Forecasting and Inventory Optimisation

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PREVIEW

Managing inventory within the supply chain has been a compelling focus of interest in both business and academic domains. Inventories constitute about 15% of the GDP in developed economies. In the United States alone are currently exceeding $2.5 trillion worth of inventory investment (goods held for sale). The vast majority of this inventory is held in warehouses managed by 3PL companies, who traditionally had no incentive to rationalise (let alone minimise) excess inventory. As competitive 3PL companies pivot from holding and moving into also managing such inventories, they need to collaborate with their customers to understand and address the primary reasons for rising inventory levels.

Inventories represent both a risk and a tremendous opportunity. How can we maximise our availability and sales given a certain inventory investment? Or, how can meet an availability target with the minimum possible investment in inventories? These questions are not straightforward to answer!

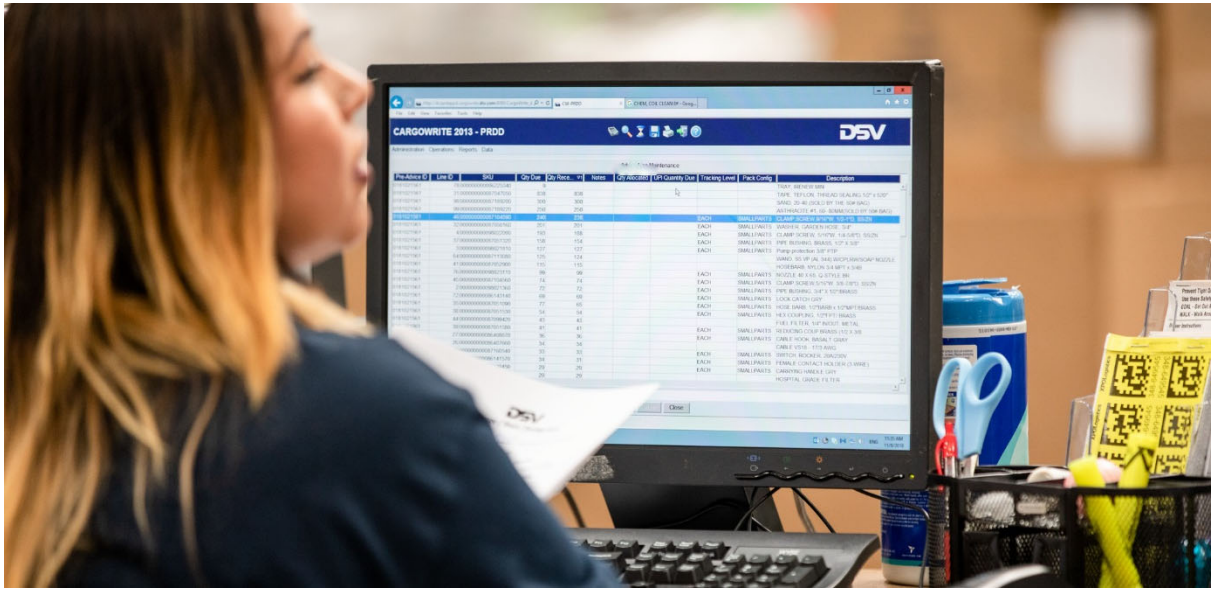
Our research institute at Cardiff University (PARC) is a joint industry-academia initiative between Cardiff and DSV. We combine academic rigour with practical usefulness to produce cutting edge research and applications. Years of fundamental research and experience have culminated in the development of an inventory-forecasting planning and optimisation tool, D2ID, that helps customers categorise their products, forecast their demand and optimise their inventory levels subject to service level considerations.

Learn more about us at: **www.cardiff.ac.uk/parc**

MOTIVATION

Globalisation and rising customer expectations have led businesses to focus on optimising their supply chains, particularly in terms of inventory management. Companies are now prioritising efficiency in reducing costs, maximise service levels, and gain a competitive edge through strategic inventory planning. Implementing effective inventory management strategies throughout the supply chain can lead to increased profitability.

Given the capital currently invested in inventories, even small improvements in inventory performance may translate to significant amounts of cash for companies. In addition to the financial benefits, there are also environmental advantages to reducing inventory, such as reducing the risk of obsolescence, using and wasting less raw materials, reducing the reliance of expensive expedited orders and thus cutting transportation costs and reducing CO2 emissions.



PARC Institute has collaborated with Brother International and Accolade Wines to provide tailor made solutions to better manage and optimise their systems and processes. Both projects involved using modelling and data analytics methods included in D2ID to accurately predict demand and optimise inventory levels. This led to improved efficiencies, cost savings, and overall better customer service.

Structure of the paper

The remainder of this report is organised as follows. First, we discuss the current inventory challenges which include huge inventory stocks, environmental legislation, and social sustainability. Next, we look specifically at the spare parts inventory management, including obsolescence management and elimination. Finally, we present the outcomes of the collaboration between PARC and two companies (Brother International & Accolade Wines).

CURRENT INVENTORY CHALLENGES

Since the 1980s, 3PL providers have considerably increased their business as companies sought to outsource operations outside their core competencies in pursuit of efficiencies. Over the years, needs developed for complicated and customised logistics services. Such services now go well beyond hauling and warehousing and can include vertical inventory management, product assembly, packaging, labelling, returns handling, customer service and order satisfaction, or even consulting services. As such 3PL companies have over this time sought to expand their value adding service provision, emphasising manufacturing solutions and even warranty repair or other circular treatment of returns.

As the backbone of modern businesses, inventory is an integral part of supply chains and the need for a 3PL to sort out inventory issues of their customers has been recognised. However, 3PL providers seem not to be concerned with the inventory performance of their customers – after all, they contract warehousing capacity and fewer inventory turns (the times an inventory is sold and replenished over a period of time) means more revenue for less picks. However, as profit margins shrink, and as 3PL companies integrate/take over operations with/from their customers, proper (and properly understood) forecasting and inventory control procedures are a prerequisite for value adding services (inventory wise).

Here lies the opportunity. The pandemic sparked a rise in e-commerce sales. Today, a record of 36.1% of all retail sales are taking place online, indicating a 77.6% increase compared with February 2020 pushing inventory levels higher across nearly all 3PL companies. For many 3PL companies, this challenge is their opportunity to considerably contribute to the effective inventory management of their clients, which can have the dual effect of increased end customer satisfaction while reducing inventory investment, increase of productivity and may also provide innovative solutions. For example, in some cases, use of manufacturing services and 3D printing of spare parts can be promoted over storing large quantities of obsolescence-prone inventories, thus reducing inventory costs for the operation and can create warehouse space for potential new customers of the 3PL.

The logistics industry is rapidly evolving in response to technological advancements, changing consumer expectations, and global economic shifts. As we look ahead, several key trends are poised to shape the

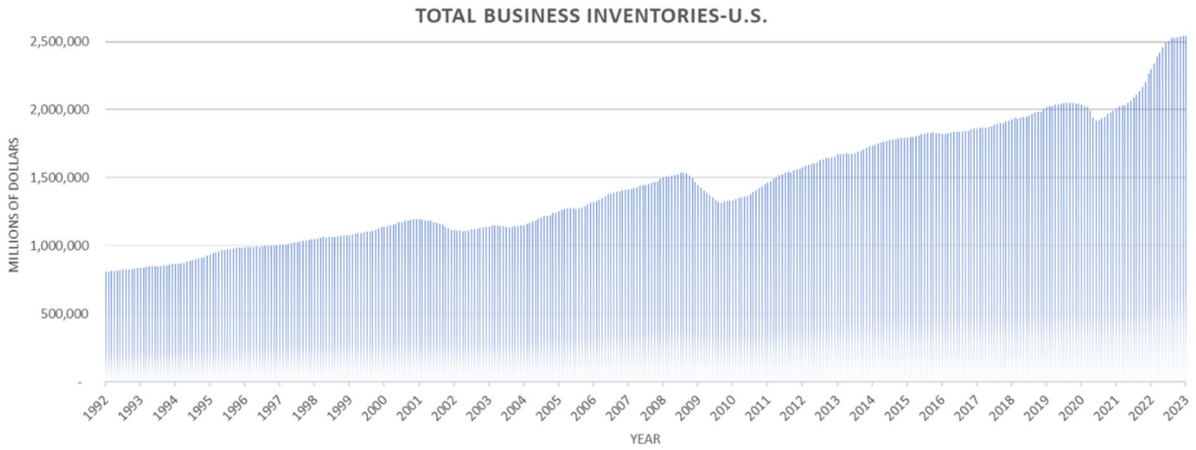
future of logistics, revolutionising the way goods are transported, warehoused, and delivered.

Digitalisation and automation are streamlining operations, while big data and predictive analytics are optimising supply chain performance. The rise of e-commerce is driving innovation in order fulfilment and last-mile delivery. Finally, sustainability and green initiatives are paving the way for a more environmentally friendly logistics sector.

All these trends have already started redefining the logistics landscape.

Estimates suggest a rise from USD 10.41 trillion in 2022 to USD 14.08 trillion by 2028 and to reach USD 16.01 trillion by 2030, presenting significant opportunities for businesses and stakeholders. Telsey Advisory Group analysts found the apparel and e-commerce industries saw significant increases in inventory holding. A report from Avery Dennison predicts that nearly 8% of excess stock worldwide will be wasted, costing around $163 billion annually.

Some companies are implementing measures to prevent further inventory growth, but experts believe it will take over a year for retailers to clear through the surplus. According to the 34th Annual State of Logistics report (CSCMP, 2024, statistics referring to 2023) and the Federal Reserve Economic Data, the US alone has been sitting on approximately $2.55 trillion worth of goods held for sale (Graph 1), which equates to 14.8% of the US gross domestic product (GDP) in that year. According to the same report, the inventory carrying costs (taxes, obsolescence, depreciation, and insurance) are estimated to be around $0.8 trillion (i.e. about 30% of the value of the goods).



Graph 1: Total Business Inventories in U.S. (Source: U.S. Census Bureau)

So, a huge amount of capital is tied up in warehouses – a problem, but also a huge opportunity as small (%) improvements in managing inventories may well translate into considerable cost benefits. We should, therefore, not be surprised to learn that firms, from manufacturing to wholesale to retail, are currently looking to outsource this function to 3PL or other specialist companies. Their aim is to minimise not only their direct investments in purchased goods inventory but also the indirect cost incurred in managing this inventory.

SPARE PARTS INVENTORIES AND CIRCULARITY

Spare parts play a crucial role in maintaining the smooth functioning of any equipment or machinery. They are replacement components that can be used in the event of a failure or malfunction of the original part. They are essential for ensuring the continuity of operations in industries such as manufacturing, transportation and construction. Spare parts management is an important issue for many companies that desperately want to reduce their holding costs while maintaining the same or even higher service levels and providing after sales support. Undoubtedly, spare parts inventory services are the game-changers in building a circular economy, offering a sustainable future.

Clients across various industries are becoming increasingly environmentally conscious, as they also increasingly realise that sustainability credentials are more core requirement rather than a competitive advantage. Businesses have seen a persistent increase in implement circular economy (CE) principles in their operations, switching from a linear take-make-dispose model to a circular approach, which involves integrating processes such as reuse, remanufacturing, and recycling. Due to the increasing importance of the after sales industry, the interest of many companies in spare parts demand forecasting and inventory control has also dramatically increased over the recent years.

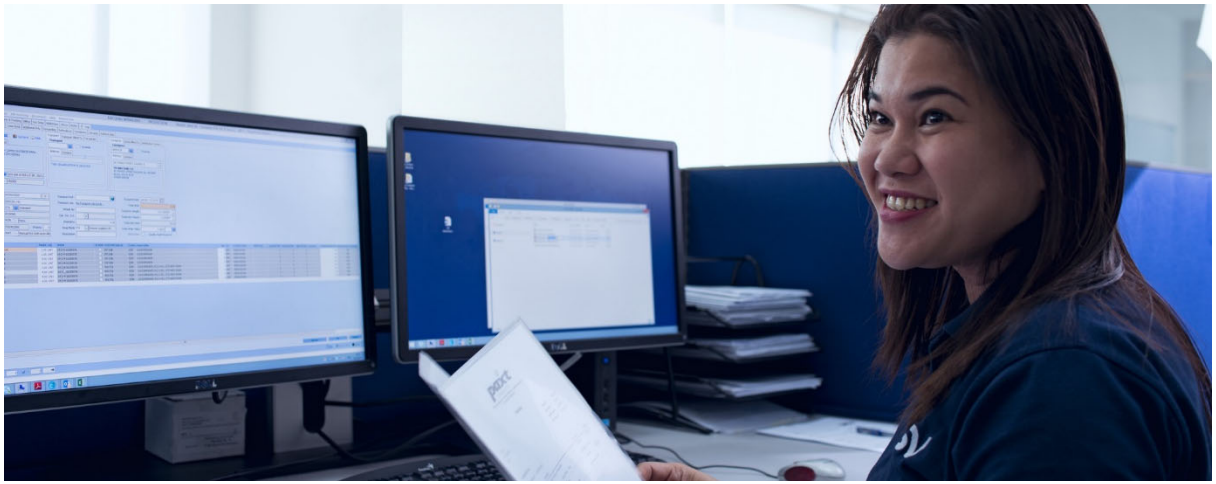
This is not a trend; it is a paradigm shift that 3PL providers must adapt to.

The demand for sustainable practices is pushing logistics companies to explore innovative solutions that reduce their and their customer's environmental footprints. As a result, 3PL providers must invest in new solutions to meet these evolving client expectations.

Spare parts inventory management has been proven to be challenging both from academic and practitioner perspectives as it involves thousands of products some of which having challenging and complex demand patterns, often exacerbated by poor data quality and other issues.

Demand for such items is typically intermittent in nature, with occasional (variable) demand occurrences interspersed around many zero demand observations. Intermittent demand items (both spare and other slow-moving items) may constitute up to 60% of the total stock value in very many contemporary industrial settings.

Such irregular demand patterns need to be categorised, as they are associated with different characteristics and therefore in turn, they require different forecasting and inventory control treatment. Intermittent demand series are very difficult to represent based on the standard time series structural components (level, trend, seasonality) as the limited number of positive observations makes decomposition (to derive any components) almost impossible.



Spare parts forecasting and inventory control are not only affected by the intermittent nature of the demand data, but also from the vast number of products available, the necessity to maintain high service levels, and the risk of obsolescence. It follows from the above, but also from our experience in working with multiple companies, that any improvements in forecasting and thus in the management of spare part items may lead to substantial cost savings, significant reduction of scrap and obsolescent items, and efficient customer satisfaction.

In an era marked by sustainability concerns and increasing consumer demands for eco-friendly solutions, the 3PL industry is facing new challenges and opportunities.

It is for such reasons that Brother International and Accolade wines approached the PARC Institute and DSV to create sophisticated logistics solution that will help them reduce inventory costs while meeting their clients' expectations.

CASE STUDIES

The PARC Institute of Manufacturing, Logistics and Inventory has successfully completed two knowledge transfer projects in the area of inventory forecasting in collaboration with Accolade Wines and Brother International. The two companies were looking for ways to meet customers' requirements via optimised inventory levels in the supply chain. This was pursued by means of creating a forecasting inventory tool that would offer operational improvements and increased visibility and control of inventory. The idea, which was vindicated by the results, was to gain considerable financial benefits and significant competitive advantage.

In both projects, PARC Institute analysed historical sales data and market trends to analyse the demand patterns of various products. PARC's deliverable was a software tool that would optimise and select appropriate forecasting procedures to forecast demand. The tool will use these forecasts to produce optimal inventory holding levels for each product, taking into account factors such as trend, seasonality, target service level and lead times. Through these projects, the knowledge and outcomes of the work transferred into the companies planning and management team. This ensured that the benefits of the projects will remain with the company in the long term and companies' employees will be able to implement improvements in the future

Brother

Brother Industries is a Japanese multinational electronics and electrical equipment company headquartered in Nagoya, Japan. Its products include multifunction printers, desktop computers, consumer and industrial sewing machines, large machine tools, label printers, typewriters, fax machines, and other computer-related electronics. The Brother group delivers products and services to customers all over the world with manufacturing facilities and sales facilities in 40 or more countries and regions of the world.

"The PARC project has been a huge success delivering real benefit both financially and in terms of transferred knowledge as we wanted. The team at Brother have been energised by the ongoing experience and we are now focused on delivery and improvements through our further learning. The inventory-forecasting solution delivered by PARC is now used to forecast and manage centrally our €600 million per year sales of consumables in Europe. Automation and centralisation of decision making has released managerial time that is now being deployed to other areas of supply chain."

Dr. Mark Keyes, Senior Supply Chain Manager, Brother International

Accolade Wines

Accolade Wines, is a multi-award winning (manufacturer of the year for 2019) bottling facility which employs over 500 people and produces 25 million 9L case equivalents of wine each year. Located in the Bristol suburb of Avonmouth, Accolade Park is the only dedicated wine bottling facility in the UK, with the ability to package every format, from 187ml to 75cl in glass bottles and 1.5Ltr to 10Ltr casks. At 82,000 sqm, Accolade Park is Europe's largest wine warehouse and distribution centre.

"The PARC team provided a new insight to our business that identified real cash savings and operational improvements, particularly in the area of demand forecasting and inventory management. The savings identified were even greater than we had hoped for. The project has most certainly, directly and indirectly, positively impacted approximately 400 employees across the South of England."

Richard Lloyd, General Manager European Operations and Supply Chain, Accolade Wines

CONCLUSION

In today's extraordinary and highly volatile environment, we are witnessing real-time consequences of inaccurate inventory management and the miscalculations of forecasting across the supply chains. The surge in logistics demand, the need for sustainable cost-effectiveness, profit-cost considerations, and environmental constraints have all resulted in the emergence of inventory management solutions that can optimise inventory levels, reduce stockouts, and minimise excess stock, ultimately leading to cost savings and increased efficiency. Cardiff University and DSV jointly work in that direction; via the PARC Institute we build on core expertise in supply chain forecasting, inventory control, supply chain modelling, to advance knowledge in the area of the circular economy and closed loop supply chains along with forecasting and inventory optimisation.

DISCLAIMER

The background work of this report was supported by Cardiff University, UK. The report is intended for general information only; it is based upon a review of the available literature coupled with two case studies undertaken with Brother International and Accolade Wines. Individuals or companies are advised to seek professional guidance regarding their specific needs and requirements prior to taking any actions resulting from anything contained in this report. Any such actions taken by individuals or companies are entirely at their own risk. Companies are also responsible for assuring themselves that they comply with all relevant laws and regulations, including those relating to intellectual property rights, data protection and competition laws or regulations. The images used in this document do not necessarily reflect the organisational entities taking part in this work.

ACKNOWLEDGEMENTS

The authors are grateful to Dr Mark Keyes (Senior Supply Chain Manager at Brother International) and Mr Richard Lloyd (who at the time of conducting the relevant work was the General Manager for European Operations and Supply Chain at Accolade Wines), for sharing their experience and knowledge during various meetings. We would also like to thank all the other organisations we have worked with for their feedback and additional reflections.

APPENDIX

The following list constitutes the background material covered to enable the writing of this report. Whilst it is not an exhaustive list that captures all the relevant literature, it is certainly representative of the research field. To enable an easier reading of this report we have opted for no embedded Harvard-style references. If you would like more guidance about the literature relevant to any of the areas covered in this report, please contact Aris Syntetos (**SyntetosA@cardiff.ac.uk**).

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PARC INSTITUTE

The PARC Institute is a joint University-Industry initiative that undertakes world-class research with impact in the fields of logistics and manufacturing operations management. The Institute bridges the gap between theory and practice in these areas for the benefit of a sustainable economy, environment and society. RemakerSpace is our incubator for innovation in 3D Printing, Remanufacturing and Repurposing.

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