. Baza, A. Y. I. W. (2019). The Impact of Organizational Change on the Success of Digital Transformation in Algerian Public Institutions. New Economy Magazine.
6. Assaker, G., & do Valle, P. O. (2015). Using Partial Least Squares Structural Equation Modeling in Tourism Research .
7. Becker, J.-M., Ringle, C. M., Sarstedt, M & ,Völckner, F. (2015). How collinearity affects mixture regression results. *Marketing letters*, 26(4), 643-659 .
8. Boushi, J. S. W. (2019). Digital Transformation: Between Necessity and Risk. Journal of Legal and Political Sciences.

9. Bouya, A. A. (2011). The role of innovation in supporting the competitive advantage of economic institutions (a case study of Algerian mobile phone operator Mobilis). University of Constantine.
10. Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2 ed.). Erlbaum Associates .
11. Danks, N., & Ray, S. (2018). Predictions from Partial Least Squares Models. In.
<https://doi.org/10.1108/978-1-78756-699-620181003>
12. Diamantopoulos, A., Sarstedt, M., Fuchs, C., Wilczynski, P., & Kaiser, S. (2012). Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective. *Journal of the Academy of Marketing Science*, 40(3), 434-449 .
13. Drolet, A. L., & Morrison, D. G. (2001). Do we really need multiple-item measures in service research? *Journal of service research*, 3(3), 196-20 .4
14. European&Comission. (2015). *Digital Transformation of European Industry and Enterprises*. European Union. https://ec.europa.eu/growth/industry/policy/advanced-technologies/strategic-policy-forum-digital-entrepreneurship_en
15. Fadda, A. Y. (2018). Education for Entrepreneurship. Osama Publishing and Distribution.
16. Fari, L. S. (2021). An analytical study of the success factors of digital transformation in companies. Algerian Journal of Economics and Finance. Algerian Journal of Economics and Finance, 8(35).
17. Ferrah, R., & Guenour, A. (2017). Knowledge management and its role in achieving innovation in business organizations. *Journal of Financial, Accounting, and Management Studies*, 4(2).
18. Geisser, S. (1974). A predictive approach to the random effect model. *Biometrika*, 61(1), 101-107 .
19. Hair, J., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2014). *A Primer on Partial Least Squares Structural Equation Modeling* .
20. Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review*, 31(1), 2-24 .
21. Hair Jr, J .F., Matthews, L. M., Matthews, R. L., & Sarstedt, M. (2017). PLS-SEM or CB-SEM: updated guidelines on which method to use. *International Journal of Multivariate Data Analysis*, 1(2), 107-123 .
22. Hair, N., Wetsch, L. R., Hull, C. E., Perotti, V., Hung, Y.-T .C. J. I. J. o. I., & Management, T. (2012). Market orientation in digital entrepreneurship: advantages and challenges in a Web 2.0 networked world. 9(06), 1250045 .
23. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43, 115-135 .
24. Hoang, H., & Antoncic, B. (2003). Network-based research in entrepreneurship: A critical review. *Journal of Business Venturing*, 18(2) .187-165 ,([https://doi.org/https://doi.org/10.1016/S0883-9026\(02\)00081-2](https://doi.org/https://doi.org/10.1016/S0883-9026(02)00081-2))
25. Khalil, Z. B. T. S. (2022). Digital transformation and its relationship to change management. *Journal of Economic Research*, 17(2).
26. Khouli, A. (2023). Entrepreneurship Simply (1st ed.). Dar Al-Jundi Publishing and Distribution.
27. Saada, H. M. H. A. (2019). The relationship between management and mobility in bringing about organizational transformation. Al-Aqsa University 2]. Palestine.
28. Lachmann, J. (2010). *Stratégie et financement de l'innovation / Jean Lachmann*. Économica. Paris. <https://bibliotheque.tbs-education.fr/Default/doc/SYRACUSE/32726/strategie-et-financement-de-l-innovation-jean-lachmann>
29. Little, R. J., & Rubin, D. B. (2019). *Statistical analysis with missing data*. John Wiley & Sons .
30. Mahri, S. (2006). The Digital Library in Algeria: A Study of the Reality and Future Aspirations. University of Constantine].
31. Marcoulides, G. A., & Chin, W. W. (2013). You write, but others read: Common methodological misunderstandings in PLS and related methods. In *New perspectives in partial least squares and related methods* (pp. 31-64). Springer .

32. Mason, C. H., & Perreault Jr, W. D. (1991). Collinearity, power, and interpretation of multiple regression analysis. *Journal of marketing research* .280-268 ,(3)28 ,
33. Mooi, E., Sarstedt, M., & Mooi-Reci, I. (2017). Principal component and factor analysis. In *Market research: The process, data, and methods using Stata* (pp. 265-311). Springer .
34. Nitzl, C. (2016). The use of partial least squares structural equation modelling (PLS-SEM) in management accounting research: Directions for future theory development. *Journal of Accounting Literature*, 37(1), 19-35 .
35. Reinartz, W., Haenlein, M., & Henseler, J. (2009). An empirical comparison of the efficacy of covariance-based and variance-based SEM. *International Journal of research in Marketing*, 26(4), 332-344 .
36. Rigdon, E. E. (2014). Rethinking Partial Least Squares Path Modeling: Breaking Chains and Forging Ahead. *Long Range Planning*, 47(3), 161-167.
<https://doi.org/https://doi.org/10.1016/j.lrp.2014.02.003>
37. Sarstedt, M., & Mooi, E. (2018). Principal component and factor analysis. In *A Concise Guide to Market Research: The Process, Data, and Methods Using IBM SPSS Statistics* (pp. 257-299). Springer .
38. Sarstedt, M., Ringle, C., & Hair, J. (2017). Partial Least Squares Structural Equation Modeling. In.
https://doi.org/10.1007/978-3-319-05542-8_15-1
39. Schein, E. H. (2010). *Organizational Culture and Leadership* (4th ed.). CA: Jossey-Bass .
40. Sekaran, Y. (2006). *Research Methods in Business: A Skills-Building Approach* (Wiley, Ed. 4 ed.) .
41. Shmueli, G., Ray, S., Velasquez Estrada, J. M., & Chatla, S. B. (2016). The elephant in the room: Predictive performance of PLS models. *Journal of Business Research*, 69(10), 4552-4564 .
<https://doi.org/https://doi.org/10.1016/j.jbusres.2016.03.049>
42. Tenenhaus, M., Esposito, V., Chatelin, Y., & Lauro, C. (2008). PLS path modelling'. *Computational Statistics & Data Analysis*, 48, 159-205 .
43. Tenenhaus, M., Vinzi, V. E., Chatelin, Y.-M., & Lauro, C. (2005). PLS path modeling. *Computational Statistics & Data Analysis*, 48(1), 159-205.
<https://doi.org/https://doi.org/10.1016/j.csda.2004.03.005>
44. Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, 889-901. <https://doi.org/https://doi.org/10.1016/j.jbusres.2019.09.022>
45. Wetzels, M., & Odekerken, G. (2009). Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration. *Management Information Systems Quarterly - MISQ*, 33. <https://doi.org/10.2307/20650284>
46. Youssef, B. Y. (2024). Evaluation of the Digital Transformation Path in Algeria (2020-2023). *Studies and Research*, 16(3).
47. Zhao, F., & Collier, A. (2016). *Digital Entrepreneurship: Research and Practice* .
48. Zott, C & ,Amit, R. (2017). Business Model Innovation: How to Create Value in a Digital World. *GfK Marketing Intelligence Review*, 9. <https://doi.org/10.1515/gfkmir-2017-0003>