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COVID-19, Supply Chain, and Profitability: A Survey Based on an Emerging Economy

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ABSTRACT

COVID-19 has stunned the whole economy and has been unveiled as a colossal threat to global supply chain management. This paper has tried to assess the implications of COVID-19 on different areas of the supply chain and the profitability of different industries in Bangladesh. The study is based on a questionnaire survey of three major industries of Bangladesh: textile, pharmaceuticals, and banking sectors conducted from December 2021 to February 2022. Descriptive statistics and t-tests for mean differences were used to analyze the data and they are displayed across tables and graphs. It is found that supply chain aspects like raw material, labor, manufacturing facility, import/export, product/service, revenue, and profit are significantly impinged by the pandemic. Furthermore, the supply chain of the manufacturing sector is more affected than that of the service sector, and statistically, significant differences are evidenced between manufacturing industries. The findings and recommendations of this study will have policy implications for regulators, companies, suppliers, investors, and customers. This is a pioneer study to investigate the implications of the pandemic on the supply chain fields.

Keywords: *Bangladesh, COVID-19, Profitability, Supply chain, Survey.*

1. INTRODUCTION

On December 31, 2019, COVID-19 was first reported in Wuhan, China, and quickly spread to all other parts of the world (WHO, 2020). After that, most of the countries-imposed lockdowns that impacted technology adaptation (Mandel and Veetil, 2020), teaching, financial market, and tourism (Shenoy *et al.*, 2020), production, employment, and livelihood (Hidayat, Farooq, and Alim, 2020). Major macroeconomic variables such as unemployment rate, interest rate, debt crisis, consumer spending, etc. are greatly shocked by the pandemic (Blanchard *et al.*, 2020; Buheji *et al.*, 2020). Consumers have limited their buying activity from non-essential items to daily necessities, thereby reducing consumer spending (Coibion *et al.*, 2020); Goolsbee and Syverson, 2020). Regarding the debt crisis, Arellano *et al.* (2020) have found that although lockdown policies are effective for the sound health system, their economic cost is so high.

Nevertheless, there are some positive aspects of COVID-19 as well. Paital *et al.* (2020) have found that carbon pollution has decreased during the lockdown period and Shehzad *et al.*, (2020) have found that nitrogen dioxide has decreased significantly because of the lockdown in India and neighboring countries. As a result, air pollution is minimized and the quality of air has improved (Saadat *et al.*, 2020).

In Bangladesh, the first case was detected on 08 March 2020 and the first lockdown was effective from March 26 to 30 May 2020 (WHO Bangladesh, 2020). So, the impact of the pandemic started in Bangladesh in the second quarter of 2020. All educational institutions were closed; public transportation, production, and services were halted for a long period. Many employees were fired from different organizations. All these incidents indicate a significant impact of the Corona Virus pandemic on the economy. As a result, the supply chain and profitability in different sectors of every economy are affected greatly.

Due to the pandemic, corporations have suffered a lot since their supply and value chain are disrupted significantly. Besides the pandemic, the supply chain is also affected by environmental factors in the past. In 2011, the tsunami in Japan forced many companies (like Sony, Nissan, Toyota, etc.) to stop their operations. The war between US and China in 2019 made many Chinese companies bound to transfer their operations to Asian countries (Kajitani, Chang, and Tatano, 2013). The United Kingdom has realized the lowest sales (97% fall) of cars in April 2020 over the last 55 years (Campbell, 2020). The impact of these catastrophes needs to be assessed to formulate strategies to cope with the future.

This study is an initiative to assess the implications of COVID-19 in different areas of the supply chain management (SCM) and industries of Bangladesh. Although many studies have been conducted to assess the impact of the pandemic on the supply chain, most of them are based on forecasting and estimation. Moreover, no paper so far quantified the effect on different areas of the supply chain. This study will try to fill up this gap and add value to the existing literature.

2. LITERATURE REVIEW

The COVID-19 Pandemic has created a significant economic downturn all over the world. Almost every sector of the economy is affected by the wave of the pandemic. In line with that supply chain and profitability of every sector are impacted by the lockdown from the pandemic (Linton and Vakil, 2020). Even e-retailer giant 'Amazon' is bound to take precautionary safeguards to lessen the risk of inventory stockout. Prior experiences make them learn that a single supplier is not sufficient to make a sure uninterrupted supply of inventories (Haque and Islam, 2018). Moreover, relaxed regulation on the global supply chain allows the manager to procure raw materials and other parts from different parts of the world (Haren and Simchi-Levi, 2020). Global competition pressurizes managers to control costs to achieve competitive advantage and they are applying different strategies such as lean production, contract-based production (Cozzolino *et al.,* 2012), outsourcing and offshoring, etc. (Hernandez and Haddud, 2018). These strategies are ineffective when an unexpected pandemic disrupts the normal supply chain (Yang *et al.,* 2018). Due to the unavailability of stocks, manufacturers become bound to cut down production or suspend production for the short time at least (Stauffer *et al.,* 2018). At the initial stage of the pandemic, manufacturers tried alternative means of collecting logistics from the local or international market, but the lockdown from the government has made all the alternatives ineffective. Therefore, there is a need to reassess the strategies to have a smooth supply chain.

Significant literature is available regarding the assessment of supply chain risks and safeguards to mitigate the risks (Anparasan and Lejeune, 2017; Maghsoudi *et al.,* 2018). Supply chain risks are classified into two types: operational risks and disruption risks (Tomlin, 2006; Tang, 2006; Craighead *et al.,* 2007; Sawik, 2011; Govindan *et al.,* 2017, Fahimnia *et al.,* 2018; Ivanov, 2018b; Choi *et al.,* 2019). Where operational risks relate to normal disturbances in the operations such as machine breakdown, lead time and fluctuations in demand, etc., the disruption risks are concerned with non-routine, highly impactful events (Ivanov *et al.,* 2017; Hosseini *et al.,* 2019; Kinra *et al.,* 2019). Disruption risks may arise due to natural catastrophes and man-made upheavals such as in 2011, the tsunami in Japan and its colossal impact on the global supply chain; in 2016, the BASF factory explosion in Germany and the global shortage of raw materials (Ivanov *et al.,* 2019b). These types of disruption risks have immediate significant impacts on all the activities of the supply chain model resulting in delays in customer delivery, customer dissatisfaction, and poor performance of the company (Ivanov *et al.,* 2014; Garvey *et al.,* 2015; Dolgui *et al.,* 2018; Pavlov *et al.,* 2019b; Dolgui *et al.,* 2020).

COVID-19 is a unique type of disruption risk that has a ripple effect with a high level of uncertainty, and it is difficult to predict its impact (Ivanov, 2020). He has predicted the impact of the COVID-19 outbreak on the global supply chain based on simulation techniques. He also used sensitivity analysis of different scenarios to illustrate the model's behavior. The key observation of the study is the differences in the period of happening COVID-19 for which the impact on supply chain performance varies. According to Guan *et al.,* (2020), loss in the supply chain due to COVID-19 depends on the number of countries under lockdown and the duration of the lockdown. They used a global trade modeling framework for analyzing the effect on the global supply chain. Another simulation-based study was done by Singh *et al.,* (2020) on the food supply chain. They have found difficulty in matching supply and demand and emphasized on resilient supply chain during COVID-19. Sharma *et al.,* (2020) have found that except for profitability, firms are having difficulties in the sustainable supply chain due to supply-demand mismatch, technology issues, etc. They have used Twitter data from NASDAQ 100 firms.

COVID-19 has impacted profitability (Karim and Shetu, 2023), liquidity, and financial health as well (Karim, *et al.,* 2021). A large volume of literature has underlined the potential implications of COVID-19 for banks and stock markets based in developed countries (World Economic Forum 2020; Stiller and Zink 2020; Cecchetti and Schoenholtz, 2020; Strietzel *et al.,* 2020) and developing economies (Karim and Saba, 2021). Due to the sudden lockdown from the pandemic, production is stopped, demand for daily necessities has shrunk, and public transportation and movement are restricted locally and internationally (Barua, 2020a, b). The COVID-19 pandemic has created a complex consequence that is a great threat to the stability of the banking system (Aldasoro *et al.,* 2020). Barua and Barua (2020) has noted that COVID-19 has worsened the Non-Performing Loan (NPL) situations in developing economy. They have estimated that the firm value, capital, and profitability of the banks will fall, and larger banks will be highly impacted by the pandemic.

Due to the macroeconomic shocks of the pandemic, borrowers (both company and individual) will face severe challenges to repay the loan; thereby increasing the loan default risk (Vidovic and Tamminaina, 2020). Borrowers relying on international trade and small businesses will be highly affected in this case (Dua *et al.,* 2020). Moreover, in the case of a secured loan, the value of the collateral may decline, resulting in higher default and credit risks (Baret *et al.,* 2020). Additionally, depositors may withdraw money from their bank account to support livelihood and health expenditures (Baret *et al.,* 2020). Due to the COVID situation, opportunities to earn will be very limited, which might make the depositor bound to spend from savings. As a result, banks will face a liquidity crisis and the lending capability of the banks will be lower (Cheney *et al.,* 2020).

Due to the economic downturn locally and globally, the demand for loans and advances will slump, as the investment opportunity will be lower; as a result, financing for short- and long-term investment projects will decline (Ryan *et al.,* 2020). The intensity of the problem will rise when the lending capacity of the banks will be limited due to the liquidity crisis (Cheney *et al.,* 2020). Furthermore, interest and non-interest income sources are more likely to drop due to concentrated international trade and business, foreign exchange, etc. Interest incomes can fall further if banks reduce the interest rate, waive fees, increase limits on a credit cards, and so on, to retain clients in this pandemic (Ryan *et al.,* 2020; Yousufani *et al.,* 2020).

The existing literature on the implications of COVID-19 is based on projection and estimation and there is a gap in the empirical data-based study. This study will try to fill up this gap based on the empirical data from a structured questionnaire survey on three different industries of

Bangladesh: bank, textile, and pharmaceuticals.

3. RESEARCH QUESTION AND OBJECTIVE

The objective of the paper is to assess the impact of COVID-19 on varied aspects of the supply chain, and the profitability of the listed companies in Bangladesh. Additionally, the study will make a comparison of the implications of the pandemic in different industries such as service and manufacturing. So, the two research questions are summarized below:

RQ1: *What are the implications of COVID-19 in different areas of the supply chain?*
RQ2: *Is the service sector more affected than the manufacturing sector by the pandemic?*
RQ3: *Is there any variation of implications of COVID-19 among the industries?*

The study will be based on empirical data. The study will have significant policy implications. The supply chain is a key success factor for every company. The key areas affected by the crisis must be focused on by the organizations and appropriate strategies should be formulated based on that (Richey, 2009). The study will help in that process. Moreover, the Government and regulatory bodies can take necessary actions based on the findings. Almost every company's profitability is affected by COVID-19 and there have been several changes in the reporting responsibilities of the companies. The study will focus on that as well.

4. THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

4.1 Theoretical Framework

Most of the studies in SCM concentrate on crisis and its implications on the supply chain (Richey, 2009). A crisis is a catastrophe that can happen due to internal or external factors (Akkermans and van Wassenhove, 2018). COVID-19 as an external factor has severely impinged the supply chain functioning (Khojasteh, 2018). As a unique crisis, COVID-19 can be better explained from the perspective of supply chain disaster and crisis pyramid (DCP) and resilience theories perspective (Raassens, Haans, and Mullick, 2022). The reasons are threefold. Firstly, the DCP is the first theory to relate to crisis supply chain management (Richey, 2009). Secondly, the DCP and resilience theories are widely used in the supply chain research arena. Last but not the least, the majority of COVID-19-related research has used DCP and resilience theories in supply chain crises (Raassens, Haans, and Mullick, 2022). Figure 1 shows the Disaster and crisis pyramid.

The DCP framework consists of 3 Cs – collaboration, communication, and consistency. The first one correlates to relationship management theory, the second one is related to communication theory and the last one is associated with competing values theory (Richey, 2009). Furthermore, the pinnacle of the pyramid demonstrates the resource-based view (RBV) of the organization. According to RBV, resources are the key to handling crises in the supply chain (Kumar *et al.*, 2021). Companies that lack resources are lagging in dealing with a crisis like COVID-19 (Raassens, Haans, and Mullick, 2022).

As the supply chain is encroached by several ways, multiple vertices are incorporated in the DCP. The first one is collaboration and relationship building (Richey, 2009). During the crisis, collaboration is like a glue that works for the reciprocal interests of the supply chain stakeholders (Jap, 2001). According to Richey (2009), Faith, loyalty, responsibility, mutual respect and long-term focus are the key drivers of relationship management during the pandemic. Estrada-Guillén *et al.*, (2020), have emphasized on emotional intelligence (EI) to be used in considering others' emotions in making decisions during crisis.

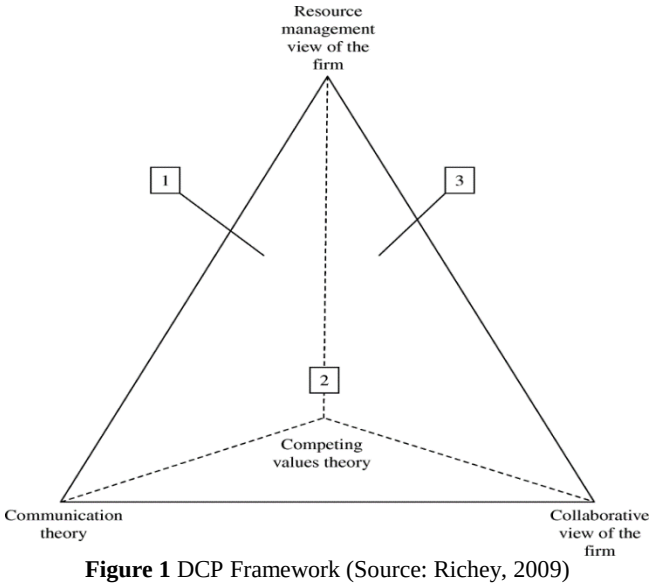

Figure 1 DCP Framework (Source: Richey, 2009)

The second component of the DCP vertices is the communication that is highly required during the supply chain crisis (Richey, 2009). Effective communication among supply chain stakeholders is the building block for maintaining collaboration and value-adding relationship to manage the crisis (Trada and Goyal, 2020). The last point in the DCP is the planning for contingent situation supported by competing value theory (CVT). According to CVT, stakeholders in supply chain should develop a strategic planning, decide appropriate leadership strategy, and adopt change management to deal with the contingencies (Richey, 2009).

Additionally, the supply chain resilience theory focuses on holistic and proactive actions to deal with the disasters like the COVID-19 pandemic (Chowdhury and Quaddus, 2016; Senbeto and Hon, 2020). Resilience helps to mitigate the implications of uncertainty (Datta, 2017). Adaptability with the pandemic is the key to get prepared for managing the supply chain. Overall, resource management efficiency, diversification, long-term focus and collaboration are the key to managing the COVID-related supply chain crisis (Raassens, Haans, and Mullick, 2022).

4.2 Hypothesis Development

COVID-19 has emerged as a unique crisis with high impacts and uncertainty and it has affected the supply chain abruptly in different industries (Raassens, Haans, and

Mullick, 2022). The supply chain of hospitality sector is significantly affected by the pandemic and the impacts exceeds the 2008-2009 financial crisis (Aigbedo, 2021). Belhadia *et al.,* (2020) have studied the implications in service and manufacturing sectors and highlighted technological factors to ensure resilience. Lioutas, and Charatsari, (2020) have studied the agricultural sectors and they emphsised on increasing the ability of agriculture to combat externalities. Raassens, Haans, and Mullick, (2022) showed the effects of COVID-19 on food firms and suggested strategies to ensure continuity. Overall, supply chain of all the industries are affected by the pandemic. So, we can propose that different areas of supply chain like raw materials, production or service, distribution, sales, and profit are affected by it. The following hypothesis is developed from this background.

H1: *COVID-19 has significantly affected different areas of supply chain.*

Literature show that the impact of COVID-19 in different industries are not equal. Unemployment in hospitality sectors increased more than manufacturing sectors due to the pandemic (Aigbedo, 2021). The manufacturing and service sectors are studied by Belhadia *et al.,* (2020) from resilience perspective and found differences in risk factors between the industries. Therefore, they have suggested different strategies for different industries. From the previous findings, we can develop the following two hypotheses:

H2: *The service sector is severely affected by the pandemic than the manufacturing sector.*
H3: *There exist significant variation of implications of COVID-19 among the industries.*

5. CONCLUSIONS AND FUTURE WORK

5.1 Hypothesis Development

The study is based on a structured questionnaire survey and adopted mixed method for discovering the research questions. This study has tried to assess the impact of COVID-19 on different areas of the supply chain like raw materials, labor, manufacturing, distribution, customers, products, and profitability. Additionally, the paper has extended the study to compare the implications in different sectors of Bangladesh's economy. Different descriptive statistics are used to achieve the first research objectives. Additionally, t-test for mean differences among the industries are calculated to test the hypotheses.

5.2 Data Collection Techniques

The data is collected from both primary and secondary sources. The primary data is collected from a questionnaire survey (Appendix 1) on the employees of different organizations under three industries (pharmaceuticals, bank, and textile) to assess the impact of the pandemic on different areas of supply chain and profitability. The list of sample companies is demonstrated in Appendix 2. The three industries are selected because they are the dominating sectors among all, represent most of the market capitalization, and have a significant contribution to the GDP. Additionally, the sectors include both the service and manufacturing companies; thereby the second objective of the paper is accomplished. As the service sector, the banking industry is selected for several reasons. First, the banking sector of Bangladesh is the most dominating industry of the economy; so, the result of this sector will reflect the picture of the whole economy. Secondly, it is predicted that fraudulent financial reporting might be practiced in the banking sector of Bangladesh evidenced by the financial scam, heists, and bribery in the industry (Karim and Hossain, 2021) and independence of independent directors (Karim and Mitra, 2019) and board (Karim, Mitra, and Khan, 2020) are highly impaired in this sector. Additionally, compliance in disclosure in financial reporting is also low in this country (Karim and Riya, 2022). Even in Islamic banks, shariah compliance is very weak (Karim and Shetu, 2020) and shariah audit faces lots of challenges in this emerging economy (Karim and Shetu, 2020). Therefore, more research should be focused on this economy.

5.3 Detailed Sampling

From the three industries, data are collected based on a structured questionnaire. **Table 1** summarizes the details of the sampling used in this paper.

Table 1 Population, Sample, and Questionnaire Distribution

Industry	Population size	Sample size	Questionnaire distributed	Questionnaire received
Textile	58	34	150	114
Pharmaceuticals	32	30	150	127
Bank	33	33	150	136
Total	123	97	450	377

From the textile, pharmaceutical, and banking sectors, 97 companies are selected as samples based on the convenience sampling method. From the baking sector, 100% of the population is selected as a sample; where from the textile and pharmaceuticals sectors, samples represent 59% and 94% respectively. On average, the sample represents 79% of the total population. For each industry, a uniform 150 questionnaire (total 450) was distributed, and 377 questionnaires are found usable representing 84% of questionnaires distributed.

5.4 Machine, Materials, and Technologies Used

To collect data through a survey, a structured questionnaire (Appendix 1) is designed based on the value chain model of Porter (1985). From the model, different areas of the supply chain are identified, and a questionnaire is developed for each to assess the impact of the pandemic on that area. The data is analyzed based on descriptive statistics. Statistical software Smart PLS 4.0 is used in this regard.

5.5 Machine, Materials, and Technologies Used

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6. DETAILED DATA ANALYSIS

This section has made a detailed analysis of the data collected through the questionnaire. The analysis is made by calculating the mean, median, mode, standard deviation, minimum, and maximum values for each of the questions used in the survey. Additionally, the mean score is compared among the three sample industries. **Table 2** summarizes the demographic factors of survey respondents.

Table 2 Demographic Profile of the Respondents

Demographic profile	Total		Textile		Pharma		Bank	
	Number	%	Number	%	Number	%	Number	%
Gender:								
Male	258	68%	68	60%	94	74%	96	71%
Female	119	32%	46	40%	33	26%	40	29%
Total	377	100%	114	100%	127	100 %	136	100 %
Age:								
25 – 30 years	60	16%	28	25%	13	10%	19	14%
31 – 35 years	66	18%	36	32%	16	13%	14	10%
36 – 40 years	107	28%	34	30%	46	36%	27	20%
41 – 45 years	101	27%	12	11%	37	29%	52	38%
Above 45 years	43	11%	4	4%	15	12%	24	18%
Total	377	100%	114	100%	127	100 %	136	100 %
Organizational Position:								
CEO/MD/DMD	22	5.84%	9	7.89%	5	4%	8	6%
Head of Supply Chain/ Procurement	42	11.14%	10	8.77%	18	14%	14	10%
Executive, Supply chain/ Procurement	203	53.85%	54	47.37%	74	58%	75	55%
Executive, Accounts, and Finance	110	29.18%	41	35.96%	30	24%	39	29%
Total	377	100.00 %	114	100.00 %	127	100 %	136	100 %

From the table, it is found that 68% of respondents are male, and in the textile, pharmaceuticals, and banking sectors they represent 60%, 74%, and 71% respectively. Most of the respondents (55%) fall in the age range of 36 to 45 while the 34% are aged between 25 and 35. Furthermost of the participants (65%) work in the supply chain department and the percentage is 72% in pharmaceutical industry. A significant percentage (around 30%) of accounts and finance executives are included in the interview to assess the pictures on profitability and supply chain related costs.

6.1 Impact on Different Areas of the Supply Chain

6.1.1 Raw Materials

Table 3 summarizes the key descriptive statistics related to raw materials aspects impacted by the pandemic. 77% respondents reported that due to the pandemic, firms are holding more raw material inventories, as the transportation was difficult during pandemic and the price of the raw materials have significantly increased due to the pandemic. On average, the price is hiked by 15% ranging from 5 to 30 percent. The lead time to make delivery of inventories has also been doubled agreed upon by most of the respondents. Due to the pandemic, average lead time is increased by 2 days with the range from 1 to 3 days. Overall, it indicates that all aspects of raw materials are negatively affected by the pandemic.

Table 3 Impact of COVID-19 on Raw Materials

Raw Material issues n=377	Mean	Median	Mode	SD	Min	Max
Are you holding more inventories due to COVID-19? (Y/N)	0.77	1.00	1.00	0.42	0.00	1.00
The price of the inputs (RM) has increased significantly. (5 points)	3.89	4.00	4.00	0.73	1.00	5.00
To what extent, the price of raw materials has increased? (%)	15%	10%	10%	8%	5%	30%
The lead time has increased significantly. (5 Points)	3.94	4.00	4.00	0.74	3.00	5.00
The impact of COVID-19 on average lead time is: (times)	1.72	2.00	2.00	0.57	1.00	3.00

6.1.2 Labor

Table 4 deciphers the implications of the pandemic on different areas of labor. About 60% of the respondents reported that COVID-19 has forced companies to retrench employees to cut costs. The median and mode for the question on retrenchment is 1.00 which also proves the layoff. According to the interviewees, production capacity was under-utilized during the pandemic requiring lay-off the employees to adjust cost with the profit. Roughly, 5% of the employees were fired with the rate of retrenchment as low as 0% and as high as 20%. Although the standard deviation (SD) is 5% which suggests that there was some variations in the rate of retrenchment, firm having layoff mostly have the rate of retrenchment around 5%. No surveyed individual reported that there was new recruitment during the pandemic. The mean, median and mode for this question is all 0.00 which implies that there was no new appointment. On the other hand, 100% of surveyed individuals testified that there was a cutdown of salary during the COVID period. Around 10% of salaries are shrunk by employers with minimum rate of 5% and maximum rate of 20%. However, there was variations (SD 4%) in the reported rate of salary cut down. But the firms who have cut down the salary have reduced the wages by approximately 10% to combat the pandemic while putting the employee's life in an unexpected situation.

Table 4 Impact of COVID-19 on Labor Related Issues

Labor issues n=377	Mean	Median	Mode	SD	Min	Max
Is there any retrenchment during COVID-19? (Y/N)	0.59	1.00	1.00	0.49	0.00	1.00
If Yes, what is the rate of retrenchment? (%)	5%	5%	0%	5%	0%	20%
Is there any new recruitment during COVID-19? (Y/N)	0.00	0.00	0.00	0.00	0.00	0.00
Is there any cut down of salary of the employees? (Y/N)	1.00	1.00	1.00	0.00	1.00	1.00

Labor issues n=377	Mean	Median	Mode	SD	Min	Max
If Yes, what is the rate of cut down of salary? (%)	8%	10%	5%	4%	5%	20%

6.1.3 Export/Import

The export and import of different industries are also impacted by the pandemic as demonstrated in **Table 5**. 64% respondents have stated that import is negatively affected with mode and median value of 1.00. On an average, import is impacted by the pandemic by 22% though, there was a deviation in the rate of implications. On the other hand, 34% surveyed people have mentioned that export is impacted adversely and the rate by which the export is affected is only 13% with standard deviation of 20% indicating variations in the rate. Overall, import is hampered by twice as export evidenced by the other statistics as well. So, the pandemic has more negative implications on import compared to export.

Table 5 Impact of COVID-19 on Import and Export

Import and Export areas n=377	Mean	Median	Mode	SD	Min	Max
Is there any negative impact on imports? (Y/N)	0.64	1.00	1.00	0.48	0.00	1.00
To what percent, import is affected? (%)	22%	25%	0%	20%	0%	80%
Is there any negative impact on export? (Y/N)	0.34	0.00	0.00	0.47	0.00	1.00
To what percent, export is affected? (%)	13%	0%	0%	20%	0%	80%

6.1.4 Manufacturing/Service Facility

Table 6 shows the implications of the pandemic on service or manufacturing facilities. Most of the respondents (81%) believe that COVID-19 has hampered the production facilities. The median and mode value of 1.00 also prove it where the deviation is only 39%. The capacity of the plant or facility is utilized at 76% on average indicating an idle capacity of 24% due to the pandemic. For majority of the firms, the idle capacity is 40% or more as the mode value is 60%. The standard deviation is only 18% which means the utilization rate is relatively consistent across the samples. Due to the pandemic, there was less demand for products and several lockdowns are imposed by the Government. As a result, production or service facilities were not utilized at all from several weeks to months.

Table 6 Impact of COVID-19 on Manufacturing/Service Facility

Manufacturing/service facility n=377	Mean	Median	Mode	SD	Min	Max
Is there any negative impact on manufacturing/service? (Y/N)	0.81	1.00	1.00	0.39	0.00	1.00
To what extent, manufacturing/service capacity is utilized? (%)	76%	80%	60%	18%	30%	100%

6.1.5 Distribution

The pandemic has severely impacted the distribution channels of the listed companies illustrated in **Table 7**. According to 93% of the respondents, distribution is hampered due to the COVID-19. The median and mode for this question is also 1.00 indicating the similar results where the standard deviation is only 25%. However, only a few firms have changed the distribution model evidenced from 31% of the respondents with high deviation rate of 46% indicating variations in the results. Furthermore, the distribution cost has increased by approximately 10% agreed by the majority (more than 50%) of the survey participants although the deviation is high in this case as well. Additionally, the increase in distribution cost ranges from 0% to 25% with SD of 9%. It signifies that the distribution cost is not increased for all firms and there exists variations in the rate of increase of distribution cost among the companies.

Table 7 Impact of COVID-19 on Distribution

Distribution areas n=377	Mean	Median	Mode	SD	Min	Max
Is there any negative impact on distribution? (Y/N)	0.93	1.00	1.00	0.25	0.00	1.00
Have you changed the distribution model? (Y/N)	0.31	0.00	0.00	0.46	0.00	1.00
Is there any increase in distribution cost? (Y/N)	0.53	1.00	1.00	0.50	0.00	1.00
If yes, what is the estimated increase rate? (%)	9%	5%	0%	9%	0%	25%

6.1.6 Product/Service

Table 8 illustrates product or service-related issues affected by the pandemic. The price of the products has increased significantly evidenced from the 71% of the respondents. The mode and median results also dictates the similar findings with 46% deviation which is high. Moreover, most companies have launched new products according to 56% of respondents although there exists differences in opinion among the respondents in this regard. COVID-19 has opened the doors for new product lancing like online banking, new vaccines and Personal protective equipment, and work from home (WFH) reporting among others (Karim and Shetu, 2023). Nevertheless, no firm has divested or dropped any product or service due to the pandemic as per the opinion of the 100% of the respondents.

Table 8 Impact of COVID-19 on Product/Service Areas

Product/Service (n=377)	Mean	Median	Mode	SD	Min	Max
The price of the product/service has increased. (Y/N)	0.71	1.00	1.00	0.46	0.00	1.00
Have you launched a new product/ service in the market during COVID-19?	0.56	1.00	1.00	0.50	0.00	1.00
Have you divested/dropped any product/service during COVID-19?	0.00	0.00	0.00	0.00	0.00	0.00

6.1.7 Revenue/Profit

The revenue and profit of the companies deteriorated during the pandemic a lot. From **Table 9**, it is observed from the 90% of survey population that COVID-19 has negatively impacted the revenue and therefore, the profit of the companies. The standard deviation is only 20% in this regard for both cases. The revenue and profit are lost by the pandemic roughly by around 30% and 10% respectively. The revenue loss ranges from 0% up to 75% and the profit loss ranges from 0%-25% with standard deviation of 14% and 4% respectively. It indicates variations among the firms in respect of revenue and profit reduction.

As COVID-19 has implications in the whole supply chain, the bottom-line figure is supposed to be impacted by the pandemic as well. Due to several lockdowns and pressures from the society, business activities were hampered severely (Linton and Vakil, 2020). The price of raw materials, supplies and other parts increased significantly. Additionally, production facilities remained idle for several weeks and months, and the distribution was so risky in that though time. Furthermore, export and import were also impacted negatively by the syndemic. As a result, revenue, and profit declines.

Table 9 Impact of COVID-19 on Revenue/Profit

Revenue/Profit (n=377)	Mean	Median	Mode	SD	Min	Max
Revenue has decreased during COVID-19. (Y/N)	0.90	1.0	1.0	0.2	0.0	1.0
If yes, what is the estimated decreased revenue? (%)	30%	30%	30%	14%	0%	75%
Profit has decreased during COVID-19. (Y/N)	0.90	1.0	1.0	0.2	0.0	1.0
If yes, what is the estimated decreased profit? (%)	9%	10%	10%	4%	0%	25%

The socio-economic condition of every country is also affected largely by the pandemic. The index in the stock market fall significantly (Karim and Saba, 2020). The global financial system was stacked by the pandemic as well (World Economic Forum, 2020). Additionally, COVID-19 has impacted the government significantly. To mitigate the impact of the pandemic, Government incurred huge expenditure on vaccines, supporting individual and business by borrowing resulting in increasing in government debt (IMF, 2020). Business firms were not escaped from the wave of the pandemic. These implications are reflected in the revenue and profit figures of companies.

6.2 Industry Comparison

6.2.1 Mean Difference

This section has analyzed the survey data based on a specific industry. It has summarized the mean score for each of the questions mentioned in the questionnaire. **Table 10** summarizes the result.

Among the three industries, the textile and pharmaceutical sectors are more affected by the pandemic than the banking sector. The manufacturing sectors hold more inventories than the service sector and the price of the raw materials in textile and pharmaceutical companies is twice or more than in the banking sector. Additionally, the lead time in the manufacturing sector is double of the banking sector. In the case of labor, retrenchment is significantly higher in the pharmaceutical and textile sector (8% and 6% respectively) than in the banking sector (1%). However, the salary cutdown is lower in the textile sector (5%) than banking and pharmaceutical sectors (11% and 9% respectively).

Table 10 COVID-19 Implications on the Supply Chain in Different Sectors

Supply Chain areas	Mean (n=377)		
Raw Materials	Textile	Pharma	Bank
Are you holding more inventories due to COVID-19? (Y/N)	0.95	0.94	0.48
The price of the inputs (RM) has increased significantly. (5 points)	3.98	3.99	3.67
To what extent, the price of the raw materials has increased? (%)	16%	22%	9%
The lead time/delivery time has increased significantly. (5 Points)	4.19	4.33	3.35
The impact of COVID-19 on average lead time is: (times)	1.98	2.18	1.05
Labor			
Is there any retrenchment during COVID-19? (Y/N)	0.71	0.85	0.25
If Yes, what is the rate of retrenchment? (%)	6%	8%	1%
Is there any new recruitment during COVID-19? (Y/N)	0.00	0.00	0.00
Is there any cut down of salary of the employees? (Y/N)	1.00	1.00	1.00
If Yes, what is the rate of cut down of salary? (%)	5%	9%	11%
Export/Import			
Is there any negative impact on imports? (Y/N)	1.00	1.00	0.00
To what percent, import is affected? (%)	25%	45%	0%
Is there any negative impact on export? (Y/N)	0.00	1.00	0.00
To what percent, export is affected? (%)	0%	39%	0%
Manufacturing/service facility			
Is there any negative impact on manufacturing/service? (Y/N)	0.93	0.91	0.62
To what extent, manufacturing/service capacity is utilized? (%)	60%	71%	96%
Distribution			
Is there any negative impact on distribution? (Y/N)	0.98	0.94	0.87
Have you changed the distribution model? (Y/N)	0.51	0.44	0.00
Is there any increase in distribution cost? (Y/N)	1.00	0.61	0.08
If yes, what is the estimated increase rate? (%)	20%	9%	1%
Product/Service			
The price of the product/service has increased. (Y/N)	0.95	0.89	0.33
Have you launched a new product/ service in the market during COVID-19?	0.00	1.00	0.61
Have you divested/dropped any product/service during COVID-19?	0.00	0.00	0.00
Revenue/Profit			
Revenue has decreased during COVID-19. (Y/N)	1.00	1.00	0.88
If yes, what is the estimated decreased revenue? (%)	35%	29%	28%
Profit has decreased during COVID-19. (Y/N)	1.00	1.00	0.85
If yes, what is the estimated decreased profit? (%)	10%	9%	7%

The import of textile and pharmaceutical sectors and only the export of pharmaceutical companies are affected by the pandemic, while the export and import of the banking sector have remained unaffected. Additionally, the idle

capacity for textile and pharma companies is around 40% and 30% respectively whereas in the service sector the idle capacity is negligible. Furthermore, the distribution channel, model, and cost of manufacturing companies are more severely affected by the pandemic than that of the service sector. The price of the manufacturing items has increased more than that of service and many new pharmaceuticals products are offered because of the pandemic. Finally, the Revenue lost by the textile sector is higher than the pharmaceutical and banking sector and most of the participants have mentioned that. Overall, manufacturing more specifically, the textile sector is more highly affected by the pandemic than the service or banking sector.

6.2.2 t-test for Mean Differences

Table 11 demonstrates the t-test (one tailed) result summarizing the mean differences between the banking and textile industry and the pharmaceuticals and textile industry. The null hypothesis of t-test for mean differences is that the difference between the group is zero and the alternative hypothesis is the difference is non-zero. Between the manufacturing and the service industry, it is noticed that the supply chain areas of manufacturing industry are more affected by the pandemic compared to service (bank) sector and the results are statistically significant. Textile companies are holding more inventories and the price and lead time for inventory have increased significantly. Though the retrenchment in textile industry is high during the pandemic, the salary cut down in banking sector is high. The import and manufacturing facility are also heavily affected by the pandemic. The distribution cost and the distribution model are interrupted seriously. Overall, the price and revenue are impacted because of the implications of all these factors.

Between two manufacturing companies, statistically significant mean differences are also noticed among the supply chain areas due to the pandemic. In terms of raw materials, labor and import-export, the pharmaceutical companies are more affected than the textile companies. On the contrary, distribution cost, price of the products, revenue and profit are more affected in textile sector compared to pharmaceutical sector and the results are significant. So, we must accept the alternative hypothesis that mean difference is non-zero. Overall, from the analysis, we can conclude that the supply chain process of companies are significantly affected by the pandemic, manufacturing sector is more affected than service sector and significant difference are evidenced among the manufacturing industries.

Table 11 Comparison of Textile, Pharmaceuticals, and Banking Industries (t-test One Tailed)

Raw Materials	Textile vs banks		Textile vs Pharma	
	t stat	Prob.	t stat	Prob.
Are you holding more inventories due to COVID-19? (Y/N)	9.40	0.00	0.34	0.37
The price of the inputs (RM) has increased significantly. (5 points)	2.83	0.00	-0.29	0.38
To what extent, the price of the raw materials has increased? (%)	13.49	0.00	-7.86	0.00
The lead time/delivery time has increased significantly. (5 Points)	13.15	0.00	-1.73	0.04
The impact of COVID-19 on average lead time is: (times)	35.29	0.00	-5.35	0.00
Labor				
Is there any retrenchment during COVID-19? (Y/N)	7.83	0.00	-2.16	0.02
If Yes, what is the rate of retrenchment? (%)	9.89	0.00	-1.85	0.03
Is there any new recruitment during COVID-19? (Y/N)	-	-	-	-
Is there any cut down of salary of the employees? (Y/N)	-	-	-	-
If Yes, what is the rate of cut down of salary? (%)	-21.10	0.00	-8.26	0.00
Export/Import				
Is there any negative impact on imports? (Y/N)	-	-	-	-
To what percent, import is affected? (%)	91.43	0.00	-13.51	0.00
Is there any negative impact on export? (Y/N)	-	-	-	-
To what percent, export is affected? (%)	-	-	-28.66	0.00
Manufacturing/service facility				
Is there any negative impact on manufacturing/service? (Y/N)	5.90	0.00	0.68	0.25
To what extent, manufacturing/service capacity is utilized? (%)	-33.82	0.00	-7.37	0.00
Distribution				
Is there any negative impact on distribution? (Y/N)	2.94	0.00	1.77	0.04
Have you changed the distribution model? (Y/N)	11.82	0.00	0.93	0.18
Is there any increase in distribution cost? (Y/N)	39.95	0.00	8.43	0.00
If yes, what is the estimated increase rate? (%)	37.10	0.00	12.15	0.00
Product/Service				
The price of the product/service has increased. (Y/N)	12.99	0.00	1.43	0.08
Have you launched a new product/ service in the market during COVID-19?	-13.31	0.00	-	-
Have you divested/dropped any product/service during COVID-19?	-	-	-	-
Revenue/Profit				
Revenue has decreased during COVID-19. (Y/N)	-	-	-	-
If yes, what is the estimated decreased revenue? (%)	3.69	0.00	3.16	0.00
Profit has decreased during COVID-19. (Y/N)	-	-	-	-
If yes, what is the estimated decreased profit? (%)	7.93	0.00	1.61	0.06

7. DISCUSSION

The objective of this paper is to assess the implications of COVID-19 among different building blocks of supply chain and discover the differences in implications between service and manufacturing industries. Additionally, the differences between manufacturing sectors are also observed. It is discovered that all of areas of supply chain including the profitability of the companies have undergone

tremendous challenges during the pandemic. Additionally, the banking sector's supply chain is less touched than the manufacturing sector. Furthermore, differences in repercussions of the pandemic on supply chain are also noticed between two manufacturing sectors: textile and pharma. The results have significant policy implications as the effects are mixed.

As the impact of COVID-19 on supply chain areas varies among industries, strategies developed for one industry may not be working properly for other industry. Therefore, key managerial position holders in the company should develop strategic planning for supply chain considering specific implications of the pandemic in different areas of supply chain (Sengupta, Heiser, and Cook, 2006). According to DCP pyramid of Richey (2009), companies should adopt three strategies during a crisis – collaboration, communication, and contingent planning. As COVID has stuck all the industries, collaboration among industries, strategic partners, and alliances will benefit the companies during this challenging times. Effective and productive communication among all stakeholders will help greatly to combat the challenges imposed by the pandemic. Additionally, contingency planning should be emphasized to make the plan flexible depending upon the situations.

According to resilience theory, a holistic initiative should be in place to combat crisis (Chowdhury and Quaddus, 2016). As a unique crisis with colossal threat, COVID-19 should be dealt with holistic strategies. Forehand *et al.,* (2021) have focused on efficiency in supply chain to combat the pandemic. They have developed a model for supply chain efficiency ratio that can be applied by the firms to achieve efficiency. Malsinghe *et al.,* (2022) also concentrates on operational excellence models to overcome the challenges during the pandemic. Additionally, several risk management tactics should be in place to combat the pandemic like reliable sourcing, safeguarding, partnership with major supplier, and real demand-based inventory management (Sumarliah *et al.,* 2021). Furthermore, getting adapted to the pandemic will enable any company to deal with any crisis in the future. Proper utilization of the resources, forward and backward integration, proper diversifications, adaptation, long-term orientation, contingency consideration - altogether can mitigate the impact of COVID-19 on supply chain. Overall, supply chain collaboration can be a source of competitive advantage to increase firm performamce (Nguyen *et al.,* 2022). Last but not the least, to achieve resilience in supply chain disruption caused by the pandemic, firms should emphasize on ambidextrous innovation and relational capital (Robb *et al.,* 2022; Kang *et al.,* 2022).

Belhadia *et al.* (2020) and Pujawan, and Umaru Bah, (2022) have emphasized on local resources and fourth industrial revolution (4IR) guided technology to deal with the catastrophe. As COVID-19 has bound us to close the border, locating, and strengthening local supply resources will advantage the firms during the pandemic. Additionally, 4IR guided disruptive technologies like internet of things (IOT) (Ben-Daya *et al.,* 2022), blockchain (Wang *et al.,* 2021; Batwa and Norrman, 2021), artificial intelligence (AI), data analytics (Aamer *et al.,* 2020), fintech etc. can assist the firms to collaborate, communicate and plan for the contingencies. Batwa and Norrman (2021) have emphasized on trust while applying blockchain in supply chain management. The linkage of DCP pyramid with 4IR technologies can be the optimum solution to handle the pandemic. This insight can guide the top-executives to formulate appropriate strategies for the resilience in the supply chain process of a firm.

8. CONCLUSION AND RECOMMENDATION

COVID-19 has severely endangered human life and the business cycle is not excluded from the wave of the pandemic. This paper has aimed to investigate the implications of the pandemic on different areas of the supply chain in varied industries based in the emerging economy, of Bangladesh. To achieve the objective, data is collected from a structured questionnaire from the professionals of the listed companies in Bangladesh. By analyzing the data based on descriptive statistics, it is proved that COVID-19 has negatively affected all the areas of the supply chain including raw materials, manufacturing, export, import, labor, product, revenue, and profit. The implications are higher for the manufacturing sector than for the service sector and it differs across industries. The finding of this study will have policy implications for Government, regulators, companies, investors, suppliers, and customers. The Government and regulators such as Bangladesh bank, and Bangladesh Securities and Exchange Commission (BSEC) can formulate appropriate policies to combat the externalities of the pandemic on the supply chain. Companies can adopt alternative strategies for each of the areas of the supply chain. The investor may use the findings of the study to make investment decisions – whether they should buy/sell their investment. Suppliers can choose alternative supply chain models and take necessary actions. Finally, customers can be aware of the overall supply chain process and take necessary buying decisions. However, this study is not out of its limitations. The study is based on survey data only, interview and other secondary data may reveal more insights. Only three sectors are considered for this study; covering more industries may make the conclusion more realistic.

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APPENDIX 1: QUESTIONNAIRE ON THE IMPACT OF COVID-19 ON SUPPLY CHAIN AND PROFITABILITY

Payworq Ltd offers payroll-processing software (PayFruit), which runs as Software as a Service (SaaS). Its move to the Please fill up the questionnaire below. All the information collected through this survey will be used for research purposes only and respondents' information will be kept secret. Thank you for giving your valuable time.

Name (Optional): ……..... Gender:……..…….. Age:……
Organizational Position:…… Company name: …….

Raw Materials

1. Are you holding more inventories due to COVID-19? A) Yes B) No
2. Due to COVID-19, the price of the inputs (raw materials) has increased significantly.
   A) Strongly disagree B) Disagree C) Neutral D) Agree E) Strongly agree

3. To what extent, the price of the raw materials has increased?
   A) Less than 10%
   B) More than 10% but less than 20%
   C) More than 20% but less than 30%
   D) More than 30% but less than 40%
   E) More than 40% but less than 50%
   F) More than 50% but less than 100%
   G) More than 100%
4. Due to COVID-19, the lead time/delivery time has increased significantly.
   A) Strongly disagree B) Disagree C) Neutral D) Agree E) Strongly agree
5. The impact of COVID-19 on average lead time is:
   A) As it was earlier B) Double C) Triple D) 4 times E) More than 4 times

Labor

6. Is there any retrenchment (employee firing) during COVID-19? A) Yes B) No. If yes, _____%
7. Is there any new recruitment during COVID-19? A) Yes B) No
8. Is there any cut down of salary of the employees? A) Yes B) No. If yes, _____ %.

Import/Export

9. Is there any negative impact on imports? A) Yes B) No
10. To what percent, import is affected? _____%
11. Is there any negative impact on Export? A) Yes B) No
12. To what percent, export is affected? _____%.

Manufacturing

13. Is there any negative impact on manufacturing? A) Yes B) No
14. To what extent, manufacturing capacity is utilized during COVID-19?
    A) Less than 20% B) 20% - 40% C) 40% - 60% D) 60% - 80% E) 80% - 100%

Distribution

15. Is there any negative impact on distribution? A) Yes B) No
16. Have you changed the distribution model? A) Yes B) No
17. Is there any increase in distribution cost? A) Yes B) No. If yes, _____%.

Product/Service

18. The price of the product/service has increased. A) Yes B) No
19. Have you launched a new product/service in the market during COVID-19? A) Yes B) No

a) Have you divested/dropped any product/service during COVID-19? A) Yes B) No

Profit

b) Revenue has decreased during COVID-19. A) Yes B) No. If yes, _____ %
c) Profit has decreased during COVID-19. A) Yes B) No. If yes, _____ %

APPENDIX 2: LIST OF SAMPLE COMPANIES

Banks	Textile companies	Pharmaceutical and Chemical companies
AB Bank Limited; Al-Arafah Islami Bank Ltd.; Bank Asia Ltd.; BRAC Bank Ltd.; The City Bank Ltd.; Dhaka Bank Ltd.; Dutch-Bangla Bank Ltd.; Eastern Bank Ltd.; Export-Import (Exim) Bank of Bangladesh Limited; First Security Islami Bank Limited; ICB Islamic Bank Limited; IFIC Bank Ltd.; Islami Bank Bangladesh Limited; Jamuna Bank Ltd.; Mercantile Bank Ltd.; Mutual Trust Bank Ltd.; National Bank Ltd.; National Credit and Commerce Bank Ltd.; NRB Commercial Bank Limited; One Bank Limited; Premier Bank Ltd.; Prime Bank Ltd.; Pubali Bank Ltd.; Rupali Bank Ltd.; South Bangla	Aman Cotton Fibrous Limited; Alif Industries Limited; Al-Haj Textile Mills Limited; Alif Manufacturing Company Ltd.; Apex Spinning and Knitting Mills Limited; The Dacca Dyeing and Manufacturing Co. Ltd.; Delta Spinners Ltd.; Desh Garments Ltd.; Dragon Sweater and Spinning Limited; Dulamia Cotton Spinning Mills Ltd.; Envoy Textiles Limited; Esquire Knit Composite Limited; Familytex (BD) Limited; Hamid Fabrics Limited; Malek Spinning Mills Ltd.; Matin Spinning Mills Ltd.; Metro Spinning Ltd.; Mozaffar Hossain Spinning Mills Ltd.; Mithun Knitting and Dyeing Ltd.; Monno Fabrics Limited; Pacific Denims Limited; Prime Textile Spinning Mills Limited; Paramount Textile	ACI Limited; ACI Formulations Limited; The ACME Laboratories Limited; ACME Pesticides Limited; Active Fine Chemicals Limited; Advent Pharma Limited; AFC Agro Biotech Ltd.; Ambee Pharmaceuticals Ltd.; Beacon Pharmaceuticals Limited; Beximco Pharmaceuticals Ltd.; Beximco Synthetics Ltd.; Central Pharmaceuticals Limited; Far Chemical Industries Limited; Global Heavy Chemicals Limited; The IBN SINA Pharmaceutical Industry Ltd.; Indo-Bangla Pharmaceuticals Limited; Imam Button Industries Ltd.; JMI Syringes and Medical Devices Ltd.; Keya

Banks	Textile companies	Pharmaceutical and Chemical companies
Agriculture and Commerce Bank Limited; Shahjalal Islami Bank Ltd.; Social Islami Bank Limited; Southeast Bank Ltd.; Standard Bank Limited; Trust Bank Limited; United Commercial Bank Ltd.; Union Bank Limited; Uttara Bank Limited.	Limited; Rahim Textile Mills Ltd.; Regent Textile Mills Limited; Ring Shine Textiles Limited; Saiham Cotton Mills Limited; Saiham Textile Mills Ltd.; Shasha Denims Limited; Shepherd Industries Limited; Simtex Industries Limited; Sonargaon Textiles Ltd.; Square Textile Ltd.; Tamijuddin Textile Mills Limited.	Cosmetics Ltd.; Kohinoor Chemicals Company (Bangladesh) Ltd.; Libra Infusions Limited; Marico Bangladesh Limited; Orion Infusion Ltd.; Orion Pharma Ltd.; Pharma Aids; Reckitt Benckiser(Bd.)Ltd.; Renata Ltd.; Silco Pharmaceuticals Limited; Silva Pharmaceuticals Limited; Square Pharmaceuticals Ltd.;

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