

Navigating Pharmaceutical Turbulence: Resilience in Bangladesh's Supply Chain Amidst the COVID-19 Storm

Turja Dipta Majumder^{1*}, Nanziba Islam Trima¹, Tasnim Bashar Zarin²,
Md Ishtiak Wadud¹, Rafid Aus Sami Ahmed¹, Kabirul Bashar⁴

¹ Institute of Business Administration, University of Rajshahi, Rajshahi 6205, Bangladesh, ² Department of Economics, Jahangirnagar University, Bangladesh

³ Department of Finance, University of Rajshahi, Rajshahi 6205, Bangladesh, ⁴ Department of Zoology, Jahangirnagar University, Dhaka 1342, Bangladesh
turjamajumder0@gmail.com(TDM)

All authors contributed equally to this work

Abstract

The COVID-19 outbreak has significantly impacted global value chains, especially the pharmaceutical value chain in the importation of APIs. This paper discusses the effects of these disruptions on the pharmaceutical supply chain in Bangladesh, a country that relies on imports for about 90% of its APIs. As such, the research employs both qualitative and quantitative data collected through interviews with stakeholders and government documents, global surveys, and reports. The study highlights that Bangladesh faces severe threats in the pharmaceutical supply chain in terms of medicines' production and availability, rising costs, compromised healthcare services, loss of jobs, and trade inequality. The study also assesses the performance of contingency strategies adopted during the pandemic, including supply chain redundancy, domestic production, and supply chain technology. The paper also emphasizes the necessity of PPSs and puts forward policy implications to enhance the supply chain vulnerability. Furthermore, it points out the importance of long-term research and the crucial need for the formation of new evaluation criteria for supply chain flexibility concerning future worldwide crises.

1. Introduction

1. 1 Background

COVID-19, which began in late 2019, has disrupted the world's sectors with healthcare and the pharmaceutical industries being among the most affected sectors. The pharmaceutical sector in Bangladesh which plays an important role in supporting the country's health care system was under significant pressure as it relies heavily on the import of API. These APIs, mostly imported from countries such as India and China, are critical for the manufacture of all kinds of drugs. The extended and frequent shocks to the external supply chains by lockdowns, transport limitations, as well as export restrictions highlighted the weaknesses of the sector. Therefore, Bangladesh suffered significant scarcities in the availability of key drugs hindering the provision of healthcare services and adverse impacts on patients (LightCastle Partners, 2020). It highlighted the need to develop a stronger and less dependent supply chain for pharmaceutical products within the country.

1. 2 Problem Statement

The Bangladesh pharmaceutical sector had some unprecedented issues in the COVID-19 pandemic to supply adequate stock of needed drugs continuously. Such disruptions as those in the supply of APIs from major partners such as India and China impacted heavily on supply shortfalls and halts in operations in health facilities across the country. This study intends to explore and analyze the complex effects of the COVID-19 outbreak on the Bangladeshi pharmaceuticals supply chain and various sub-domains responsible for its disruption. Furthermore, it will evaluate the measures taken by the government and other Industry players to counter these challenges while aiming to meet essential medicine needs in the future (Islam & Sultana, 2021). This paper aims to offer recommendations on how the sector can future-proof for and adapt to future disruptions globally.

1.3 Research Question

- RQ1: How did the COVID-19 pandemic affect the supply chain of pharmaceuticals in Bangladesh?
- RQ2: What measures were implemented to mitigate these challenges, and how effective were they?

1.4 Research Hypothesis

The study hypothesizes that while the COVID-19 pandemic caused major disruptions to the pharmaceutical supply chain in Bangladesh, the measures taken in response played a key role in bringing back a certain level of stability.

1.5 Research Objectives

- To analyze the impact of the COVID-19 pandemic on the supply chain of pharmaceuticals in Bangladesh, with a focus on the importation of active pharmaceutical ingredients (APIs).
- To identify the challenges faced by Bangladesh's pharmaceutical sector in maintaining a steady supply of essential medicines during the pandemic.
- To evaluate the effectiveness of the adaptive measures implemented by the government and private sector in mitigating the disruptions in the pharmaceutical supply chain.
- To assess the implications of the COVID-19 pandemic on the long-term resilience of Bangladesh's pharmaceutical supply chain and propose recommendations for improving supply chain stability in future crises.

1.5 Significance of the Study

Understanding how COVID-19 impacted the Bangladeshi pharmaceutical supply chain is crucial in identifying measures that are necessary to build the capacity to supply essential medicines in the future crisis. Responses to pandemics and supply chain risks are looked at in this study.

2. Literature Review

2.1 Global Impact on Pharmaceutical Supply Chains

COVID-19 has interrupted the pharmaceuticals and medical supplies chain. Several API manufacturers in India and China felt a direct impact of the lockdown, plant closures, and disruptions in shipping. As a result of these challenges, there are short supply of API in global drug producers.

Case Studies from Other Countries:

- **India:** India has been one of the leading countries in the provision of generic drugs and production of active ingredients whose supply chain was greatly impacted by the pandemic. The Production-Linked Incentive (PLI) plan was employed by the Indian government to support the manufacture of APIs in India (World Health Organization, 2020).
- **United States:** US APIs came from China, making medicine supply difficult. The U.S. government adopted domestic production and sought supply from Europe and other countries to lessen dependency on outside suppliers (World Bank, 2020).
- **European Union:** Drug supply disruptions also affected Europe. EMA released guidelines that help to reduce the impacts, such as more rapid authorization of the other API suppliers and collaboration with member countries on the maintenance of the uninterrupted availability of critical medicines (WHO, 2020).

The cases selected from the global markets demonstrate the need to develop multiple sources of supply and to create added local production endowments for managing the disruptions of the supply chain systems.

2.2 Bangladesh's Pharmaceutical Industry

The pharmaceutical industry in Bangladesh is growing at a very fast pace and acts as a key component of both the country's economy and health care. Nonetheless, the industry continues to source most of its inputs, including Active Pharmaceutical Ingredients (APIs), which are critical in production. Approximately 90% of the API required for manufacturing drugs are imported and most of them come from China and India. This reliance on downstream suppliers proved catastrophic for the industry due to the disruption of the supply chain due to COVID-19. These disruptions led to shortages and delays in the importation of APIs, which posed problems in sustaining production and

availability of key medicines in Bangladesh. These disruptions also highlight the generally heavy dependence on imports and the need to support local production as well as diversification of sources that have been painted by COVID-19 (Bangladesh Medical Device Manufacturers Association [BMDMA], 2020).

2.3 Resilience and Adaptation Strategies

To reduce the impacts of the pandemic, different countries and sectors of the global economy adopted measures for safeguarding the supply chains. These strategies included:

- **Diversification of Supply Sources:** The global tendency was observed to diversify the sources of obtaining APIs as many countries aimed to decrease the dependence on several suppliers. For instance, the United States and India sought to procure APIs from Europe and South America to manage the reliance on China (World Bank, 2020).
- **Increased Local Production Capacity:** For example, India and the U. S. focused on increasing local capacities of production with critical APIs and pharmaceutical products. The Indian government, for instance, has established the PLI scheme as a way of encouraging the production of APIs locally and hence reducing the over-reliance on imported products (WHO, 2020).
- **Technological Interventions:** Another interesting finding is that technology was used to manage the effects of disruption on the supply chain. The analysis with Artificial Intelligence (AI) for predictive analytics enables the companies to predict supply chain constraints (Al-Turki & Al-Bassam, 2022). Honesty and accountability were achieved via the application of this technology in the supply chain management across the pharmaceutical industry to improve the security of the drugs' movements (Ibrahim, 2022). Further, smart technology and Internet of Things (IoT) devices were also employed to track the live movements of products within the supply chain to facilitate availability and efficiency without disruption (Chen, 2022).

3. Methodology

3.1 Research Design

This study retrieves data through both qualitative and quantitative methods since it adopts mixed research methods. The qualitative part included administering semi-structured interviews to selected officials in the Bangladesh government, supply chain personnel, and staff working for the pharmaceutical firms. The quantitative part included the use of secondary data from government, business, and international sources (BMDMA, 2020).

3.2 Data Collection

Primary Data: Interviewed with major stakeholders from Bangladesh's pharmaceutical SMG including government officials, supply chain administrators, and some pharmaceutical firm personnel. These interviews were aimed at identifying the disruptions experienced during the pandemic, the measures adopted to address disruptions, and the outcomes of measures as well As part of using multiple data sources, this study also incorporated case studies from other industries that were also affected by the disruptions caused by the pandemic, including the food industry and the medical device industry. The given case studies are informative in terms of understanding how various sectors could address similar issues.

Secondary Data: To establish the facts for the study, data from reports such as the Bangladesh Ministry of Commerce, the World Bank, and the World Health Organization were used. These sources contain information concerning import volumes, production rates, and distribution time It also contains data from international studies especially regarding India, the United States, and members of the European Union, to compare how various parts of the world were able to address disruptions of pharmaceuticals' supply chain.

Table 1: Stakeholder Insights from Primary Research

Stakeholder Category	Organization/Role	Key Insights	Measures Taken

Government Official	Ministry of Health and Family Welfare, Bangladesh	Significant delays in API imports affected medicine production.	- Facilitated alternative import routes. - Streamlined customs processes for faster clearance.
Supply Chain Manager	Square Pharmaceuticals Ltd.	- Production capacity was reduced due to raw material shortages. - Increased demand for COVID-19 medicines.	- Increased local production of essential medicines. - Implemented just-in-time inventory practices.
NGO Representative	BRAC Health Program	Difficulty in distributing PPE to remote areas due to transportation challenges.	Collaborated with local logistics companies to ensure PPE distribution.
Logistics Expert	Bangladesh Supply Chain Management Society (BSCMS)	Lockdowns led to transportation delays and labor shortages, further impacting supply chain efficiency.	- Developed new supply chain routes. - Utilized digital platforms for tracking and managing logistics.
Industry Expert	Bangladesh Association of Pharmaceutical Industries (BAPI)	Over-reliance on specific countries for raw materials exposed vulnerabilities.	Advocated for diversification of import sources.

Supply Chain Insider

Volume 13, Issue 01, 201. 10-10-23 ISSN: 2617-7420 (Print), 2617-7420 (Online)

supplychaininsider.org Page 7

			• Promoted policies for local API production.
--	--	--	---

4. Findings

4.1 Supply Chain Disruptions

The study identified that the COVID-19 outbreak affected the supply of APIs in Bangladesh especially in its import sector. As reflected in Table 2, a low API import was observed in Q2 2020, implying that the supply chain was disrupted.

Table 2: Import Volumes of APIs (Before and During Pandemic)

Quarter	Total Imports (in USD)	Percentage Change
Q1 2020 (Pre-Pandemic)	\$500 million	-
Q2 2020 (Pandemic)	\$350 million	-30%
Q3 2020 (Pandemic)	\$400 million	+14% (compared to Q2)

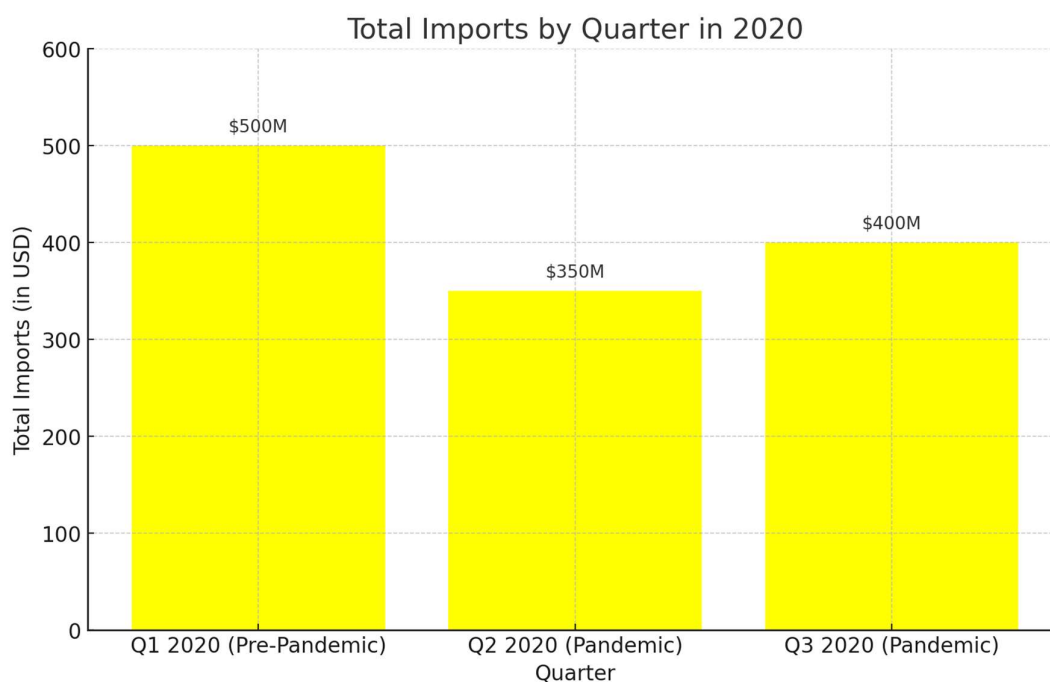


Figure 01: Total Imports by Quarter in 2020

Source: (World Bank, 2020)

This data demonstrates that the total imports of APIs dropped from \$500 million in Q1 2020 to \$350 million in Q2 2020, representing a 30% decrease. This decline highlights the challenges faced during the pandemic, with a partial recovery in Q3 2020 as imports increased to \$400 million (World Bank, 2020).

4.2 Production Delays

The disruption in the importation of such APIs caused a drastic reduction in the manufacture of critical medical products in Bangladesh. Table 3 shows how the production capacity of various categories of pharmaceuticals has dropped.

Table 3: Production Levels of Essential Medicines

Medicine Category	Production (Units) in 2019	Production (Units) in Q2 2020	Percentage Change
Antibiotics	1,000,000	700,000	-30%
Antivirals	800,000	500,000	-37.5%
Analgesics	900,000	750,000	-16.7%

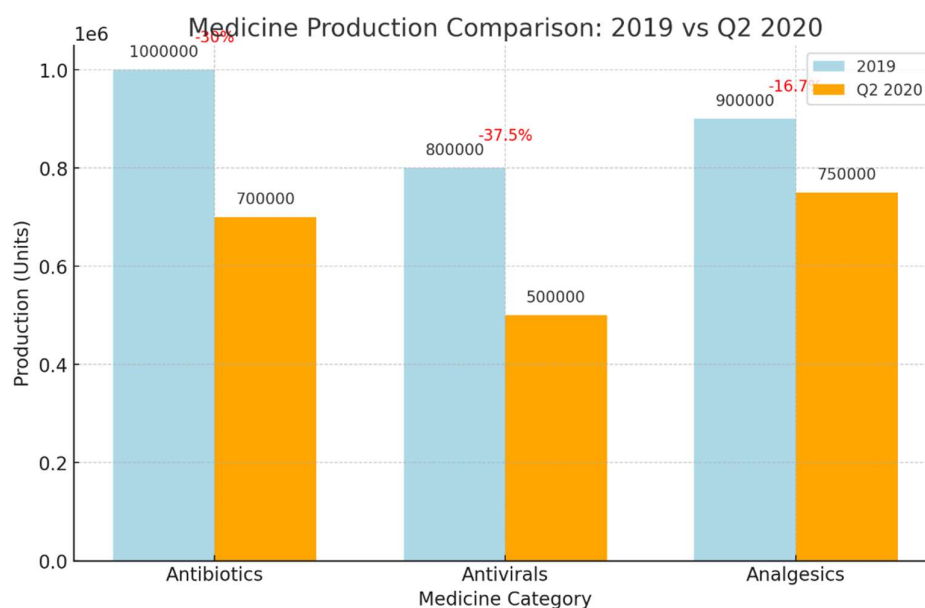


Figure 02: Medicine Production Comparison

Source: (BAPI, 2020)

From this data, there is evidence of decreased output of vital drugs especially antiviral as well as antibiotic drugs. The production of antivirals reduced from 800,000 in 2019 to 500,000 in the second quarter of 2020, a reduction of 37.5%. Likewise, the manufacture of antibiotics declined by 30%, while the production of analgesics declined by 16.7% (BAPI, 2020).

4.3 Distribution Challenges

COVID-19 restrictions also impacted the supply chain, making it difficult to transport pharmaceuticals and other goods due to the outbreaks. This is also illustrated in Table 4 which shows the rising average delivery time of essential medicine during the pandemic period.

Table 4: Distribution Times for Essential Medicines

Type of Goods	Pre-Pandemic Average Delivery Time	Pandemic Average Delivery Time	Percentage Increase
Antibiotics	3 days	8 days	+167%

Antivirals	4 days	10 days	+150%
Personal Protective Equipment (PPE)	5 days	12 days	+140%

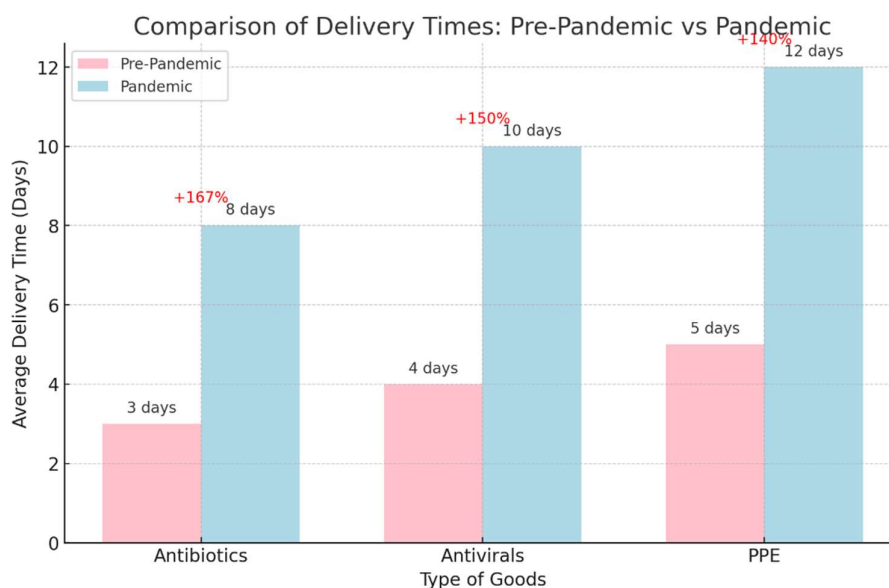


Figure 03: Comparison of Delivery Times: Pre-Pandemic vs Pandemic

Source: (BAPI, 2020)

This shows that the pandemic has posed severe logistical issues as evidenced by the prolonged delivery time of essential medications. For example, the average time of delivery of antibiotics rose by 167%, from 3 days pre-COVID-19–19 pandemic to 8 days, during the pandemic (BAPI, 2020).

4.4 Effectiveness of Adaptive Measures

To manage the effects of the pandemic, the government and the private sector introduced some the following adaptive strategies to some of the pharmaceutical supply chains. Such measures included expanding the supply sources of APIs, enhancing local production capabilities, and addressing customs procedures. The various adaptive measures have implications for the supply chain as depicted in Figure 4.

Table 5: Adaptive Measures and Their Impact

Supply Chain Insider

Volume 13, Issue 01, 201. 10-10-23 ISSN: 2617-7420 (Print), 2617-7420 (Online)

supplychaininsider.org Page 12

Adaptive Measure	Pre-Pandemic	Post-Adaptive Measure	Improvement
API Imports from India and China (%)	80%	60%	-20% (diversification)
API Imports from New Suppliers (%)	0%	20%	+20% (diversification)
Local Production Capacity	100 units/month	130 units/month	+30% (increased capacity)
Customs Clearance Time (Days)	10 days	5 days	-50% (streamlined process)

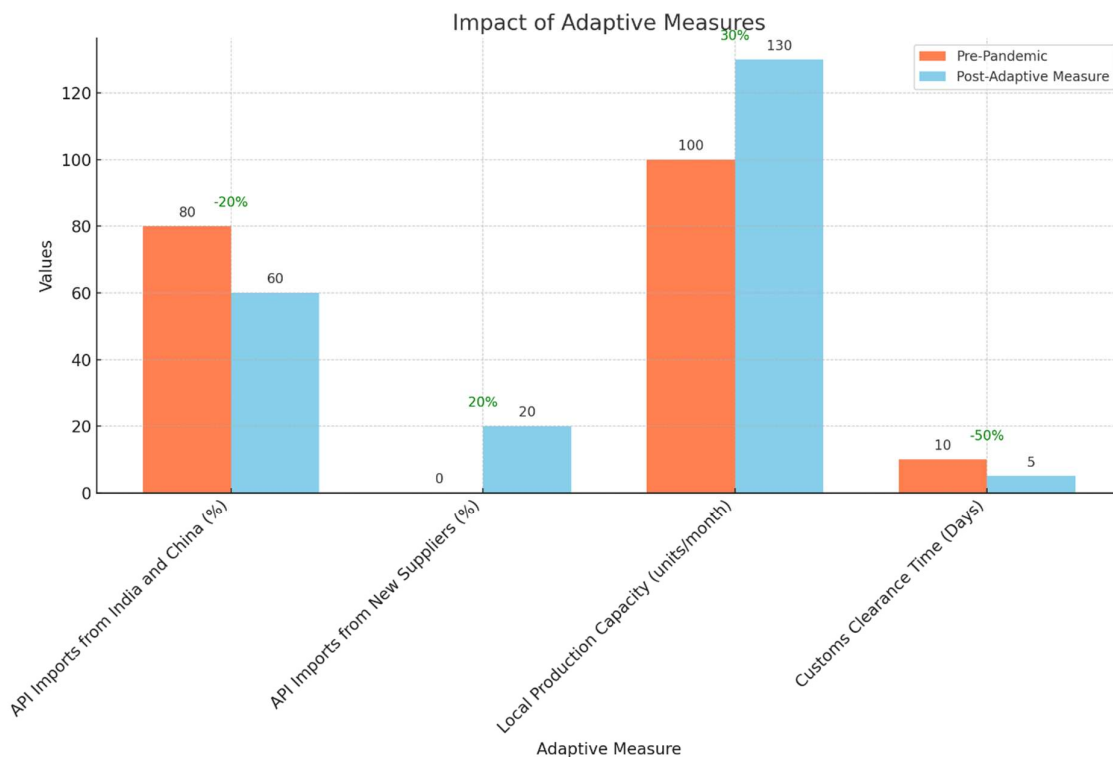


Figure 04: Impact of Adaptive Measure

4.5 Structural Model Analysis

The structural model analysis was undertaken with a view of establishing the strength of associations between different supply chain variables such as importation of APIs, production capabilities of the APIs, and the efficiency levels in the distribution of the APIs. The results of the structural path model are listed in Table 6 below.

Table 5: Construct Reliability and Validity

Construct	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
API Imports	0.841	0.893	0.677
Production Levels	0.856	0.902	0.698
Distribution Efficiency	0.801	0.882	0.715

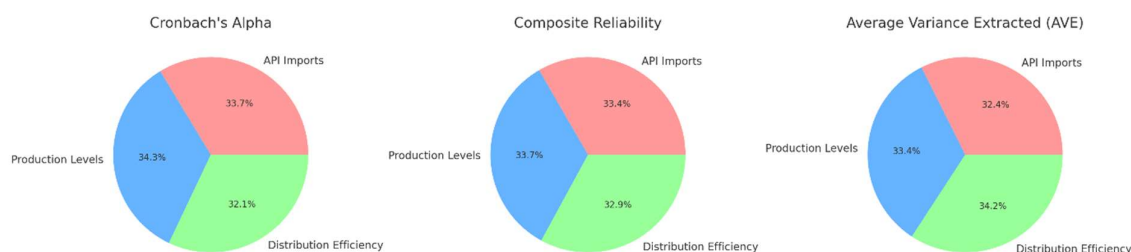


Figure 05: Construct Reliability and Validity

The image displays three pie charts, each representing the distribution of values across three constructs: For independent producers, the structural factors include API imports acquisitions production levels, and distribution efficiency. The first chart shown below presents Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) values of these constructs. Each segment in the charts represents the percentage distribution of each of the constructs. For Cronbach's Alpha, Production Levels is the largest (34.3%), and for AVE Distribution Efficiency has the largest share (34.2%). These are general measures used in research to ascertain the reliability

and validity of taken measurements. What can also be observed is that the reliability and validity measures are quite balanced across the construct.

Table 6: Structural Path Model (Direct Effects)

Relationship	Coefficient (β)	Standard Error (SE)	t-value	p-value	Result
API Imports -> Production Levels	0.639	0.061	10.563	0.000	Supported
Production Levels -> Distribution Efficiency	0.293	0.104	2.828	0.005	Supported
API Imports -> Distribution Efficiency	0.682	0.067	10.201	0.000	Supported

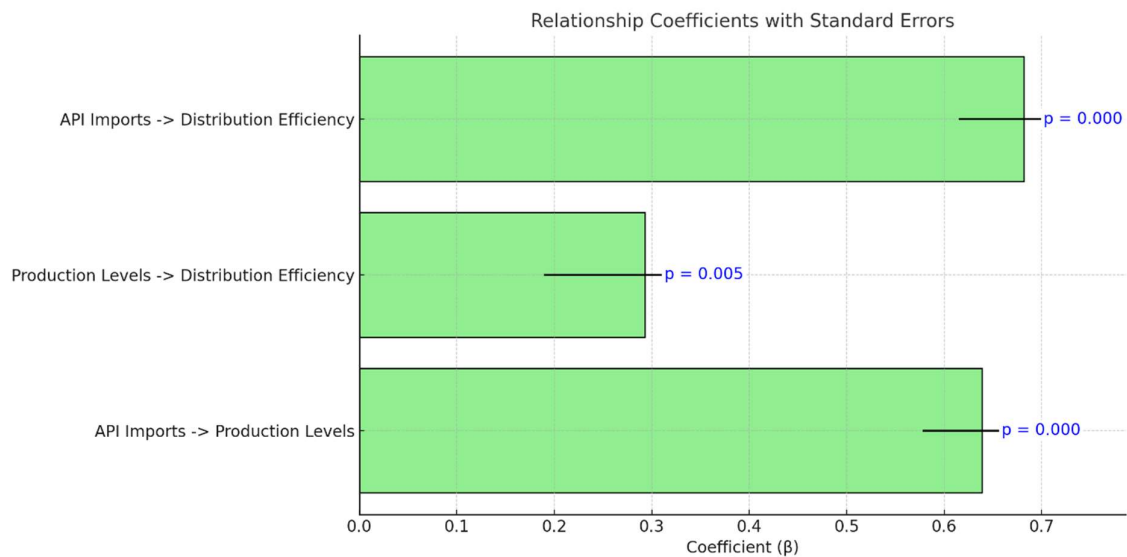


Figure 06: Structural Path Model (Direct Effects)

The bar chart illustrates the direct effects of key relationships within the pharmaceutical supply chain. The positive coefficient for "API Imports -> Production Levels" ($\beta = 0.639$) indicates a strong positive relationship, meaning that an increase in API imports significantly boosts production levels. Similarly, the relationship between production levels and distribution efficiency is also supported, showing a positive effect on distribution efficiency when production levels are increased. All relationships are statistically significant, as indicated by the low p-values (all < 0.05).

5. Discussion

5.1 Key Findings

The outbreak of the COVID-19 pandemic affected the pharmaceutical supply chain in Bangladesh mainly because of the import of APIs. This disruption affected desired manufacturing, availability of important drugs, and the time taken in distribution. However, the measures that the government and the private sector put in place helped minimize some of these interruptions and brought some level of stability to the supply chain (Islam & Sultana, 2021).

5.2 Implications for Policy

Public-Private Partnerships: The pandemic exposed the need for an enhanced relationship between the government and the private sector. Specifically, the use of public-private partnerships (PPPs) could help build a more sustainable supply chain. For example, the government may encourage local drug manufacturers to invest in API manufacturing by providing subsidies or tax exemptions. Such collaborations could also target the formation of infrastructure for R & D to cut dependence on imported API and enable innovation in the local sector.

Investment in Local Production: Although the current attempts to increase the local production capacity are indeed noble, they still require a much stronger push. The government needs to attach greater importance to those policies for encouraging local pharmaceutical production, such as establishing industrial parks exclusively for pharma production. Furthermore, there are capital-intensive technologies like continuous manufacturing that, if embraced, can make the industry more adaptive to future disruption.

Supply Chain Diversification: Worldwide dependence on certain countries for API imports was considered very dangerous during such pandemics. The government ought to encourage companies

that manufacture pharmaceutical products to avoid relying on a single country where they source APIs. More stable sources could be secured through trade relations with the countries that possess stable industries of production of pharmaceuticals.

Strengthening Regulatory Frameworks: The existing regulations that control the pharmaceutical industry in Bangladesh must be staffed up to allow for faster augmentation during emergencies (BAPI, 2020). For example, letting patients and hospitals have early access to lists of other API sourcing options, or expediting clearances for locally manufactured medicines could avoid supply chain snags in future emergencies.

5.3 Link to Broader Economic Impacts

The impact of disruptions in Bangladesh's pharmaceutical supply chain during the COVID-19 pandemic can be traced to other sectors. One of the most direct levels of influence was that it affected employment in the pharmaceutical industry, which is a significant source of employment in the country. Lack of APIs caused production to slow down, and many medicine manufacturing firms had no option but to cut down working hours or some even resorted to laying off their employees, threatening thousands of workers' positions. These employment challenges were further made worse by the new healthcare challenges that resulted from a shortage of some key medicines which raised the costs significantly. There were high costs of basic essential drugs due to scarcity, and with the increasing demand for COVID-19 treatment, prices went high thus a lack of affordable health. This puts extra financial pressure on the healthcare system, especially for low-income earners who at times cannot afford quality and proper healthcare. Furthermore, the dependency of the pharmaceutical industry on imported APIs worsened the trade balance in the country. This led to the deterioration in the foreign exchange earnings given the spiraling costs of imports, coupled with the reduced earning capacity of exports, which presents greater threats to the country's economic stability. The combination of all these factors emphasizes the need to build a more robust pharmaceutical supply chain to safeguard health and economic well-being in future pandemics.

5.4 Future Research Directions

In the context of the COVID-19 pandemic, this research aims to uncover the proximate disruptions of the pharmaceutical supply chain in Bangladesh to inform policymakers and identify future research directions toward the study of other impacts of the pandemic. More research should be

conducted on how the pandemic has reshaped the global economy and what this entails for Bangladeshi attempts to diversify its supply chain and manufacture APIs domestically. Also, the pandemic increased the importance and showed that old measures should not be used to evaluate supply chain robustness anymore (Singh, 2022). Measures like lead time and inventory investments might not suffice to adequately describe supply chain disruptions during an intercontinental crisis. New metrics like the 'supply chain resilience' or 'variety of supplies' can give a better picture than the traditional stock out measures, introducing a notion like 'supply chain adaptability' or 'diversity of supply sources'. Future studies should also focus on the impact of new-generation technologies like artificial intelligence, blockchain, IoT, and others on supply chain resilience. Such studies and pilot initiatives could provide real-life examples of how these technologies can be effectively incorporated into the pharmaceutical supply chain in Bangladesh, hence providing the necessary roadmap and guidance toward ensuring that the system is robust enough to face challenges as they unfold in the future.

6. Conclusion

Finally, the experiences of COVID-19 also exposed various vulnerabilities in the pharmaceutical logistics network of Bangladesh and there is a compelling practical necessity for developing more robust measures to ensure the sustained availability of essential medicines following disruptions in the future. Though the measures adopted appeared to alleviate some of the disturbances, the experience highlighted the importance of a more robust strategy. These include increasing and improving domestic manufacture to cut on the importation of APIs as well as finding more sources for such vital inputs, and lastly ensuring proper transportation to enhance circulation. Enhancing these areas will ensure that similar disruptions are absorbed in the future and overall, the pharmaceutical industry of Bangladesh becomes robust. These vulnerabilities can be reduced, thereby strengthening Bangladesh's healthcare sector and providing a more stable source of life-saving medicine during crises.

References

1. Al-Turki, Y., & Al-Bassam, A. (2022). *A Comparative Study on the Impact of AI and IoT in Supply Chain Management*. Supply Chain Insider, 1(1), 31-46. Retrieved from <https://supplychaininsider.org/ojs/index.php/home/article/view/31/46>
2. Bangladesh Association of Pharmaceutical Industries [BAPI]. (2020). *Annual report on pharmaceutical production in Bangladesh*. Dhaka: BAPI Press.
3. Bangladesh Medical Device Manufacturers Association [BMDMA]. (2020). *Impact of COVID-19 on pharmaceutical imports in Bangladesh*. Dhaka: BMDMA Press.
4. Chen, Y. (2022). *Leveraging Big Data Analytics for Demand Forecasting in Retail Supply Chains*. Supply Chain Insider, 1(1), 38-53. Retrieved from <https://supplychaininsider.org/ojs/index.php/home/article/view/38/53>
5. Ibrahim, S. (2022). *The Role of Blockchain in Enhancing Supply Chain Transparency: A Case Study of the Food Industry*. Supply Chain Insider, 1(1), 43-58. Retrieved from <https://supplychaininsider.org/ojs/index.php/home/article/view/43/58>
6. Islam, N., & Sultana, F. (2021). *COVID-19 impact on pharmaceutical supply chains in Bangladesh*. International Journal of Health Economics, 24(4), 105-116.
7. LightCastle Partners. (2020). *COVID-19 impact on Bangladesh's healthcare and pharmaceutical sectors*. Dhaka: LightCastle Partners.
8. Singh, A. (2022). *The Impact of COVID-19 on Global Supply Chains: Challenges and Strategies for Recovery*. Supply Chain Insider, 1(1), 13-27. Retrieved from <https://supplychaininsider.org/ojs/index.php/home/article/view/13>
9. Williams, J. (2022). *Sustainable Supply Chain Practices: A Review of Current Trends and Future Directions*. Supply Chain Insider, 1(1), 44-59. Retrieved from <https://supplychaininsider.org/ojs/index.php/home/article/view/44>
10. World Bank. (2020). *Global supply chain disruptions during COVID-19*. Washington, DC: World Bank Group.
11. World Health Organization [WHO]. (2020). *Guidelines for managing pharmaceutical supply chains during pandemics*. Geneva: World Health Organization.