





## *Innovation among entrepreneurial SMEs during the COVID-19 crisis in Iran*

### *La innovación entre las PYME emprendedoras durante la crisis de la COVID-19 en Irán*

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#### **Abstract**

COVID-19 is affecting the development of the global economy and threatening the survival of SMEs worldwide. In light of the current situation, this paper examines the factors affecting product and process innovation in SMEs during the COVID-19 crisis. We carried out a simple random sample of 185 SME entrepreneurs in Ardakan, Iran, using a multivariate regression analysis. The results showed that experience is one of the most important factors affecting innovation. Organization size and age were negatively associated with process innovation during the current crisis. Moreover, the findings reveal that training to facilitate cooperation as well as higher commitment to R&D can lead to greater innovation. An important conclusion is that, during the COVID-19 pandemic, government efforts to encourage SMEs to create new products helped them to withstand the crisis. The study suggests that, during the COVID-19 crisis, embracing innovation as a core organizational value helped SMEs to remain competitive.

**Keywords:** innovation; entrepreneur; small and medium-sized enterprises; SMEs; COVID-19

**JEL Classification:** L26; M10; O31; O36

#### **Resumen**

La crisis COVID-19 está afectando al desarrollo de la economía mundial y amenazando la supervivencia de las PYMEs de todo el mundo. A la luz de la situación actual, este trabajo examina los factores que afectan a la innovación de productos y procesos en las PYMEs durante la crisis de la COVID-19. Para ello se realizó un muestreo aleatorio simple de 185 empresarios de PYMEs de Ardakan, Irán, utilizando un análisis de regresión multivariante. Los resultados mostraron que la experiencia es uno de los factores más importantes que afectan a la innovación. El tamaño y la edad de las empresas se asociaron negativamente con la innovación de procesos durante la crisis actual. Además, los resultados revelan que, la formación encaminada a facilitar la cooperación, así como un mayor compromiso en I+D, pueden conducir a una mayor innovación. Una conclusión importante es que, durante la pandemia de la COVID-19, los esfuerzos del gobierno por alentar a las PYMEs a crear nuevos productos les ayudaron a resistir a la crisis. El estudio sugiere que, durante la crisis del COVID-19, la adopción de la innovación como valor organizativo fundamental ayudó a las PYME a seguir siendo competitivas.

**Palabras clave:** innovación; emprendedor; pequeñas y medianas empresas; PYMEs; COVID-19

**Clasificación JEL:** L26; M10; O31; O36

#### How to cite this article

Van Auken, H. E., Fotouhi Ardakani, M., Carraher, S., & Khojasteh Avorgani, R. (2021). Innovation among entrepreneurial SMEs during the COVID-19 crisis in Iran. *Small Business International Review*, 5(2), e395. <https://doi.org/10.26784/sbir.v5i2.395>

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## 1. Introduction

Crises are complex and their effects are felt not only immediately but also over a long period of time (Ansell & Boin, 2019). In the context of crisis, innovation has been identified as a powerful influence for the organizational resilience of SMEs (Nah & Siau, 2020). Coincidentally, this was the most affected sector during the COVID-19 pandemic (Fernandes, 2020, Hamilton, 2020). Innovative activity may help SMEs to protect themselves from the effects of crises (Gupta, 2020), and innovation grants a survival premium (Cefis et al., 2020). On the other hand, Disoska et al. (2020) found indications that crises have a negative influence on the willingness of SMEs to innovate. As Clark et al. (2020) state, countries have responded to the COVID-19 crisis in many different ways, according to their regulatory policies.

The COVID-19 pandemic has accelerated innovation all over the world (Galanakis et al., 2021). This change has already been seen in places where the virus hit first (e.g., in China), where large companies such as Huawei have increased their expenses for research and development (Galanakis et al., 2021). Since the 1990s, researchers have resorted to emergent technologies that typically cause a substantial disturbance in established market structure and prominent SMEs. This disturbance is generated by manufacturing products which are more highly efficient, less complicated and more accessible than established innovations (Galanakis et al., 2021; Schuelke-Leech, 2018). The uncertainty arising from the COVID-19 pandemic will shape future disruptive technologies that may emerge from entrepreneurs, start-up SMEs and larger established companies (Ebersberger & Kuckertz, 2021). These SMEs are willing to integrate new solutions in order to provide smaller, lighter, more flexible and more convenient products (Rowan, 2019). Therefore, SMEs have a vital role to play in innovation and in providing benefits to their local societies. (Alamolhodaie & Ardakani, 2015). Consequently, SMEs need to adapt by developing dynamic capabilities in order to continuously support and provide new products and to improve on their existing ones (Ramadani et al., 2019), especially in product and process innovation.

In this context, innovation could be considered as a way out of a crisis situation (Nemlioglu & Mallick, 2020), and as a tool that contributes towards increasing SME performance and competitive opportunities (Castaño et al., 2016). According to Onetti et al. (2012), the success and survival of SMEs in the global markets depend on the joint effects of innovation. In highly competitive SMEs, entrepreneurs must generate relevant innovations in order to sustain their financial performance and achieve a competitive advantage (e.g., Bagherzadeh et al., 2020; Iglesias et al., 2020). This is especially so during the COVID-19 pandemic, since innovation has long been suggested as one of the most effective strategic responses to crises (Wenzel et al., 2021). However, innovating during crises can be difficult as it requires quick and decisive actions, often with limited resources (Chesbrough, 2020; Wenzel et al., 2021). Due to time and resource constraints during crisis periods, firms increasingly engage in innovation activities (Markovic et al., 2021; Chesbrough, 2020; Dahlander & Wallin, 2020). In periods of crisis, such as the COVID-19 pandemic, companies must gain access to such resources in a timely manner in order to be able to develop relevant innovations before it is too late (e.g., Chesbrough, 2020).

An entrepreneur is commonly seen as an innovator, a source of new ideas, services, and procedures (Ardakani, 2013), and as someone who is able to improve SME performance (Ardakani & Avorgani, 2021). An entrepreneurial attitude includes an emphasis on personal control over a situation and that incorporates some degree of innovation, which has been important during the COVID-19 crisis (Brown & Rocha, 2020). This means emphasizing an individual's ability to change a course of action as a result of their self-confidence and need for achievement (Rauch & Hulsink, 2015). Therefore, the COVID-19 pandemic represents a unique opportunity for entrepreneurs to transform existing practices (Kirk & Rifkin, 2020). According to Lecerf (2012), SMEs have the ability to develop and launch new products and services or implement new processes through innovation, to produce new products and services, and/or to implement new methods of production (Saridakis et al., 2019). SMEs that introduce new processes are more likely to introduce new products (Ardakani, 2013). Others argue that SMEs tend to focus their efforts more on product innovation than on process innovation in order to increase their profits and to grow in size (e.g., Wolff & Pett, 2000). Product innovation is the main determinant for the establishment of new SMEs (Pedeliento et al., 2018). Therefore, there is a need to gather most of the currently available knowledge regarding innovation within SMEs, and to formulate alternatives so that SMEs may strengthen their businesses when faced with different restrictions. To address this need, several authors (as Lu et al., 2021; Caballero-Morales, 2021; Breier et al., 2021; Sun et al., 2021; Li et al., 2021; Hamilton, 2020; Eggers, 2020; Kuckertz et al., 2020) have published articles regarding the impact of the COVID-19 pandemic on SMEs, as well as reviews on previously published works which provided recommendations for SMEs.

A wide range of literature (such as Leckel et al., 2020; Ramadani et al., 2019; Romero & Martínez-Román, 2012; Battisti & Stoneman, 2010) exists dealing with the factors which condition firm innovation and, in particular, innovation in SMEs. From these works it is possible to identify three levels of key factors influencing innovation in SMEs: the personal characteristics of the individual entrepreneur, the characteristics of the organization and, lastly, the characteristics of the external environment. These three levels of factors are not independent but are rather interrelated dimensions which have a direct and crucial influence on innovation within the SMEs.

Hence, this study focuses on the relationships between entrepreneur characteristics (including level of education, experience, motivation and age), internal organizational characteristics (including education and training, cooperation, and size), the external environment (including Research and Development (R&D), government support and culture), and product and process innovation during the COVID-19 pandemic. Specifically, this study examines the factors (entrepreneur characteristics, internal and external characteristics) affecting product and process innovation among 185 SME entrepreneurs in the city of Ardakan, Iran, during the COVID-19 crisis. The role of innovation in the success of SMEs is central for sustaining a competitive advantage in the market because those SMEs with a high innovation capacity can respond faster to external challenges (Jiménez-Jimenez et al., 2008) such as that of the COVID-19 crisis. Therefore, this discussion leads to the research issues investigated in the study: (1) the relationship between entrepreneur characteristics and product and process innovation during the COVID-19 pandemic; (2) the relationship between organizational characteristics and product and process innovation during the COVID-19 pandemic; and (3) the relationship between the external environment and product and process innovation during the COVID-19 pandemic.

The paper is structured as follows: the next section of the paper presents previous research on innovation followed by a presentation of the research questions and results. We then describe the data and methods of analysis. Finally, we present a discussion of the results and conclusions.

## 2. Literature review and research framework

The COVID-19 crisis was a low-probability event that was both unpredictable and unexpected (Ratten & Jones, 2021; World Health Organization, 2020). The COVID-19 pandemic has challenged governments, societies, and SMEs all over the world (Breier et al., 2021; Clark et al., 2020). While some SMEs (e.g., in the food industry) suffered minor consequences, many almost completely lost their business for months (Baum & Hai, 2020). As a result, economic flow was severely reduced throughout all kinds of enterprises (Caballero-Morales, 2021). Even for countries with a strong economy, such as the United Kingdom, the lockdown period is estimated to have caused a 3.0% decrease in GDP (Nicola et al., 2020). The lockdown also led to an increase in unemployment and the closure of businesses, further highlighting social inequality (Blustein et al., 2020; O'Connor et al., 2020). The COVID-19 pandemic has led to a changing environment posing many challenges that call for innovative solutions, resulting in a changing innovation landscape (Ebersberger & Kuckertz, 2021).

Innovation is imperative for organizational survival and success in the turbulent market environment, especially during the current COVID-19 pandemic (Lee & Trimi, 2021). Research on innovation has emphasized the need for processes through which organizations may renew their resource bases by both recombining their existing resources and introducing new resources and factors of production (Mahoney, 2004). This enables them to respond to environmental challenges and market opportunities with a view to seeking out a sustained competitive advantage (Zollo & Winter, 2002). Innovation has been a key factor in the long-term success of SMEs (Van Auken et al., 2008), creating growth as well as a competitive advantage for SMEs (OECD, 2005). Innovation provides an important motivation for companies to collaborate and participate in inter-organizational relationships (Pittaway et al., 2004).

Innovation may be classified as either product innovation or process innovation (Ramadani et al., 2019). Process innovation is different to product innovation (Hervas-Oliver et al., 2014). Furthermore, Añón Higón and Driffield (2011) distinguish between product and process innovation activities. Following Chetty and Stangl (2010), among others (e.g., Chiva et al., 2014; De Massis et al., 2015), product innovation is defined in this research as the introduction of improved goods or services in order to, for example, increase sales or improve customer service. Product innovation occurs when SMEs implement a new or improved product or process that is new to the SMEs themselves but which has already been implemented in other SMEs (Saridakis et al., 2019). In this research, process innovation is defined as the introduction of new methods of production that aim to decrease costs, increase quality, or improve services (Chiva et al., 2014; OECD, 2005). According to Paul et al. (2017), SMEs can gain competitive advantages from innovation when the foreign market requires a specific type of service or product innovation. During the COVID-19 crisis, innovation could mean the implementation of a new or significantly improved process (e.g., different delivery methods) or product (e.g., a change in the properties of a product).

Innovation determines the level of success, priority, and positive influence on firm performance (Danai et al., 2018). Entrepreneurs and the managers of SMEs can embrace product, technology and process innovation but must also consider the culture, norms and values of the organization (Humphreys et al., 2005). Ho (2011) stated that innovation could be divided into two categories: product and process. Edwards et al. (2002) believes that innovation can mean representing products and processes by creating new applications of existing technologies. From the process perspective, innovation means the implementation of an idea that initiates the process and which eventually leads to the production and distribution of a new product (Tidd & Bessant, 2009). Some researchers claim that process innovation based on new technological advancements is generally used to enhance product innovation (e.g., Lewandowska et al., 2016; van Beers & Zand, 2014). We

examine the effect of product and process innovation on each other. Studies that take into account these complementarities between product and process innovation provide a useful insight but not a consistent picture. Innovations are considered to be the building blocks of the future of SMEs (Hisrich & Ramadani, 2017), and represent a decisive and substantial factor in determining SME performance and success (Gërguri-Rashiti et al., 2017). SMEs that do not innovate may underperform or even go out of business (Ratten, 2015).

In recent years, the pace of innovation has been frantic due to 1) the rapid advances in technology, science, and the digital transformation of organizations; (2) the compounding effect of the increasing complexity of the extended global value chains; and (3) the recent COVID-19 pandemic (Ip, 2020; Tonby & Woetzel, 2020). Thus, innovation has become an imperative for organizations and has demonstrated its importance during the COVID-19 pandemic (Stoll, 2020). Therefore, SME innovation can be an effective policy approach for sustaining economic development during the COVID-19 crisis.

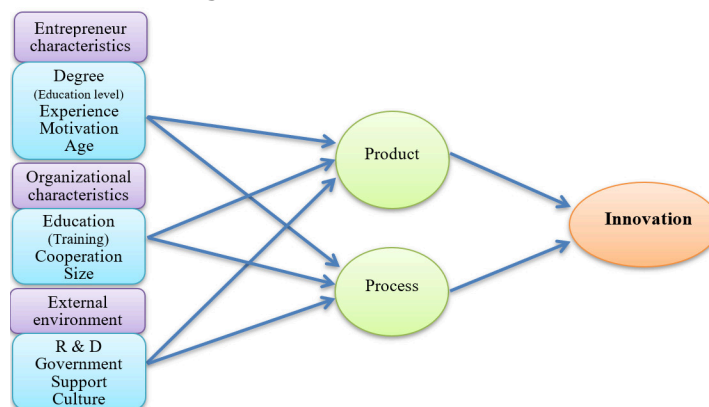
The COVID-19 pandemic has forced SMEs to innovate, entrepreneurs have had to work remotely, and processes have had to be rapidly transformed. Hence, innovation is important for strengthening and promoting SMEs (Markovic et al., 2021). Currently, SMEs introduce innovation by implementing new or different strategies (Van Auken et al., 2008). Successful implementation strategies often depend on factors that may facilitate the introduction of innovation, such as entrepreneur expertise, and a close relationship between entrepreneurs and clients. Furthermore, Hausman (2005) reported that those SME entrepreneurs who exert too much control and who lack the appropriate training are limited in their ability to develop the innovative climate of their businesses. Other studies found that barriers to innovation may be associated with cost, human resources development, organizational culture, and government policy (Mohnen & Röller, 2005). Innovation can be especially limited in SMEs due to their limited resources (Hewitt-Dundas, 2006).

The current pandemic crisis has led many organizations to take innovation much more seriously, resulting in changes in the aims of SMEs and the repurposing of products, for example. (Bello et al., 2020). To compete successfully in this unstable environment, organizations must develop dynamic capabilities based on agility, flexibility, resilience, and speed (Aghina et al., 2018). Thus, innovation has become a strategic priority for all kinds of organizations, such as SMEs and governmental or nonprofit enterprises (Lee & Trimi, 2021; Veronica et al., 2020). The adoption of innovation requires organizational commitment and effort (Madrid-Guijarro et al., 2009). McAdam et al. (2004) concluded that weak management commitment is one of the most significant barriers to innovation among SMEs. Hausman (2005) pointed out that SME entrepreneurs often lack the level of education and training necessary for a successful innovation strategy. In addition, entrepreneurs allow SMEs to achieve innovation and corporate entrepreneurship (Secundo et al., 2017; Secundo et al., 2020).

SMEs play an important role in the economic development of all countries (Tsai & Kuo, 2011). Therefore, information about the external environment of SMEs, such as market opportunities, changes in technology, and government policy, affect how entrepreneurs adopt innovation as a strategy to better meet customer needs and to help make their SMEs more competitive and innovative (Galia & Legros, 2004). The external environment of SMEs includes a variety of influences and challenges that require them to communicate to managers the importance of innovation as a core strategy that is needed in order to be competitive (Frishammar & Ake Horte, 2005). Souitaris (2002) found a positive relationship between economic conditions and innovation. Economic turbulence creates conditions that motivate SMEs to incorporate innovation into their business strategies in order to remain competitive (Madrid-Guijarro et al., 2009).

In accordance with our research framework (Figure 1), we examine the three main factor categories affecting innovation in SMEs – entrepreneur characteristics, organizational characteristics, and the external environment– and how these affect product and process innovation.

**Figure 1.** Research Framework



Source: Own elaboration

## 2.1. Entrepreneur characteristics and SME innovation

**1) Level of education.** COVID-19 is posing a significant challenge to management education (Brammer & Clark, 2020; Marshall & Wolanskyj-Spinner, 2020). Characteristics such as the adoption of technology and hiring human capital with applied education help develop learning by doing, as well as the interacting mode of innovation (Ramadani et al., 2019). Hornaday and Tiken (1979) reported that successful entrepreneurs often believe that younger generations are less educated than the older population. In fact, the educational backgrounds of managers, business owners and entrepreneurs have been found to be important for SME innovation (Romero & Martínez-Román, 2012). Brockhaus and Nord (1979) found that the self-employed tend to be less educated than managers. Ramadani et al. (2017) concluded that labor costs and the skills and level of education of employees had a positive impact on the ability of SMEs to invent and bring to market innovative products.

**2) Experience.** Previous experience has a significant influence on innovation within SMEs. Innovation can be enhanced within an organization by increasing the knowledge and experience of entrepreneurs. A large part of the relevant knowledge for innovation is of a tacit and unspoken nature and is derived from experience (Romero & Martínez-Román, 2012). An entrepreneur's practical knowledge is especially important within the process of organizational learning, the development phase of the innovation process (OECD, 2005) and the process of incremental innovation (Romero & Martínez-Román, 2012). Jennings (1994) reported that most technology companies prefer to hire employees with previous experience due to the contributions which they may provide to an innovative company culture. In addition, companies that have more experienced employees possess a higher level of innovation than those with fewer experienced employees (Rosenbusch et al., 2011). Fernandes et al. (2013) found that a skilled and experienced labor force has a positive, statistically significant impact on product innovation.

**3) Motivation.** Entrepreneur motivation and attitude also affect SME innovation (Block & Sandner, 2009). Motivation is a prerequisite for creativity (Wong & Ladkin, 2008). Individual characteristics and traits associated with innovative behavior include curiosity, cognitive flexibility, learning orientation, and perseverance (Baron & Tang, 2011). Guzmán and Javier Santos (2001) stated that those entrepreneurs who are extrinsically motivated may be less willing to accepting innovation. Furthermore, the motivations behind these efforts lack empirical analysis (Bogers et al., 2017; Santos & Mendonça, 2017).

**4) Age.** Fry (1993) showed that most people who start a business are between 20-50 years old, and that 65% are between 20-40 years old. These ages provide a balance between required experience and family responsibilities (Fry, 1993). Susbauer (1972) believed that entrepreneurs younger than 25 and older than 60 are often too limited by a lack of experience or energy to be able to run a business successfully.

## 2.2. Organizational characteristics and SME innovation

**1) Education (Training).** As the COVID-19 crisis has deepened around the world, so has the need to practice and think in an entrepreneurial manner (Parnell et al., 2020). The effects of the COVID-19 crisis have been felt in diverse parts of society and have resulted in increased inequality gaps between rich and poor (Pantano et al., 2020). The interest in entrepreneurship education has grown due to changing economic conditions emphasizing ecological sustainability and social equity (Ratten & Jones, 2021).

The growth of entrepreneurship education during the past decade has been phenomenal and is now a common course in most business schools (Santos et al., 2019). The right training approach can lead to innovation and improved entrepreneurial success (Campos et al., 2017). Walsworth and Verma (2007) show that human resource training is positively associated with both product and process innovation. Universities contribute to the promotion of innovation and human capital training (Audretsch et al., 2016). Beugelsdijk (2008) suggested that human resource training contributes to incremental innovation. Individual training contributes to the generation of new ideas within a business (Nonaka & Takeuchi, 1996).

**2) Cooperation.** Cooperation and coordination among organizational units have a positive influence on SME innovation (Nonaka & Takeuchi, 1996). Systematic research into new market opportunities and interactions with similar companies enhance SME innovation (Guzmán-Cuevas et al., 2009). Collaboration with foreign SMEs is an important factor of product innovation in transition economies (Kastrati et al., 2016). These relationships can be summarized as follows (Gërguri-Rashiti et al., 2017): (1) Local SMEs can learn about the designs of new products and technologies through reverse engineering and then come up with new and improved innovations; (2) This collaboration can cause spillovers to local SMEs through labor market turnover where skilled workers who once worked for the foreign SMEs move to local SMEs; (3) The products of foreign SMEs may stimulate creative thinking within local SMEs and help generate blueprints for new products and processes. Hence, it would be beneficial to increase collaboration between SMEs, entrepreneurs, research institutions and the public sector in order to encourage innovation so that it is both easily accessible and beneficial for SMEs (Leckel et al., 2020).

**3) Size.** SME size is directly associated with innovation due to the capabilities and resources needed to create innovation (Soete, 1979). Romero and Martínez-Román (2012) showed that the effects of SME size on innovation can vary significantly among industries. Rogers (2004) emphasized the role of the industry life cycle as innovation tends to concentrate within larger SMEs as industries evolve towards maturity. The nature of the knowledge environment has emerged as a factor influencing the relationship between SME size and innovation (Vaona & Pianta, 2008). In addition, Forés and Camisón (2016) found that the size of an organization has a positive effect on incremental innovation performance but a negative non-significant effect on radical innovation performance.

### 2.3. External environment and SME innovation

**1) Research and Development (R&D).** R&D represents a company's internal efforts to obtain knowledge that will lead to greater innovation (Hull & Covin, 2010). R&D includes both product and process R&D. In product R&D, business owners improve their products, while in process R&D marginal costs are reduced (van Egeraat, 2010). Absence of an R&D system could lead to lower SME competitiveness and performance (Lee et al., 2011). Companies often need external sources such as collaboration with other companies, partnerships with universities, and R&D initiatives to enhance innovation (Kroll & Schiller, 2010). Reviewing studies into innovation, Becheikh et al. (2006) concluded that 80% found a positive and significant effect of R&D expenditures on innovation activities. Hashi and Stojčić (2013) found that R&D leads to both product and process innovation. However, it may well be the case that this statistically insignificant relationship could be attributed to the fact that many SMEs might underreport their R&D measures and their innovation activities (Saridakis et al., 2019).

**2) Government Support.** Improving relationships between government and SMEs is a major factor affecting innovation. Government can assist in planning, raise industry awareness regarding the importance of innovation, and stimulate innovation (Moffat & Auer, 2006). Moreover, government policies, such as lowering tax rates and granting loans, can promote SME innovation (Souitaris, 2002).

**3) Culture.** A supportive organizational culture is essential in order to achieve innovation (Morris, 2007). National culture affects innovation through, for example, an efficient use of R&D and technology (Dwyer et al., 2005). These are all related as culture directly affects SME innovation (Akman & Yilmaz, 2008).

## 3. Methodology

### 3.1. Population and sample

We conducted a survey targeting innovation in SMEs to test our hypotheses during the COVID-19 crisis. These SMEs were selected because they operate within a highly competitive and dynamic environment where the ability to innovate is a requirement for growth and high performance (Madrid-Guijarro et al., 2009; Cenamor et al., 2019). Moreover, by sampling SMEs, we focused on those that offer new products and thus possess an innovation process. We chose to conduct our study in the city of Ardakan, Iran, for several reasons. Firstly, the local SMEs are competitive in innovation and product improvement. Secondly, SMEs play a key role in Ardakan city as do most of the entrepreneurs working there. Therefore, Ardakan's economy moved from being production-based to being one based on innovation.

There are approximately 225 SMEs in Ardakan. The population of this study includes entrepreneurs at these SMEs from whom we collected data in order to test the proposed hypotheses. During the COVID-19 pandemic of 2020-2021, most of these SMEs remained closed. Therefore, we used questionnaires and interviews for data collection. The interviews were carried out by phone and the questionnaires were sent by mail to a random sample.

As our research focuses on process and product innovation, our samples were taken from SME entrepreneurs. In this survey, we interviewed 108 entrepreneurs, of whom only 101 responded (answer rate=93.5%). In addition, 92 questionnaires were distributed, of which only 84 were usable (return rate= 91.3%). Finally, we collected data from 185 SME entrepreneurs during the COVID-19 pandemic of 2020-2021.

### 3.2. Variable measurement

This research is a descriptive survey study and initially used library resources to review the literature. A questionnaire was then designed consisting of two parts: the sample characteristics include the number of staff, experience, education, age, and measurements of the main variables, which were a combination of questions about entrepreneur and organizational characteristics and the external environment. Table 1 shows the description of the variables.

A total of 34 questions measured aspects of (1) internal organizational characteristics (including training, cooperation and size); (2) entrepreneur characteristics (including education level, experience, motivation and age); and (3) external environment (including R&D, government support and culture). We employed a 5-point Likert scale using values from 1 (totally disagree) to 5 (totally agree).

**Table 1.** Summary of variables

Variables		Measurement items		Measure
Dimension	Description			
<b>Independent variables</b>	<b>Entrepreneur characteristics</b>	Degree (Education level)	Entrepreneurs had a university degree or lower and higher degree.	Ordinal
		Experience	Entrepreneurs had previously worked in SMEs.	Ordinal
		Motivation	Motivation of entrepreneurs for change or improve of products	Ordinal
		Age	Old of entrepreneurs.	Ordinal
	<b>Organization characteristics</b>	Education (Training)	Entrepreneurs had attended any course about business administration or specific topics related to their business activity.	Ordinal
		Cooperation	Cooperation of entrepreneurs with other entrepreneurs and or with employees and employers.	Ordinal
		Size	Sectors of SMEs (Quality control, technical office and etc.) and number of employees worked in the SMEs.	Ordinal
	<b>External environment</b>	Research and Development (R&D)	Integration between the activities of entrepreneurs with R&D and universities.	Ordinal
		Government support	Support and help of government to EMEs and entrepreneurs (as like financial support).	Ordinal
		Culture	Culture of entrepreneurs to change and innovation in SMEs.	Ordinal
<b>Dependent variables</b>	<b>Innovation</b>	Product innovation	Introduction of a goods or services that are new or significantly improved.	Ordinal
		Process innovation	Changes in the technology and equipment used in the design, development, and manufacturing of products or services.	Ordinal

Source: Own elaboration

In this study, standard questionnaires were used to assess the validity of our questionnaire. An initial questionnaire was drawn up and distributed during the COVID-19 crisis among experts, scholars, and entrepreneurs. Then, after collecting their opinions, we modified the initial questionnaire. In the next stage, we distributed 35 questionnaires among SME entrepreneurs.

The questionnaire was pre-tested and revised based on the comments received and reliability. The trust ability of the questionnaire was assessed with the Cronbach's  $\alpha$  measurement method using SPSS22 software. In order to assess the reliability level, a survey with a sample of 185 entrepreneurs was carried out in Ardakan. The results of the test indicated that the Cronbach  $\alpha$  values for all the variables were 92.1%. To summarize, the measurement indicators of the questionnaire in this study possess good reliability and validity.

After considering the limitations imposed by the COVID-19 crisis, we decided that the best way to collect information was by means of a questionnaire. The data collection process consisted of four stages. First, we selected the measurements of the core variables from the literature and research such as that of Romero and Martínez-Román (2012), making appropriate adjustments to accommodate the Persian context. Second, we had the original English language questionnaire (standard questionnaire) translated into Persian. Third, a pilot study was conducted among 45 randomly selected SMEs. 30 entrepreneurs and 10 experts from SMEs as well as 5 university professors were requested to read and assess the questionnaire in terms of language issues related to coherence, clarity and unity, and technical issues such as format and layout.

The final questionnaire was revised according to the feedback received, and necessary modifications were then made to fit the target population. Finally, the data collection took place between October 2020 and March 2021 during the COVID-19 crisis.

### 3.3. Statistical analysis

Path analysis is a generalized form of multiple regression method in the formulation of causal models. In addition to the direct effects, the indirect effects of each of the independent variables on the dependent variables are identified. The default linear regression used in the path analysis shows that the distribution of the dependent variables is either normal or near normal.

In order to verify the normality of the data, a one-sample Kolmogorov-Smirnov test was used. This test compares the observed cumulative distribution function and the normal theoretical cumulative distribution function. The results of the Kolmogorov-Smirnov test showed that, for most variables, there is a statistically significant deviation from normality. Therefore, we can reject the null hypothesis of no deviation from normality and there is a significant difference between the observed and the expected frequencies. Because of the abnormal data distribution, a natural logarithm was used for the regression analysis. In conducting the

path analysis, innovation was a dependent variable, individual and organizational characteristics and external factors were independent variables, and product and process innovation were mediator variables.

Stepwise regression was used in the path analysis. All factors were used in the regression. One of the most important assumptions in testing causal relationships is the lack of co-linear relationships between the variables. High co-linearity signifies a low validity despite a high coefficient of determination. The Variance Inflation Factor (VIF), which is the reverse of tolerance statistics or the proportion of variance that is not explained by other independent variables, was used to test for co-linearity. The rate of co-linearity increases for lower values of tolerance and higher values of VIF index. This leads to an increase in the variance of the regression coefficients and causes adverse regression models for prediction. The maximum VIF in the regression models used in all path analysis procedures is 1.532, which is an acceptable number and which indicates high model validity. The empirical model and results are shown in Figure 2.

## 4. Results

The demographic data shown in Table 2 indicate that 34.05% of the entrepreneurs sampled had been working at the SME for 1-3 years and that 49.73% did not have a university degree. These results reflect a low educational level, and this would therefore be expected to have a negative impact on innovation. 45.41% of the entrepreneurs were between 30 and 40 years of age, which prevented the formation of business units for reasons such as military service and/or education. These indicate direct control over the business by the board members. Which is consistent with Menguc and Auh (2010), Xu et al. (2008) and Chandler et al. (2000).

**Table 2.** Respondent Characteristics

Variables	Frequency N = 185	Percent (%)
<b>Number of Staff</b>	<10	46.49
	10-19	28.65
	20-29	14.59
	>29	10.27
<b>Experience (years)</b>	<1	24.32
	1-3	34.05
	3-6	20.54
	6-10	12.97
	>10	8.11
<b>Degree (Education level)</b>	< Diploma	49.73
	Bachelor	35.14
	Graduate <	20.54
<b>Age</b>	<30	31.89
	30-40	45.41
	>40	22.70

Source: Own elaboration

The correlations shown in Table 3 were used to examine the relationships between the variables. The dominant structural features associated with the external and internal environments of the organization have a significant correlation with the characteristics of individuals in this period of time. The values in Table 3 show that the average is less than 2, which indicates low values for age, organization size, and level of education. In addition, experience and motivation revealed the highest correlation with innovation during the COVID-19 pandemic.

The values in Table 3 show that organization size and age were significantly and negatively related to process innovation ( $r = -0.146$ ,  $P < 0.05$ ;  $r = -0.167$ ,  $P < 0.05$ ), but not significantly related to product innovation ( $P$ -value  $> 0.05$ ). For the two contextual variables, experience and motivation were significantly and positively related to product innovation ( $r = 0.431$ ,  $P < 0.01$ ;  $r = 0.184$ ,  $P < 0.05$ ; respectively). Therefore, the contextual variable, government ( $r = 0.165$ ) was significantly related to process innovation at the 0.05 level. In fact, the government forced the SMEs to create new products as a result of the COVID-19 situation.



**Table 3.** Correlation between Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Age	1												
(2) Degree	-0.210**	1											
(3) Experience	0.324**	-0.161*	1										
(4) Size	-0.090	0.161*	-0.076	1									
(5) Education	-0.437**	0.238**	-0.139	0.141	1								
(6) Cooperation	0.205**	0.136	0.000	-0.027	0.171*	1							
(7) Motivation	-0.154*	-0.107	0.041	-0.206**	0.296**	0.055	1						
(8) Culture	-0.027	-0.120	-0.016	-0.263**	0.225**	0.271**	0.559**	1					
(9) R & D	-0.143	-0.050	-0.087	0.097	0.445**	0.367**	0.484**	0.414**	1				
(10) Government	0.066	-0.082	-0.068	0.346**	0.273**	0.375**	0.108	0.079	0.287**	1			
(11) Innovation	0.071	-0.017	0.417**	-0.145*	0.088	0.053	0.252**	0.170*	0.148*	0.057	1		
(12) Product	0.167*	0.077	0.431**	-0.088	0.066	0.015	0.184*	0.102	0.096	0.165*	0.804**	1	
(13) Process	-0.050	-0.103	0.245**	-0.146*	0.206**	0.099	0.223**	0.172*	0.143	-0.254**	0.814**	0.309**	1
Mean	1.86	1.79	3.64	1.81	3.73	3.42	3.46	4.16	3.26	2.43	38.054	3.87	3.74
Std. Deviation	0.968	1.001	0.786	0.962	0.816	0.828	0.654	0.567	0.711	0.927	0.689	0.842	0.861

Source: Own elaboration

\*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

Table 4 shows the results and presents the procedure of path analysis and effect on all variables over 8 stages. In stage 1, process innovation is more important than product innovation. In stages 2 and 3, organizational size and age are significantly and negatively associated with process innovation ( $r = -0.271$ ,  $r = -0.216$ ). Government ( $r = 0.426$ ) and experience ( $r = 0.191$ ) are significantly and positively associated with process innovation. Also, experience ( $r = 0.438$ ), motivation ( $r = 0.199$ ) and level of education ( $r = 0.157$ ) are significantly and positively associated with product innovation. In addition, government is significant at the 0.01 level and negatively associated with product innovation ( $r = -0.144$ ). In the other stages, the findings show that other variables are also associated with innovation.

**Table 4.** Total Procedure of Path Analysis

Stage	Dependent Variable	R <sup>2</sup>	Adjusted R <sup>2</sup>	F	Sig	Independent Variable(s)	Beta	Sig	VIF
1	Innovation	0.662	0.660	358.670	0.000	Process	0.625	0.000	1.105
						Product	0.611	0.000	1.105
2	Process	0.301	0.281	15.395	0.000	Product	0.309	0.000	1.259
						Government	0.426	0.000	1.180
						Size	-0.271	0.000	1.153
						Experience	0.191	0.009	1.336
						Age	-0.216	0.001	1.143
2-1	Government	0.348	0.333	24.008	0.000	Cooperation	0.381	0.000	1.045
						Size	0.365	0.000	1.043
						Degree	0.244	0.000	1.092
						Education	0.214	0.001	1.097
2-1-1	Cooperation	0.300	0.281	15.394	0.000	R & D	0.422	0.000	1.372
						Age	0.284	0.000	1.095
						Degree	0.223	0.001	1.072
						Culture	0.256	0.001	1.532
3	Product	0.261	0.245	15.900	0.000	Experience	0.438	0.000	1.035
						Motivation	0.199	0.003	1.023
						Degree	0.157	0.018	1.045
						Government	-0.144	0.027	1.024
3-1	Experience	0.105	0.100	21.530	0.000	Age	0.324	0.000	1.000
3-2	Motivation	0.443	0.431	35.826	0.000	Culture	0.411	0.000	1.381
						R & D	0.404	0.000	1.393
						Cooperation	0.208	0.001	1.180
						Size	-0.143	0.017	1.137
3-2-1	R & D	0.393	0.376	23.172	0.000	Education	0.353	0.000	1.184
						Culture	0.288	0.000	1.274
						Degree	0.159	0.011	1.129
						Size	0.155	0.013	1.133

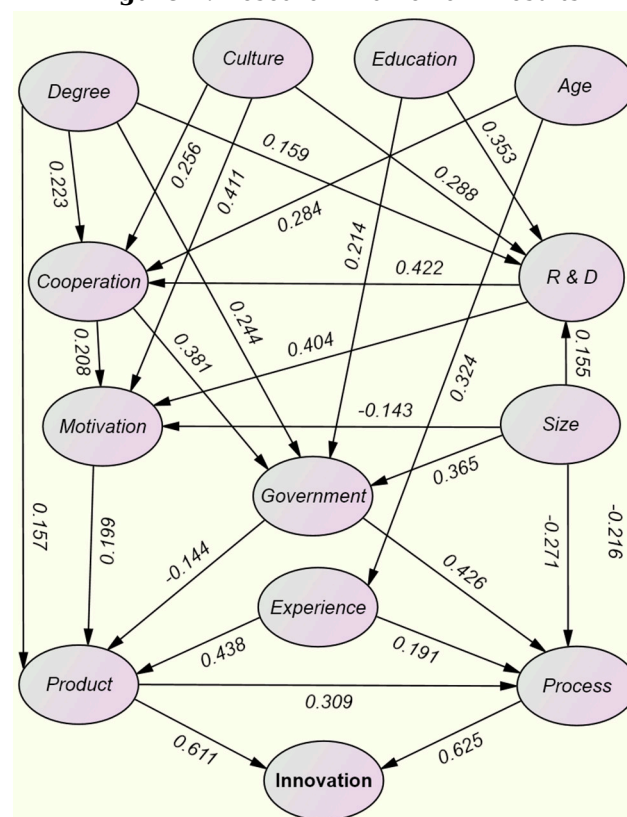
Source: Own elaboration

The impact of direct, indirect and total effects was calculated to determine which variables are associated with innovation. The findings shown in Table 5 during the COVID-19 pandemic indicate that no external environment or entrepreneur characteristics are directly associated with innovation. Product innovation had a higher effect on innovation than process innovation. However, product innovation had the highest effect on innovation. SME size was negatively associated with innovation (-0.098). Innovation declined as SME size increased. Specifically, the variables may have direct and indirect effects on product innovation (0.804), but do not have indirect effects on process innovation (0.625). The other SME variables do not have a direct effect on innovation but rather have an indirect effect on it.

**Table 5.** Type and Intensity Impact of Each Variable on Innovation

Variables	Effects		
	Direction effect	Indirection effect	Total
Product Innovation	0.611	0.193	<b>0.804</b>
Process Innovation	0.625	-	<b>0.625</b>
Experience	-	0.471	<b>0.471</b>
Degree	-	0.162	<b>0.162</b>
Motivation	-	0.160	<b>0.160</b>
Government	-	0.150	<b>0.150</b>
Culture	-	0.118	<b>0.118</b>
R & D	-	0.102	<b>0.102</b>
Size	-	-0.098	<b>-0.098</b>
Cooperation	-	0.090	<b>0.090</b>
Education	-	0.068	<b>0.068</b>
Age	-	0.043	<b>0.043</b>

Source: Own elaboration

**Figure 2.** Research Framework Results

Source: Own elaboration

## 5. Conclusions and discussion

These findings show that, during the recent crisis, experience was the most important factor influencing innovation. In addition, education and the possession of a degree are also significantly associated with innovation. SME size was found to be indirectly associated with innovation. As the number of employees increased, the rate of innovation declined. These findings are consistent with Romero and Martínez-Román (2012). Size is also indirectly associated with innovation, which is consistent with the findings of Soete (1979).

Additional findings show that cooperation and assistance between business units was associated with product improvement and the design of new products at SMEs during the COVID-19 crisis. Sher and Yang (2005) found that cooperation between business units and their integration has a positive effect on innovation. These results suggest that R&D allows SMEs to develop products that better meet consumer needs. This is consistent with Bertrand (2009), who found that innovation depends heavily on R&D. Another factor that affects innovation is government support. Government policies help entrepreneurs to acquire or develop new technologies that can ultimately improve SME performance (Madrid-Guijarro et al., 2009).

This finding is consistent with Kang and Park (2012) who showed that a positive relationship exists between state aid and innovation. Through a reduction in SME constraints, such as financial and human resources, and by providing the required infrastructure, government policy had a significant impact on SME performance and improvements in innovation, especially in product innovation, during the COVID-19 crisis.

The various limitations of this study also provide avenues for further research. The main limitation of this study is the data source, which was collected at a single point in time during the coronavirus crisis and access to entrepreneurs was difficult. The study could be expanded to investigate the relationship between innovation and performance across multiple markets and regions of the world during the COVID-19 pandemic. A longitudinal study could provide further evidence for the relationship between innovation and multiple SME characteristics over the business cycle in times of crises. Future studies may focus on SME flexibility and strategic innovation in the post-COVID-19 era.

While COVID-19 continues to cause devastating disruption to the global economy more than a year into the pandemic, it is also continuing to force remarkable innovations throughout different SMEs. SMEs have found new ways to produce, create, service and operate during the crisis. On the other hand, COVID-19 has helped entrepreneurs to recognize the risks of enterprise inertia and has caused many SMEs to seek new innovation-led growth or at least a consistent profit margin. COVID-19 has highlighted innovation as an effective approach for SMEs to generate relevant innovations in order to overcome the negative consequences of the pandemic. To sum up, COVID-19 has forced entrepreneurs and SMEs to innovate. Hence, this research project examined product and process innovation among 185 SME entrepreneurs during the COVID-19 crisis in Ardakan, Iran. In addition, this research is one of only a few papers to examine innovation during the COVID-19 period.

This study has several implications for entrepreneurs. Firstly, entrepreneurs should be aware of the relationship between age and product innovation. From a practical perspective, this means that older entrepreneurs developed and implemented new ideas in their SMEs during the COVID-19 crisis. Older entrepreneurs are therefore advised to foster innovation in order to adapt their SMEs to the crisis. Secondly, the results of this study indicate that motivation and experience are directly associated with innovation while organization size is negatively associated with innovation. Employee training to facilitate cooperation as well as higher commitment and willingness to engage in creative R&D collaborations can lead to greater innovation. Thirdly, for SME entrepreneurs interested in increasing or reactivating their innovativeness, this study has shown that government plays an important role in innovation processes. In times of crisis, governments should, based on these findings, focus on facilitating access to resources and equipment for SMEs rather than on limiting them and closing them down. In addition, regional governments are trying to rethink and focus on innovation so that it is re-established on a more sustainable level.

The results should be useful for entrepreneurs, governments, stockholders, SME owners and providers of services to SMEs in order to better understand which factors affected the adaptation of innovation during the COVID-19 pandemic. Understanding the factors that affect innovation can provide a perspective on how SMEs can continue to embrace innovation as a core value and remain competitive in the increasingly competitive world markets, especially during crises such as the COVID-19 pandemic. In times of crises, financial statements provide important information that should be used, both by external and internal assessors, to help guide decisions. Entrepreneurs, business owners and service providers can use the information to understand which factors affected their use of financial statements during the crisis. A thorough understanding of these influencing factors may improve the process by which financial statements are incorporated into the decision-making process.

## Acknowledgements

We would like to thank who those for their kind cooperation and suggestions to this study.

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