

## Article

# Toward a Rapid and Sustainable Recovery in the Tourism Industry Using Lean Manufacturing Principals

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**Abstract:** The tourism industry sector is among the economic growth drivers in many countries worldwide. Unfortunately, this sector was one of the most affected sectors by the COVID-19 pandemic. The objectives of this study are to implement selected lean management principles to speed up and sustain the sector's recovery. The country of Jordan is among those countries which is depending on the tourism industry and will be selected as a model to implement the goals of this study. The number of tourists visiting Jordan on a monthly basis for two years, their nationalities, and the trip organizing agencies were collected and investigated for this study using group technology. Group technology, as a lean manufacturing tool is selected to be investigated and applied for having favorable clusters in terms of their economic, social, and health impact. Two scenarios were examined: the first scenario is clustering visitors based on their nationalities, and the second scenario is clustering based on travel agencies. Then, for each scenario, the developed tools were used to come up with recommendations for Tourism Regulatory Authority (TRA) to communicate between the travel agencies to take advantages from the grouping to arrange and optimize tourists' trip which may increase their profit and reduce tourists' travel cost. In conclusion, the used procedure could provide the planners with a useful and powerful instrument for tourism development and prosperity.

**Keywords:** rapid sustainable recovery; tourism industry; lean manufacturing; group technology; clustering; Jordan



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## 1. Introduction

The tourism industry is an important driver for the economic growth in many countries, as a large number of their people work in professions and jobs related to this sector, which has a tangible contribution in increasing the national income, prosperity, and wealth for these countries [1]. The tourism industry encompasses a wide variety of jobs and businesses such as hospitality, restaurant sectors, entertainment, coordinating visits to archeological sites and museums, religions, and medical tourism [2]. European tourism contributes nearly 48% of the entire outbound travel and tourism activities globally. Travel and tourism are essential business enablers and contributors to the global economy. The local GDP of the destination nation is driven by tourism [3]. The Jordanian tourism sector has great importance in the economic structure with income reaching approximately USD 5.8 billion at the end of 2019 [4] (Ministry of Tourism and Antiquities, 2010/2011). Jordan has many distinguished heritage sites, such as Petra which was one of the world wonders in 2007, Madaba, Jerash, Dead Sea, and others. Jordan is characterized by security and safety as well as a moderate climate. The tourism sector in Jordan is considered one of the vital sectors. It occupies the second level of employment in the private sector [5].

Tourists play a considerable part in transferring viruses or pandemics between destinations. Studies showed that travel restrictions are the most beneficial and successful interventions in the early and final stages of the infectious pandemic to reduce the spread of infection and monitor its transmission rate in the world [3].

Lean philosophy is a way of thinking that focuses on organizing human activities to eliminate waste. Many industries have adopted lean thinking, such as the tourism industry to improve quality, optimize productivity in hotels and restaurants, and improve the performance of selected tasks to obtain an effective customer-oriented system [6].

This study aims to propose an innovative method for sustainable and rapid recovery of the tourism sector utilizing a selected lean tool, mainly clustering approach by using group technology methodology in a way that does not contradict the determinants set by the COVID-19 pandemic: such as not crowding and maintaining the necessary social distancing. The proposed method can be used even after this pandemic is over, and even at the occurrence of another pandemic in the future.

## 2. Literature Review

This section presents a literature review about the tourism sector in general, then the focus will be on the tourism sector in Jordan, explaining how this sector was affected by COVID-19 and other past crises and how this sector can utilize lean principles to speed up its recovery from the COVID-19 pandemic, and in particular utilizing group technology principle.

Tourism is considered one of the most important elements of economic growth and works to increase capital in addition to other economic elements. Tourism supports many other economic fields, such as transportation, hotels and internal sales operations, where the tourists seek to spend money in the host country and carry with them some souvenirs and gifts from the distinctive tourist areas [7]. All this increases the revenues and opens the way for other economic aspects. The economic return provided by the tourism sector, have a major role in spreading investment and attracting investors, which increases competition in the market of those interested in developing their capabilities and knowledge and technological capabilities [8] and thus increases the openness of societies and readers of social and psychological life. Tourism creates a lot of work options for individuals and institutions, and it is not limited to a specific or fixed type of job opportunity. On the contrary, a large number of work fields and sectors may be involved in it. It is not limited to a specific group of society, but rather it accommodates all specializations, educational qualifications and experiences [9]. Those interested in the economy encourage poor and developing countries to invest in the field of tourism as it is the most important source for increasing income and helps the growth and development of countries [10]. Interest in tourism and its development helps to change and develop the behavior of individuals and leaders of the country and enriches the economy and changes the social, behavioral, environmental makeup of countries [11]. However, those interested in the environment and those who preserve environmental resources consider the tourism sector a factor in the depletion of environmental resources, which negatively affects the environment and its resources [12]. Economists do not disagree on the economic and developmental importance of tourism. Tourism [13,14] in turn damaged the environment and the ecosystem, which showed on the surface the negatives and challenges of tourism despite the positives and economic development for it. Pollution, waste and emission of harmful gases such as carbon dioxide formed an obsession among those interested in the environment. The term sustainable tourism has appeared, which in turn combines the presence of tourism and the preservation of the environment and its sources from another aspect for a healthy life in the present and future [15–17]. It is worth mentioning that tourism has a changing process in different regions and urban areas of the world and the interest in tourism and its development helps to change and develop the behavior of individuals' educational role, mainly for the younger generation [18,19].

According to the statistics of the Ministry of Tourism and Antiquities in Jordan, Jordan witnessed the highest levels of growth in the tourism sector during the year 2019, as the number of visitors reached 5,360,587 and tourism income rose to 4108.2 million Jordanian dinars which is approximately equivalent to USD 5794.07 million. The Jordanian Government stated that 2019 was a golden year in tourism. The most important tourist

visited places in Jordan are Petra, Nebo Mountain, and Jerash accounting, respectively, for 1,135,300, 669,581 and 475,526 tourists in the year 2019 [4].

According to statistics, travelers favor staying in Amman, Petra, and the Dead Sea. Amman has held down the top spot in terms of the number of stays with 613,201 tourists residing in Amman, followed by Petra with 396,298 tourists, the Dead Sea with 234,193 tourists [4].

Tourism is associated with economic development, and it includes an increasing number of new sea diverse tourist destinations, which transforms travel and tourism into a major force for social and economic advancement.

Understanding and recognition of the COVID-19 pandemic and immediate post-pandemic impact is fundamental for future crisis management [20–22]. Therefore, many studies have examined the effect of other pandemics prior to COVID-19 on the tourism and hospitality sector, such as Page et al., 2012 showed the impact of swine flu in the UK; they studied swine flu pandemic in the second quarter of 2009, which was evaluated by comparing the variations in the number of visitor arrivals from each market. It is obvious that the swine flu had a negative impact on demand in all 14 swine flu-impacted countries which led to a loss of 1.6 million visitors in the second quarter of 2009 [23,24].

As a response to the COVID-19 pandemic spread, different countries of the world have taken actions such as quarantine, border closures, and travel stops. The tourism and hospitality industry are influenced by either limiting or closing their operations (Japutra & Situmorang, 2020) [23]. Several recent studies have also studied the effects of the COVID-19 pandemic. For example, Japutra & Situmorang in 2020 showed the effect of the COVID-19 pandemic on the tourism and hospitality sector particularly hotels in Indonesia and how the hotel managers react to these conditions to survive. The Indonesian Travel Agents Association recorded a decline in sales of up to 90%, which is nearly USD 245 million losses due to the cancellation of reservations. Additionally, more than 95% of the drop in Bali airport revenue where the number of departing flights in the first quarter of 2020 was only four. Additionally, showed that the tourism and hospitality industry contribute significantly to the economy since it creates many job opportunities and generates income [25].

Cahyadi and Newsome in 2021 [26] provide a summary of the impact of COVID-19 on tourism activity in geoparks in Indonesia.

Akbulaev & Aliyev in 2020 [27] studied the effect of the COVID-19 in China on the tourism industry. As a result of coronavirus, the flights from and to China were canceled. So, the airline industry was hardly affected because the sales and revenue of airline companies were reduced (the number of passengers was insufficient). In similar way, the hotels and cruise operations were closed. The traveling agencies are closed by the Chinese government due to quarantine.

Wen et al., 2020 [28] studied the impact of COVID-19 on the lifestyles of Chinese citizens and travel preferences by investigating the local and international level of the tourism and hospitality trends. Chinese travelers' consumption patterns were impacted by COVID-19, including the rise in popularity of luxury journeys, health, and wellness tourism. It is likely that these effects differ with individuals' cultural backgrounds. Various action plans were taken to encounter and mimic the effect of the COVID-19 pandemic.

Chang et. al. 2020 [29] showed that it is crucial to look into how the industry will bounce back after COVID-19 and how it can be made sustainable in a world that has undergone significant changes. As a contribution to the industry, the authors present a charter for tourism, travel, and hospitality after COVID-19. This charter is deemed necessary to establish balanced and sustainable tourism, travel, and hospitality industries because they consist of safety rules. The charter presents 10 points for sustainable tourism after COVID-19. The main points were social distancing from the tourist source, and at the destination should be managed and implemented the social distancing in all aspects of the travel industry. Tourism numbers should apply to travel and entry processes. Personal protection equipment (PPE) should be mandatory and obligatory to implement thorough and regular monitoring to control pandemics, identify early warning signs of infection.

### 2.1. Lean Management Philosophy

Lean thinking is a methodology that aims to provide a new way to think about how to do more with less by eliminating waste. Lean thinking has been used in many industries to remove and eliminate all types of waste. Lean thinking is mainly inspired by the Toyota Production System (TPS) which has been focused on the elimination of waste and improving customer satisfaction [30].

Lean management developed many useful tools and techniques to reach the waste elimination concept. The main idea from the development of lean management principles is to improve performance through the elimination of waste sources. Lean principle is defined as a set of instructions and techniques that can guide organizations to add value to their products; this can be implemented by promoting the necessary process and steps while eliminating processes that do not add value consistently. However, lean has also been widely applied in non-manufacturing areas. Lean has many applications in the industrial sector, manufacturing, healthcare systems, managerial sector, etc. [31].

#### 2.1.1. The Use of Lean Management in Service Sector

To reduce waste and add value throughout the process, techniques such as Single Minute Exchange of Die (SMED) or quick tool change, Poka-Yoke, Kanban, Kaizen, Visual Management, Standardized Work, Gemba, Andon, and Total Productive Maintenance (TPM) were used. By getting rid of the processes that do not add value to the company, the outcomes can be improved, and a competitive edge can be gained. By integrating the team and tools and adding value to each process without overtaxing the team through behavioral changes, the application of lean thinking in health opens up a variety of opportunities for continuous improvement, resulting in a system that can recognize the true needs of the user and be able to provide what he needs on time [32]. Bloj et al., 2020 [33] explained the effect of implementing lean on one of the energy companies. They found that the customer data actualization rate improved from 2.6% to 20% in 3 months after lean manufacturing implementation, through updating the internal procedures, identifying the main issue of the calls, and improving the overall process. This case study was conducted at a call center, focusing on shortening the customer's waiting time, preparing colleagues for the most enjoyable interaction, and promptly solving requests by improving internal processes. Lean implementation was performed using the problem-solving methodology DMAIC, a SIPOC (suppliers, inputs, process, outputs, and customers) map that is a visual tool for documenting a business process and analyzing the customer's voice. Then, the data were analyzed using Minitab18 and tested the collected data to see the differences between the operators and check the process capability [33]. In another study, lean thinking was implemented to investigate the relation between servant leadership and job crafting behaviors [34].

#### 2.1.2. Lean Management and Tourism

As lean management approach had succeeded in the industrial sector, it is also applied in the tourism industry efficiently and effectively. Al-Aomar in 2018 [35] assessed the adoption of lean techniques across the supply chains of hotels, aiming to deliver high quality products and services across the supply chain, increase effectiveness, reduce waste and costs, and being environmentally responsible.

Kaushal and Srivastava in 2021 studied the major challenges that encounter the hospitality and tourism industry during the current conditions. The study was performed by interview 15 participants in senior positions in the hospitality industry, tourism and hospitality education services. Their study shows the importance of having multi-skills and professional employees, the importance of raising the sense of hygiene and sanitation for better crisis readiness. The study suggested that after COVID-19, organizations have to redesign their business models based on the loss that happened and market conditions for the future [36].

Rauch et al., 2015 [37] showed the importance of lean implementation in the tourism industry and hospitality.

Cristina applied lean tools to the restaurant sector by collecting actual data from a restaurant and observing how the employee's work. Then, the observed situation was analyzed, and some lean tools were applied to improve the performance of the selected tasks and to obtain an effective customer-oriented system of an organization [38].

### 2.1.3. Lean Management and COVID-19

Researchers have recognized the potential use of lean tools and principles to mimic the impact of COVID-19 on the manufacturing environment and service sector.

How lean will lessen the impact of COVID-19 within healthcare environments was studied by Hundal et al., 2020 [39]. The goals of this research were to understand the relationship between lean and COVID-19 through a thorough analysis of contemporary literature, identify the gaps in current understanding of lean in COVID-19 mitigation in health care environments, and define the lean principles.

Leite et al., 2022 applied the lean principles on healthcare operations during the disruptive impact of the COVID-19 pandemic in an emergency department in Brazil. The study proved the applicability of lean management during the pandemic [40]. Muhammad N. et al. used the lean management and sustainability practices in small firms during COVID-19 leading to excellence operations in the industrial zones of Pakistan [41]. Pellini F et al., 2021 proved the usefulness of lean management in the organization of the preoperative and postoperative times during the COVID-19 pandemic at the Verona University Hospital [42].

Abdelhakim Abdelhadi in 2021 applied 15 different lean tools to control the spread of COVID-19. The causes of the spread of the virus were studied and then lean tools were applied. For example, 5s can be used during COVID-19 by maintaining cleanliness and using preventive measures to minimize exposure to the virus causes [43].

## 3. Group Technology and Data Collection

Group technology (GT) is one of the lean tools that can be defined as an approach in which similar parts are identified and grouped together to take advantage of the similarities in the design process and production. GT is also defined as a method of organization for the machines, tools, and people, by joining them into different groups. The machines in each group must be placed together in one location. Additionally, GT is an alternative method to organize the processes based on process specialization [44].

The concept of GT in tourism is to create families to take advantage of their similarities in planning tourist trips. Additionally, this will result in many benefits in many aspects including economic, social, health, administrative and planning, sustainability, etc.

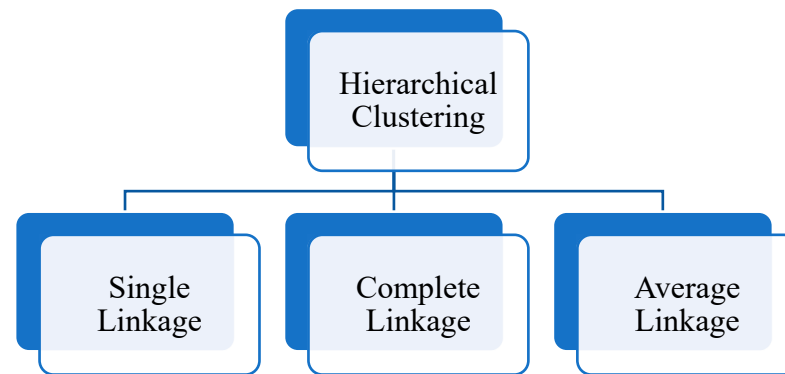
### *Clustering Algorithms and Data Collection*

The group of those similar and homogeneous cases is referred to as a cluster [45]. Hierarchical clustering methods are performed by a series of successive mergers. The main goal of cluster analysis is to form a classification system to group relatively similar cases within themselves.

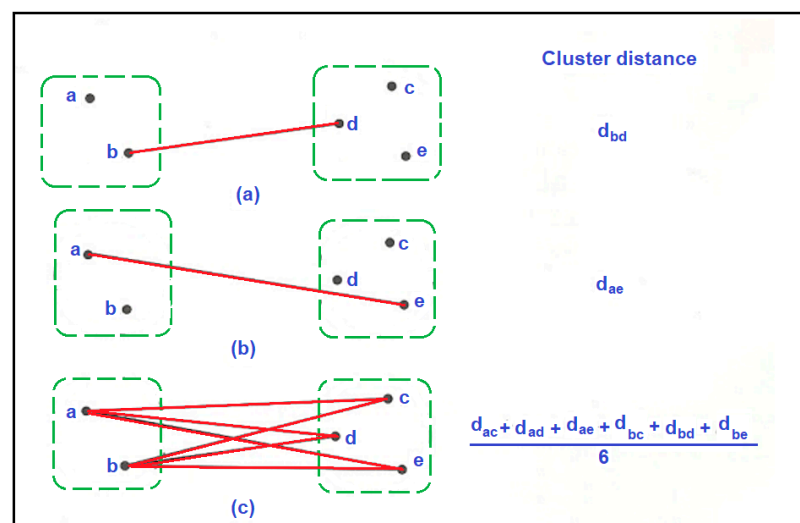
Three different methods of hierarchical linkage clustering are shown in Figure 1: single-linkage (minimum distance or nearest neighbor), complete-linkage (maximum distance or farthest neighbor), and average linkage (average distance). These are all based on the similarity level but the main difference between them is the selection of the data points that are examined to take as a final criterion on which the similarity or distance depends [46,47].

The joining of clusters of the three linkage mechanisms is shown in Figure 2. No rule exists that can brief around the most proper clustering algorithm for a particular problem. A lot of testing and statistical logic is necessary to choose an effective clustering algorithm. Dinh et al. [48] proposes an algorithm named k-SCC to estimate the optimal k in categorical data clustering.





**Figure 1.** Hierarchical clustering mechanisms.



**Figure 2.** Intercluster distance (dissimilarity) for (a) single linkage, (b) complete linkage, (c) average linkage.

The dendrogram is the graphical display of clustering. Usually, it is built backward, starting from the final cluster with all the objects and from similarity 0 [49].

#### Single Linkage (Minimum Distance)

Groups of clusters are created from single entities by merging or combining nearest neighbors, the nearest neighbor connects the smallest distance or largest similarity.

In the beginning, the smallest distance in  $D = \{d_{ik}\}$  should be found, and then merged with the corresponding objects, say U and V to obtain the cluster (UV).

The distances between (UV) and any other cluster W are computed by Equation (1):

$$d_{(UV)W} = \min \{d_{UW}, d_{VW}\} \quad (1)$$

here  $d_{UW}$ ,  $d_{VW}$  are the closest distances between the neighboring clusters groups of U and W and group cluster V and W, respectively.

Simple linkage tries to be very nearsighted. The object that will be added to the cluster should be close to any one of the other objects in the cluster, even if it is relatively far from all the others. So, the single linkage has a goal to make long, stringy clusters and nonconvex cluster shapes.

#### 4. Data Collection

Information was collected on the number of tourists groups visiting Jordan, regardless of the destination for the visit (archaeological, medical, religious sites, etc.) from the records of the Ministry of Tourism and the Tourism Regulatory Commission. The data are collected

based on a monthly basis for different nationalities in the years 2018–2020. The number of nationalities for tourists visiting the Kingdom was 49, and the number of travel agencies arranged the trips was 19. It is crucial to emphasize that gathering accurate data is a key component of maximizing the benefits from the proposed method, which necessitates collaboration with offices and travel agencies to identify the nationalities of tourists and the distribution of their numbers throughout the year.

#### 4.1. Data Clustering Analysis

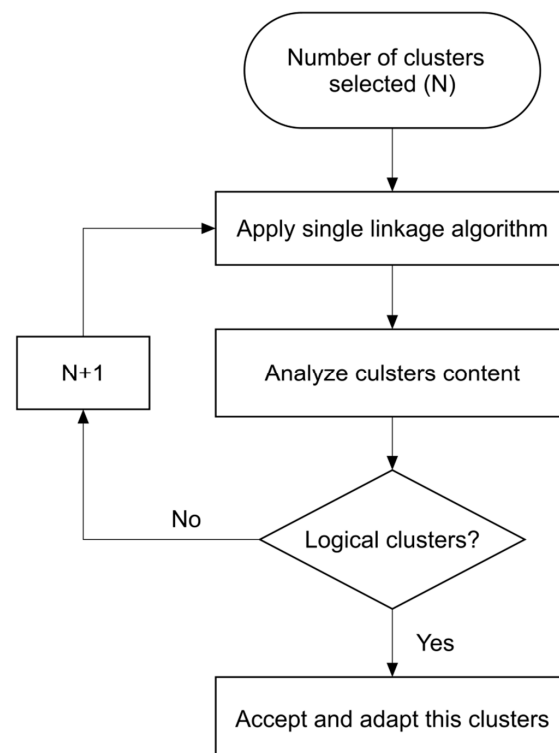
The concept of group technology and data clustering is used as the basic means in analyzing the information collected; this information will be processed with the aim of assisting the decision makers in making appropriate decisions that enable maximizing utilization of this information. Data will be sorted and organized into groups based on selected types of their similarities. The Single Linkage algorithm will be used in the group building process, and the resulting groups will then be analyzed to see how they can be used.

Two scenarios will be studied to classify the information collected:

- A. Clusters will be built based on different tourists depending on the proximity in the geographical areas from which they came and regardless of the tourist agencies that organized the tours.
- B. Clusters will be built based on different tourist agencies depending on the similarities of tourist nationalities for which offices organize trips.

##### 4.1.1. Clustering Scenario, I (Tourist Nationalities)

This scenario aims to create clusters of nationalities regardless of the tourism agencies who arranged trips. The option of single linkage algorithm was used to process the collected data for the year 2019 to be used as an example. In the literature, there is no optimal number of clusters which can be used to have a meaningful number of clusters results. The process starts by selecting the number of clusters ( $n = 3$ ), then, applying the clustering algorithm shown in Figure 3.

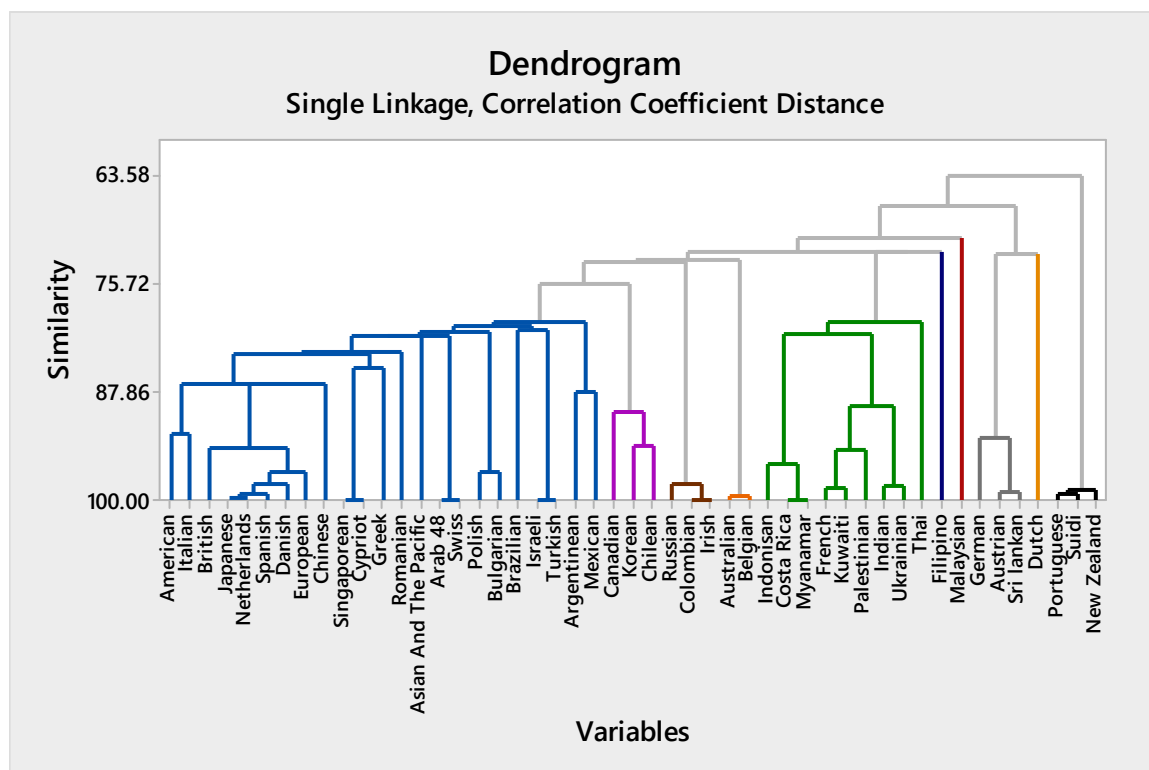


**Figure 3.** Flowchart describes steps used to determine number of clusters.

Each month through the year 2019, the procedure described in the described flow chart was conducted using different clustering numbers (n). At each time, the outcome of clustering was analyzed in terms of its impact on economic, health, social, sustainability, and administration aspects. In order to analyze the content of the clusters, the clusters are named A, B, C, etc. As an example, the content of clusters when  $n = 10$  for January 2019 is presented in Table 1 and the corresponding dendrogram is shown in Figure 4.

**Table 1.** Clusters content when the number of clusters is equal to ten ( $N = 10$ ).

Month	Clusters	Nationalities
January, 2019	A	American, Italian, British, Chinese, Japanese, Spanish, Argentinean, Mexican, Brazilian, Romanian, Singaporean, Cypriot, Greek, Israeli, Netherlands, Asian And The Pacific, European, Swiss, Polish, Bulgarian, Danish, Turkish
	B	Malaysian
	C	Indonesian, French, Indian, Thai, Palestinian, Costa Rica, Ukrainian, Kuwaiti, Myanmar
	D	Canadian, Korean, Chilean
	E	German, Austrian, Sri Lankan
	F	Dutch
	G	Filipino
	H	Russian, Colombian, Irish
	I	Australian, Belgian
	J	Portuguese, Saudi, New Zealand



**Figure 4.** Dendrogram for January, 2019 using single linkage clustering algorithm when  $N = 10$  (scenario I).

The dendrogram in Figure 2 shows the hierarchal relationship between objects (variables), that will be used to form clusters (in this scenario: nationalities) on the horizontal

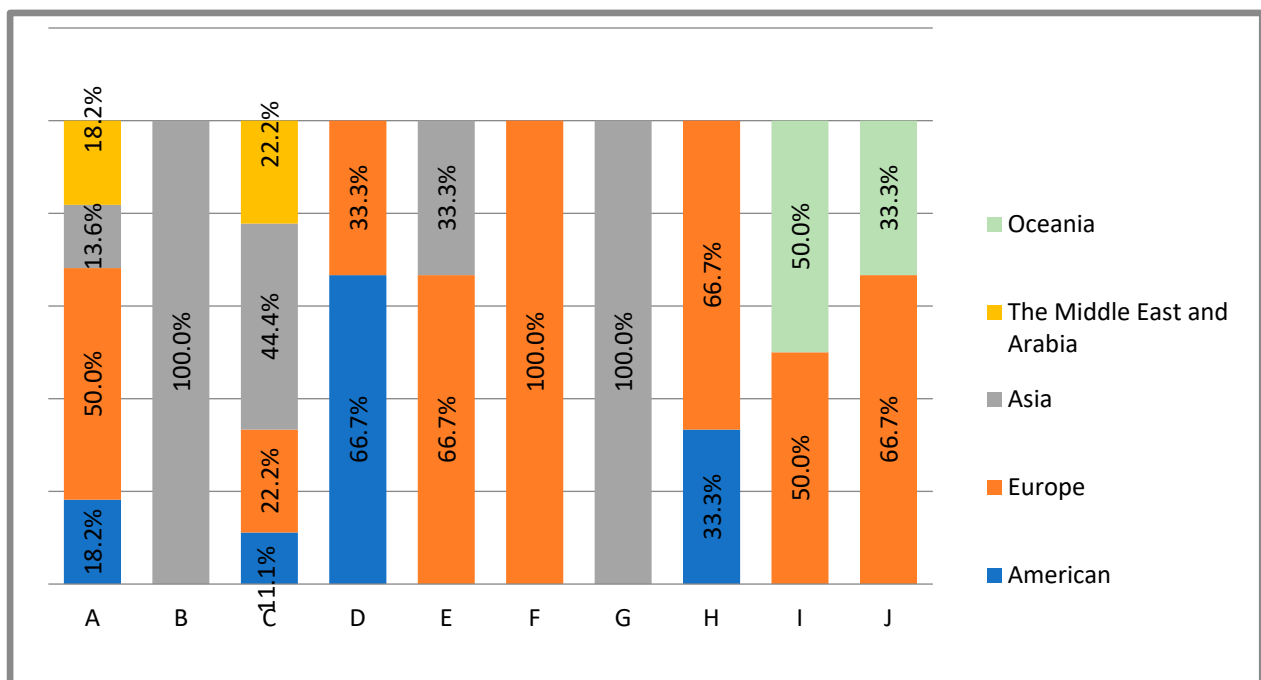


axis, and the similarity coefficient used to create clusters between its variables (nationalities) on the vertical axis. In general, the shorter the height of the link that joins two variables together, then these two variables are the most similar. The link height indicates the order in which the clusters were joined. For example, the dendrogram suggests that Americans and Italians are much closer to each other than Americans and the Chinese.

In each cluster, the distribution of different nationalities was studied within six geographical regions, namely these regions are: Oceania, the Middle East and Arab countries, Asia, Europe, America, and Africa, by determining percentage of tourists who hold the nationalities of countries belonging to a particular region.

To facilitate visual perception of the distribution, distinct colors were used for each region, and the contents of each colored group were displayed using a bar chart where each column represented a cluster. When the number of colors in the cluster is less, it means that there is more homogeneity in the contents of the cluster. The ideal situation is to have one color in each column.

Figure 5 shows the bar chart for the clusters regions distribution (CRDC) when  $N = 10$ , January 2019. It shows that clusters B, F, and G have nationalities from the same regions, whereas clusters D, E, H, I, and J have nationalities from two different regions. Clusters A and C have more than three different nationalities.



**Figure 5.** Clusters region distribution for January 2019 when  $N = 10$ .

Gathering tourists coming from a specific geographical area into one group has positive repercussions in many aspects. From an economic point of view, reducing the operational costs of tourist agencies arranging the trips, as these tourists have close habits due to the similarity between the peoples of the region in social, food habits, and probably the language which facilitates their communication.

Tourist companies can coordinate together in determining the number of trips and their destinations in proportion to the number of tourists coming from a particular area, and this in turn contributes to reducing the operational cost of offices, which is positively reflected in the decrease in the cost of the trip for tourists, which encourages tourism investment and increases the number of tourists. Following are some benefits of using Scenario I in the tourism sector:

- Transportation costs will be reduced for each tourist because all nationalities that have similar routes will go on the same trip, so the number of transportations used will be decreased and each one of the transportations will reach its full capacity, thus the individual cost will be reduced, and the offices will benefit from this idea because it saves money.
- The tourists for sure will feel psychological comfort because all people talk the same language, and have the same interests.
- The number of tourists on the trip will be small at each site, so the social distancing will be excellent and safety protocols will be used.
- This mechanism reduces the number of tourists on one route, so it will reduce the possibility of Coronavirus infection.
- Instead of each agency take its tourists from different nationalities with different routes to all places, this mechanism will take all nationalities on the same route on the same tourism trip, which will reduce the lost time on-road and save the transportation cost and then the economic cost to each office.
- It allows the creation of advanced tourist routes and protects the quality level of the services provided.
- Reducing the travel trips using this approach will contribute achieving the goals of the UN sustainability 17 goals, such as goal number 8, 9 and 12.

#### 4.1.2. Clustering Scenario, II (Clusters of Offices Based on Tourist Nationalities)

This scenario aims to create clusters of tourist agencies based on similarities between the tourist nationalities visiting the country. The option of a single linkage algorithm in Minitab software was used in this scenario to process the collected data for the year 2019.

The process starts by selecting the number of clusters that are tourist offices ( $N = 3$ ), applying the clustering algorithm, and analyzing the content of clusters in terms of their goodness; then, the process is repeated until meaningful logical results are attained.

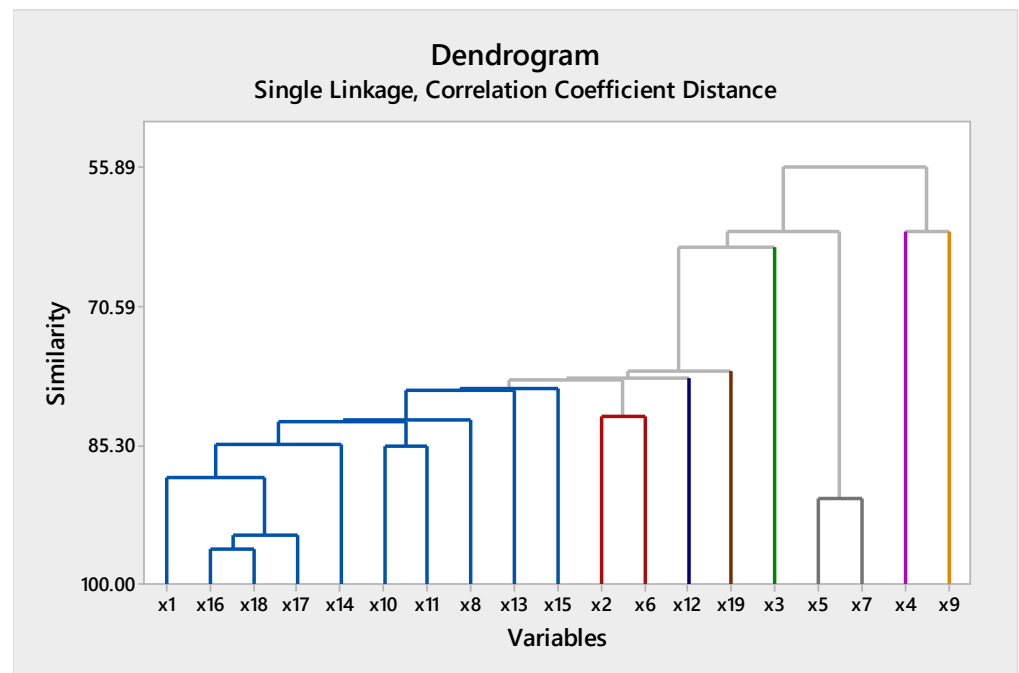
In this scenario, there were 19 ( $\times 1, \times 2, \times 3, \dots, \times 19$ ) major tourism agencies under considerations. So, the number of clusters used in this study was from  $N = 3$  to  $N = 9$ . For every month through 2019, the procedure described in the previous section was conducted using various clustering numbers ( $n$ ). At each time, the end result of the clustering process was analyzed in terms of its consequences on economic, health, social, sustainability, and administration aspects. With respect to analyze the content of the clusters, the clusters are named A, B, C, etc. As an example, the content of clusters when  $N = 8$  for February 2019 is presented in Table 2, and the correlated dendrogram is shown in Figure 6. For example, cluster A in February 2019 has four tourist offices which are  $\times 1, \times 16, \times 17$ , and  $\times 18$ . The dendrogram in Figure 6 shows the hierarchal relationship between objects (travel agencies), that will be used to form clusters on the horizontal axis, and the similarity coefficient used to create clusters between its variables—depending on the similarities of tourist nationalities for which offices organize trips—on the vertical axis. For example, the dendrogram suggests that  $\times 16$  and  $\times 18$  are much closer to each other than  $\times 16$  and  $\times 17$ .

**Table 2.** Clusters content when the number of clusters is equal to eight ( $N = 8$ ).

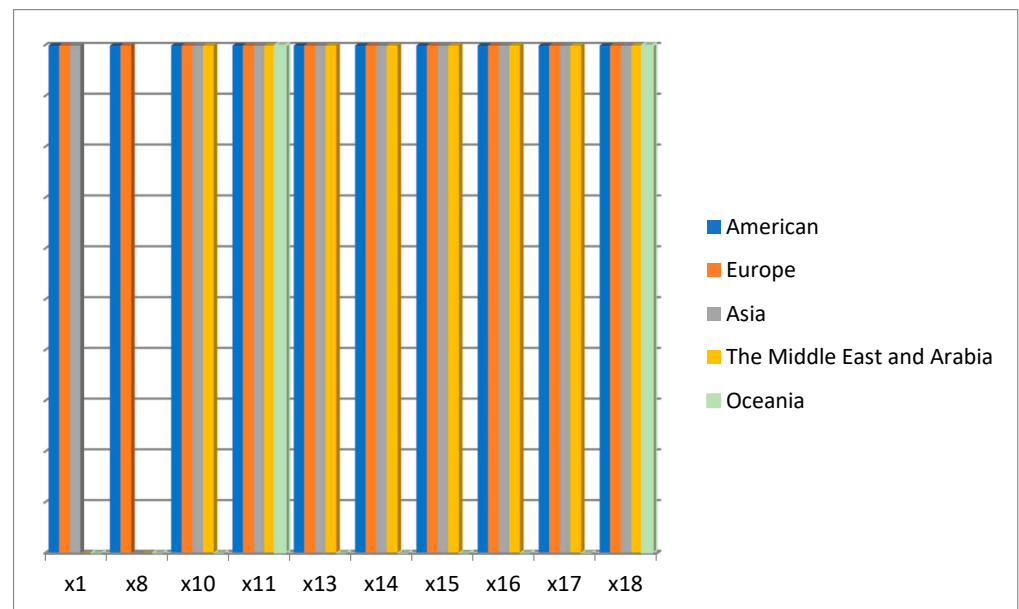
Months	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E	Cluster F	Cluster G	Cluster H
February	$\times 1, \times 16,$ $\times 17, \times 18$	$\times 2, \times 6$	$\times 3$	$\times 4$	$\times 5, \times 7$	$\times 9$	$\times 10, \times 11,$ $\times 12, \times 13,$ $\times 14, \times 19$	$\times 15$

A cluster content visualization chart (CCVC) was used to display regions of each office in the clusters when  $N = 8$ . Figure 7 shows cluster A content visualization using color coding for January when  $N = 8$ . As shown cluster A has 10 tourist offices, all of these offices have tourists from America and Europe, 90% of these offices deal with Asian tourists, 80%

of these offices have tourists from the Middle East and Arabia, and just 20% deal with tourists from Oceania.

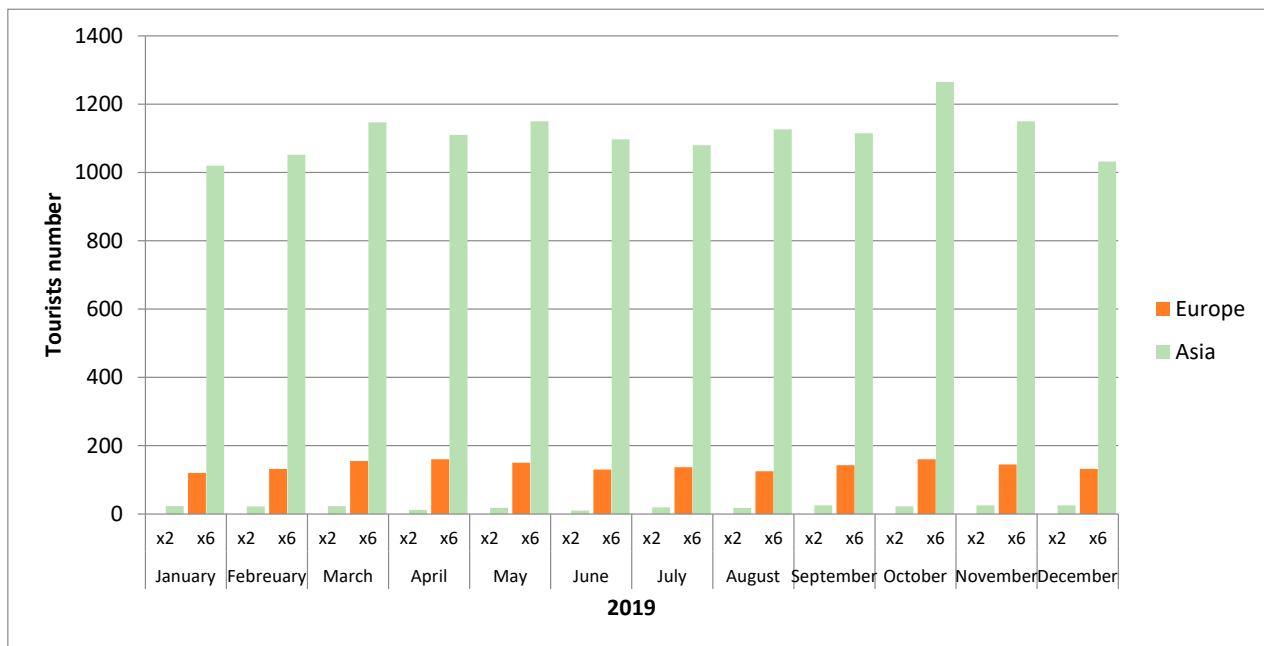


**Figure 6.** Dendrogram for offices during January2019 using single linkage clustering algorithm when N = 8 (scenario II).



**Figure 7.** Cluster A content visualization using color coding for January when N = 8.

A cluster content explanation chart was used for all clusters throughout the year to monitor how the nationalities number changed in the same cluster from January to December. For example: Figure 8 shows the cluster B content explanation chart. The y-axis represents the number of tourists for each geographical area in the cluster, and the x-axis represents the offices within cluster B throughout the year.



**Figure 8.** Cluster B content explanation chart throughout the year of 2019 when N = 8.

Clustering agencies into groups based on the similarities between the nationalities they serve will create a positive effect and will add value to the tourism sector on many ways, such as:

- Transportation costs will be reduced for each agency because all the tourists in the handled by many agencies will go on the same trips, so the transportation cost will decrease.
- Give opportunities for tourists to form new relationships with different nationalities.
- The number of tour guides who will go on trips will be decreased so we can give the other tour guides the opportunity to make video clips for tourist places and make advertisements and then share them.
- Make organized trips and schedules to offices in the same cluster, which leads to saving time and effort.

## 5. Conclusions

The approach used in this research will help preserve the environment in deferent ways, such as minimizing the amount of fuel consumed when visiting any site of interest. Henle, those interested in the environment and those who preserve environmental resources will consider this research as an important step toward preserving the globe. This research will be part of sustainable tourism, which in turn combines the presence of tourism and the preservation of the environment and its sources from another aspect for a healthy life, present and future. Additionally, the approach used here can be adapted by any country in any future occurrences of pandemics similar to the COVID-19.

Tourism economic and social significance have been recognized in all countries in the world. The Jordanian tourism sector has great importance in the economic structure with income reaching approximately USD 5.8 billion at the end of 2019. Unfortunately, it is one of the most sectors that suffered from the COVID-19 pandemic. Many governments used the lockdown policy, and quarantine to reduce the virus spread. This study proposed an innovative method for sustainable and rapid recovery of the tourism sector utilizing some selected lean tools in a way that does not contradict the determinants set by the COVID-19 pandemic: such as not overcrowding and maintaining the necessary social distancing. The proposed method can be used even after this pandemic is over, and even at the occurrence of another pandemic in the future. The proposed approach relies on making clusters of nationalities and tourism offices from the data collected from the Jordanian Ministry of

Tourism and Antiquities using single link hierarchical agglomerative clustering. Gathering tourists coming from a specific geographical area into one group has positive repercussions in many aspects, including: reducing the operational costs of tourist agencies arranging the trips, improving tourist's psychological feelings, reducing the possibility of coronavirus infection, allowing the creation of advanced tourist routes and enhancing the quality level of the services provided. Clustering agencies into groups based on the similarities between the nationalities they serve will create a positive effect and will add value to the tourism sector on many ways, such as: reducing the transportation costs, giving opportunities for tourists to form new relationships with different nationalities, saving time and efforts.

It is advised that the government and the Tourism Regulatory Authority implement some incentive policies to encourage tourism offices to implement the research's recommendations, such as installment payments of taxes and fee reductions for tourism institutions or return financial guarantees for travel and tourism offices and businesses.

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