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Shipping and Transportation Traffic of Medical and Non-Medical Goods Before and During COVID-19 in Oman

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Abstract

The transportation and logistics services have been severely disrupted starting from February 2020 due to precautionary measures of partial and complete lockdown taken by a number of countries to control the spread of COVID-19. The study aims to investigate the changes in the shipping and transportation traffic of medical and non-medical goods during and before the start of COVID-19 pandemic in Oman. The research question that will be addressed here is “Is there any significant difference in the volume of shipping and transportation traffic of medical and non-medical goods before and during COVID-19 in Oman?” The study applies the Wilcoxon Signed Rank Test and Friedman’s two way ANOVA on the data collected from 61 companies operating in Oman. The study found that the shipping and transportation traffic of both medical and non-medical goods decreased by 6.5% and 25.6% respectively during COVID-19. The higher percentage of decrease is noticeable in non-medical goods than the medical.

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Keywords: medical goods; non-medical goods; goods supply; goods demand; supply chain; transportation; shipping; COVID-19

1. Introduction

The COVID-19 has directly and indirectly affected the flow of goods globally. For instance, goods transport

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companies have reported decline in the turnover of goods in the Middle East and North Africa (22%), Asia (21%), and Europe (17%) [1]. The major effects of COVID-19 include, late delivery of products/services, shortage of products/services, and demand-supply mismatch. The suspension of logistics activities during lockdowns has created a heavy burden on the demand and supply of food products [2] and raw materials shortage [3]. The textile and apparel industries witnessed 35 % reduction in logistics while food processing 23 %, machinery and transport equipment 22%, chemical and plastics 22%, and non-manufacturing 22% [4]. The COVID-19 shutdown resulted in demand and supply problems of goods such as fresh vegetables, eggs, and milk [5] to toilet paper [6] in the USA. The COVID-19 has directly and indirectly affected the flow of goods globally. For instance, goods transport companies have reported decline in the turnover of goods in the Middle East and North Africa (22%), Asia (21%), and Europe (17%) [1]. The major effects of COVID-19 include, late delivery of products/services, shortage of products/services, and demand-supply mismatch. The suspension of logistics activities during lockdowns has created a heavy burden on the demand and supply of food products [2] and raw materials shortage [3]. The textile and apparel industries witnessed 35 % reduction in logistics while food processing 23 %, machinery and transport equipment 22%, chemical and plastics 22%, and non-manufacturing 22% [4]. The COVID-19 shutdown resulted in demand and supply problems of goods such as fresh vegetables, eggs, and milk [5] to toilet paper [6] in the USA.

Nižetić [7] analyzed the impact of COVID-19 on the air transport mobility in the European Union (EU) for the data (January to April 2020) collected from two major airports in Croatia. It was found that the air transport mobility in terms of flight reduced to more than 89%. However, the Cargo traffic saw increased traffic in some cases due to the supply of medical equipment. During COVID-19 masks both surgical masks and N95 respirators were in demand since they prevent the spread of respiratory infections. The other equipment such as medical protective clothing, catheters, sterile gloves, ventilators, oxygen masks, oxygen concentrators, hand sanitizers, patient monitors, X-ray equipment, and breathing masks were in high demand. The USA accounted for 18% of COVID-19 products imports globally while 9% were related to Germany, although they were also exporters of certain products from Germany (15%) and the USA (11%) [8].

The Omani government understands the importance of logistics and supply chain and thus in 2013 it announced to spend US\$20bn over the next 15 years on the transport and logistics sector [9]. The COVID-19 outbreak has placed the medical and non-medical goods supply chain's vulnerability into sharp focus. As of late March, 2020 the governments in the Middle East region, suspended inbound, outbound and transit flights, allowing only essential goods and life-saving medical supplies. The business in the Sultanate of Oman faced numerous challenges in transportation and logistics whether importing the raw materials or exporting the finished goods. Therefore it is important to study the impact of the pandemic on logistics and freight movement [10]. The disruption and implications in the shipping and transportation during COVID-19 require investigation [11]. The barriers and drivers to goods' shipping and transportation depend on countries whether developing or industrialized, product types, type of economy whether exporting or importing [12, 13]. Hence, it is of critical importance to evaluate the experience of logistics and supply chain sectors with respect to supply of goods both medical and non-medical in Oman. This research will help scholars and policy makers in reasoning out causes of reduced freight traffics and choosing certain mechanisms and technologies in handling future disruption caused by either pandemic or man-made.

The research question that will be addressed here is "Is there any significant difference in the volume of shipping and transportation traffic of medical and non-medical goods before and during COVID-19 in Oman?" The following null hypotheses have been developed for answering the research question- H_{a0} : There is no significant difference between freight traffic of medical goods before and during COVID-19. H_{b0} : There is no significant difference between freight traffic of non-medical goods before and during COVID-19. There are six sections. Section 2 describes the literature. Section 3 corresponds to the research method. Section 4 illustrates the results and analysis. Section 5 presents discussion. Last section concludes with the findings.

2. Background

The surge in demand for vital medical equipment, particularly ventilators and oxygen therapy equipment, in the EU and the USA were reported during COVID-19. At first instance, it was tough for manufacturing companies to increase the output for medical equipment during COVID-19. Prior to the COVID-19 crisis, trade and production for medical supplies were interdependent, with advanced industrial countries like the USA and Germany specializing in the relatively high-tech medical devices sector, while low-cost production hubs like China and Malaysia were leading producers of face masks, surgical gloves, and medical gowns [11].

Arellana et al. [14] observed that in Colombia during COVID-19 the airline industry was allowed to operate air cargo for medical and necessary supplies only. The supply chain of nonessential products got disrupted due to reduction in freight trips to 38%. Loske [15] studied the changing volume and capacity dynamics in road haulage due to COVID-19 by conducting a case study using the data of transport volume ($n=15,715$ routes) during the period 23.03.2020 to 30.04.2020 in German food retail logistics. He argued that increasing freight volume for dry products in retail logistics remained independent of COVID-19 duration instead of depending on the total number of new infections per day. In case of non-cooled transport capacity the transportation companies and food retail logistics faced conflict of interest.

After COVID-19 outbreak shortage of medical equipment (life-saving mechanical ventilators, patient monitors, and X-ray machines) and medicines were reported in many parts of the world with the reasons attributed to structural defects or rigidities in their supply chains [11]. Pahl et al. [16] evaluated the impact of COVID-19 on the disruption of Global Value Chains and its association with economic activities of the developing countries. They took trade in value-added data for a sample of 12 developing countries in sub-Saharan Africa, Asia and Latin America to examine the demand and supply dependency from China, Europe and North America. They found that South-East Asian countries were highly integrated to Global Value Chains with a higher share of both benefits and loss. The USA and Germany have expertise in production of medical devices while China is a leader in the personal protective equipment (PPE), protective goggles, thermometers, and medical headwear. The USA imported 26% of these items from China. After all, due to the surge in demand, the USA-FDA had to add medical devices in a shortage list [17]. Xu et al [18] conducted theoretical analysis of COVID-19 impact on the GSC. They found that most of the GSC such as pharmaceuticals, food, electronics, automotive industry, etc. could not cope with the pandemic disruption.

Due to disruption of the Global Supply Chain (GSC) network mainly from China a number of small-and medium-scale manufacturing companies around the world faced challenges in fulfilling demand of consumers [19]. The global apparel value chain was disrupted [20]. The export from Korea reduced by 27% with a huge impact on heavy industries and textiles [21]. Sen [22] in an exploratory study on apparel manufacturing industries reported that continuous lockdown caused disruption of supply networks and labor shortage. Biswas and Das [23] found workforce shortage as a barrier with higher weight among other obstacles (shortage of raw materials and cash flow) in the Indian logistics sector. When compared to the same month in 2019, global container trade volumes fell by 8.6% in February 2020 [24]. Container traffic growth in the Europe-Asia direction has slowed since 2019, and has sunk to negative readings of -6.9% in 2020. Trans-Pacific and Transatlantic, on the other hand, experienced a similar drop of -6.6 percent and -5.6 percent, respectively [25]. Containerized cargo decreased by 5% in volume terms in Chinese ports in January 2020, followed by a drastic drop of 17 percent in February 2020, and a slight loss of 2% in March 2020. Ports on the West Coast of North America saw significant cutbacks. Volumes decreased by 13% year over year in February 2020, and then by another 18% in March 2020 [24]. In the first months of 2020, total container volumes handled at Chinese ports fell by 10.1 percent. automobile, electronics, medicines, medical equipment and supplies, as well as consumer items, were among the industries affected around the world [26]. In February/March 2020, there were 188 blank sailings, up significantly from prior years, with 85 on the Asia-North America West Coast trade route and 49 on the Asia-North Europe trade lane. In early March 2020, the share of idle container ship capacity reached 2.5 million Twenty-foot Equivalent Units (TEU), or 10.6% of total capacity [24]. Table 1 shows the changes in container trade volume by world region, 2020.

Table 1. Changes in container trade volume by world region, 2020

Region	Change January 2019 to January 2020 (%)	Change February 2019 to February 2020 (%)
Far East	0.0	-17.5
Europe	0.7	-4.0
North America	-0.3	-7.0
Australasia and Oceania	-6.5	-2.8
Indian Subcontinent and Middle East	3.7	6.1
South and Central America	2.4	2.8
Sub-Saharan Africa	5.4	7.4

3. Research Method

The study has used following important tests Kolmogorov–Smirnov, Wilcoxon Signed Rank Test, and Friedman’s two way ANOVA. The Kolmogorov–Smirnov Test is a test for normality distribution proposed by Massey in 1951 (Massey Jr, 1951). The Wilcoxon Signed Rank Test is used to compare two related samples, matched samples, or to perform a paired difference test of repeated measurements on a single sample to see if their population mean ranks are different before and after the treatment. The Friedman’s two way ANOVA is an extension of Wilcoxon Signed Rank Test for data having three or more correlated or recurrent outcomes and a non-normal distribution.

The null hypothesis of the test claims that the sampling distribution has properties similar to a normal distribution. The normality of the sample should be checked before applying parametric or non-parametric tests. The values found in Kolmogorov-Smirnov test were- freight traffic for non-medical goods before COVID-19, $D(61) = 0.211$, $p < 0.001$; freight traffic for non-medical goods during COVID-19, $D(61) = 0.235$, $p < 0.001$; freight traffic for medical goods before COVID-19, $D(61) = 0.452$, $p < 0.001$; freight traffic for medical goods during COVID-19, $D(61) = 0.470$, $p < 0.001$. Therefore, non-parametric tests were selected in the study. The mean and standard deviation were - freight traffic for non-medical goods before COVID-19 ($M = 2.08$, $SD = 1.201$), freight traffic for non-medical goods during COVID-19 ($M = 1.03$, $SD = 0.983$), freight traffic for medical goods before COVID-19 ($M = 0.44$, $SD = .940$), freight traffic for medical goods during COVID-19 ($M = 0.34$, $SD = 0.892$).

Wilcoxon Signed Rank Test is a two-group non-parametric comparison test equivalent to the parametric t-test and it takes into account difference scores in population median [27]. One of the groups is called a treatment group and another as a control group. It uses ranked or ordinal data. Furthermore, the test assumes that observations are correlated (i.e., paired data), random sampling, and measured on ordinal scale. The Friedman’s Test is used to see if there are statistically significant differences between groups when they are compared using different factors provided population distribution is non-normal.

A total of 61 samples were collected from logistics companies operating in different regions inside the Sultanate of Oman. The surveyed sample consists of 90% male and 10% females. The Omani account for 67% and Non-Omani 33% of the sampled data. The participants were mainly Director/CEO, HR Manager, Logistic Manager, and Operational Manager. Table 2 shows the characteristics of participants.

Table 2. Characteristics of participants

Male/Female	N	%	Number of employees in the company	N	%
Female	6	10%	50 and below	42	69%
Male	55	90%	51 to100	9	15%
Total	61	100%	101 to150	5	8%
Omani/Non-Omani	N	%	201 to 250	3	5%
Non-Omani	20	33%	Above 250	2	3%
Omani	41	67%	Total	61	100%
Total	61	100%	Company head office location	N	%
Positions/employment	N	%	Muscat	44	72%
Director/CEO	37	61%	Al Dhahira	2	3%
HR Manager	5	8%	Al Batinah South	4	7%
Logistic Manager	10	16%	Al Batinah North	8	13%
Operational Manager	9	15%	Al Wusta	2	3%
Total	61	100%	Al Sharqiya North	1	2%
Type of company	N	%	Total	61	100%
Omani	54	88%			
Non-Omani	7	12%			
Total	61	100%			

4. Results and Analysis

Wilcoxon Signed Rank Test was used to compare the freight traffic before and during COVID-19. The test indicated that median freight traffic of medical goods ranks ($Mdn = 1.86$) during Covid-19 was statistically significantly lower than median freight traffic of medical goods ranks ($Mdn = 1.99$) before Covid-19, $Z = 24.0$, $p < .001$, thus rejecting the null hypothesis. The Standard Error and Standardized Test Statistics are 12.278 and -1.222 respectively.

The Wilcoxon Signed Rank Test was conducted to find the differences in the shipping and transportation volumes of non-medical goods during and before COVID-19. The test indicated that median freight traffic for non-medical goods ranks ($Mdn = 2.62$) during COVID-19 was statistically significantly lower than median freight traffic for non-medical goods ranks ($Mdn = 3.52$) before COVID-19, $Z = 78.50$, $p < .001$, thus rejecting the null hypothesis. The Standard Error and Standardized Test Statistics are 89.078 and -5.186 respectively. Table 3 shows the Wilcoxon Signed Rank Test for changes in freight traffic for medical and non-medical goods before and during COVID -19. Figure 1 shows the changes in freight traffic for medical and non-medical goods before and during COVID-19 as observed in Wilcoxon Signed Rank Test.

Table 3. Wilcoxon Signed Rank Test for changes in freight traffic of medical and non-medical goods before and during COVID-19

Freight traffic for medical goods		Freight traffic for non-medical goods	
Total N	61	Total N	61
Test Statistic	24.000	Test Statistic	78.500
Standard Error	12.278	Standard Error	89.078
Standardized Test Statistic	-1.222	Standardized Test Statistic	-5.186
Asymptotic Sig.(2-sided test)	.000	Asymptotic Sig.(2-sided test)	.000

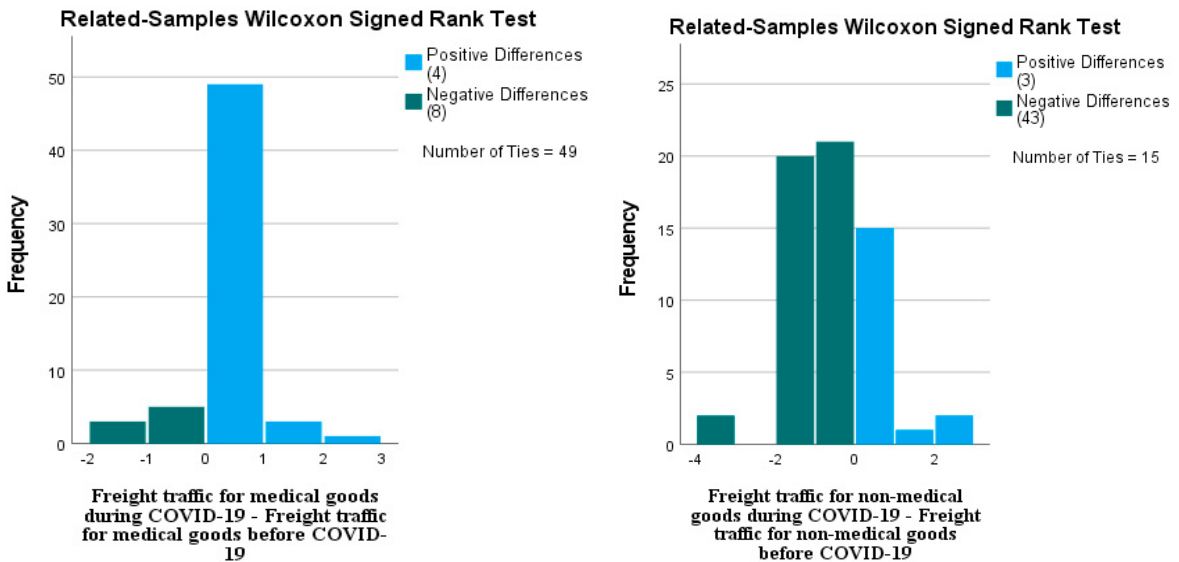


Figure 1. Freight traffic for medical and non-medical goods before and during COVID-19 (Wilcoxon Signed Rank Test)

Moreover, Friedman's two way ANOVA on the data collected also shows the similar results (figure 2). The freight traffic of medical and non-medical goods was higher before COVID-19 than during COVID-19 in Oman.

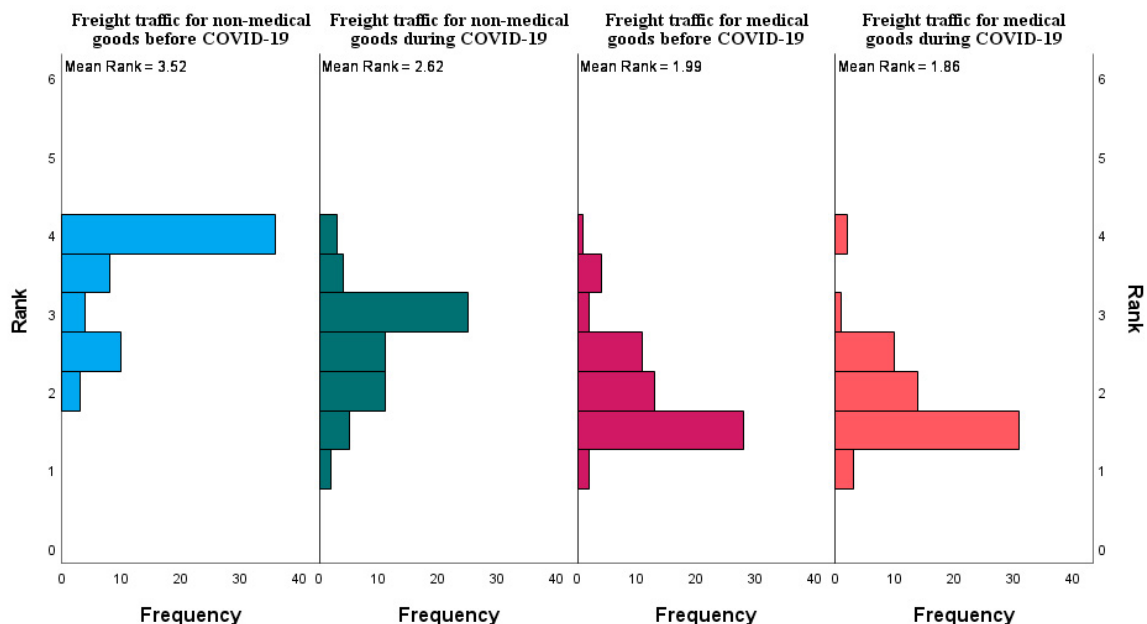


Figure 2. Freight traffic for medical and non-medical goods before and during COVID-19 (Friedman's two way ANOVA)

5. Discussion

Movement restrictions owing to reduced international transportation capacity, as well as border inspections and export restrictions, hampered product supply during the COVID-19 pandemic, since countries prioritized the demands of their own citizens over those of international consumers. In the pandemic the firms found difficulty in demand-supply mismatch, technology, and availability of sustainable supply chain [28]. The shortages were observed for a wide range of commodities required for daily care delivery, including testing supplies, dialysis materials, medications, and a wide range of other commodities for patients with and without COVID-19 [29]. It cannot be ignored that the disruption of the supply chain at one point disturbs the entire networks globally [30, 31]. Consequently, this empirical research assessed the direct and indirect effects of COVID-19 on traffic volume of medical and non-medical goods in Oman.

At first freight traffic for medical goods before COVID-19 and freight traffic for medical goods during COVID-19 was tested in order to assess the changes in the supply of goods. It was found that the median of differences between freight traffic for medical goods before COVID-19 and freight traffic for medical goods during COVID-19 is not equals to 0. This reject the null hypothesis. COVID-19 has severely disrupted the global operations, supply chain management, and its performance [32, 33]. Among the many medical products that industry experts have identified as critical in the fight against COVID-19, the USA imported US\$22 billion of these goods in 2019, before the outbreak of COVID-19. The USA continued to import a large volume of medical goods from countries like India, China, and Germany during COVID-19 and as such companies could not fulfill the demands coming from developing countries like Oman. The other reason for the lower volume of goods being the border and mobility restriction, and therefore before COVID-19 the median freight traffic was 1.99 while during COVID-19 it was 1.86, a decrease of 6.5%.

Furthermore, it was found that the median of differences between freight traffic for non-medical goods before COVID-19 and freight traffic for non-medical goods during COVID-19 is not equal to 0. This reject the null hypothesis. Before COVID-19 the median freight traffic of non-medical goods was 3.52 while during COVID-19 it was 2.62, a decrease of 25.6%. COVID-19 has had a severe impact on global shipping and operations [34]. The

shipping lines faced the challenge of the import and export operation from the Far East and EU [35]. The Sultanate of Oman, depends on the UAE, Saudi Arabia, India, and China for non-medical goods including grains, raw materials, textiles, fruits, and vegetables. The frequent COVID-19 spikes and lockdown in the mentioned countries decreased the flow of goods. In addition, due to the uncertain environment the government was less motivated to export essential items so as not to incur mismatch in the domestic demands. Although the Omani residents did not face the scarcity of essential goods and there was no panic buying, there was no surplus. Some countries found themselves under pressure. For instance, the restrictions imposed by the German government resulted in panic buying among consumers and placed extra pressure on the transport volume and freight capacity in food retail logistics [15]. Table 4 shows the summary of hypothesis testing.

Table 4. Summary of hypotheses testing

	Null Hypothesis	Test		Sig. ^{a,b}	Result
Ha₀	There is no significant difference between freight traffic of medical goods before and during COVID-19	Wilcoxon Rank Test	Signed	$p < .001$	Reject
Hb₀	There is no significant difference between freight traffic of non-medical goods before and during COVID-19	Wilcoxon Rank Test	Signed	$p < .001$	Reject
a. The significance level is .050; b. Asymptotic significance is displayed					

The hypotheses results illustrate a significant decrease in the freight traffic/shipping and transportation traffic of medical and non-medical goods in Oman during Covid-19. The delay in loading and unloading, product and raw material shortage, shortage of empty containers, and shipping congestion affected the overall goods flow and supply. In India, there was labor shortage to load and unload the goods during Covid-19 lockdown [36]. The opening and closing times of facilities had a stronger impact on supply chain disruption than the pandemic itself.

6. Conclusion

The reduced mobility due to COVID-91 resulted in economic hardships, transportations and logistics challenges to the supply of medical and non-medical goods. The shipping and transportation traffics of medical and non-medical goods in Oman, have encountered different degrees of intensity as a result of changes in the border closure and demand and supply mismatch. The study found that median freight traffic of medical goods ranks ($Mdn = 1.86$) during COVID-19 was statistically significantly lower than median freight traffic of medical goods ranks ($Mdn = 1.99$) before COVID-19, $Z = 24.0$, $p < .001$, thus rejecting the null hypothesis. The Standard Error and Standardized Test Statistics are 12.278 and -1.222 respectively. The Wilcoxon test indicated that median freight traffic of non-medical goods ranks, ($Mdn = 2.62$) during COVID-19 was statistically significantly lower than median freight traffic of non-medical goods ranks ($Mdn = 3.52$) before COVID-19, $Z = 78.50$, $p < .001$, thus rejecting the null hypothesis. The Standard Error and Standardized Test Statistics are 89.078 and -5.186 respectively. There is a need to design and incorporate systemic and strategic plans into the medical and non-medical supply chains. Additionally, measures such as product capacity building in the home country and distributed productions (different sites and locations) are required. Furthermore, public-private partnership is needed. The adoption of lean production and Just in Time supply chains would be useful in uncertainties, reducing the unnecessary inventories, and thus lowering the overall costs.

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