**Original Article**

# Effective factors in dealing with industrial crises caused by widespread virus outbreaks

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## Abstract

**Background**: The global spread of the COVID-19 virus has not only posed a severe threat to public health but has also triggered a profound economic crisis affecting numerous industries. Addressing and mitigating the economic repercussions of the pandemic is imperative to prevent further damage. While prior research has explored the negative impacts of the COVID-19 pandemic on various industries, there has been a notable gap in understanding the specific factors that influence how industrial crises stemming from viral outbreaks are managed.

**Methods**: This article undertakes a comprehensive investigation into these influential factors. Through in-depth interviews with industry experts, we identified a set of 30 pivotal variables in this context, forming the basis of an initial model. Subsequently, a questionnaire was administered to a cohort of one hundred managers and industry experts to assess these variables. Employing exploratory factor analysis, we categorized the 30 variables into six distinct categories: producer-related factors, supplier-related factors, distributor-related factors, retailer-related factors, consumer-related factors, and government-related factors.

**Results**: Our findings revealed several strategic considerations for effectively addressing industrial crises in the face of viral outbreaks. These include the importance of building trust with customers in emerging markets, streamlining the adoption of digital technologies by customers, enhancing the customer relationship management process, prioritizing awareness, concern, and environmental consciousness, and providing support to consumers during times of viral spread.

**Conclusion**: To effectively navigate industrial crises triggered by the widespread dissemination of viruses like COVID-19, businesses and governments should prioritize strategies that align with the identified factors. By focusing on these key areas, industries can bolster their resilience and minimize the adverse effects of such crises, ultimately contributing to economic stability and recovery in the face of global health emergencies.

**Keywords: Disease Outbreaks; Emergencies; Factor Analysis, Statistical; Industry.**

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## Introduction

COVID-19 has become a global challenge with a significant rate of prevalence, and it has exerted devastating consequences in epidemic, economic and social terms .(1)

One of these socio-economic effects was that During the outbreak of Corona, citizens were asked to observe social distancing and stay at home(2). Isolation may be harmful to society as well as business(3). The disadvantages that this isolation causes

include depression, the loss of many businesses, increased violence in the family, and disputes between neighbors(4). This situation also has positive behaviors, such as learning new skills, taking care of the living space, starting internet businesses, recycling waste, and saving(5).

Due to the spread of the Coronavirus, many of the country's industries face a lack of customers or weakness, an inability to continue business with production, and many imposed losses(6). From a practical point of view, many factors cause significant problems for the country's industries, such as business restrictions, the impossibility of employee activities during this period, and the absence of customers. Therefore, strategies to deal with these problems should be provided to enterprises so that they can overcome these problems. The official statistics of the World Bank in 2021 show that the outbreak of the Coronavirus has reduced industrial production worldwide by 18% (7). This article seeks to find strategies to deal with industrial crises during the outbreak of widespread viruses, which is of great importance due to the many losses imposed on industries during this period. In addition, from a theoretical perspective, research has been done on the spread of the Coronavirus and the problems that have arisen. For example, the study of(2), (8), (9), and (10)concluded that the Coronavirus has negatively affected important and essential industries. None of these researches have been done exploratory to know the effective factors in dealing with industrial crises caused by the spread of pervasive viruses. Therefore, the present study was conducted to identify and investigate effective factors in dealing with industrial crises caused by the spread of epidemic viruses. Thus, this article identified the effective factors in dealing with industrial crises caused by the spread of widespread viruses while conducting a systematic review of the research and through in-depth interviews with ten experts, surveys, and archival documents. Then, 30 main variables were determined using the fuzzy Delphi technique, and the initial model was presented. A questionnaire was designed and assessed by 100 industry experts selected through random sampling to evaluate the model. The exploratory factor analysis technique was used for data analysis, and all influential factors were placed in 6 categories.

*Theoretical foundations of research*

Environmental shocks refer to disturbances that are challenging to predict and result in unforeseen disruptions that significantly impact a company's outcomes. When confronted with a crisis, businesses react by safeguarding their financial assets, workforce, and supply chain resources while minimizing the resultant harm (11). In this context, the literature investigates how companies strategically respond to crises, with critical factors including the timing, severity, and involvement of institutions playing pivotal roles in crisis management (12). The element of time plays a crucial role as companies determine their strategic reactions to environmental variables (13). The speed at which strategic decisions are made determines whether firms can secure advantages as early adopters or if they respond later. Additionally, the availability of information and resources can change over time, influencing firms to make proactive or reactive choices. Therefore, the duration of an event holds significant importance when assessing or making decisions about a company's response strategies to such an event.

Conversely, companies address shocks while preserving vital resources and minimizing adverse effects. In the long run, these companies adopt strategies that position them ahead of competitors, enabling them to attain cost advantages and leverage their networks. A crisis is an event of such magnitude that it disrupts the typical operations of an entire industry. Catastrophic events are not uncommon in the tourism industry, and their impact can

range from local and regional to global scales. For instance, while the SARS outbreak in Asia in 2003 affected 8,000 people over eight months, COVID-19 had a global impact, infecting over 75,000 individuals and claiming more than 2,100 lives in just three months(14).

The COVID-19 crisis has created a double crisis, reflecting the problems of many health systems worldwide and the infection control measures that have created an economic crisis by damaging many economic activities. Innovative startups are primarily overlooked during the pandemic. The policy initiatives adopted through the pandemic are mainly focused on protecting the existing industrial sectors of established companies and economies, so these measures aim to protect employees and focus on the continuation of essential economic activities. In other words, policies are focused on preserving the present and do not care about the future. Startups will shape future economic activity. Even in normal times, businesses face small and new liabilities (15)that threaten their existence, and the situation worsens during the COVID-19 crisis. Thus, it reduces the tremendous potential for accumulated innovation. In recent years, it was supposed to create economic and potential social and environmental value(16).

The COVID-19 pandemic has brought about a dual crisis. It has shed light on the challenges faced by various healthcare systems globally and has also triggered an economic downturn due to the impact of infection control measures on various economic activities. During this pandemic, there has been insufficient attention given to innovative businesses. The policies implemented in response to the pandemic have primarily been centered on safeguarding existing industrial sectors of established companies and economies, with a focus on protecting workers and ensuring the continuity of essential economic operations. In essence, these policies are geared towards preserving the status quo and show little concern for the future. However, businesses play a pivotal role in shaping future economic activities. Even in ordinary times, businesses encounter new responsibilities that pose threats to their survival (15). The situation has been exacerbated during the COVID-19 crisis, creating significant potential for accumulated innovation that was previously expected to yield economic, as well as potential social and environmental, benefits in recent years (16).

The pandemic-induced quarantines have given rise to a novel and unparalleled environment not found in entrepreneurship literature. However, extensive research on entrepreneurship and crisis management, exemplified by studies (17) and (18) among others, offers valuable insights for addressing the pandemic. This research is divided into two key streams. The first stream delves into how entrepreneurs manage crises and navigate them, while the second stream puts forth policies to bolster organizational resilience in times of crisis and surmount the existing challenges (15). Furthermore, the second stream can assist policymakers in devising effective interventions to fortify and support businesses.

Numerous studies conducted within a brief timeframe have assessed the impact of the COVID-19 pandemic on entrepreneurs across various countries and explored strategies to minimize the associated damage. Most of these studies concur that the Coronavirus has had a profoundly adverse effect on all sectors (16).

Historical research underscores the substantial influence of environmental uncertainty and adverse conditions on work relationships within and outside organizational boundaries. The COVID-19 pandemic has underscored how businesses can be upended during crises, even altering the dynamics of partnerships in a "force majeure" situation. Such crises often stress-test relationships and lay bare

transformations in relationship development and management practices (19).

One manifestation of these changes in relationship development and management practices pertains to how business partners and their cross-border employees interact and communicate. For instance, COVID-19-induced quarantines in several countries compelled marketers to break free from conventional thinking and marketing practices (20). Many meetings and communication activities had to migrate to the digital realm. Even before the pandemic, virtual communication and digital marketing were gaining prominence in business relationships (21). The COVID-19 crisis merely accelerated this trend across organizations. Nevertheless, certain aspects of the pandemic's impact on industrial relationships have remained underexplored. Factors such as flight cancellations, physical distancing regulations, remote work, and other restrictions (19) have rendered it nearly impossible to visit current and potential customer sites. While virtual meetings and advanced technologies like three-dimensional (3D) displays have mitigated some negative effects, certain elements crucial to these businesses cannot be conducted remotely, an aspect often overlooked in the context of the COVID-19 pandemic's impact on industrial relationships (19).

Conversely, despite the growing prevalence of virtual communication and digital marketing practices in industrial relationships and the sweeping changes precipitated by the COVID-19 crisis (22), there exists relatively limited knowledge concerning the psychological and cognitive challenges faced by industrial partners. Cross-border professionals contend with measures that may be temporary following crises, yet they must manage business relationships and processes likely to endure. Key considerations include whether and how virtual communication and cross-border interactions during the COVID-19 crisis can supplant physical meetings and location-based personal relationships. In this context, the radical shifts in the working patterns of border-crossing professionals during the crisis (23) may yield unforeseen consequences for their interactions with business partners (19).

*Research background*

The initial study conducted by (24) underscores the pandemic's global challenges, manifesting as a significant health crisis that has profoundly affected all aspects of life, including trade, work, lifestyle, and consumption patterns. Small and medium-sized enterprises (SMEs) have been particularly hard-hit as customers remain homebound, supply chains face disruptions, and small industries, which generate 70 percent of jobs in many countries, are under severe pressure. (25) highlights the adverse economic impact of the Coronavirus on Pakistan, with most companies experiencing negative repercussions in terms of finances, distribution, and supply chain disruptions leading to reduced profits and sales.

(26) focuses on the impact of the pandemic on SMEs in Serbia, revealing that the crisis has disrupted SMEs' daily operations in several ways. To adapt, many have shifted toward online business practices, addressing supply chain challenges, reduced working hours, resource shortages, wage payments, and production inefficiencies.

According to(27), underscores the importance of marketing innovation for SMEs during crises, advocating for innovative marketing strategies involving alterations to the marketing mix (product, price, place, and promotion). Research suggests that such innovations positively affect SME profitability. The international quarantine imposed due to the COVID-19 outbreak has prompted the adoption of online business and marketing strategies, essential for the survival and resilience of

SMEs amid the pandemic and post-pandemic challenges (28).

(29) provides an overview of the pandemic's impact on African countries, highlighting significant changes in life since the first quarter of 2020. The study emphasizes the substantial challenges faced by innovative startups, particularly in light of plummeting fuel prices, reduced foreign direct investment, and declining global demand for exports. The study recommends that African countries bolster fiscal and monetary policies and enhance productive capacities to manage vulnerabilities and crises effectively.

Finally, (30) investigates the effects of the COVID-19 pandemic on SMEs in Sri Lanka through qualitative interviews with 14 SMEs. The study reveals that the strategies and protocols employed to mitigate the pandemic's negative impact have incurred substantial human and economic costs, including reduced demand, material shortages, order cancellations, debt repayment challenges, investment and savings limitations, and high implementation costs for COVID-19 workplace measures. The study calls for government support and effective post-crisis recovery policies, emphasizing the critical role of policymakers, SME operators, and the government in SME resilience.

(22) explores cooperation and competition dynamics in business-to-business marketing strategies during the pandemic, contemplating whether businesses should continue collaborating with competitors or operate independently post-pandemic. This paper suggests avenues for future research. Meanwhile,(31) analyzes the pandemic's effect on business models, highlighting the significant variability in its impact on different companies and the importance of understanding these differences in crafting effective strategies for navigating the crisis and the future.

(9) examines crisis management for small businesses in Macao during the pandemic, focusing on survival, flexibility, and renewal strategies. The study emphasizes the importance of adaptable human resource strategies and underscores the benefits of having a formal crisis plan and prior experience in dealing with crises.(22) revisits cooperative business marketing strategies during the COVID-19 crisis, delving into how organizations can effectively implement collaboration in large-scale emergencies. The study underscores the need to balance the risks and benefits of collaborative activities and determine whether continued collaboration with competitors or a shift to individual business models is more appropriate post-pandemic.(32) investigates industrial marketing responses to the COVID-19 crisis, categorizing responses into three areas: product development management, supply chain management, and customer relationship management. The study emphasizes the need for proactive adaptation and resilience strategies among businesses.

(14) explores crisis management and resilience in the airline industry during the pandemic, tracing the evolution of decision-making as the industry grappled with the virus's spread. It underscores the industry's shift toward transporting high-demand goods and medical supplies as the crisis deepened.

(33) examines how changes in consumer purchasing behavior during COVID-19 impact the business models of consumer service companies. The study posits that shifts in purchase behavior can lead to new business model designs, particularly focusing on consumer intent, motivation, and time frames.

(16) investigates the response of Egyptian SMEs to the COVID-19 pandemic, emphasizing the importance of flexibility and innovation while acknowledging varying opinions on the Egyptian government's post-epidemic measures.(19)

delves into the challenges faced by Finnish high-tech industrial companies in managing international customer relations during COVID-19. The study highlights the rapid adoption of new practices, including online meetings and 3D displays, while underscoring persistent obstacles related to physical visits and trust-building with new customers.

(34) assesses the impact of COVID-19 on business performance, focusing on small and medium-sized businesses in Ardabil province. The study establishes relationships between the pandemic and customer, market, and financial performance.(35) reviews crisis response strategies in the production and industry sectors during the COVID-19 crisis, categorizing responses into withdrawal, persistence, innovation, and exit strategies. It emphasizes the significance of understanding these strategies for managers and researchers.

(36) examines the factors and challenges of business management during the pandemic, highlighting strategies for mitigating negative effects on human resources management in various sectors.

(37) investigates the influence of entrepreneurial skills and tenacity on business performance during the COVID-19 crisis, drawing on data from GEM 2020 Iran. The study explores the complex relationship between entrepreneurial skills, personality, and competencies in the context of business performance.

(37) identifies the factors and challenges of business management in the supply of raw materials during the pandemic, using Tasha Machinery Company as a case study. The study recognizes the COVID-19 pandemic's multifaceted impact on the global business environment and underscores the role of consumer support in luxury brand decision-making.

These studies collectively shed light on the diverse and profound effects of the COVID-19 pandemic on various aspects of business and entrepreneurship, offering valuable insights for navigating these challenging times and shaping post-pandemic strategies.

## Methods

This research aims to identify influential factors in dealing with industrial crises caused by the spread of widespread viruses. In addition, the main question is whether dealing with industrial crises caused by the spread of widespread viruses depends on the factors.

This research is applied in terms of purpose and descriptive correlation in collecting the required data. This research uses quantitative and qualitative data, and its implementation strategy is also based on a multi-case study. The required information was collected through comprehensive past research studies, in-depth interviews with key experts, surveys, and archival documents. Generally, data and information related to banks are collected through primary or secondary sources. In primary data, we directly ask experts or observe and study the actual behavior of the banking service supply chain. In secondary data, we collect data that already exists. Secondary data is often easier and faster to collect but also has limitations(38). This research examined the library study of theoretical foundations and research records and documents. In the field part, the approach of interviewing experts was used, which is common in such studies. The experts of this research include managers and banking service experts.

**Step 1**: Preparing a list of effective factors in dealing with industrial crises caused by widespread virus outbreaks.

Exploratory and semi-structured interviews were also conducted with the following people:

The first category is academic experts in the field of industrial management

The second category is managers and experts of manufacturing industries

Using semi-structured interviews allows the person's point of view to be well understood due to the possibility of receiving feedback from the interviewee, improving qualitative research's validity(39). In this research, the active interview method was also implemented(40). In this method, interviewees process and interpret events in the developing theory of the company. In all cases, the data obtained from the interviews were compared with information collected from other sources (such as regulations, annual reports, and website information) with no significant differences overall. To prepare a list of effective factors in dealing with industrial crises caused by the spread of widespread viruses, the initial list of factors obtained from the literature and research records (Table 1) was reviewed by selected experts. Their opinions about whether these factors are effective in Iran's environment were considered, and the necessary reforms were made. Finally, the list of influential factors in dealing with industrial crises caused by the spread of widespread viruses was finalized by 15 experts using the fuzzy Delphi technique (Table 3).

**Step 2:** Classification and validity evaluation of the designed research model using the FA method

In the second stage of this study, a quantitative approach was used. At this stage, a researcher-made questionnaire was designed to confirm the model. In this study, the reliability of the collection tool by Cronbach's alpha was 0.832. The following steps were performed to determine the validity of the questionnaire:

1-Compiling the questionnaire based on the factors extracted from the theoretical foundations and records (content validity) so that all the factors were extracted from valid research and presented in Table 3 regarding the source. These factors were used in the questionnaire by experts.

2-Conducting a pre-test with a limited group of respondents (10 people) to assess reliability. Finally, the questionnaire was completed by 100 managers and experts in industry and university.

*Development of conceptual framework (research model)*

Based on the influential factors in dealing with industrial crises caused by the spread of widespread viruses, the variables have been extracted based on the theoretical foundations of research and past research (Table 3). Then, the indicators were screened with the opinion of 10 experts. Finally, the 30 variables were obtained as described in Table 3. The factors were screened so that the variables compatible with Iran's conditions and could be summed up in one word were standardized, and some variables were redefined according to Iranian literature.

Now, it is necessary to prepare and give the researcher-made questionnaire to 10 experts using the fuzzy Delphi technique to ensure accurate identification of the variables and to reach a consensus about them. The following nine spectrums were used (Table 1) to design the researcher's questionnaire.

After receiving the answers from the research experts, the resulting data are shown in the Table below (Table 2).

Table 1- Linguistic variables

| Linguistic variables | Fuzzy number | Fuzzy triangular number |
|---|---|---|
| very unimportant | $\tilde{1}$ | (0,0.1,0.1) |
| Between very unimportant and very unimportant | $\tilde{2}$ | (0.1,0.2,0.3) |
| very unimportant | $\tilde{3}$ | (0.2,0.3,0.4) |
| Between very unimportant and relatively important | $\tilde{4}$ | (0.3,0.4,0.5) |
| Moderately important | $\tilde{5}$ | (0.4,0.5,0.6) |
| Between medium and very important | $\tilde{6}$ | (0.5,0.6,0.7) |
| Very important | $\tilde{7}$ | (0.6,0.7,0.8) |
| Between very and very important | $\tilde{8}$ | (0.7,0.8,0.9) |
| very important | $\tilde{9}$ | (0.8,0.9,0.9) |

Table 2 Converting experts' opinions into fuzzy numbers

| Factors | Expert1 | Expert2 | Expert3 | Expert4 | Expert5 | Expert6 | Expert7 | Expert8 | Expert9 | Expert10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Online business development | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Online marketing strategies | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) |
| Appropriate choice of financial and monetary policies | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) |
| Support for vulnerable groups and enterprises | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) |
| flexibility | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Develop a strategy to deal with the crisis before the outbreak | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Creating cooperation networks in the distribution | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) |
| Government aid packages | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) |
| Developing trust with customers in emerging markets | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Reconstruction of channels | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) |
| Tehsil in the process of accepting digital technologies | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Integrated communication approach in supply | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) |
| Meeting the real needs and feelings of consumers | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) |
| Explore new markets and increase learning | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Improving the customer relationship management process | (0.8,0.9,0.9) | (0.8,0.9,0.9) | (0.4,0.5,0.6) | (0.8,0.9,0.9) | (0.8,0.9,0.9) | (0.6,0.7,0.8) | (0.7,0.8,0.9) | (0.5,0.6,0.7) | (0.7,0.8,0.9) | (0.5,0.6,0.7) |
| Diversity in supplier selection | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) |
| Coordination of suppliers to meet high-demand | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Migration to digital distribution channels | (0.8,0.9,0.9) | (0.8,0.9,0.9) | (0.5,0.6,0.7) | (0.8,0.9,0.9) | (0.8,0.9,0.9) | (0.6,0.7,0.8) | (0.7,0.8,0.9) | (0.5,0.6,0.7) | (0.6,0.7,0.8) | (0.8,0.9,0.9) |
| Appropriate pricing strategy | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) |
| Training and empowerment of human resources | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Identify financing methods | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) |
| Reduce costs | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Applying human resources management system | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) |
| Vaccine supply | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) |
| Ability to receive orders from customers virtually | (0.7, 0.8, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) |
| Online advertising | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) |
| Attention to awareness, concern, and environmental habits | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) |
| Consumer protection | (0.5,0.6,0.7) | (0.6, 0.7, 0.8) | (0.5,0.6,0.7) | (0.5,0.6,0.7) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5,0.6,0.7) |
| Pandemic vaccine development, large-scale production | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) |
| Online business development | (0.6, 0.7, 0.8) | (0.6, 0.7, 0.8) | (0.8, 0.9, 0.9) | (0.7, 0.8, 0.9) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) |
| quick reaction | (0.4,0.5,0.6) | (0.5,0.6,0.7) | (0.8, 0.9, 0.9) | (0.4,0.5,0.6) | (0.5,0.6,0.7) | (0.5, 0.6, 0.7) | (0.4,0.5,0.6) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.4,0.5,0.6) |
| Providing cheap facilities | (0.5,0.6,0.7) | (0.6, 0.7, 0.8) | (0.5,0.6,0.7) | (0.5,0.6,0.7) | (0.6, 0.7, 0.8) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.5, 0.6, 0.7) | (0.6, 0.7, 0.8) |

After the calculation steps specific to the Delphi technique, in the continuation of the calculation steps and the numbers whose average de-fuzzified value is less than 0.7, that factor is rejected, and if it is 0.7 and above, that factor is accepted. (Table 3)

Based on the findings of the Table, 30 influential variables for dealing with the industrial crisis during the outbreak of epidemic viruses were obtained.

Table 3- The finalization of the effective factors in dealing with the industrial crisis during the outbreak of epidemic viruses

| Factors | Fuzzy average | Average De-fuzzed | Accepted/rejected |
|---|---|---|---|
| Online business development | (0.7222,0.8222,0.8777) | 0.807 | Accepted |
| Online marketing strategies | (0.7222,0.8222,0.888) | 0.8111 | Accepted |
| Appropriate choice of financial and monetary policies | (0.7333,0.8333,0.888) | 0.815 | Accepted |
| Support for vulnerable groups and enterprises | (0.7444,0.8444,0.9) | 0.829 | Accepted |
| flexibility | (0.7333, 0.8433, 0.8767) | 0.821 | Accepted |
| Develop a strategy to deal with the crisis before the outbreak | (0.69, 0.79, 0.84) | 0.77 | Accepted |
| Creating cooperation networks in the distribution | (0.7333, 0.8333, 0.8777) | 0.614 | Accepted |
| Government aid packages | (0.7555, 0.8555, 0.888) | 0.833 | Accepted |
| Developing trust with customers in emerging markets | (0.7333, 0.8333, 0.8777) | 0.814 | Accepted |
| Reconstruction of channels | (0.7333,0.8333,0.888) | 0.818 | Accepted |
| Tehsil in the process of accepting digital technologies | (0.7444, 0.8444, 0.888) | 0.825 | Accepted |
| Integrated communication approach in supply | (0.5888, 0.6888, 0.7444) | 0.67 | Accepted |
| Meeting the real needs and feelings of consumers | (0.7444, 0.8444, 0.888) | 0.825 | Accepted |
| Explore new markets and increase learning | (0.58888, 0.68888, 0.7777) | 0.6888 | Accepted |
| Improving the customer relationship management process | (0.7222,0.8222,0.888) | 0.8111 | Accepted |
| Diversity in supplier selection | (0.7333,0.8333,0.888) | 0.818 | Accepted |
| Coordination of suppliers to meet high-demand | (0.66, 0.76, 0.82) | 0.74 | Accepted |
| Migration to digital distribution channels | (0.7333,0.8333,0.888) | 0.818 | Accepted |
| Appropriate pricing strategy | 0.7222, 0.8222, 0.8777) | 0.807 | Accepted |
| Training and empowerment of human resources | (0.69, 0.79, 0.84) | 0.77 | Accepted |
| Identify financing methods | (0.7444,0.8444,0.9) | 0.829 | Accepted |
| Reduce costs | (0.7333, 0.8433, 0.8767) | 0.821 | Accepted |
| Applying human resources management system | (0.58888, 0.68888, 0.7777) | 0.6888 | Accepted |
| Vaccine supply | (0.7555, 0.8555, 0.888) | 0.833 | Accepted |
| Ability to receive orders from customers virtually | (0.7333, 0.8333, 0.8777) | 0.814 | Accepted |
| Online advertising | (0.5888, 0.6888, 0.7444) | 0.77 | Accepted |
| Attention to awareness, concern, and environmental habits | (0.58888, 0.68888, 0.7777) | 0.7888 | Accepted |
| Consumer protection | (0.5888, 0.6888, 0.7444) | 0.77 | Accepted |
| Pandemic vaccine development, large-scale production, and distribution timing | (0.7333, 0.8333, 0.8777) | 0.814 | Accepted |
| Online business development | (0.58888, 0.68888, 0.7777) | 0.7888 | Accepted |
| Quick reaction | (0.7333, 0.8333, 0.8777) | 0.614 | rejected |
| Providing cheap facilities | (0.5888, 0.6888, 0.7444) | 0.67 | rejected |

Table 4- Exploratory factor analysis of factors effective in dealing with the industrial crisis during the outbreak of epidemic viruses

| Factors | 1st category | 2nd category Supplier | 3rd category Distributor | 4thcategory retail seller | 5th category consumer | 6th category Government |
|---|---|---|---|---|---|---|
| Online business development | | | | | | |
| Online marketing strategies | 0.825 | | 0.642 | | | |
| Appropriate choice of financial and monetary policies | | | | | | 0.452 |
| Support for vulnerable groups and enterprises | | | | | | 0.429 |
| flexibility | | | | | | |
| Develop a strategy to deal with the crisis before the outbreak | 0.812 | | | | | |
| Creating cooperation networks in the distribution | 0.719 | | 0.632 | | | |
| Government aid packages | | | | | | 0.441 |
| Developing trust with customers in emerging markets | | | | | 0.595 | |
| Reconstruction of channels | | | 0.641 | | 0.548 | |
| Tehsil in the process of accepting digital technologies | | | | | 0.512 | |
| Integrated communication approach in supply | | 0.711 | | | | |
| Meeting the real needs and feelings of consumers | | | | | 0.564 | |
| Explore new markets and increase learning. | | | | | | |
| Improving the customer relationship management process | | | | | 0.540 | |
| Diversity in supplier selection | | 0.705 | | | | |
| Coordination of suppliers to meet high-demand | | 0.698 | | | | |
| Migration to digital distribution channels | | | 0.768 | | | |
| Appropriate pricing strategy | | | | 0.514 | | |
| Training and empowerment of human resources | | | | | | |
| Identify financing methods | 0.814 | | | | | |
| Reduce costs | 0.756 | | | | | |
| Applying human resources management system | 0.830 | | | | | |
| Vaccine supply | | | | | | 0.480 |
| Ability to receive orders from customers virtually | | | | 0.528 | | |
| Online advertising | | | | 0.584 | | |
| Attention to awareness, concern, and environmental habits | | | | | 0.548 | |
| Consumer protection | | | | | 0.562 | |
| Pandemic vaccine development, large-scale production | | | | | | 0.475 |

**Model development**: Based on the opinion of the experts, it is necessary to create a general classification within the variables. The researcher has achieved his expected goal by using exploratory factor analysis. Factor analysis is one of the advanced multivariate statistical techniques(41). This method is used for specific purposes such as modeling, hypothesis generation, validation of scales, and recognition of subscales. It can also provide the possibility of implementing other advanced statistical methods, such as structural equation modeling. The mechanism of factor analysis is to explore the structure of a set of variables and reduce and categorize them into more basic variables under the name of "factor." The present study used exploratory factor analysis to group variables with internal correlation. To

perform this analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy test was first calculated to ensure the adequacy of the sample size. One hundred people who completed the questionnaire (by sampling) were asked to answer the questions of the researcher-made questionnaire. Then, the correlation between the test questions is the basis of factor analysis. Therefore, Bartlett's Test of sphericity was used to determine that the correlation between the variables is not equal to zero with a confidence level of 0.95. (Kaiser-Meyer-Olkin Measure of Sampling Adequacy: 0.902, Chi-Square: 10165.8, df: 351, PValue<0.001)

The result shows that Sampling Adequacy is in its "excellent" degree in this research (KMO=0.902). Bartlett's test is also confirmed at the confidence level of 0.95 (P<0.05). In the following, using Varimax rotation, the results of the classification of 30 variables identified in the fuzzy Delphi stage will be as shown in Table 3.

The software output shows that these 30 variables can be explained in 6 categories with 60.325% of changes. Next, it is necessary to name the categories based on each category's existing concepts and components. Therefore, after consultations with five banking experts, this classification has been made as follows. (Table 5)

Table 5- Classification and naming of factors

| Factor | Latin Naming | Naming | Number of sub-factors |
|---|---|---|---|
| 1 | A | Producer | 7 |
| 2 | B | Supplier | 3 |
| 3 | C | Distributor | 4 |
| 4 | D | Retail seller | 3 |
| 5 | E | Consumer | 7 |
| 6 | F | Government | 6 |
| Total factors | | | 30 |

## Discussion

This article studies influential factors in crises caused by the spread of widespread viruses in the industry: producers, suppliers, distributors, retailers, and consumers (people (42); (43) (44) (45); (46) (47)concluded similar results in their studies. In the present study, with an exploratory approach to influential factors in dealing with industrial crises caused by the spread of widespread viruses, 30 variables were identified, and the initial model was presented. One hundred managers and industry experts designed and evaluated a questionnaire to assess the model. Using exploratory factor analysis, these 30 variables were classified into six categories. Following the consultation with five banking experts, these categories were named producer, supplier, distributor, retailer, consumer, and government, and the results are separately stated below.

*1-Consumer*

The Coronavirus has severely affected the behavior of consumers. Both the supply and demand sectors have been damaged in the Corona crisis. The decrease in the sale of products that are not considered basic goods in the family's consumption basket and the increase in the sale of some products are observed simultaneously. The supply sector is facing a decrease in the power of the supply chain, closure of units, decrease in sales, and decrease in productivity. The demand sector is facing a change in the purchasing behavior of customers. Fluctuations in supply and demand occur for two reasons. The main reason is the disruption in the production of essential items due to the lack of supply and the increase in demand due to the increase in the needs of the epidemic. The second reason is the hoarding behavior of people. The following factors can be an excellent strategy to deal with the industrial crisis in this sector: developing trust with customers in newly emerging markets, facilitating the process of accepting digital technologies by customers, improving the process of customer relationship management, paying attention to awareness, concern and environmental habits and supporting consumers.

*2-Retailers*

The retailer in the desired model receives the demand as a representative of the retailers. Then, it compares it with the inventory. If the inventory has a non-zero amount, it fulfills the received demand partially or completely (according to the amount of inventory on hand). The amount of unanswered demand is considered delayed demand to be compensated in the future when receiving inventory from the factory and paying the deficit penalty. Every week, the retailer checks the inventory status, uncompensated demand (overdue), and inventory on the way. According to the inventory ordering policy, a periodic system in this article, the amount required for ordering is determined by the upstream member, the distributor. The proposed policies to deal with the existing conditions are the appropriate pricing strategy, the possibility of receiving orders from customers virtually, and online advertising.

*3-Distributor*

Distributors receive demand from retailers. Then, it compares it with the inventory, and if the inventory has a non-zero amount, it fulfills the received demand partially or fully (according to the amount of inventory on hand). The amount of unanswered demand is considered as delayed demand. The following factors can be suitable for the distributor: online marketing strategies, creation of cooperation networks in distribution, reconstruction of channels, and migration to digital distribution channels

*4-Producer*

The producer receives the orders received from the distributor. The behavior of the producer factor is more complicated than the behavior of the distributor factor because it deals with two types of inventory. 1- The inventory of the product demanded by the distributor, and 2- The inventory of the raw materials used to produce the product. After receiving the order from the distributor, the producer checks the possibility of supplying all or part of the order according to the amount of stock in his warehouse.

The development of online businesses, flexibility, formulating a strategy to deal with the crisis before the outbreak, training and empowering human resources, identifying financing methods, reducing costs, and using the human resources management system can help improve this sector's current conditions.

*5- Suppliers*

The weekly orders received from the producer are analyzed and processed in the supplier's factor, and if the inventory of raw materials and parts is not zero, they are answered in whole or in part. Part of the unanswered order is referred to as a delayed order. By reviewing his inventory and considering the ordering policy, the supplier buys (orders) raw materials. An integrated communication approach in supply, diversity in supplier selection, and coordination of suppliers to meet high demand can be a suitable strategy in this situation.

In general, it can be said that with the spread of widespread viruses, consumer demand for essential goods increases compared to non-essential goods, and we see a significant decrease in the inventory of suppliers, producers, distributors, and retailers. In addition, with the start of mandatory vaccination (strategy), the situation will improve, and despite fluctuations in consumer demand for essential and non-essential goods, we will not face a severe shortage of supplier, producer, distributor, and retailer stock.

*Suggestion*

Mandatory vaccination has the most significant impact in dealing with industrial crises caused by the spread of widespread viruses. Therefore, it is suggested that industry managers diligently follow up on vaccinating employees in the production sector and other sectors. Employees are also

advised to pay attention to achieve collective immunity in receiving the coronavirus vaccine.

Using robotics significantly affects dealing with industrial crises caused by the spread of pervasive viruses. This epidemic has made automation more critical in industries for business flexibility. No company wants to experience a long-term workforce outage again, and automation can ensure that future shutdowns are minimized, and help reopen businesses. Therefore, governments are suggested to put measures to target specific computers for each industry in their agenda so that manufacturing companies can afford the high costs of robotics and use them more.

Regarding the future suggestion, the research with the following features is presented:

Systematic identification and analysis of essential variables in industrial crises caused by widespread virus outbreaks and their causal relationships through the system dynamics approach and using the results obtained in factor-based simulation.

Using statistical models to estimate the behavioral rules of agents' decision-making and complex/straightforward relationships of critical variables.

Using neural networks to cluster consumers' factors and involve them in factor-based modeling.

### *Competing Interest*

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### *Authors' contributions*

Conceptualization, Abbas Toloie Eshlaghy and Reza Radfar; Data curation, Alireza Pour Ebrahimi; Formal analysis, Mahdi Reza Adamian; Investigation, Mahdi Reza Adamian; Methodology, Mahdi Reza Adamian, Abbas Toloie Eshlaghy and Reza Radfar; Supervision, Abbas Toloie Eshlaghy and Reza Radfar; Validation, Alireza Pour Ebrahimi; Writing – original draft, Mahdi Reza Adamian; Writing – review & editing, Abbas Toloie Eshlaghy and Reza Radfar. All authors read and approved the final manuscript.

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