**The impact of covid-19 on the Tunisian supply chain: A** **case study**

**ABSTRACT**

 **Purpose**: This article aims to provide rough orders of magnitude of the impact of the COVID-19 pandemic on the functioning of Tunisian businesses. Based on a sample of 192 Tunisian companies, the results showed a sharp contraction in inactivity due to the disruption of the various links in the supply chain following the generalized confinement of the population and the closure of borders.

**Design/methodology/approach**: We therefore sought to find out which links in the supply chain were the most impacted. To do this, the K-means offers the possibility of carrying out the analysis of variance (ANOVA).

**Findings**: The findings suggest that the analysis of the results makes it possible to detect the manifest existence of specific operating models.

**Originality/Value**: Overall, this study contributes both to the study of the effect of COVID-19 on the Supply Chain and to the implications of the literature in this area and has important practical implications.

 **Keywords:** Supply Chains – COVID-19 (Corona-virus) - Crisis Management – Crisis Logistics.

1. **Introduction**

 The year 2019 ended with the news of the outbreak of a mysterious respiratory disease that appeared in China in the city of Wuhan. Since then, the virus, which has taken the official name of "corona-virus disease 2019", has spread to more than 200 countries and regions around the world affecting more than 85 million people and causing the death of more than 1.87 million as of December 31, 2020. In addition to human lives, the pandemic has severely affected the global economy and caused the largest economic contraction since the Great Depression (Gautam, 2020; Ranga Rao, 2020).

The health measures put in place by national governments have caused the suspension of non-essential economic activities for several months. The world has plunged into an unprecedented crisis in the real economy affecting the two engines of growth, supply and demand. Despite the measures taken to support household income and business activity, the IMF forecasts a decline in global growth of 4.5% and 3.9% at the end of 2021 and 2022.

The closure of several regions in China and the speed of the virus spreading globally, have disrupted supply chains and reduced business activities (Hobbs, 2020; Kumar and Mishra, 2020; Sohrabi et *al*., 2020). The interdependence of economies due to the globalization of trade has created critical dependencies. The COVID-19 pandemic has shaken certain certainties about the triumph of globalization presented by economic thought as a remedy for market imbalances and disparities in levels of development.

The COVID-19 pandemic has revealed the strategic importance of logistics in business value chains, but also its vulnerability. From the reduction of orders to the partial or total cessation of activities, almost all industries have suffered the consequences of the collapse in volumes transported.

In Tunisia, the economy has been devastated by the months of confinement, the financial and human efforts of public and private actors and the decline in the morale of the population. The High Commission for Planning indicates that the unemployment rate fell from 9.4% to 12.7% between the third quarter of 2019 and the same period of 2020. The volume of employment fell by 581,000 jobs and the Consumer Price Index (CPI) recorded in October 2020, an increase of 1.3% compared to the same month of the previous year. There are 83.4% of Very Small Company (VSC) and Small and Medium Company (SMC) in Tunisia were in total cessation of activity during confinement.

The interdependence of international and national value chains has been a decisive factor in the slowdown in production activities. Logistics professionals and their client companies have faced many disruptions which have reminded us of the crucial role that this activity plays in normal times and especially in times of crisis.

The COVID-19 crisis challenges companies on their ability to anticipate new risks, in particular health hazards, in the definition of their Supply Chain strategy. The question also arises in terms of the resilience and ability of their supply chain to sustain or recover quickly in times of crisis. Finally, the overall performance of the company depends on the reliability and regularity of the supply chain, the challenge being to build new logistics strategies by providing them with the capacity for responsiveness and efficiency in a context characterized by uncertainty.

In this research work, we will present the results of an empirical study carried out with the aim of measuring the impact of the COVID-19 pandemic on the Moroccan supply chain. After the presentation of the conceptual framework of the study, we will present the research methodology adopted and the working hypotheses chosen. The results of the study will be discussed and recommendations will be offered to enrich the field of business possibilities.

1. **Conceptual framework**

This section will present a conceptual framework that successively concerns three aspects that guide this research, namely: Crisis management, supply chain and crisis management and the COVID-19 pandemic.

* 1. **Crisis management**

The world of crises and disasters is changing to integrate new risks. The frequency, nature and consequences of these unpredictable events evolve (Lagadec and Boin, 1970; Missiroli, 2006; Richard A. Posner, 2016). A crisis is an unusual and brutal situation which presents a high risk of instability for the company and which implies specific governance in order to return to a regular and usual mode of operation (Shaluf et *al*., 2001). Crisis management is the process by which an organization manages any major unpredictable event that threatens to harm the organization, its stakeholders or the general public (Oparanma and Wechie, 2014).

Crisis is a dynamic phenomenon that evolves over time and has common characteristics (Chartier et *al*., 2010; Evans and Elphick, 2005; Weisath et *al*., 2002):

* Uncertainty and complexity;
* The time pressure and the duration of the situation (exhaustion of the men);
* Urgent decisions;
* Emergency plans overwhelmed by the scale of the situation;
* Implementation of significant emergency resources;
* An alteration in the cognitive abilities of the workers following the stress generated by the situation;
* Unusual trigger events causing a sense of surprise.

Crisis management involves the implementation of operational systems (monitoring and alert system, ad-hoc organization, crisis exit plan, material resources, communication plan, steering process, etc.) to predict the modes of operations and the necessary resources before, during and after the occurrence of disruptive events and thus reduce the impact on the company and its stakeholders.

Crisis management strategies emphasize the ability to anticipate potential risks. This preparation or pre-crisis phase involves a preventive policy to minimize the probable damage (Coombs & Laufer, 2018). This involves identifying the risks that could disrupt the operation, reputation or stakeholders of the organization. It involves detecting signals, preparing action plans and training teams.

During the crisis, action plans are implemented and adjusted to minimize the damage to the survival of the business.

The post-crisis period is a period of restructuring and repair. The evaluation of the situation experienced must be programmed in order to strengthen the maturity and resilience of the organization.

* 1. **Supply chain and crisis management**

Crisis events occur more frequently and become increasingly severe (Desoutter and Lavissière, 2018; James and Wooten, 2011; Jeong et *al*., 2020; Richey, 2009; Wright, 2008). In general, crises occurring in supply chains represent real threats for companies whatever their size (James and Wooten, 2011), on the other hand, Khalifa (2019) sees that the crisis offers opportunities and the possibility of begin to develop new models of crisis management and adopt strategies to overcome them.

However, in a supply chain, a crisis occurs when the activities of one or more links in the chain are interrupted, resulting in a major disruption of the normal flow of goods or services (Natarajarathinam et *al*., 2009). The magnitude of the effect of a crisis depends on many factors and varies each time (Lynch, 2009). Although crisis in a supply chain is unpredictable, it may not be unexpected (Coombs, 2014). The process of making proactive decisions to avoid crisis and reactive decisions to overcome it is called crisis management (Abe & Hoontrakul, 2015). Most authors (Perona & Miragliotta, 2004; Serdarasan, 2013) agree that, the global supply chain has become more complex in the recent past. The following table summarizes the main threats to the regularity and resilience of the supply chain.

**Table 1**: Category of risks in the supply chain

|  |  |
| --- | --- |
| **Risk category** | **Risk factor** |
| * **Perturbation**
 | * Natural disaster
* Work conflict
* Bankruptcy of suppliers
* War and terrorism
* Dependence on a single source of supply as well as the capacity and responsiveness of alternative suppliers
 |
| **Delays** | * High capacity utilization at source of supply
* Supply source rigidity
* Poor quality or yield at the source of supply
* Excessive handling due to crossing borders or changing modes of transport
 |
| **Systems** | * Information infrastructure failure
* System integration or extended system networking
* E-commerce
 |
| **Forecasts** | * Inaccurate forecasts due to long lead times, seasonality, variety of products, short life cycles, small customer base
* The Bullwhip Effect or distortion of information due to sales promotions, incentives, lack of supply chain visibility and exaggeration of demand in times of product shortages
 |
| **Intellectual property** | * Vertical supply chain integration
* Outsourcing and Global Markets
 |
| **Supplies** | * Currency risk
* Percentage of a key component or raw material purchased from a single source
* Industry-wide capacity utilization
* Long-term versus short-term contracts
 |
| **Receivables** | * Number of customers
* Financial strength of customers
 |
| **Inventory** | * Product obsolescence rate
* Cost of holding inventory
 |

***Source :*** *(Chopra and Sodhi, 2014)*

* 1. **The supply chain and the COVID-19 health crisis: degrees of resilience**

The COVID-19 pandemic has affected supply chains globally (Queiroz et al., 2020). It was a challenge for the resilience of supply chains at the global level. The destabilizing effect of the crisis has prompted some researchers (He et al., 2021; Sarkis, 2020) to rethink new logistics solutions.

According to Cabinet Deloitte (2020), the actions of companies in the face of the crisis can be grouped into three groups:

* Level 1 - Companies that have anticipated the likelihood of a crisis and prepared to mitigate its impact: they have put in place proactive management strategies to ensure business continuity. These companies opted for geographical diversification of their supply chain in order to minimize dependence on a main supplier. They have also implemented management and planning strategies to avoid stock-outs and overstocking.
* Level 2 - Companies better prepared to react to the probability of the crisis: These companies have built strong links with their external environments (suppliers, customers). They have put in place a system capable of ensuring risk management to be one step ahead of the repercussions of the crisis. They have invested heavily to implement digital supply chain planning solutions and control systems to address issues affecting the supply chain as a whole.
* Level 3 - Companies unable to react to the impact of the pandemic: These companies depend on a geographical area or a main supplier for their strategic supply. Their supply chains are not resilient enough to cope with internal or external disruption. They do not have a stock and production management or planning system that could help them anticipate stock-outs and optimize resources.
1. **Methodology**

The study presented in this article seeks to assess the impact of COVID-19 on the Tunisian supply chain. In this context, a qualitative study was conducted using a survey distributed to managers of Tunisian companies established on Tunisian territory and operating in the commercial productive sectors.

Our questionnaire began with a general diagnosis of operating activity for each sector of activity. Then, it sought to understand the impact of the pandemic on the internal management of human resources, before focusing on the various links in the supply chain to verify the consequences of the crisis on operations. Finally, it looked at the actions taken by companies to deal with the crisis in terms of short-term strategies and long-term solutions (Figure 1).

**Diagnostic of the operating Activity**

**Impact on Human Resources management**

**Impact of Corona-Virus on the supply chain**

**Purchase Activity**

**Production Activity**

**Distribution Activity**

**Delivery Activity**

**Crisis Management**

**Short Term Solution**

**Long Term Solution**

 **Figure1**. *Methodological structure of Impact of COVID-19 on the supply chain*

1. **Assumptions**

The COVID-19 crisis has impacted the functioning of national companies regardless of their size or sector of activity. Since the early 2000s, no economic or health crisis has had such an effect on the economic structure of our country (World Bank Group, 2020). We are interested in companies that represent the hard core of economic activity in order to understand the level of this effect on their activities.

Two hypotheses guide this research:

 - The first can be formulated as follows: The crisis has seriously impacted the operating activity of Tunisian companies (H1).

 - The second hypothesis focuses on the different links in the supply chain and will be broken down as follows: The level of impact of the crisis on the units of the supply chain is heterogeneous (H2).

The hypotheses are schematized in the form of figure 2.

**Economic Crisis and Corona-virus**

 **H1**

**Operating Activity of Tunisian companies**

**Gap in the level of impact of the supply chain of Tunisian companies**

 **H2**

**Figure 2**: Schematization of the hypotheses of the impact of COVID-19 on the Tunisian supply chain

 The interpretation of the results of our study was based on two statistical analyzes which sought to measure the degree of impact of the crisis on the progress of activities. The Khi-2 (𝜒) test was used to test the hypothesis of dependence of qualitative variables, while the K-means method was used to group variables that have the same characteristics in terms of impacts and measure the level of dissimilarity between the dependent variables using ANOVA analysis of variance.

1. **Results and discussion**

The distribution of the questionnaire was carried out electronically and the responses were collected through online data entry on the Internet via the Google Forms application. The Internet was the only tool considered for the distribution of the questionnaire, in particular through the sending of emails and the use of social networks.

The operation began on 20 June, 2020 and ended on 17 September, 2020 with a total of 192 responses. This questionnaire shows that the COVID-19 pandemic has a strong undesirable influence on the various human resources data of Tunisian companies. This will be simplified by the figure 3.

 Other

Tele-working

Dismissal of employees

The temporary reduction in working hours of all or part of the staff

**What strategies have you adopted with a view to overcoming the consequences of the crisis?**

 45%

 33%

 22%

**Partial cessation Complete maintenance**

 **cessation**

**Following the spread of the epidemic, have you decided?**

21%

41%

29%

9%

**Figure 3**: Data relating to human resources of Tunisian companies

 Source: Made by Elleuch Fadwa using Microsoft Excel

 The crisis linked to the COVID-19 pandemic has had a real impact on the national economy. According to our survey, 67% of the companies in our sample declared that they had completely or partially stopped their activities.

Faced with the scale of the crisis, the Human Resources services had to adapt their work arrangements in order to maintain part of the activities and respect the measures taken by the government, in particular the confinement of the population. The 41% of companies have adopted Tele-working to reconcile the various constraints they had to face, while 29% of companies have adjusted through a reduction in working time. It should be noted that 21% of companies have separated from their employees.

* 1. **Activity level**

 After a survey of 192 Tunisian companies, the sampling result will be presented in Figure 4 which targets to measure the level of the impact of COVID-19 on business activity in Tunisia.

**Figure 4:** Measurement of the level of impact on business activity

 The consequences of COVID-19 have proven to be heavy on the national economy. The results of our study show that 68% of companies experienced a drop in activity after confinement. With 72% of them judged this drop to be moderate or severe.

 While on the contrary, only (21%) of companies recorded an increase in activity. In our sample, these companies belong to sectors that have benefited from the health crisis and the confinement of the population (the pharmaceutical industry, medical and mass distribution).

* 1. **Logistics**

 The impact of COVID-19 on the industry is also very significant. Many countries around the world have since been facing a health crisis, causing enormous damage to the population, especially in Tunisia where the corona virus is developing with frustrating frequency.

Very quickly, logistics appeared to everyone as an essential pillar in the management of this pandemic. For this, we have summarized in Figure 5 the sectors most affected by COVID-19 in the Tunisian supply chain.

**Figure 5:** The logistics activity of Tunisian companies

 The effects of the crisis have been observed at all levels of the supply chain from supply to distribution. The (27%) of companies said they had been affected in their supply chains. The (18%) suffered from disruptions in their transport system and (17%) were impacted in terms of purchasing and distribution. The (13%) experienced a deterioration in their production and finally, (8%) of companies experienced destabilization in their storage and warehousing.

Several causes have led to the dysfunction of supply chains. (49%) of companies associated the disruption observed with transport problems, while the cessation of activities at suppliers was the cause of (31%) the disruptions.

It should be noted that (60%) of the companies in our sample declare that they source their supplies abroad, mainly from Europe (22%) and North America (10%). Companies that import from Asia represent 8% of our sample.

* 1. **Crisis Management**

 Although the full impact of COVID-19 is still unknown, many organizations are being impacted by declining sales and reduced consumer demand, supply chain disruptions and transportation restrictions. These issues will have an adverse effect on global markets, with escalating risk likely to affect those not yet directly impacted by COVID-19. These companies need to consider their pandemic preparedness measures and be proactive and prepared. This part of paper focuses on identifying the management crisis. In a crisis, you have to act quickly. And you need to quickly build a crisis team to support you. The most important thing to remember for a crisis management mission is to ask the following question: "Do you have a logistics crisis management plan?" This will be represented by Figure 6.

**Do you have a logistics crisis management plan?**

Yess

70%

No

No

30%

Yes

0%

10%

20%

30%

40%

50%

60%

70%

80%

 **Figure 6:** Crisis management plan

 The survey revealed that 70% of companies had plans for managing the logistics crisis and therefore had adaptation solutions.

The axes of the logistics crisis management plan mainly included the diversification and monitoring of suppliers (33%), the review of stock levels (14%) and the review of logistics processes (12%).

Faced with disruptions in supplies, companies have favored the diversification of suppliers and the search for substitute products. They also asked for the extension of payment deadlines due to the drop in activity.

The COVID-19 crisis has highlighted the important role digital technologies can play in running businesses. Also, during and after the crisis, 73% of the companies questioned partially or totally implemented digital solutions, while 10% had planned this implementation. Several solutions have been used to increase the productivity of companies and their ability to regulate flows and data: Integrated management systems (32%), Document scanning (20%), Barcodes (15%), planning and scheduling (10%), etc…

The digital transition, which was advancing cautiously in Tunisia, suddenly accelerated. The crisis has highlighted the role of digital in transforming the operating models of our companies. Whether it concerns supply or distribution processes, companies have considered that the development of digital platforms represents the most appropriate solution to the health crisis, as it is agile and flexible. This transformation concerned the digitization of the offer up to 33%, online sales and payment as well as Tele-working (22%).

In summary, the study has proven that the COVID-19 health crisis has impacted the economic activity of Tunisian companies. More than two thirds of companies have totally or partially stopped their activity. Faced with this situation, companies first sought to maintain the continuity of their activities through Tele-working and when the constraints were insurmountable, they had to lay off their employees. The disruptions observed at the various links in the supply chain have resulted in a sharp drop in operating activities for more than two-thirds of companies. The action plans put in place to mitigate the consequences of the crisis have combined managerial solutions and investments in technological infrastructure to promote the resilience of the supply chain.

1. **Value Correlation and Clustering Analysis**

The descriptive analysis of the results showed that the Tunisian companies that participated in the study experienced deterioration in their operating activities. In order to make our conclusions more reliable, we used inferential statistical analysis.

* 1. **The chi-square test**

The use of the Chi-square test will make it possible to verify the existence of a statistically significant relationship (p <0.005) between the two variables studied and thus validate the hypothesis of the dependence between the degree of impact of the pandemic and activity of the companies surveyed.

**Table 2:** Presentation of cross table between the impacts of the crisis on the evolution of the activity of Tunisian companies

|  |  |  |  |
| --- | --- | --- | --- |
| **Impact of the crisis** | **Evolution of the operating activity** | **** | **** |
| **Any** | **Increase** | **Decrease** |
| **Any** | **2** | **4** | **0** | 41.431\*\* | .460 |
| (1.4) | (2.7) | (-4.1) |  |  |
| **Low** | **9** | **20** | **20** |  |  |
| (4.0) | (9.5) | (-13.5) |  |  |
|  **Medium** | **4** | **11** | **74** |  |  |
| (-5.1) | (-8.1) | (13.2) |  |  |
| **Severe** | **5** | **7** | **40** |  |  |
| (-.3) | (-4.1) | (4.4) |  |  |
| ***\*\* p < .005*** |  |  |  |  |  |

 ***Source: Produced by Elleuch Fadwa through SPSS***

The results obtained show that the relationship between the impact of the crisis and the evolution of operating activity is significant (rejection of the null hypothesis) 2 (6, N = 196) = 41.431, p = 0.000 (<0.005).

The analysis of the cross table (tab.2) indicates that 68% of companies have experienced a deterioration in their activities due to a medium or severe impact of the COVID-19 pandemic. Overall, the crisis has impacted the activity of the majority of Tunisian companies surveyed (91%), either in a negative (n = 134; 68%) or positive (n = 42; 22%) way.

The results thus obtained make it possible to confirm the hypothesis of the relationship between the impact of the crisis and the deterioration of the operating activities of companies.

* 1. **K-means partitioning analysis**

 At this stage, we have observed that the COVID-19 pandemic has disrupted the normal mode of operation of Tunisian companies. Half of the companies have been seriously affected by the events that accompanied the spread of the virus. For the rest of our work, our attention focused on the internal functioning of these companies. We sought to identify the services most impacted and the strategies adopted to overcome the crisis situation.

Our analysis was based on a statistical method that allows us to group variables with the same statistical characteristics. K-means clustering analysis is an algorithmic method that aims to analyze data and then group them into clusters. The usefulness of this method is to extract models with repetitive or similar variables. For our case, we will apply this method to group companies that have experienced the same changes in their supply chains. In other words, we will seek to identify the services that have been affected to gather them into clusters.

**Table 3**: Distribution of the sample based on a cluster of 4 dimensions

|  |  |
| --- | --- |
| **Niveau de la chaîne logistique** |  **Cluster**  |
|  | **1** | **2** | **3** | **4** |
| Z-Score Supply | - .712 | .573 | .201 | -.055 |
| Z-Score Purchase | -1.267 | .626 | .633 | -.089 |
| Z-Score Production | .126 | .233 | -.251 | -.048 |
| Z-Score Storage and Warehousing | .373 | .373 | .373 | -2.670 |
| Z-Score Transportation | .005 | .305 | -.101 | -.338 |
| Z-Score Distribution | .223 | -1.338 | .743 | .050 |

***Source: Produced by Elleuch Fadwa through SPSS***

 Based on the partitioning analysis in K-means (K means), Tunisian companies have been classified into four clusters according to the type of service (tab.3). The distribution of our sample shows that companies that have had a deterioration in their production and transport services are the most widespread (n = 68). They have been grouped under the third cluster. They are followed by companies in cluster 1 representing structures that have suffered from a deterioration in their supply and purchasing services (n = 56). The companies grouped in cluster 2 experienced disruptions in their distribution service (n = 48). Finally, the fourth cluster brings together companies that have been impacted by a deterioration in their supply, purchasing, production, storage, warehousing and transport services (n = 24).

The K-means clarified the analysis of the impact of the pandemic on internal processes. We found two levels of impact on the companies in our sample: the first category is that of the companies that were affected upstream (cluster 1). The second category is made up of companies affected downstream of the supply chain (clusters 2 and 3). Faced with the crisis situation, companies had to react according to their financial and administrative capacities to ensure the regularity of their operation. Two strategies were adopted to deal with the disturbances. The first focused on the restructuring of internal services, in particular through the adoption of Tele-working and the temporary reduction of working hours. The second strategy aimed to minimize the costs of the operating structure, through the abandonment of certain services and the dismissal.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Action** |  | **1** | **2** | **3** | **4** |
|  | Yes | 27 | 20 | 22 | 9 |
| ***Temporary reduction*** | No | 29 | 28 | 46 | 15 |
|  | Yes | 20 | 13 | 11 | 12 |
| ***Dismissal*** | No | 36 | 35 | 57 | 12 |
|  | Yes | 22 | 31 | 40 | 15 |
| ***Tele-working*** | No | 34 | 17 | 28 | 9 |

**Table 4:** Solutions adopted to overcome the crisis

***Source: Produced by Elleuch Fadwa through SPSS***

 Disruption of procurement and purchasing services for Tunisian companies in cluster 1 led to a temporary reduction in the number of employees (n = 27), the adoption of telework (n = 22) and layoffs employees (n = 20). For companies in clusters 2 and 3, the actions applied are the use of Tele-working, the temporary reduction of staff and finally dismissal. The action plan of companies in the fourth cluster included the following main actions: Tele-working (n = 15) then the permanent or temporary reduction in the number of employees.

The analysis of the results makes it possible to detect the manifest existence of specific operating models. The companies in the clusters having been impacted upstream of the supply chain followed the following sequence: The temporary reduction in the number of employees, then Tele-working and finally layoffs, while the companies having been impacted downstream of the supply chain followed the following sequence: Tele-Working then the temporary reduction of the number of employees and finally the dismissal. Incidentally, companies in cluster 4 have favored Tele-working, layoffs and finally the temporary reduction in the number of employees.

The choices made follow a managerial logic guided by the necessary adaptation of means and processes to facilitate the continuity and survival of the company. Cluster 1 is impacted upstream. The Tunisian companies in this cluster found it difficult to continue their activities and they had to draw on their stocks (companies in the secondary sector) or on initial orders for services (companies in the tertiary sector). As a result, temporarily reducing the number of internal agents (suppliers, buyers, etc.) was the most optimal action, while waiting for business visibility to improve.

Clusters 2 and 3 were impacted downstream. This has pushed companies in these clusters to adopt Tele-Working for internal agents (such as logistics managers, coordinators, etc.) and then, the temporary reduction in the number of external agents (drivers, deliverers, etc.) to keep a minimum of activity in terms of transport and distribution.

The long confinement of the population and the restrictive measures decided to limit the spread of the pandemic have heavily affected the national economy. The use of Tele-Working was initially the most optimal solution to maintain production during the crisis. The lack of visibility subsequently forced companies to adjust the number of employees employed.

Based on the K-means method, we were able to assess the degree of impact on supply chains. We were also able to identify the action plans carried out by the companies to deal with the disruptions observed. The fact remains that the various links in the chain have not been affected equally. The purpose of the ANOVA method is to check the mean of the groups of the same population thanks to the F3 value. Our hypothesis consists in determining the level of the supply chain which has the largest value F, which constitutes a value of discrimination between the groups of the cluster.

The analysis of variance allows us to confirm the hypothesis of the heterogeneity of the crisis on the units of the supply chain. This will be summarized in the table 5.

**Table 5**: ANOVA analysis of Tunisian Companies

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Supply chain level** | **Cluster** |  | **Error** |  |  |  |
| Mean Square | df | Mean Square | df | **F** | **Sig.** |
| **Z- Score Supply** | 15,65 | 3 | 0,771 | 192 | 20,296 | 0 |
| **Z- Score Purchase** | 45,409 | 3 | 0,306 | 192 | 148,339 | 0 |
| **Z-score Production** | 2,616 | 3 | 0,975 | 192 | 2,683 | 0,048 |
| **Z-Score Storage and Warehousing** | 65 | 3 | 0 | 192 | . | . |
| **Z-score Transport** | 2,634 | 3 | 0,974 | 192 | 2,703 | 0,047 |
| **Z-score Distribution** | 42,13 | 3 | 0,357 | 192 | 117,895 | 0 |

 The analysis of the results (Table.5) shows that the value F is very high at the level of the purchasing and distribution departments. These two services were the most affected during the period studied. Faced with this situation, the decision-making choices of companies have followed two directions. Indeed, we found that the companies making up clusters 2 and 3 (n=116), i.e. 59% of the population, have accelerated their purchases and reinforced their stocks in order to cope with the shortage that may result from the disruption of the supply chain. Companies in clusters 1 and 4 (n=80), i.e. 41% of the population, preferred to manage their cash while waiting for better visibility on the evolution of the situation and as a result, totally or partially stopped their purchasing process. On the distribution side, 75% of companies, mainly in clusters 1, 3 and 4 (n=148) have reinforced their product distribution policy

**Conclusion**

 By focusing on national companies, the study carried out sought to highlight the extent of the crisis on the country's economy. The results obtained confirmed the existence of a major impact on the operating activity of the Tunisian companies in the sample. 68% of the companies surveyed recorded deterioration in their activities and 29% of them experienced a severe decrease. To cope with the consequences of the crisis, three policies have been adopted to quantitatively and qualitatively adjust human resources to the needs of companies: temporary reduction in the workforce, Tele-working and dismissal.

The study then shed light on the situation of the supply chain of companies. Four behavior patterns were detected. Maintaining a fluid and regular relationship with suppliers and customers has pushed companies to implement technological solutions to manage flows and maintain the relationship.

However, the results of our research remain limited due to the low response rate from companies. The theoretical framework is not sufficiently referenced due to the novelty of the subject. Finally, we lack the necessary perspective on the consequences of the strategies adopted by companies. All of these limitations offer new avenues for future research.

COVID-19 is an exceptional event that has had a major impact on supply chains globally. The pandemic has highlighted the weight of the supply chain in the regular functioning of the global economy. It also highlighted the importance of taking into account new risks as well as the necessary mobilization of more technologically advanced tools to prepare for them.

The complexity of supply chains makes the development of commercial transactions fragile. This context offers, on another level, a multitude of opportunities for new structures and new business models.

Post-COVID-19 is a major challenge for the national economic fabric. The crisis has encouraged the renewal of management methods. Working remotely and in collaborative mode, revising its processes, automating and securing them, making its information system agile and reliable… become the levers of operational excellence and a tremendous step forward.

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