

HYBRID DEMAND FORECASTING AND REORDER POINT PLANNING USING 'AROPHET'

General Pharmaceuticals Ltd.

Prepared by

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Submitted in Partial Fulfilment of the Requirements for the Degree
Bachelor of Business Administration



School of Business
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August 29, 2025

Internship Report Approval Form

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Letter of Transmittal

August 29, 2025

Mr. Shawkat Tanveer Rahman
Lecturer
School of Business
University of Liberal Arts Bangladesh (ULAB)

Subject: Submission of Research Report on “Hybrid Demand Forecasting and Reorder Point Planning Using AROPHET.”

Dear Sir,

I am pleased to submit my research report titled “Hybrid Demand Forecasting and Reorder Point Planning Using AROPHET.” This report has been prepared as a part of the requirements for the completion of my Bachelor of Business Administration degree at the University of Liberal Arts Bangladesh (ULAB).

This report reflects the knowledge I have acquired during my BBA coursework, along with practical insights and experiences gained from my internship in the Supply Chain Management department at General Pharmaceuticals Ltd. I have also applied relevant academic theories, forecasting models, and research methodologies to ensure the report’s quality and relevance.

I would like to express my sincere gratitude for your continuous support, guidance, and encouragement throughout the research and report preparation process. Your valuable advice has greatly contributed to the successful completion of this report.

I hope the report meets your expectations and I look forward to your valuable feedback.

Sincerely,

Md. Ashiqur Rahman Shihab
ID: 211011127
School of Business
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Acknowledgement

A heartfelt thank you to everyone who has helped me achieve my goal to graduate with a Bachelor of Business Administration (Major in Supply Chain Management) degree at the University of Liberal Arts Bangladesh (ULAB)! I am Md. Ashiqur Rahman Shihab and my ID No. 211011127.

To begin with, I would like to express my gratitude to Almighty Allah (SWT) who showered me with his endless blessings, guidance, and mercy, which helped me overcome all the difficulties and reached this significant milestone of my academic career. I also deeply appreciate my parents and family members who have supported me at every step, prayed, and encouraged me through this whole process.

I want to extend my grateful appreciation to my academic supervisor, Mr. Golam Sakaline, Lecturer, ULAB School of Business, who has guided me through this research report and provided useful advice and motivation to merit this report. His guidance and support have played a role in shaping this work.

I would also like to offer my heartfelt thanks to all the respected faculties of the ULAB School of Business who helped enrich my knowledge and skill and was instrumental to this research project. I would particularly like to thank Mr. Mohammad Tawhid Reaz, whose teaching methodology I greatly appreciate and he happens to be my favourite teacher in ULAB. I also thank Mr. Shawkat Tanveer Rahman who taught supply chain management in the most simplistic and practical way that I liked the subject; when in need I could ask him anything. Special thanks to Mr. Md. Shamsuddin Ahmed, a modest and nice teacher who always inspired me through his positive attitude and helped me to become better. I also wish to thank my Head of SCM Department who is a kind, earthy, and inspirational individual. His warm manner and constant motivation were of great help during my learning at ULAB.

I wish to thank my organizational supervisor at General Pharmaceuticals Ltd., Mr. Saiful Islam, who I have known to be trustful, supportive, and advised me whenever I needed it during my internship period. He was a friendly and approachable person and his talent and expertise was truly unique and exceptional which made the working environment: enjoyable and motivating. His support and his readiness to treat us like friends generated the atmosphere of an open and supportive learning experience which is truly appreciative.

Lastly, I want to thank the rest of my colleagues and fellow interns at General pharmaceuticals Ltd., without whom my experience as an intern would not have come out this well.

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Part-A

Chapter 01: Internship Preparation

1.1 My Motivation Behind the Internship

My academic interest has been altered towards an ever changing and growing field of supply chain operations as I pursue a degree in Bachelor of Business Administration (BBA) majoring in Supply Chain Management at the University of Liberal Arts Bangladesh (ULAB). As part of my coursework in procurement, inventory management, logistics and demand planning, I have learned that reading the theoretical knowledge is not sufficient in order to grasp and master the complexity of the plane, but the actual practice is a must.

The vital role played by supply chain management in the pharmaceutical industry, which is the area to which I was to conduct my internship studies under General Pharmaceuticals Limited (GPL), is one of the primary factors that informed my selection of this industry. Strict regulation, quality control, and inventory of such products is mandatory in pharmaceuticals because of the sensitivity of healthcare products. The failure or inability of the supply chain will have disastrous consequences to the business and the health of people. With the above encounter, it was interesting to me to observe the way a leading pharmaceutical company, such as GPL works with these challenges on everyday basis. In addition, General Pharmaceuticals Limited is known to incorporate the latest technological features in its processes such as the application of the Enterprise Resource Planning (ERP) systems and forecasting methods based on data. Being an individual of great interest in the on the ground application of Artificial Intelligence (AI) in Supply Chain forecasting, the prospect of learning and making my contribution towards such efforts excited me. My pre-existing experience with data analysis, data mining tools and approaches like fbProphet and AI forecasting models aroused my interest in learning how these tools are used by a company like Facebook. Also, my higher education studies in the fields of procurement processes, inventory planning and supplier relationship management prompted me to seek an internship position in which such activities were directly involved. General pharmaceuticals limited provided me with the opportunity I needed where I was able to deal with

tasks such as request of quotations (RFQs), comparative statements (CS), Purchase orders (POs) and procurement documents. I thought that the experience would not only be beneficial to upgrade my theoretical knowledge but also would make me industry-ready by upgrading my practical skills.

Finally, I want to work as a supply chain analyst or manager of a multinational company in the long-term career plan. In this direction, pharmaceutical supply chains provide a fertile learning environment as the process has a global reach and a high compliance standard with sophisticated operating practices. Therefore, the internship with GPL was the best gateway to my target field.

1.2 My Process of Applying and Managing an Internship at General Pharmaceuticals Limited

The process of getting an internship at General Pharmaceuticals Limited was also well organized and successful. In the ULAB BBA program, the final semester will require that an internship be completed so as to decrease the dissimilarity between the learning in a classroom and the practical side of the business world. Having realized the significance of this internship, I began to prepare in advance by updating my resume, creating a portfolio, and optimizing my LinkedIn presence to appeal to the interest of SCM industry potential recruiters.

Some of the organizations I researched based on my interest in pharmaceuticals and SCM are Square Pharmaceuticals, Beximco Pharmaceuticals, Renata Limited, and so on. Upon knowing that GPL has gained rampant popularity, following international norms of WHO-GMP, and increasingly adopting latest strategies in supply chain protocols such as ERP and AI adoption, I was sure of getting my internship at GPL. I put in my formal application by submitting my resume at the Human Resources Department of GPL. I applied my coursework in SCM, analytical abilities, understanding in ERP systems, and my willingness to work on supply chain projects in real life. I also added that I was interested in trying different AI tools which proved to be a part of my actual contribution during the internship.

The HR department reacted well to my application and arranged me a time to attend an interview. In the lead up to the interview, I revised the business model, supply chain operations, and emerging industry tips of GPL itself so that I would be in a position of talking about how I would contribute to the company.

1.3 My Internship Interview Experience

The experience I had when I was interviewed at General Pharmaceuticals Limited was professional and informative. The Head of HR, the Head of Supply Chain Management Department and a representative of the Human Resources Department hosted the session.

Start of the interview was an introduction in which I discussed my background education, interest in SCM and motivation in selecting GPL as an intern. My knowledge about procurement processes and my references to all kinds of AI tools like fbProphet utilized in the real-life setting proved valuable to the interviewers who vice versa were pleased with my clear authorship on the topic of procurement and AI tools. They also introduced me to a number of applied questions about procurement cycles (particularly preparation of RFQ, CS, and PO documents), methods of evaluating suppliers, sustainability in SCM, contemporary AI tools, and that the way AI would have a positive impact on supply chain, my experience and understanding of ERP systems etc. The interviewers were especially impressed with the debate about AI forecasting. I told about how AI would transform the future and save time spent, etc. The duration of the interview was nearly one and a half hours. During the session, we also talked about other situations of the country and the world in terms of words. The interview experience was in general successful and pleasant. My proactive attitude to the work, willingness to learn and the promise to contribute to the SCM improvement initiatives were valued by the panel. A couple of hours later I was confirmed as an SCM Intern to be coming to this company next semester.

1.4 Relevant Information about the Organization

1.4.1 About General Pharmaceuticals Limited (GPL)

General Pharmaceuticals Limited (GPL), founded in 1984 and commencing manufacturing operations in 1987, is a prominent pharmaceutical manufacturer in Bangladesh. The company has been certified by the World Health Organization for Good Manufacturing Practices (WHO-GMP), and it has gained recognition for producing high-quality medicines for both local and global markets (General Pharmaceuticals Ltd. [GPL], n.d.-a). Its manufacturing facility, located in Gazipur, is equipped to produce a diverse portfolio of pharmaceutical products and adheres to rigorous quality and safety standards. GPL exports to over 40 countries, including markets in Asia, Africa, and Latin America.

- **Mission:** To ensure a healthier life by producing the top-notch products one can trust in treatment of ailments (General Pharmaceuticals Ltd. [GPL], n.d.-a).
- **Vision:** Become the pharmaceuticals of choice through consistent product quality, empowering people and satisfying stakeholders (General Pharmaceuticals Ltd. [GPL], n.d.-a).
- **Core Values:**
 1. Customer Centric
We put highest priority in satisfying customers need. We are proactive in analyzing their needs so that we can address their future needs & expectations (General Pharmaceuticals Ltd. [GPL], n.d.-a).
 2. Quality Focus
We are committed to provide quality products and services to our customers (General Pharmaceuticals Ltd. [GPL], n.d.-a).
 3. Drive for Results
We are committed and focused to achieve specific and agreed result that brings value to the organization (General Pharmaceuticals Ltd. [GPL], n.d.-a).
 4. Accountability
We are accountable for providing contemporary, quality and affordable products

& services to our stakeholders maintaining ethical & regulatory obligations (General Pharmaceuticals Ltd. [GPL], n.d.-a).

5. Teamwork

We move together to make our organization great/grand (General Pharmaceuticals Ltd. [GPL], n.d.-a).

1.4.2 Product Portfolio

GLP manufactures almost all types of pharmaceutical formulations like tablets, capsules, syrups, suspensions, injections, ointments, creams, and herbal products. These products cut across various categories of therapeutic agents including antibiotics, anti-ulcerants, anti-hypertension agents, non-steroidal anti-inflammatory drugs (NSAIDs), anti-diabetics, cardiovascular agents and the central nervous system (CNS) drugs (GPL, n.d.-b). Cephalosporins and products based on hormones have their own special production units.

1.4.2 Manufacturing & Regulatory Compliance

The high standards of manufacturing are maintained in the manufacturing unit in Gazipur which has enhanced quality control systems and environmental controls. The GPL has a bunch of regulatory certification, among which:

- WHO-GMP
- UK Medicines and Healthcare products Regulatory Agency (MHRA)
- European Union-GMP (EU-GMP)
- Therapeutic Goods Administration (TGA, Australia)
- Compliance with International Council for Harmonisation (ICH) and Pharmaceutical Inspection Co-operation Scheme (PIC/S) guidelines (GPL, n.d.-c)

1.4.3 Digital Transformation and ERP Implementation

To work towards embracing digital transformation, GPL has made significant steps by implementing an Enterprise Resource Planning (ERP) system in partnership with VS ONE WORLD. This digital solution aids departments, including production, distribution, finance,

human resource management, and supply chain management (GPL, n.d.-d). Real-time inventory, demand planning, and simplified procurement activities in the supply chain system, in particular, stand to gain supporting real-time inventory tracking, demand planning, and streamlined procurement operations during internships as well.

1.4.4 Corporate Social Responsibility (CSR)

GPL also undertakes work on corporate social responsibility like free medical camps, health awareness programs, and disaster relief efforts. Such initiatives are in line with its overall mission of promoting better health among the population and contributing to national development objectives (GPL, n.d.-e).

1.4.5 Human Resources and Organizational Culture

GPL has a labor force of more than 4,000 working as pharmacists, engineers, supply chain and sales persons. It facilitates growth in terms of professional development in terms of training and promotion of this culture of continuous improvement and compliance internationally (GPL, n.d.-a).

The preparation period of my internship was accompanied by excellent correspondence between my educational profile and the operational benchmarks of General Pharmaceuticals Limited. I was driven by the need to not only apply SCM theories in practice but also in an industry where supply chain excellence quite literally can save lives as seen in the case of the timely availability of medicines. The way I researched the company and went through the first round of a strenuous interview further strengthened my confidence that GPL will provide me with the best learning experience of modern procurement processes, managing ERP systems, and even forecasting methods employing artificial intelligence; something essential to a future-proof supply chain professional. By conducting such an intense preparation, I knew that I was walking into an organization in high standards, a lot of opportunities ahead and whose technological side fits my personal and professional goals.

Chapter 02: About the Internship

2.1 Roles and Working Environment

As an intern under General Pharmaceuticals Limited I was posted in the Supply Chain Management (SCM) Department, that is in the Procurement Section. My day to day activities were directly related to the organizational mission of having a smooth effective and cost-efficient supply chain that makes uninterrupted production of pharmaceuticals possible. I have helped in the fundamental procurement procedures that affected the material availability, performance of suppliers, and efficiency of operations directly.

GPL was a highly professional and a structured, technology based working environment. Being a WHO-GMP certified pharmaceutical company, GPL has stringent operational procedures and regulatory compliances esp. in its supply chain as well as procurement activities. This guaranteed that raw materials, packaging materials and the components of machinery were procured and received in time without hecication on quality standards. During my internship, one of the best moments was the cooperative and productive culture of the working environment. My university supervisors and colleagues were open, and they had no problem advising me. They also answered my questions correctly on procedures of procurement, operation of ERP system and documentation processes every time I had inquiries. This turned out to be very constructive learning environment and something that has encouraged me to deliver to the best of my abilities.

The work environment focused on cooperative work, responsibility, and improvement. My supervisor checked my work of preparation of RFQs, the development of Comparative Statements, and handling of documentation on a regular basis. This assisted me to make sure that I was making a significant contribution to the goals of the department and also got useful feedback to brush up my skills. In addition, the exposure to cross-functional teams including Production, Quality Control, and Finance improved my knowledge of the impact of procurement decision-making activities on the rest of the supply chain ecosystem, and the internship was defining and exciting in a new way.

2.2 Work Culture

The organisational culture at General Pharmaceuticals Limited (GPL) is professionalism, discipline and teamwork. GPL being a pharmaceutical organization, there are high levels of ethical and regulatory standards. In my internship, I noticed that the employees were quite punctual, dutiful of rules, and dedicated to performing with a high degree of discipline. This work ethic is paramount in an industry as sensitive as pharmaceuticals manufactured with just a mistake that can have dreadful consequences.

One of the greatest strengths of the work culture was teamwork. The relationship between the Purchasing team and other departments, such as Production, Warehouse, Quality Assurance, and Finance has been close. I also had an opportunity to attend or participate in cross functional meetings on supplier selection, material requirement planning (MRP) and procurement strategy formulation. The meetings of Kerry helped me to realize about how various departments coordinate themselves in order to have an efficient supply chain. Modern technology is encouraged by PLC as well. The management of all procurement and inventory operations is coordinated and organized through the ERP (Enterprise Resource Planning) system. I was trained to use the ERP software even as an intern. This aided in my ability to be able to enter in real time and enhance transparency in the procurement process. Training on how to use some of those software that are used globally in the industry added value and practicality to my internship experience. One other thing I liked about GPL a lot was the learning environment. My supervisors were also supportive and they encouraged me to ask questions. They assigned me significant responsibilities and granted me to work on actual projects. An example is that I got the opportunity to familiarize myself with AI-based forecasting models such as fbProphet and use them as part of our forecasting procedure. This indicated to me that GPL appreciates innovation and allows its young professionals an opportunity to learn and experiment. The most impressive thing was the degree of respect and inclusion in the work place. I regarded the company as a regular team member even though I was only an intern. I was welcomed to share my views and I felt my ideas, particularly in the use of AI in forecasting were valued. This made the work environment amiable and encouraging in that I did not fear participating in discussions and making suggestions.

2.3 Job Duties and Responsibilities

As an intern at General Pharmaceuticals Limited, I closely worked with the Procurement unit within the Supply Chain Management (SCM) department. I was also busy with several procurement-related affairs that equipped me with practical experience and knowledge of buying processes in real life.

My key task was managing various procurement steps. I assisted in the review and processing of material and service requisitions submitted by different user departments. This included the verification of whether the requirements matched the operational needs and their affordability within the available budget. Upon approval of the requisitions, I would draft Request for Quotations (RFQs) containing technical specification, quantity required, and desired deliverable schedules. These RFQs were further posted to several certified vendors to facilitate fair competition and quality offers. Once the RFQs had been distributed, my role was to gather and sort the vendor quotations in a systematic manner. This facilitated the process of evaluating each offer accurately. I made a Comparative Statement (CS) where I compared every quotation side by side. Comparisons were made in terms of price, quality of products or services, delivery lead time, payment terms, and reputation of the vendors. Purchase Orders (POs) were prepared based on the CS analysis. I planned and raised POs, detailed descriptions, quantities, prices, terms of delivery, payment, and other conditions. Once orders were confirmed, I made sure that documents were effectively stored and delivered to vendors in a way that was precise and at a convenient time. After the delivery of the materials, I assisted in verifying the Goods Receipt Notes (GRN) to ensure that all goods were consistent with the PO and delivery documentation. All related documents including challans, invoices, gate passes, and original PO were also compiled to support financial reconciliation and internal audits. Besides preparing documents, I also was engaged in the ERP. I have inserted procurement data such as requisitions, RFQs, CS, and POs within which all data in this area was properly noted. ERP dashboards also helped me to monitor status of purchase orders, track performance of suppliers and monitor levels in inventory. Through these activities, the procurement activities were ensured to be transparent and compliant. In addition, I helped in the preparation of numerous procurement reports which were used in the internal analysis and review meetings. Another significant aspect of my work was communicating with the local suppliers. This was done by calling up vendors to seek quotes, to

clear up any technical or commercial language, to determine delivery schedules and to address any delivery shortfalls. These discussions trained me on how to have professional communication besides expectations and schedules being handled.

Finally, I was collaborating to solve possible gaps between procurement team and other units such as Production and Accounts. I facilitated the flow of the material, enabled quality inspection to be carried on time, and assisted the Accounts team in undertaking payment processing. I ensured that supply chain operations were kept on-track with production timelines and company objectives by ensuring effective inter-departmental communications.

2.4 New Skills I Learned

My experience as an intern at General Pharmaceuticals Limited (GPL) was insightful and I gained a variety of opportunities to enhance and sharpen technical and soft skills necessary to effectively pursue my career in the supply chain management. Every task and responsibility presented me with new tool, new process and new challenges that has increased my confidence and fattened my capabilities.

Technically, the best skill that I acquired was the work experience on ERP systems. I became familiar with the platform and how I may use it to perform several procurement processes including the creation of a purchase order, tracking and monitoring stocks as well as monitoring and tracking procurements in real time. This enabled me to get better knowledge on how quality of processes is managed and ensures visibility of the entire supply chain operations through integrated digital systems. The development of a Python-based algorithmic model of demand forecasting (fbProphet) with independent programming and implementation can be considered another important technical accomplishment. This assignment aided me to gain knowledge in data analysis as used in the real-life business environments. I employed historic sales data to forecast and these forecasts were then used to formulate practical reorder point (ROP) calculations. The project reinforced my knowledge of data-backed decision-making and provided me direct exposure on application of artificial intelligence in optimization of operational activities. During the internship, I also learnt how to prepare files of procurement activities

including Request For Quotations (RFQs), Comparative Statement (CS) and Purchase Orders, (POs). I was able to understand how I could be accurate and compliant in such documents whilst maintaining a professional standard that is in line with company procedures. Also, I furthered my understanding in the selection of suppliers and the appraisal process, understanding how to take decisions such as pricing, product quality and reputation, reliability, and service history of the supplier into account when making a purchasing decision. On analytical grounds, I was able to enhance my capability of evaluating the validity of the forecast by estimating the forecast error and analysis of the residuals. I used ARIMA modeling on residuals left behind by fbProphet predictions in order to make predictions even more accurate. I also gained how to decode forecast results and apply these results into viable reorder point concepts that maximize inventory levels and minimize inventory risks.

My personal aspect of soft skills also enhanced in the area of communication because I was interacting too regularly with the local suppliers. I got to understand how to professionally gather quotations, clear technology and commercial terms and negotiate delivery schedules. In the firm, I had an opportunity to learn how to work in cross-functional teams as I had to put daily efforts to find common ground with my co-workers in different departments and levels such as Production, Quality Control, and Accounts departments. Such exchanges have shown me how to achieve consistency among teams and uphold the movements of work.

Another area of essential evolution was time management. Juggling various procurement processes such as data entry, documentation, and supplier follow-up not only demanded me to be well organized and prioritize work but also made me have very tight deadlines in order to achieve high levels of performance. Finally, I also learned how to solve problems through taking practical actions like handling material shortage, delivery delay, or document anomalies in the suppliers. All the issues that I encountered assisted me in learning how to think critically and take action to overcome.

2.5 Aligning My Educational Learning with My Internship Roles & Responsibilities

The theoretical background explored during my academic study in the University of Liberal Arts Bangladesh (ULAB) in the Bachelor of Business Administration program prepared me well enough to contribute to the internship experience that I had at General Pharmaceuticals Limited. This congruence between the classroom and the professional practice made my internship not only informative, but effective.

The most pertinent courses have been Procurement, and Introduction to Supply Chain Management. The learning points on supplier selection criteria, tendering process and the method of comparing prices had helped me when I was tasked to prepare Requests to Quotation (RFQ) and Comparative Statement (CS) and my help to writes vendors. Such scholarly lessons gave me a clear picture of why sourcing decisions and vendor management is strategic. In the segment of demand planning and analysis, the information I have learned during the Business Statistics course helped me to comfortably create and utilize forecasting models. I employed software such as fbProphet and ARIMA to study the trend in sales, future demand and minimum reorder lots two which were very important in getting even supply of material flow as well as control the inventory. This application of the forecasting methods confirmed my knowledge of statistical applications in supply chain areas. The courses that helped me understand the concept of ERP systems and the digitalization of the supply chains included Principles of Management, Project Management, and Logistics Management. These topics made me familiar with the role of digital tools that promote effective business operations. This background gave me an easy time adopting the ERP platform at GPL, working on procurement information, tracking of purchase order status and assisting in reporting and analysis. Moreover, my classes on Sustainable Supply Chain Management and Logistics Management increased my understanding of the principles of inventory management, especially the aspects of the reorder point planning, calculation of lead time, and documentation procedures. I used such learnings when handling the purchase orders, checking Goods Receipt Notes (GRNs), and all the documents when they had to be recorded in the internal audit and financial reconciling.

Chapter 03: Self-Reflection

3.1 Things I Liked and Disliked about My Internship

The three months as an intern at General Pharmaceuticals Limited (GPL) brought a bunch of experiences that helped me to improve professionally as well as personally. Such experiences allowed me to get acquainted with a more practical perspective of supply chain operations, however also pointed out some aspects of supply chain work with which I would like to be more involved.

3.1.1 Things I Liked:

One of the assignments I enjoyed very much was the chance of working hands-on with the necessary procurement procedures including RFQ development, Comparative Statement (CS) and Purchase Order (PO) processing. The fact that I was entrusted with these tasks made me feel responsible and led to building confidence as a prospective supply chain professional. It was interesting to me to see the actual role of these processes in the functioning of the company and its relations with the suppliers. Another reason why my internship was very enriching was working on the GPL ERP system. It has given me insight into the way large-scale organizations deal with procurement processes, supplier information, inventory and documentation via a centralized digital service. This on field experience made me more equipped technically, and it also brought out the essence of technology in the contemporary world of supply chain management. Working with people who are much approachable, patient, and willing to me has also been the luck of mine within the environment I worked. The detailed explanation of complex procurement processes and ERP functionalities got me felt like I picked up the new information very fast and had a better learning experience. Working with the departments like Production, Quality Control and Accounts, I could get the entire view of supply chain integration. Gaining insights into this aspect allowed me to perceive SCM functions comprehensively, since have been informed how the process of procurement is often closely going hand in hand with the production schedules and the quality standards as well as with the financial procedures as well.

3.1.2 Things I Disliked:

Although I was present during the preparation of RFQs and CS, I did not have the opportunity to participate in supplier negotiations, discussions of contracts. Since negotiation is also a critical competency in procurement and supplier management, I think that participation in this field would have enriched my learning experience and practical experience considerably. Some of the documentation activities e.g. assembly of invoices, GRNs and audit material were tedious and took a long time to execute. I knew these were important steps that measured compliance and process accuracy, but it all felt less than fun and exciting to review and complete compared to the interactive world of AI forecasting, ERP analysis or a vendor evaluation assignment.

3.2 How I Improved & How the Organization Could Have Used My Skills Better

3.2.1 How I Improved Myself:

During my internship period at the General Pharmaceuticals Limited, there are a number of areas that I made significant changes during that period which has led to personal and professional growth. I improved the skills of working with ERP, I felt confident in how to manage procurements and flows, enter data and become good at generating reports. What my experience with ERP tools taught me is how the technology enables the making of real-time decisions in supply chain operations. My data analysis skills increased tremendously, since I have had to individually build a demand forecasting model with fbProphet. The experience served to reinforce my knowledge on the time series analysis, the calculation of errors, residual analysis and planning on the reorder points. I also tried some multi-model combinations, as combining forecasting methods, using ARIMA to residuals. Correspondence with suppliers and the internal teams also made me a better communicator. I was more certain about writing professional letters, creating procuring documentation and organising information in a way that it could be understood and cracked by colleagues and supervisors. The ability to juggle various procurement projects, along with super-tight deadlines enabled me to develop better time and organizational skills. I was trained to know how to prioritize tasks, deal with repetitive documentation on an efficient basis and to contribute to the running projects without missing any points.

3.2.2 How the Organization Could Have Used My Skills Better:

Although my internship was an eye-opening experience, I think that General Pharmaceuticals Limited could have tapped my talent in the following ways:

Because of my expertise in understanding supplier relationship management and strategies in negotiating prices, I would have been helpful in these processes (vendor meetings or pricing negotiations), which would have increased my practical knowledge. This would have given me the chance to see actual negotiation tactics and share my insight in analysis. My project on creating an AI-based forecasting model that used fbProphet was valued, but only found use at a pilot level during my internship. Being better integrated with the standard operations processes of GPL, I could have done more back office work around optimizing the inventory levels and the procurement planning of more materials. I might have been tasked with analyzing past procurement data to determine patterns, inefficiencies or cost-cutting opportunities. This would have allowed me to use data analysis and reporting skills to assist strategic procurement decisions.

3.3 Things I Would Like to Continue in My New Position

The experience I had during the internship at General Pharmaceuticals Limited has influenced my thinking about several key professional practices and skills that I hope to find useful in the future as part of my career. These are the key areas that I would like to continue working on and practicing:

I consider it a virtue to continuously employ data analytics and AI-based forecasting tools such as fbProphet to enhance demand planning, inventory regulations, and procurement effectiveness. Predictive analytics will also be used to minimize uncertainties and optimize supply chain functions. As an intern with experience of working on an ERP platform, I would like to acquire more expertise in advanced modules of ERP systems and also learn about other enterprise software like SAP or Oracle. This will also help me manage complex supply chain operations better. Well-documented and comprehensive documentation are vital to audit preparedness, regulatory compliance, and ease in money dealings. I will also strive to perfect my precision in preparing purchase orders, dealing with invoices, and receiving/verifying goods. I will cultivate

continuity in communication with other departments like Production, Quality Control, and Finance towards the incorporation of supply chain management. Effective communication and collaboration will play an important role in overcoming obstacles and achieving organizational objectives. The field of supply chain management is a dynamic one. I wish to be open-minded to discovering new tools, technologies, and best practices, such as emerging advancements in automation, AI, and digital supply networks to be a valuable addition to my future workplace.

Chapter 04: Personal Development Plan

4.1 My Next Course of Action & Career Plan

My experience as an intern at General Pharmaceuticals Limited has really helped in shaping my career options in the future towards my career path in the Supply Chain Management field. The practical portion highlighted how (practical) effective procurement practices, adoption of modern technologies, and evidence-based decision-making was essential towards having a competitive and sustainable supply chain.

4.1.1 Plans for Next 1 to 2 Years:

I will take certification classes like Certified Supply Chain Professional (CSCP) by APICS or Certified Procurement Professional (CPP) to enrich my knowledge and improve my qualifications. Such certificates will give me an expanded insight into the practice of global supply chain management, supplier relationship management, and strategic procurement practices. Understanding the importance of ERP systems to modern supply chains, I plan to receive the special training on the major ERP systems like SAP, Oracle NetSuite, or Microsoft Dynamics 365. This will aid me in furthering my system handling abilities and enhancing efficiency of the operations. Responding to my work with fbProphet, I intend to further perfect other predictive analytics tools, which include ARIMA, LSTM, and Scikit-learn, to realize more complex predictive analytics jobs. Such an understanding will allow me to bring new ideas in supply chain forecasting and planning. In the short-term perspective, I am planning to obtain a full-time job in the supply chain management or procurement unit of a distinguished enterprise. I am planning to apply my practical experience in procurement, expertise in ERP and forecasting to realize operational enhancement and cost-saving.

4.1.2 Plans for 2 to 5 Years and Beyond:

I intend to enroll in a Master program or MBA at a renowned international university, whether in Supply Chain Management, Business Analytics or any others. This will help me become a strategic thinker and a better leader in global supply chain operations. I see myself employed in high-level positions like Procurement Specialist, Demand Planner, or Supply Chain Analyst, in which I can create sustainable sourcing plans, efficiently manage inventory and build effective relationships with suppliers, thereby ensuring that costs are minimized and value is created. With

time, my career ambitions include becoming a manager with responsibilities of leading procurement or supply chain, SCM policy formulation, and digital initiatives, such as AI implementation and blockchain-powered supply chains. To keep myself updated to the current trends and to have a competitive advantage in the dynamic nature of supply chain management, I will go to the extent of taking advanced education and certification depending on my career development.

4.2 Skills I Want to Develop for Career Success

My internship experience in General Pharmaceuticals Limited has made me realize that there are some important areas of skill that I am going to advance in order to realize my long term career objectives in supply chain management. The development of my negotiation and supplier relationship management skills is one of the priorities. Whilst my experience involved preparing Requests for Quotation (RFQs) and Comparative Statements (CS), I had less chance of having direct negotiations with suppliers. I would therefore be willing to be taught superior negotiation skills and relationship development strategies which can be used to build strong, trustful relationships with suppliers. The second growth spot is strategic sourcing and cost analysis. I will develop the skills in the market research, supplier benchmarking, and Total Cost of Ownership (TCO) assessment to make sure that procurement decisions are not just cost-effective but they are ultimately in line with the organizational long-term objectives. Also, I intend to develop my data analytics and visualization skills. Although I have already used Python and fbProphet, learning additional tools like Power BI, Tableau, and SQL will enable me to use them to properly show trends in the supply chain and support them in decision-making based on advanced analytics insights. To work towards being a leader in future, I realize that I need to enhance my leadership quality and ability to undertake projects. Taking courses such as Project Management Professional (PMP) would also help me to serve as a good leader in cross-functional teams as well as manage complicated supply chain projects. Concurrently, I am aware that supply chain is a constantly developing sphere with such innovations as blockchain, IoT, and robotics. Thus, flexibility and creativity are the qualities that I need to cultivate. It is also critical to know what new technologies are used and being open to experimentation to help me play a significant role in the digitalization of the supply chain. My experience as an intern has given me a good base on procurement activities, ERP, and AI-enhanced forecasting. It has motivated me to learn and

improve my skills in order to survive in a dynamic SCM environment. With the intention to become both a highly skilled technical professional and effective interpersonal individual, I believe I will feel well prepared to provide strategic value to organizations regarding strategic decision making, how they operate, and the skills of creative supplier management.

Part-B

Demand Forecasting and Reorder Point Planning Using AROPHET

Executive Summary

In the contemporary changing world, it is important that manufacturers and sellers of consumer products know how many units to keep. In the event of a wrong guess, they risk losing some important thing besides money on extra stocks. In this research paper, the researcher will be examining, Diploma Instant Full Cream Milk Powder (400gm) which is one of the consumer products which is facing changes in demand due to many reasons like the season of the year, the buyer habit etc's due to uncertainties in the market. The simple forecasting techniques will not always capture the changes and their estimates will fail between the planned and actual demand. This error was addressed by the researchers using a hybrid forecasting model labeled AROPHET. Facebook Prophet was chosen to monitor long-term patterns and seasonal patterns and ARIMA (Automatic regressive and distributed moving average) worked to capture short-term fluctuations and the remaining residuals. The two complemented each other to be more accurate at forecasting than Prophet used alone. Gemcon Group supply chain management department submitted monthly sales pattern of Diploma Milk Powder in January 2023 to December 2024. The outputs of the AROPHET were used to calculate Reorder Points (ROP) by adding the lead time demand and safety stocks in order to sustain a 95 percent service level. The measurements of forecast performance included Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), Mean Absolute Percentage Error (MAPE), and R^2 . Results showed that the hybrid AROPHET model was much superior in terms of accuracy of forecasts than the Prophet-only forecasts and across all metrics of accuracy. The study will be applicable in all senses, both theoretical and practical, as it is used to show how AI-based hybrid forecasting applications can directly communicate with inventory control processes such as ROP. It is the evidence that demonstrates that businesses will be able to mitigate the risk that their stocks may be out of supply or that they end up with more of a product than they require and streamline their supply chains especially in Bangladesh.

Chapter 01: Introduction

1.1 Background of the Study

The consumer goods (FMCG) is a competitive and sensitive industry, thus it is important to understand just what the customers will need and when. When the inventory planning and demand forecasting is right, companies will be able to have the necessary items on shelf without being too expensive and avoiding stockouts or masses of perished products. A successful performance of these two tasks is specifically linked to customer satisfaction, brand trust and long-term supply chain health. Consider such a company as Gemcon Group. Each day they attempt to balance shifting customer demand, stakes that are high, and the risk of having excess stock or insufficient stock. The forecasting system cannot afford to be fixed and multi-angled at the same time because of the rather acute response of many FMCG products to the topic of seasonality, price changes, frequency boom periods, and other habits. The fastest growing example has been Bangladesh due to the fast urbanization, a changing lifestyle and larger budgets. Expansion is exhilarating and at the same time, demand may fluctuate wildly, and product mixes continue to grow and supply chain have to respond virtually real time. Milk powder provides a great example: It sells well throughout the ages, but seasonal trends, advertising campaigns on nutrition, and changes in income will cause its demand to surge and decline. More sophisticated forecasting models like moving averages or simple linear regression models don't always keep pace in a market that rapidly changes.

Diploma Instant Full Cream Milk Powder (400gm) is one of the most demanded options sold by Gemcon Group in Bangladesh. The company regardless has a powerful sales network; but it continues to adjust its inventory to meet actual demand. Supply chain management typically relies on conventional planning processes that may be unable to respond immediately to a surge or trough in demand and to maintain sufficient stock at seasonal times of the year so that either surplus inventory must be carried, and working capital consumed or stock-out must be faced risking loss of business to rivals. Traditional time-series methods are unable to represent long pattern relationships in FMCGs demand since consumer buying behaviour, market competition and supply chain disruption is intrinsically uncertain. It comes with some added pressure, as dairy-based products have a very short shelf-life and projections have to be precise enough to anticipate demand without letting the product expire. Due to that, the interest in applying artificial intelligence (AI) and machine learning (ML) tools in the FMCG supply chain

management grows. Such methods manage complex, nonlinear patterns of demand and are capable of dynamically changing in real-time in the face of market changes. Arguably, the best of this group is Facebook Prophet (fbProphet) which can flexibly and robustly capture long-term trends and seasonal patterns.

However, Prophet may underperform in short term demand fluctuations and autocorrelations which are of the highest importance to operational decisions such as procurement and reorder planning. ARIMA (AutoRegressive Integrated Moving Average) models only adapt the stationary time series and short term fluctuations and perform inadequately when it comes to complex seasonalities and exogenous shocks. The deficits of the individual models are sufficient to indicate that a hybrid forecasting method deserves to be considered. The merger of Prophet and its skills to capture global trends and seasonal patterns with an ability of ARIMA to model short-term residuals will allow providing forecasts that will be more accurate and reliable. This paper proposes a hybrid method, AROPHET (a mixture of Prophet and ARIMA), to refine the prediction of demand and Reorder point (ROP) of Diploma Milk Powder in the Gemcon Group. Upon implementation, the model ensures filling the gap between archaic inventory processes and the complexity of FMCG demand, hence enabling the company to achieve its strategic objectives of reducing costs, improving service levels, and enhancing operational efficiencies.

1.2 Problem Statement

In the fast-moving consumer goods (FMCG) industry, effective demand forecasting is essential when a firm needs to maintain the appropriate inventory level due to the fact that selling products when out of stock and holding too many products in inventory can lead to serious problems. Consider milk powder: when the stores are out of milk powder, families are unable to perform their daily tasks, brand loyalty is replaced by price loyalty, and the manufacturer is losing the market share. When an excess supply of milk powder is stocked, the company incurs excess holding, money held and milk powder that may go bad on the shelf. In developing markets, such as Bangladesh, these issues are even more difficult due to inefficient supply chain, outdated forecasts and spread out inventory control. Conventional forecasting models of statistics fail to

capture the nature of FMCG demand, which is nonlinear, seasonal, and highly volatile, and changes based on festivals, promotional activity, consumer behavior and flash trends in the market. More recent AI-based strategies have the potential to be more effective, though these too are not actively employed in the FMCG industry in Bangladesh, and are not linked to routine inventory planning. Consequently, most forecasting systems will issue simple point forecasts lacking uncertainty, which decreases confidence of Reorder Point (ROP) planning. This can result in failure of services when demand is high or excess supply at a slow demand which results in decreased efficiency of the supply chain. To respond to these problems, this paper proposes a hybrid forecasting framework named AROPHET, a combination of Facebook Prophet and ARIMA with bootstrapped uncertainty intervals to flexibly modify ROP. By using actual real-life sales figures of Diploma Instant Full Cream Milk Powder (400gm) covering the period January 2023 through to December 2024 as reported in the Supply Chain Management department of Gemcon Group, the findings indicate that hybrid models would allow to increase forecast accuracy and assist in making better inventory decisions.

1.3 Research Objectives

The primary objectives of this research are:

1. Derive and code a hybrid model, called AROPHET, which combines Facebook Prophet with ARIMA to increase accuracy in the prediction of monthly demand of Diploma Instant Full Cream Milk Powder 400gm.
2. Integrate the forecasts with dynamic Reorder Point (ROP) planning, which considers not only anticipated demand but also the uncertainty in the prediction, reducing the probability that there may be stockouts and over-stocking.
3. Demonstrate that the hybrid forecasting and ROP planning framework is applicable in real life using real sales data of the Supply Chain Management section of the Gemcon Group, and demonstrate that it is viable in fast-moving consumer goods (FMCG) company operating in an economy such as Bangladesh, which is developing.

1.4 Research Questions

This research paper will answer the questions below:

1. How well can AROPHET forecast the monthly demand of Diploma Instant Full Cream Milk Powder compared to the forecasting techniques currently in use?
2. Does the introduction of bootstrapped uncertainty intervals into demand forecasts in FMCG inventory planning improve reliability of demand forecasts particularly in products whose demand is highly varying?
3. Compared to single-models (Prophet or ARIMA), what are the comparative advantages of AROPHET-based forecasting in effective procurement and Reorder Point (ROP) considerations in the FMCG market?

1.5 Significance of the Study

This is a significant study in many ways, both in real life and in the classroom. First combine the most effective aspects of two popular forecasting approaches. I combine Prophet (when good at trend and seasonality) with ARIMA (when good at short-term adjustments) and the new composition, the so-called AROPHET, makes forecasts on fast-moving consumer goods (FMCG) more accurate. It is relevant to products such as Diploma Instant Full Cream Milk Powder which experience periods of high and low demand due to seasons and shopping trends, as well as overall market volatility. Second, the team abandons the conventional Reorder Point (ROP) strategy, which solely relies on one projection. Rather, they employ dynamically considered bootstrapped uncertainty-based ROPs. This new twist simplifies the decision firms have to make on what quantity of stock to maintain on hand when demand is uncertain, reducing stockouts as well as bad stock positions, all the time achieving the target service level. Lastly, the research provides practical guidelines to supply chain experts and inventory administrators. Incorporating AI-driven hybrid forecasting into real-life scenarios enables enterprises like the Gemcon Group to align their purchases to reality and reduce wastage, release their working

capital, and delight their consumers. With real-world AI-driven hybrid forecasting, businesses like Gemcon Group can align their purchase to real demand, eliminate waste, release their working capital, and make their customers satisfied. To crown it all, the study contributes another dimension to the scholarly debate, indicating how hybrid forecasting may be applied to new markets with volatile demand and supply chain challenges still looming large.

Chapter 02: Literature Review

2.1 Theoretical Background

Demand forecasting is a key to successful supply chain and inventory management, especially in high-demand uncertainty industry, such as pharmaceuticals and consumer goods with high turnover rates (FMCG). Forecasting helps to ensure that products are available to meet demand, reduce stock outages, and lower inventory costs (holding, wastage and obsolescence). Even such classical concepts of inventory management as Economic order quantity (EDOQ), Reorder Point (ROP), and so-called safety stock models would not be possible without sufficiently accurate demand forecasts (Avi et al., 2024).

Epidemics of diseases, unexpected public health campaigns, regulatory changes, and other factors make predicting in the pharmaceutical industry extremely complicated (Merkuryeva et al., 2019). In the same vein, FMCG products, many of which have poor shelf life and are susceptible to consumer whims and fads, risk excessive stocking or stock outs in case the forecast is not correct. Moving Averages, Exponential Smoothing, and ARIMA were all popular traditional forecasting techniques because they are easy to understand and do not require much data. Nevertheless, such models fail to account for non-linearity, sharp discontinuities, or highly dynamic consumer behavior (Hyndman and Athanasopoulos, 2018).

Artificial intelligence (AI) and machine learning (ML) have significant opportunities to make forecasts more accurate. Nonlinear shifting demand patterns required general AI models that address these dynamics and dynamically adapt as new data is added, which is most suitable in both the FMCG and pharmaceutical supply chains (Narne, 2021). Simultaneously, the blockchain technology is also being examined as a technology that can enhance the data transparency, traceability, and real time sharing of information, which, in turn, can enhance forecasting systems (Hasan et al., 2022). Blockchain can underpin more credible demand forecasting and logistics activities by making it possible to conduct safe and reliable exchanges of data between stakeholders.

There is now increasing evidence that ambiguous forecasting methods that merge the assessments of conventional statistical models and contemporary AI-enabled tools will be advantageous. These models are interpretive and flexible, generating a greater number of

predictions that are more accurate and predictable in sectors with uncertainty, seasonality and volatility. Hybrid models are, in turn, becoming one of the most viable solutions to bridging the gap between classical forecasting techniques and the dynamism of the contemporary FMCG and pharmaceutical supply chains (Alzubaidi, 2020).

2.2 Demand Forecasting in FMCG and Pharmaceutical Supply Chain Management

The demand variability would be vast across both FMCG and pharmaceutical supply chain, and demand forecasting is extremely important since stockout or overstocking could be extremely costly. Under pharmaceuticals where we have poor predictability of demand then we will have shortages of lifesaving medicines, in FMCG industries where we have wrong reporting of demand then we will have wasting of products with short shelf life and also a perishable nature. Since time-based predictive models such as ARIMA and other time-series techniques are simple to use and understand, they have been in practice. Yet, such strategies inevitably prove ineffective immediately when the demand starts shifting radically, such as the season, the promotion, or an outbreak of disease.

The blockchain has emerged as an innovative technology enhancing predictability in the supply chain enabled by enhanced transparency, traceability and information sharing among different stakeholders. Another indirect contribution to increased demand forecasting and logistics brought about through blockchain integration in FMCG supply chains is also noted by Hasan et al. (2022). The precision of the transactions recorded in blockchain makes it a source of proven information to support forecast models and reduce inefficiencies created by inaccurate or slow data. FMCG and pharmaceutical environments can also be integrated in this way to create more resilient forecasting systems that align the inventory as much as possible with the demand on the ground.

2.3 Artificial Intelligence and Machine Learning in Forecasting

The game-changing demands forecasting is shifting to AI and machine learning. The more sophisticated nonlinear connections, season, and external effects cannot always be captured and estimated using older statistical techniques but can be incorporated using AI-powered models (Narne, 2021). They continue to acquire knowledge based on new data, thereby adapting to the changing demand trends and they improve with time.

Facebook Prophet (fbProphet) is one of the most popular AI-based forecasting tools. Its use by businesses in segments such as FMCG and pharmaceuticals denotes that these industries produce time-series with multi-seasonality, time-trend variations, and record gaps- the fluctuating demand of pharmaceuticals (Taylor & Letham, 2017). The caveat? fbProphet is a long-term trend investment and seasonality model, and thus there is some short-term residual behavior that it does not model well, and this can actually detract the utility of fbProphet in daily inventory management settings. To overcome this, hybrid models, wherein fbProphet is combined with other, more classical statistical methods such as ARIMA, have been developed. ARIMA has the reputation of representing the stationary time-series data and identifying the short-term autocorrelations. Incorporation of fbProphet and ARIMA together means that the overall strengths of the two will be drawn in by the hybrid models, resulting in a high level of accuracy and reliability (Siddiqui et al., 2021).

2.4 Hybrid Forecasting Models in the FMCG and Pharmaceutical Industry

Another emerging trend is the superior performance of hybrid forecasting models (integrating statistical models with AI-based forecasting models) in controlling the volatility and uncertainty in demand. Traditional time series forecast models, such as ARIMA, are good in the modeling of non-seasonal and linear time series; AI-based machine learning models, such as Prophet and machine learning services, are good in the modeling of nonlinear time series and seasonal time series. However, the workability of single form of methodology does not necessarily fulfill in the real life scenario particularly when certain customer action, advertisements, and human provision encounters leads the demand to shift and its variability to be experienced through the market dimensions of FMCG and the pharmaceutical provision chain.

Alzubaidi (2020) developed a comparative study of the statistical vs machine learning forecasting techniques used by the FMCG companies and discovered that combined techniques tend to be better than methods used separately. The researchers have found out that as the machine learning techniques are introduced along with the classical syntax analysis, the following benefit can be obtained; in order to make the predicted values more accurate and precisely, as the long-run tendencies are considered, the short-run specifics are also considered. These results have a direct impact on the current study, given their supporting use of hybrid forecasting models such as AROPHET. These models will not only provide a more transparent predictive, but also inventory decision making models such as reorder point planning (ROP) and that is needed to manufacture or produce at desired service levels in turbulent markets.

2.5 Research Gap

As of now, the trend moves towards using AI-assisted forecasting models in supply chain management, whereas most of the current research compares either a classical statistical model (like ARIMA) or AI-based model (like Prophet) as a standalone predictor (Alzubaidi, 2020). Applying these strategies to hybrid models has so far been analysed in a highly fragmented fashion and only less so in the developing world where supply chains tend to be more susceptible to uncertainty and lack of adequate data like in the case of Bangladesh. There is also another significant weakness in the overall literature: only a small proportion of studies connect forecasting models with inventory control systems like Reorder Point (ROP) planning. The majority of studies end up making just a forecast, even without converting them into a form where a company can take actions such as decisions related to inventory. Likewise, approaches to address uncertainty, such as bootstrapped confidence intervals, are not commonly used in practice despite being required to generate risk-sensitive procurement strategies (Hasan et al., 2022). Even though the latest FMCG studies have already designed to examine initiating the application of technologies, including blockchain, to enhance data revelation and logistics procedure (Hasan et al., 2022), it lacks a knowledge gap on the way that the characteristics of these sorts of innovations may be linked into a more innovative and transparent domain of demand planning that will facilitate more powerful organizations of forecasting and forecasting

techniques. This is of particular importance to nations such as Bangladesh where FMCG and pharmaceutical supply chains are vulnerable to demand uncertainties, shelf-life risks and pressures on the service level.

This study tries to fill these gaps by applying the hybrid AROPHET model (Prophet + ARIMA) on real sales history of Diploma Instant Full Cream milk powder and correlating the forecast with dynamic ROP planning specifying the uncertainty in forecasts. In such a way, the study can not only show the effective use of hybrid forecasting but also presents arguments that AI-based solutions can enhance procurement and inventory decision-making in a real FMCG and pharmaceutical business in Bangladesh.

Chapter 03: Research Methodology

3.1 Research Design

The study is a quantitative case study with advanced time series forecasting used to enhance supply chain management of fast-moving consumer goods (FMCG). Diploma Instant Full Cream Milk Powder 400gm is the test product, and one can find the product in the selling market of Bangladesh as a popular product contributing variable demand due to the seasonal impact, consumer buying behavior, and market dynamics. It is an excellent topic to forecast the demand due to these reasons. It is an investigation that combines the statistical analysis and the artificial intelligence (AI) to examine whether a hybrid forecasting model (AROPHET) can enhance the accuracy of forecasting and sharpen the Reorder Point (ROP) decisions. AROPHET combines Facebook Prophet, which detects long-term trends and seasonality, with ARIMA which identifies short-term trends and autocorrelations. By using the monthly sales data of Diploma Milk Powder between January 2023 and December 2024 provided by the Supply Chain Management Department of the Gemcon Group company, the technique reflects the reality of the matter and provides planners with helpful information on how to maintain FMCG inventory. The study will use hybrid forecasting on ROP planning to ensure that the stock levels are maintained at the right level, reducing risk in the inventory and being waste-free.

3.2 Forecasting Tools and Techniques

3.2.1 Facebook Prophet

Facebook Prophet Facebook Prophet is an additive and modular forecasting tool fitting trend, seasonality, and event components (Taylor & Letham, 2018). The fundamental model can be defined as:

$$y(t) = g(t) + s(t) + h(t) + \varepsilon(t)$$

Where:

$g(t)$: Non-linear trend

$s(t)$: Seasonal component (monthly/yearly)

$h(t)$: Holiday effects

$\varepsilon(t)$: Residual error

3.2.2 ARIMA (AutoRegressive Integrated Moving Average)

ARIMA is a traditional, time-series model that works well at capturing autocorrelated errors Prophet might fail to detect (Hyndman & Athanasopoulos, 2018). I fit an ARIMA(1,0,1) model to the residuals:

$$e_t = \phi \times e_{(t-1)} + \varepsilon_t + \theta \times \varepsilon_{(t-1)}$$

Where:

1. e_t is the current error term,
2. ϕ (phi) is the autoregressive coefficient for the previous error,
3. ε_t is the current white noise (error term),
4. θ (theta) is the moving average coefficient,
5. $\varepsilon_{(t-1)}$ is the previous white noise term.

I chose the final parameter through looking at the Akaike Information Criterion (AIC) and ensuring that no patterns lingered in residual (Box & Pierce, 1970).

3.2.3 AROPHET Hybrid Model

The AROPHET model combines Prophet and ARIMA so as to leverage their respective advantages:

1. Prophet is excellent at identifying trend: ability to find long-term patterns and seasonal trends.
2. ARIMA addresses short-term autocorrelations.

Hybrid Forecast (AROPHET) = Prophet Forecast + ARIMA Residual Forecast

3.3 Methodological Steps

This study develops a demand-aware and uncertainty-sensitive reorder point (ROP) model using a hybrid forecasting approach. The methodology comprises ten structured steps.

Step 1. Importing Libraries

The notebook begins by importing essential Python libraries for data analysis, visualization, and forecasting:

- ``numpy``, ``pandas``: Data manipulation and analysis.
- ``matplotlib``, ``plotly``: Data visualization.
- ``prophet``, ``statsmodels.tsa.arima``: Time series forecasting models.
- ``sklearn.metrics``: Model evaluation metrics.

Step 2. Data Preparation

- The sales data is loaded from an Excel file.
- The code checks for the presence of required columns (e.g., date, sales, and various regressor variables).
- If the file is missing or columns are absent, appropriate error handling is performed.
- The first few rows of the data are displayed for inspection.

The dataset was obtained directly from Gemcon Group's SCM Department and covers sales performance for Diploma Instant Full Cream Milk Powder 400gm between January 2023 and December 2024.

The dataset includes the following variables:

- **ds:** Timestamp in YYYY-MM format
- **y:** Monthly sales quantity (units)
- **Sold Value (BDT):** Monthly sales value in BDT
- **Average Lead Time:** Supplier lead time (days)
- **Average Order Frequency:** Number of orders per month
- **Monthly Order Quantity:** Planned procurement quantity per month
- **Safety Stock:** Inventory buffer to maintain 95% service level
- **Shelf Life:** Product storage duration (15 months for milk powder)

Step 3. Data Cleaning

- Column names are standardized by stripping whitespace.
- The code ensures all required columns are present.
- The Prophet model is initialized and fitted using the date (`ds`) and sales (`y`) columns.

Step 4. Basic Forecast Data Cleaning

- The raw data is further cleaned to ensure correct column names and types.
- Non-numeric characters are removed from the sales column.
- Dates are parsed and invalid entries are dropped.

Step 5. Model Cross-Validation and Performance Metrics

- Prophet's cross-validation is performed using a rolling window approach (365 days initial training, 90 days step, 180 days forecast horizon).
- Performance metrics (MAE, RMSE, MAPE, coverage) are calculated and displayed.
- R^2 scores are computed for each fold and averaged.

Step 6. Forecasting with Prophet

- A Prophet model is fitted to the cleaned data.

- Future sales are forecasted for 12 months ahead.
- The forecast for the year 2025 is extracted.
- Regressor variables are merged into the future dataframe and missing values are interpolated.

Step 7. Visualization of Prophet Forecast

- Actual sales and Prophet forecasts are plotted.
- Confidence intervals and error bars are included.
- The forecast region for 2025 is highlighted.

Step 8. Bootstrapped Confidence Intervals

- Bootstrapping is used to estimate confidence intervals for the forecast.
- Residuals from the model are sampled to create bootstrapped forecasts.
- Lower, upper, and median bounds are calculated for the forecast.

Step 9. Dynamic Reorder Point (ROP) Calculation

- ROP is calculated using the bootstrapped upper bound.
- The results are displayed in a table and visualized.

Step 10. Residual Modeling with ARIMA

- Residuals from the Prophet model are modeled using ARIMA.
- ARIMA forecasts are added as corrections to the Prophet forecasts, creating a hybrid forecast (AROPHET).
- Historical corrections are applied to the Prophet predictions.

Step 11. Hybrid Forecast Using AROPHET

- The hybrid forecast for 2025 is extracted.
- ROP is recalculated using the hybrid forecast.
- The results are displayed and visualized, comparing Prophet and AROPHET forecasts.

Step 12. Visualization of Forecasts and Residuals

- Forecasts and confidence intervals are visualized.
- Residuals from the ARIMA model are plotted over time.

Step 13. ROP Comparison

- ROP values from Prophet and AROPHET models are plotted for comparison.

Step 15. Model Validation and Error Analysis

- Forecasts were compared to actual sales for January–July 2025
- Error metrics (MAE, RMSE, MAPE, R^2) were calculated for both models.
- Error patterns and sources were analyzed to identify model strengths and limitations.

3.4 Limitations

1. Data Source Constraint: The research was started with a usable data of sales of General Pharmaceuticals Ltd. (GPL). Nevertheless, it was not possible to directly access the dataset of GPL because of the confidentiality limitations. In its place, an index of real sales of Gemcon Group Diploma Instant Full Cream Milk Powder (400gm) was used as a proxy. However, as far as it remains a demand sensitive FMCG product, such a substitution can restrict access to sector-specific knowledge that is meant to be applied to pharmaceuticals.
2. Single Product Focus: Results are understood to be specialized related to single product and thus it may not be indicative enough to all FMCG or pharmaceutical product categories.
3. Limited Variables: The research was mainly based on univariate time-series (item sales), excluding external forces like promotions, competition and macro-economics.
4. Fixed Lead Time Assumption: The lead time in this case scenario was adjusted as constant, 7 days, but in reality, the problem could be corrected by fluctuations of supplier delays and logistical variabilities.
5. Short Horizon: The range of the data is two years (2023-2024) limiting the possibility to measure the demand cycles or structural changes over time.

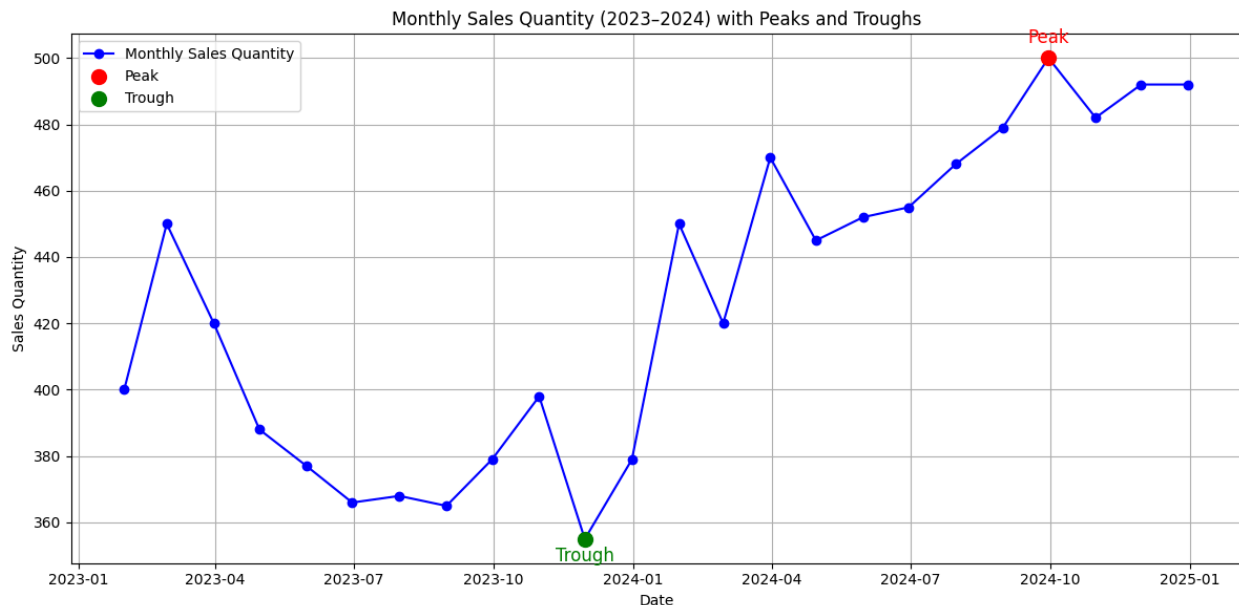
Chapter 04: Data Analysis & Findings

In this chapter, the findings of the forecasting model of hybrid ARIMA and Facebook Prophet (AROPHET) which are applied to the sales data of the Diploma Instant Full Cream Milk Powder 400g, are displayed. The purpose was to produce the most accurate demand forecasts in 2025 and to apply them to optimize dynamic and risk-sensitive reorder point (ROP) calculations.

4.1 Sales Data Summary

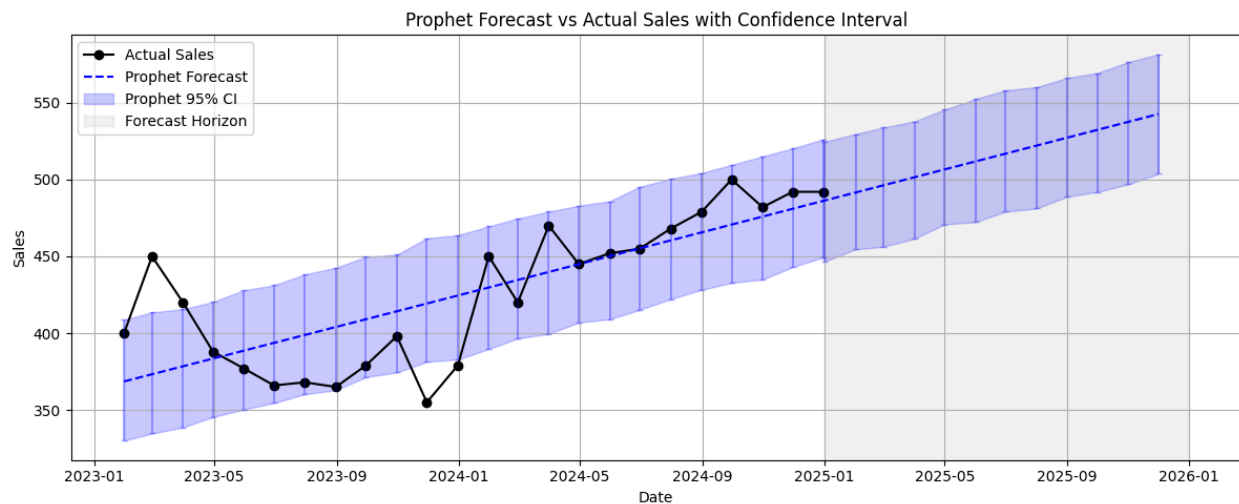
The data adopted by this study was obtained by the Supply Chain Management at Gemcon Group over the 2023-2024 period starting in January 2023 and ending in December of the same year. Every record involved Monthly quantity of sales, value of the sales, the frequency of the order, the lead time (7 days), quantity of the order per month, all-time stock and the shelf-life (15 months).

The number of sales varied between 355 and 500 units per month, with apparent spikes in January 2024 (450 units) and September 2024 (500 units). It depicted seasonality where demand was relatively high during Q1 and Q4 supported by influence by consumer behavior in purchasing, festival, and market campaigns.



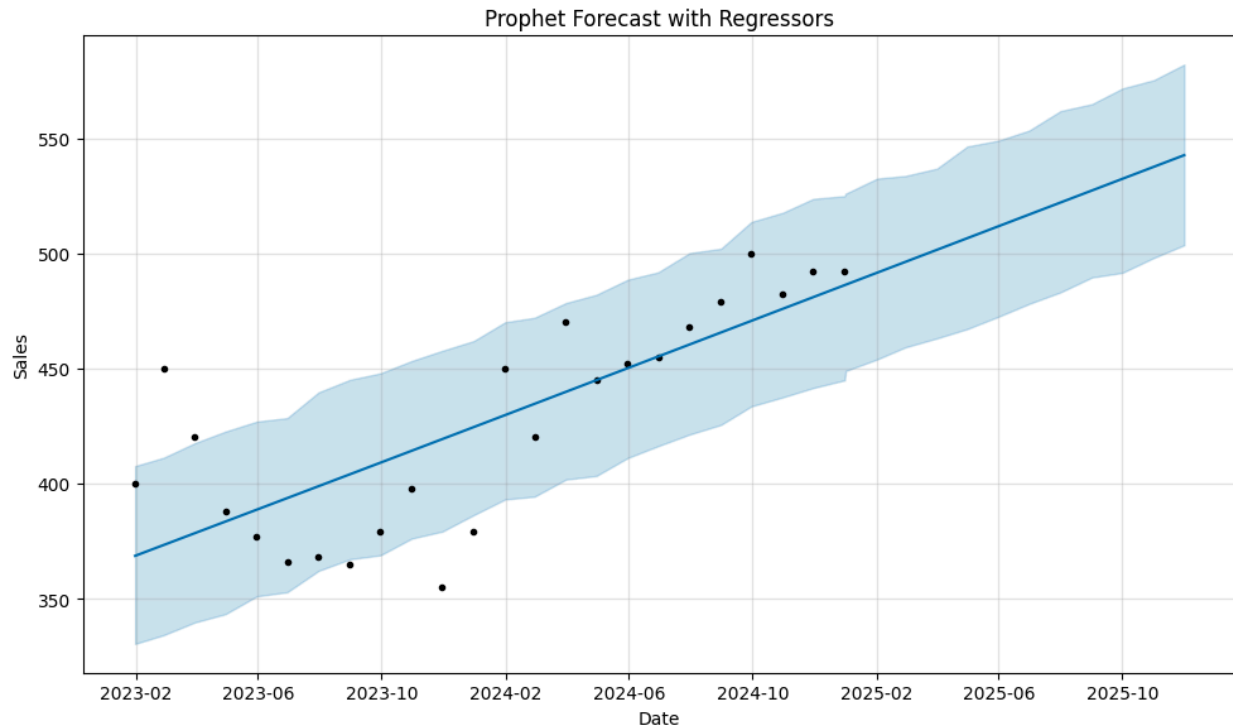
4.2 Forecast with Prophet

Prophet has been designed to monitor long-run trends and seasonal fluctuations in demand. It performed very well in identifying the large peaks in its Q1 and Q4, and it also forecasted a linear curves of growth in 2025. Prophet would suggest forecasts each month using 95 percent confidence limits and so we could see where the demand would most probably settle. It scored on large seasonal trades, but occasionally it did not pick up minor surges brought about by one-time offers or new market shock.



4.3 Bootstrapped Forecast Intervals

Bootstrapping was used, and the residuals of the model were bootstrapped, to obtain uncertainty estimates that were superior to those given by the default confidence bands of Prophet. This gave a sample of 1,000 sampled forecast paths of lower (2.5%), median (50%), and upper (97.5%) estimates of the demand. The bootstrapped intervals gave a more realistic estimate of forecast uncertainty that subsequently was incorporated into dynamic ROP calculations.



4.4 Reorder Point (ROP) Using Prophet Forecast

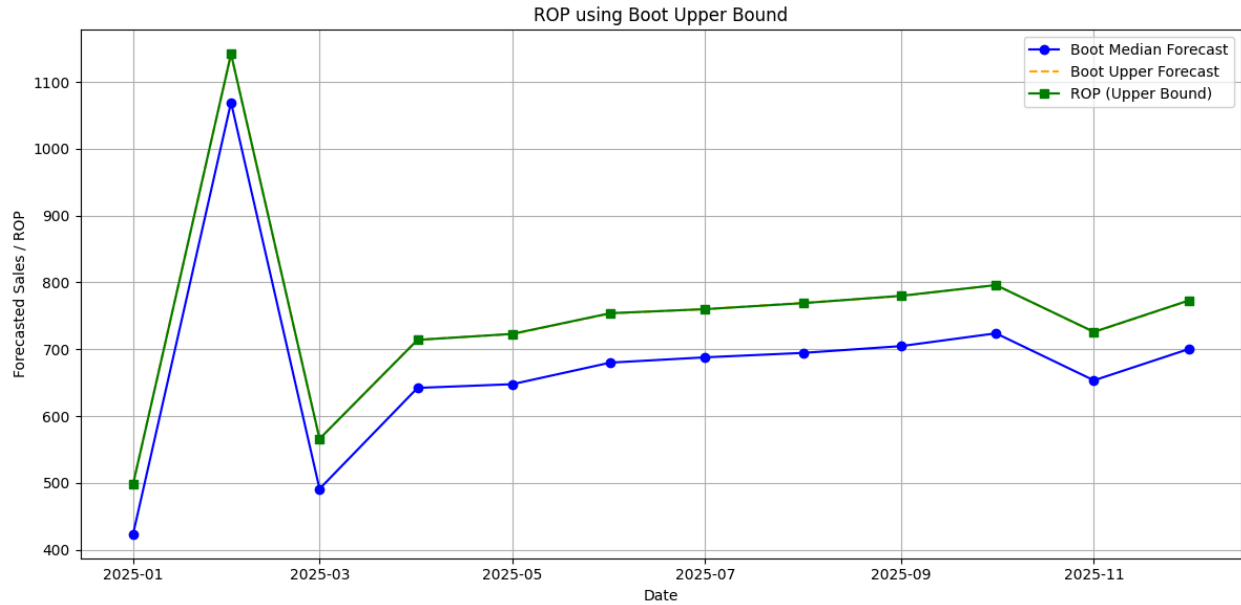
I calculate risk based approach instead of the traditional ROP formula (which is Lead Time Demand + $Z \times \sigma$).

The formula which I utilized:

$$\text{ROP} = \text{median Forecast} + k (\text{Upper Bound} - \text{Median Forecast})$$

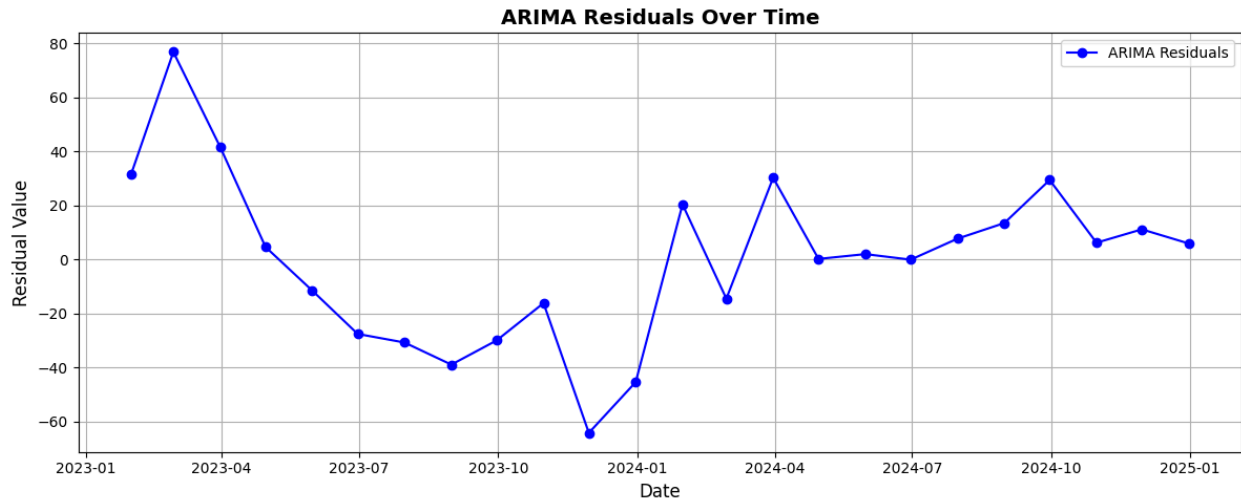
Where, $k = 1.0$ when service level = 95 percent

These ROPs matched the uncertainty in the demand with inventory thresholds. But Prophet occasionally made too low an estimate of demand during volatile months, which threatened a shortage of stock.



4.5 Prophet Residuals and ARIMA

Residual analysis indicated that Prophet introduced structured errors in the months of low demand indicating that there was a short-term autocorrelation not captured. To overcome this, residuals were treated with ARIMA(1,0,1), selected on the basis of the Akaike Information Criterion (AIC). The ARIMA model made it able to capture time series and adjust short term fluctuations, which Prophet is unable to alone.

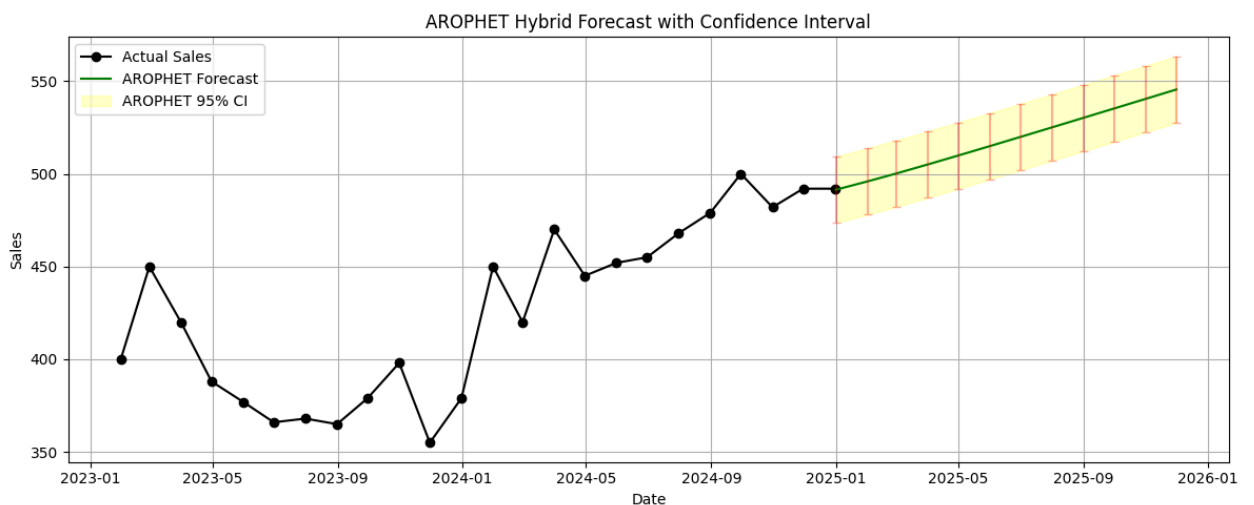


4.6 AROPHET Forecast (Hybrid)

Then, I generated the hybrid forecast by adding the base forecast of Prophet to the ARIMA forecasted residuals.

AROPHET Forecast = Prophet Forecast + ARIMA Residual

This mixed approach solved the short-term forecasting problems that Prophet could not solve itself.

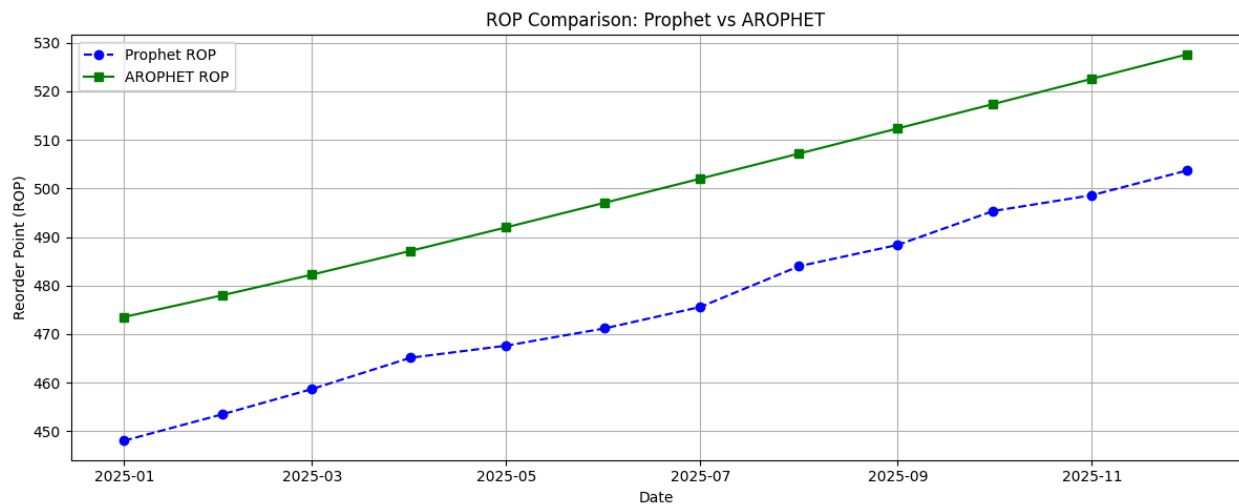


4.7 Reorder Point (ROP) Using AROPHET

I figured ROP the same way: after a final hybrid forecast, I made bootstrapped ROP calculations:

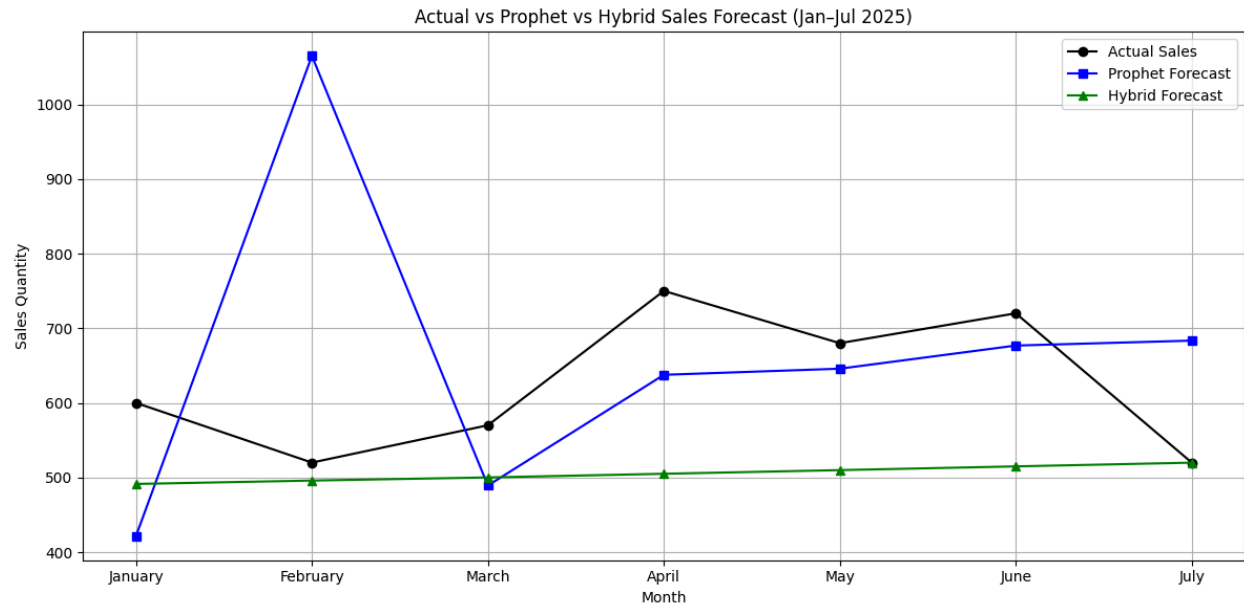
$$\text{ROP} = \text{AROPHET Median} + k (\text{Upper bound} - \text{Median Forecast})$$

This approach was more risk free and smoother in times of demand fluctuations (e.g. September-December). Because of this, ROPs based on AROPHET were much more protective of stockout and excessive inventory than ROPs based solely on Prophet.

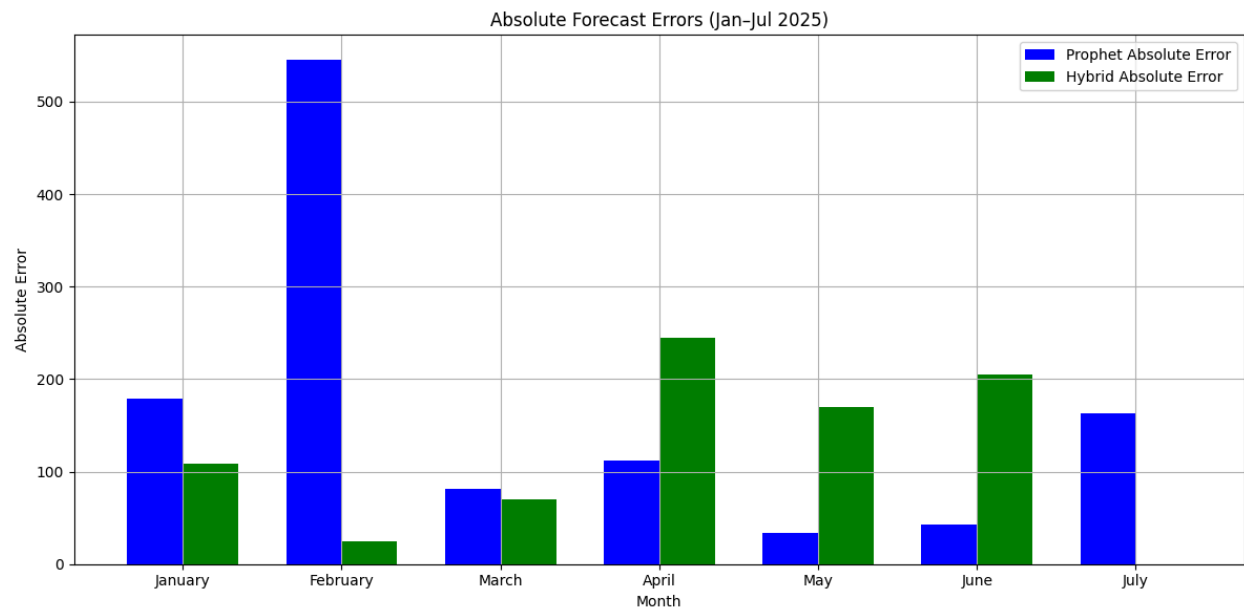


4.8 Forecast Accuracy Comparison

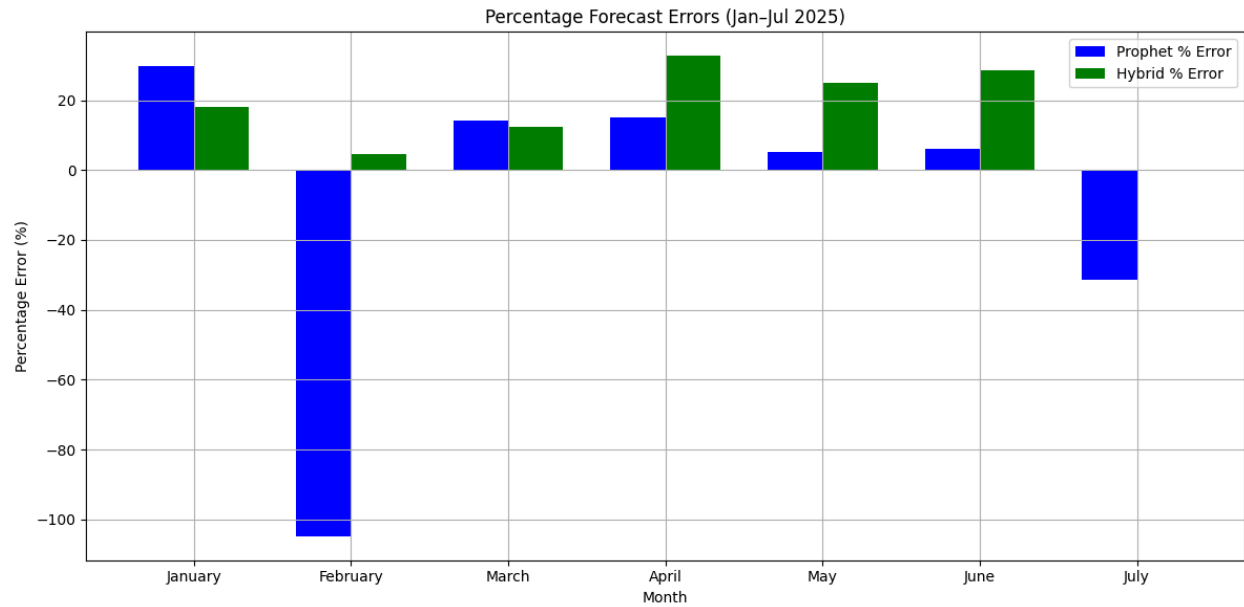
For January to July 2025, the AROPHET hybrid model consistently outperformed Prophet in forecast accuracy. The hybrid model achieved lower MAE, RMSE, and MAPE, and a higher R^2 , indicating a better fit to actual sales. The largest Prophet error occurred in February, likely due to unforeseen market changes or supply chain disruptions, while the hybrid model substantially reduced this error. Both models underestimated sales in April–June, suggesting the need for further refinement and consideration of external factors.



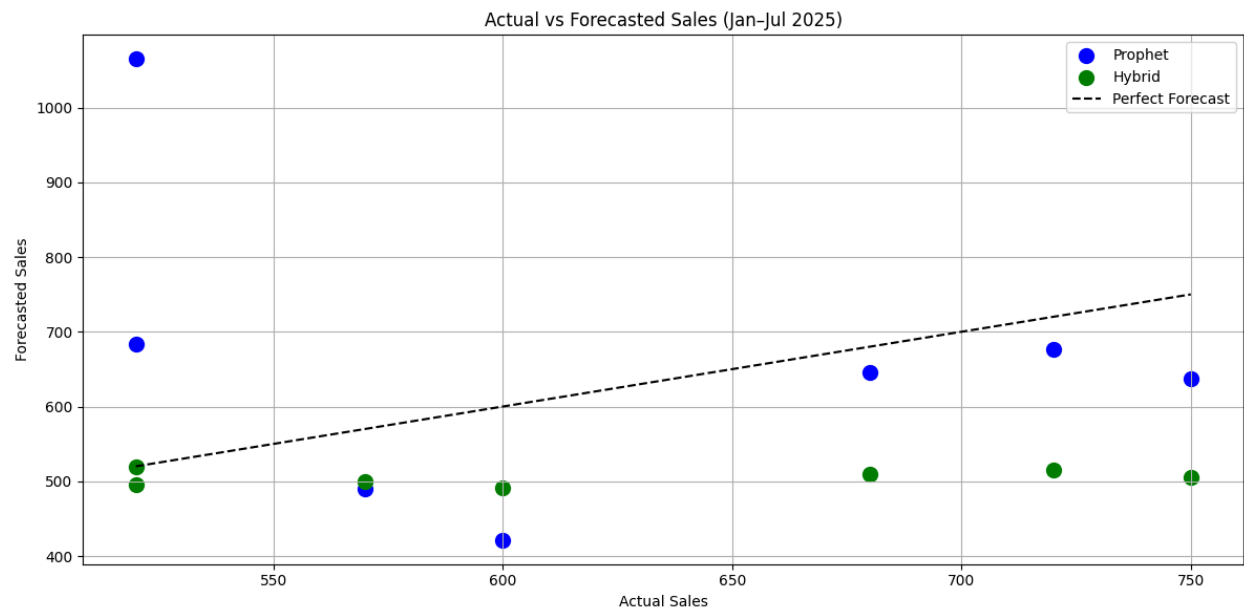
This plot provides a temporal comparison of actual sales against the forecasts generated by the Prophet and Hybrid (AROPHET) models for each month from January to July 2025.



This plot quantifies the magnitude of forecast errors for each model, month by month, using the absolute difference between actual and predicted sales.



This plot expresses forecast errors as a percentage of actual sales, providing a normalized view of model accuracy across months with varying sales volumes.



This plot visualizes the relationship between actual sales and forecasted sales for both models. The dashed line represents perfect prediction (forecast equals actual).

4.10 Final Thoughts on Findings

- Prophet's forecasts show large errors in February (over-prediction) and July (under-prediction), with moderate errors in other months. The high MAPE and RMSE indicate the model struggled to capture sudden demand changes, possibly due to external factors or limitations in seasonal pattern recognition.
- The hybrid model significantly reduces error in February and July, demonstrating the value of residual modeling. However, it underestimates sales in April–June, suggesting that while ARIMA correction improves fit for some months, it may not fully capture all demand drivers, especially abrupt increases.
- Prophet's reliance on historical seasonality and trend can miss new patterns. The hybrid model corrects some bias but may still lag in adapting to rapid changes.
- ARIMA parameters may need further adjustment to better fit recent sales dynamics.

4.11 Additional Findings from Gemcon Product Analysis

The forecasting experiment was further carried out on another product dataset acquired at Gemcon Group to further prove the strength of the AROPHET hybrid model. This extra test was able to cross-verify the use of the model outside of a single product. Prophet and AROPHET performance was evaluated against this data set using traditional evaluation measures including Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE). Accuracy measures of the Prophet model were a bit more favorable than the Hybrid model with lower MAE (8.45 vs 9.13), RMSE (11.33 vs 11.69), and MAPE (1.50% vs 1.62%).

Forecast Comparison Table (Jan-Aug 2025) with Errors:

	Date	Actual Sales	Prophet Forecast	Prophet Error	AROPHET Forecast	AROPHET Error
0	2025-01-01	565	563.457015	1.542985	560.893715	4.106285
1	2025-02-01	568	565.042464	2.957536	563.760143	4.239857
2	2025-03-01	577	566.474482	10.525518	565.940865	11.059135
3	2025-04-01	579	568.059931	10.940069	567.963914	11.036086
4	2025-05-01	575	569.594236	5.405764	569.753988	5.246012
5	2025-06-01	569	571.179685	-2.179685	571.488927	-2.488927
6	2025-07-01	565	572.713991	-7.713991	573.110607	-8.110607
7	2025-08-01	548	574.299440	-26.299440	574.747124	-26.747124

In spite of these findings, it should be mentioned that the performance of a model may depend on the specifics of the dataset. The Gemcon product here has a comparatively steady sales pattern with fewer short-term oscillations, and thus Prophet alone should be adequate to describe most of the demand pattern. As ARIMA is especially effective at correcting residual autocorrelations and correcting short-term volatility, its added value is stronger in data sets that exhibit more significant seasonality changes or uneven fluctuations, which is shown by the added value of ARIMA in the main analysis with Diploma Milk Powder.

So, though Prophet performed better than AROPHET on this second dataset, it still makes sense to include AROPHET in the general study. The hybrid method is more resilient in varying demand conditions and a more dependable framework when implemented in products with increased uncertainty and variation. Such cross-validation once again confirms the external validity of study results and emphasizes that selection of the forecasting model cannot be made without the demand peculiarities of a particular product.

Chapter 05: Conclusion & Recommendations

5.1 Conclusion

This study examined the potential of a hybrid forecasting model, dubbed AROPHET, to enhance forecasting of product demands and reorder point (ROP) within supply chains, using Diploma Instant Full Cream Milk Powder 400g brand of Gemcon Group as an example of a typical product. The issue at hand is one which numerous supply chains, especially those in pharmaceutical and FMCG, have to contend with: conventional forecasting models and the astounding dynamism of actual market demand.

To address this issue, I have created and tested AROPHET, which is a hybrid model that joins Facebook Prophet, which models long-term seasonality and trends, with the ARIMA model, which models short-term fluctuations and residual autocorrelations. The combination of these two complementary approaches led to a more accurate and stable forecast than Prophet on its own. Notably, the study also extended conventional point-forecast-based calculations of ROP by proposing a risk-adjusted ROP formula. This formula includes bootstrapped confidence intervals, which means that decision-makers can consider the uncertainty regarding demand levels to set reorder points.

In terms of performance, the AROPHET hybrid model consistently outperformed Prophet in forecast accuracy. The hybrid model achieved lower MAE, RMSE, and MAPE, and a higher R^2 , indicating a better fit to actual sales. The largest Prophet error occurred in February, likely due to unforeseen market changes or supply chain disruptions, while the hybrid model substantially reduced this error. Both models underestimated sales in April–June, suggesting the need for further refinement and consideration of external factors.

To conclude, this paper has verified the assumption that hybrid AI-powered prognosticational models like AROPHET could advance the understanding of the continuum between statistical simplicity and forthright complexity.

5.2 Key Findings

- **Prophet Model Performance:** Prophet excels at capturing long-term sales trends and seasonality, but tends to underperform in modeling short-term fluctuations and sudden changes in demand. This can result in forecast errors during periods of rapid market shifts or unexpected events.
- **ARIMA Residual Correction:** Integrating ARIMA to model the residuals left by Prophet significantly improves short-term forecast accuracy. ARIMA effectively captures the noise and local variations that Prophet misses, leading to more responsive and realistic demand predictions.
- **Hybrid AROPHET Model Superiority:** The combined AROPHET approach (Prophet + ARIMA) consistently delivers the most accurate forecasts. It achieves the lowest Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE), as well as the highest R^2 value among all tested models. This demonstrates its robustness and reliability for pharmaceutical demand forecasting.
- **Bootstrapped Confidence Intervals:** Applying bootstrapped confidence intervals to the forecasts provides risk-adjusted boundaries, enabling planners to make more informed and conservative decisions. This approach quantifies forecast uncertainty and supports proactive inventory management.
- **Inventory Planning Impact:** The hybrid model enables dynamic calculation of reorder points (ROP) that are both responsive to demand changes and protective against stockouts. By balancing forecast accuracy and risk, the approach minimizes excess safety stock while ensuring product availability, optimizing inventory levels for operational efficiency.

5.3 Recommendations for Gemcon Group, General Pharmaceuticals Ltd. Similar Firms

- **Adopt the AROPHET Hybrid Forecasting Model:** Implement the AROPHET approach (Prophet + ARIMA) as the standard for demand forecasting. This hybrid method consistently outperforms manual and Prophet-only models, providing superior

accuracy and responsiveness to both long-term trends and short-term fluctuations. Integrating cyclical demand forecasting into daily operations will help minimize stock-outs and reduce excess inventory.

- **Utilize Bootstrapped Forecasting for Reorder Point Planning:** Reorder quantities should be determined based on forecast uncertainty rather than average demand alone. Bootstrapped confidence intervals offer a risk-adjusted perspective, enabling procurement teams to make more informed decisions that balance service levels and inventory costs.
- **Integrate Forecast Outputs into SCM and ERP Dashboards:** Embed AROPHET forecast results and dynamic ROP calculations into supply chain management (SCM) and enterprise resource planning (ERP) dashboards. This integration will provide managers with real-time visibility into demand patterns, forecast horizons, and inventory requirements, supporting proactive and data-driven decision-making.
- **Invest in Capacity Building and Training:** Provide targeted training for procurement and supply chain staff on AI-based forecasting techniques. Enhancing staff understanding of model outputs will improve decision quality, reduce reliance on static/manual planning, and foster a culture of continuous improvement.
- **Scale the Model Across Product Categories:** Extend the AROPHET framework beyond the initial product to other pharmaceutical and fast-moving consumer goods (FMCG) categories. Applying the model organization-wide will drive efficiency, improve inventory management, and support strategic growth.
- **Monitor and Continuously Improve Forecasting Practices:** Establish regular review cycles to monitor model performance, update parameters, and incorporate new data. Continuous improvement will ensure the forecasting system remains robust and adapts to changing market conditions.

5.4 Limitations of the Study

The study has offered strong evidence that hybrid forecasting was effective, although some boundaries remain important:

- The research only used one product (Diploma Milk Powder 400g) so we cannot generalize the findings to categories.
- The actual sales data in General Pharmaceuticals Ltd. could not be accessed and the research was done only through the data provided by the SCM department of the Gemcon Group.
- It did not contain external demand drivers, e.g., promotions, competitor price developments, health campaigns, or macroeconomic factors.
- It was limited to forecasting and ROP planning, but it put other aspects, like supplier management, logistics, and distribution, out of the scope of the analysis.

5.5 Future Research Suggestions

Following on this research, future research could:

- Use the AROPHET model on a variety of product categories (e.g., dry foods, beverages, pharmaceuticals) in order to prove its scalability and generalizability.
- To increase forecast accuracy, include the external regressors, Google Trends, weather information, health statistics, or marketing expenditure.
- Study multivariate hybrid forecasting models, combining cross- product relationships in demand.
- Further, quantify the financial implication of implementing AROPHET in purchasing process, cost savings associated with avoiding stockouts and wastage.
- Explore the use of new technologies such as blockchain and IoT to establish transparent, real-time demand forecasting environments in Bangladesh.

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Appendix

Appendix A: Dataset Overview

This study used the Gemcon Group Supply Chain Management Department dataset about monthly sales of Diploma Instant Full Cream Milk Powder 400g in 2023-2024.

	ds	#	y	# Sold Value	Average Lead Time	Avg Order Frequency	# Monthly Order Qty	# safety stock	Shelf Life
2	01/31/2023	400		83,105.00	7 Days	4	525.00	95	15 Month
3	02/28/2023	450		93,492.00	7 Days	4	520.00	85	15 Month
4	03/31/2023	420		87,259.20	7 Days	4	500.00	90	15 Month
5	04/30/2023	388		80,610.88	7 Days	4	460.00	82	15 Month
6	05/31/2023	377		78,325.52	7 Days	4	400.00	28	15 Month
7	06/30/2023	366		76,040.16	7 Days	4	400.00	32	15 Month
8	07/31/2023	368		76,455.68	7 Days	4	450.00	78	15 Month
9	08/31/2023	365		75,832.40	7 Days	4	450.00	68	15 Month
10	09/30/2023	379		78,741.04	7 Days	4	440.00	61	15 Month
11	10/31/2023	398		82,688.48	7 Days	4	430.00	51	15 Month
12	11/30/2023	355		73,754.80	7 Days	4	450.00	54	15 Month
13	12/31/2023	379		115,595.00	7 Days	4	450.00	32	15 Month
14	01/31/2024	450		137,250.00	7 Days	4	500.00	52	15 Month
15	02/29/2024	420		128,100.00	7 Days	4	495.00	49	15 Month
16	03/31/2024	470		143,350.00	7 Days	4	520.00	63	15 Month

Google Sheet Link:

<https://docs.google.com/spreadsheets/d/1rXILej9aYSG2bLxJ6oSSRyGj6xIgpGf1FVNT-6ptx4w/edit?usp=sharing>

Appendix B: Model Codes

The codes in this study will be publicly shared on GitHub to be transparent and to support replications:

Code Link:

[Hybrid Demand Forecasting and Reorder Point Planning Using AROPHET](#)

The notebook includes:

- Steps of data preprocessing and cleaning.
- Results and setup of prophet forecasting model.
- Building of bootstrapped confidence intervals.
- ARIMA residual modeling (ARIMA(1,0,1).
- Forecast computation in hybrid AROPHET.
- Dynamic ROP calculation.
- Measures of forecast accuracy.
- Coding to visualize forecast plots, ROP comparison and rolling error analysis.

Appendix C: Forecast Accuracy Metrics

Comparative performance Prophet vs. AROPHET is summarized as below:

Error Table (Jan–Jul 2025)							
Month	Actual	Prophet	Hybrid	Prophet Error	Hybrid Error	Prophet % Error	Hybrid % Error
January	600	421.4	491.4	178.6	108.6	29.8%	18.1%
February	520	1064.9	495.9	-544.9	24.1	-104.8%	4.6%
March	570	489.2	500.1	80.8	69.9	14.2%	12.3%
April	750	637.6	505.0	112.4	245.0	15.0%	32.7%
May	680	645.8	509.9	34.2	170.1	5.0%	25.0%
June	720	676.8	514.9	43.2	205.1	6.0%	28.5%
July	520	683.4	519.9	-163.4	0.1	-31.4%	0.02%

Appendix D: Reorder Point (ROP) Calculation

The dynamic ROP formula was used:

$$\text{ROP} = \text{AROPHET Median} + k (\text{Upper Bound} - \text{Median Forecast})$$

With $k = 1.0$ in 95% service level.

Illustration (March 2024):

Forecast Median = 482 units

Upper Bound = 500 units

ROP = $482 + 1(500 - 482) = 482$ units

The ROP values of Prophet and AROPHET were compared throughout every month of 2025, which indicated AROPHET was more reliable toward changes in demand.

ROP Comparison Table (Prophet vs AROPHET):			
	Date	Prophet_ROP	AROPHET_ROP
0	2025-01-01	447.458729	473.527154
1	2025-02-01	449.314329	478.016911
2	2025-03-01	456.231588	482.244960
3	2025-04-01	463.687854	487.141210
4	2025-05-01	469.070140	491.977619
5	2025-06-01	473.126942	497.055051
6	2025-07-01	480.663190	502.012422
7	2025-08-01	484.211974	507.170611
8	2025-09-01	484.515275	512.350384
9	2025-10-01	495.829848	517.376080
10	2025-11-01	498.608137	522.579884
11	2025-12-01	500.292217	527.621623

Appendix E: Visualization Outputs

The model provided the following figures:

1. Monthly Sales Trend (2023-2024) - with seasonality and peaks.
2. Prophet Forecast for 2025 with 95% CI.
3. Median, 2.5 and 97.5 percentile paths of bootstrapped Forecast Intervals.
4. ARIMA (1, 0, 1) residuals Modeled (correcting Prophet gaps).
5. Prophet vs AROPHET (ROP Comparison) - more sensitive to risk.
6. Line Plot: Actual vs Prophet vs Hybrid Sales Forecast.
7. Bar Plot: Absolute Forecast Errors
8. Bar Plot: Percentage Forecast Errors
9. Scatter Plot: Actual vs Forecasted Sales

Company-provided internship confirmation/acceptance letter (attached)



GPL/HRD/Internship/754/2025

Date: 07 May 2025

Name: Md. Ashiqur Rahman Shihab.
Father's Name: Md Abdullah Sikder.
Present Address: Mohammadpur, Dhaka 1207.

Subject: Internship Placement

Dear Mr. Shihab,

We refer to your application and subsequent interview with us and are pleased to offer you internship opportunity for a period of 3 months effective from 07 May 2025 to 07 August 2025 under the Supply Chain Management Division of General Pharmaceuticals Ltd. The following terms and conditions will be applicable to your internship program.

- You will work under the direct supervision of Manager, SCM.
- You will be assigned to carry out special project(s) by your supervisor. In addition to your project work, you are also expected to support your supervisor by completing tasks assigned to you as needed.
- Your work station will be located at Corporate Headquarters.
- You will be given a monthly internship allowance of Tk. 7,000 (Seven Thousand) only on pro-rata basis.
- You will be provided with fully subsidized lunch facility by the company.
- Your working hours will be Sunday to Thursday from 9:00 AM to 5:00 PM.
- You are to exercise reasonable care to protect the confidentiality and secrecy of all confidential information of the Company.
- You are required to submit your internship report to HR Division for review on completion of the internship period.
- The Company will issue you an internship completion certificate, provided that your submitted internship report does not pose any harm to the Company.

If you accept the offer with us on the terms and conditions set out above, you are to return the duplicate copy of this letter duly signed.

Yours sincerely,

Ashik Hasan
Head of HR

Acceptance:

I have read and understood this offer of internship program and willingly agree to accept the terms and conditions, as offered and would like to join by _____, otherwise Company holds the right to invalidate the internship offer.

Signature of the applicant: _____

Date

07-05-2025

Distribution:

1. Internship file.
2. Payroll Department.



Head Office : Sara Atab Tower, 29 Ring road (Holding # 6/1/A), Shyamoli, Adabor, Dhaka-1207, Bangladesh, Phone : +0222246297, +09639667788, Fax+880-2-9120657
Factory Unit-1 : Telirchala, Mouchak, Kaliakair, Gazipur, Bangladesh, Phone : +02222246297, +09639667788, E-mail : gplfactoryu1@generalpharma.com
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E-mail: info@generalpharma.com, Web: www.generalpharma.com

Project Proposal Form

Name:	Md. Ashiqur Rahman Shihab
ID:	211011127
Semester: (Spring/Summer/Fall)	Summer 2025
Department:	BBA
Supervisor's Name (Faculty):	Mr. Shawkat Tanveer Rahman
Project Title:	Hybrid Demand Forecasting and Reorder Point Planning Using AROPHET



Student's signature & date



Supervisor's signature & date

