

Improving Materials Management at Toon Air: Challenges and Strategies for Success

ENGINEERING MANAGEMENT LEADERSHIP – ACEA7006

GAVIN JOHN (1809103)

Abstract

This paper evaluates the challenges facing Toon Air, a small UK-based airline, in managing its purchasing and materials management function. The company is facing increasing competition in its niche market and is looking for ways to cut costs and improve efficiency, particularly in the acquisition, storage, and distribution of supplies, including spares and consumable items. This paper considers outsourcing the management of the parts warehouse and supply chain to the engineering function as a potential solution. However, outsourcing comes with risks and requires careful planning and management. This paper evaluates the benefits and risks of outsourcing, provides recommendations for selecting and managing outsourcing partners, and outlines key performance measures to monitor the outsourcing company's performance. Additionally, this paper examines ways to improve the supply of spares to end-users, which is critical for the success of the outsourcing process. This paper concludes that by implementing these measures, Toon Air can improve its efficiency, reduce costs, and maintain its competitiveness in the market.

Contents

Abstract.....	1
Table of Figures	4
1. Introduction	5
2. Improving the Supply of Spares to the End User	6
2.1. Introduction to the Aviation Industry and Toon Air	6
2.2. Current Issues with Toon Air's Inventory Management Systems.....	7
2.3. Solutions Toon Air Can Adopt	8
2.3.1. Satellite Warehouses.....	8
2.3.2. Identification of Parts.....	8
2.3.3. Utilisation of Bill of Materials.....	8
2.3.4. Available Software for Inventory Management	9
2.3.5. Critical Spares.....	9
2.3.6. Improving Communication.....	10
2.3.7. Monitoring Performance.....	10
2.4. Purchase Ordering System	11
2.5. Future Integration of Additive Manufacturing.....	12
3. Outsourcing the Management of Spares	13
3.1. Introduction to Outsourcing	13
3.2. The History of Outsourcing	13
3.3. Benefits of Outsourcing	14
3.3.1. Cost Reduction	14
3.3.2. Access to Specialised Expertise.....	14
3.3.3. Increased Efficiency and Productivity	15
3.3.4. Flexibility and Adaptability.....	15
3.3.5. Risk Management	15
3.4. Risks Associated with Outsourcing.....	16
3.5. Special Considerations	17

4.	Performance Measures Required for Outsourcing	18
4.1.	Service Level Agreements	18
4.2.	Evaluating Inventory Accuracy and Cost Saving Metrics.....	18
4.3.	Implementing Quality Control Measures.....	19
4.4.	Measuring Customer Satisfaction	19
4.5.	Measuring Turnaround Time and Order Fulfilment.....	19
5.	Recommendations	21
5.1.	The Importance of Efficient Parts and Supply Management	21
5.2.	Implementing an Effective Inventory System.....	21
	Bibliography	22

Table of Figures

Figure 1 – Comparison of the Point-To-Point and Hub & Spoke Model, Courtesy of (G. Cook, 2008)....	6
Figure 2 – Overview of Reorder Point Planning, Courtesy of (Hedge, 2023)	7
Figure 3 - Overview of Kanban vs Reorder Point, Courtesy of (Romain, 2015).....	8
Figure 4 - Example of a Purchasing System, Courtesy of (Adams, 2023)	11
Figure 5 - Overview of an ERP System, Courtesy of (Zwets, 2020)	9
Figure 6 - Visualisation of Outsourcing and its Benefits, Courtesy of (KB, 2022).....	13
Figure 7 - Advantages of Outsourcing, Courtesy of (Johnston, 2022).....	14
Figure 8 - Risks of Outsourcing, Courtesy of (Ahydik, 2020)	16
Figure 9 - Example of Types of KPI's That Can be Used, Courtesy of (Gupta, 2021)	18

1. Introduction

Toon Air is a successful UK-based airline that operates regular flights within the UK and to several Greek islands. However, the increasing competition in the market has forced the company to look for ways to cut costs and improve efficiency, with particular attention to its purchasing and materials management.

Upon investigation, several issues have been identified in the company's purchasing and supply function, including high inventory investment, technical obsolescence, and delays in obtaining spare parts for on-site maintenance. It was also found that the purchasing of spares bypassed the purchasing department with engineers going directly to the suppliers. To address these issues, the company is considering outsourcing the management of its parts warehouse and supply chain to the engineering function, which has the potential to significantly improve efficiency and reduce costs.

However, outsourcing also poses risks, and requires careful planning and management to ensure its success. The benefits and risks of outsourcing will be discussed to provide recommendations for selecting and managing outsourcing partners and outline key performance measures to monitor the outsourcing company's performance. Additionally, an examination into how to improve the supply of spares to end-users, which is critical for the success of the outsourcing process. With advancements in technology, a review of technology will be conducted to see what is currently available and how to utilise these systems. With the advancement in 3D printing, it is discussed how this could impact the industry in future years. By implementing these measures, Toon Air can improve its efficiency and maintain its competitiveness in the market.

2. Improving the Supply of Spares to the End User

2.1. Introduction to the Aviation Industry and Toon Air

The aviation industry is a very fast pace and expensive industry. Thus, for an organisation like Toon Air, the more time planes are in the air rather than on the ground, the more turnover is generated. In the early days of aviation, many airlines followed the Hub and Spoke model, where airlines would fly between hubs around the world, then a connecting flight would be required to get to the destination airport (Mostafa Parsa, 2019). This allowed for spares to be housed at these hubs. This model has been replaced by the point-to-point model. The point-to-point model revolutionised the industry as it allowed for direct flight between airports, which drew more passengers due to its convenience (Tommy K.Y. Cheung, 2020). A comparison of these models is shown in Figure 1.

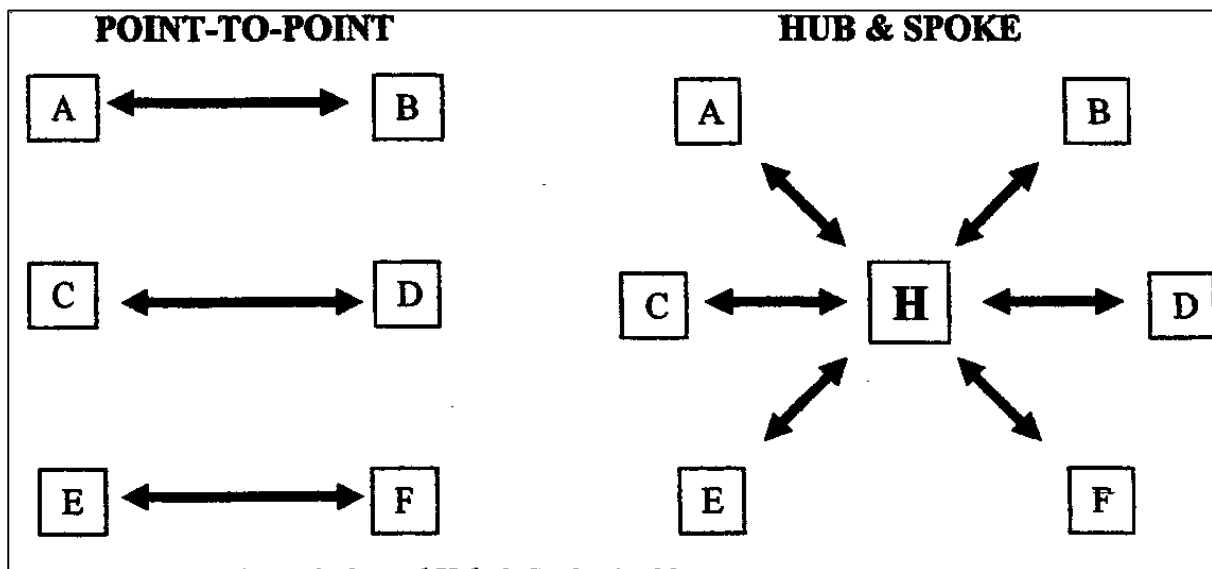


Figure 1 – Comparison of the Point-To-Point and Hub & Spoke Model, Courtesy of (G. Cook, 2008)

This model makes breakdowns on airlines more problematic and longer downtimes occurs when parts are required. With Toon Air being a UK based company, its warehouse is located in the North of England, 30 miles from the nearest airport. With Toon Air's regular flying routes to the Greek Islands, there are around 18 possible routes for Toon Air, which have an average flight time of 3 hours 40 minutes, significant delays should be expected if parts are needed from the warehouse in the UK.

2.2. Current Issues with Toon Air's Inventory Management Systems

The current inventory management system appears to be inflexible and is resulting in a high level of technical obsolescence with Toon Air currently adopting a reorder point system. This methodology indicates an items minimum stock level at which new stock should be ordered in order to avoid a stockout (Miguel Gutierrez, 2021). The reorder point is calculated by adding the lead time demand and the safety stock. An overview of this method is shown in Figure 2. This system is reliant on the calculations and projections of demand and lead times, which may not account for breakdowns (Dariusz Milewski, 2022).

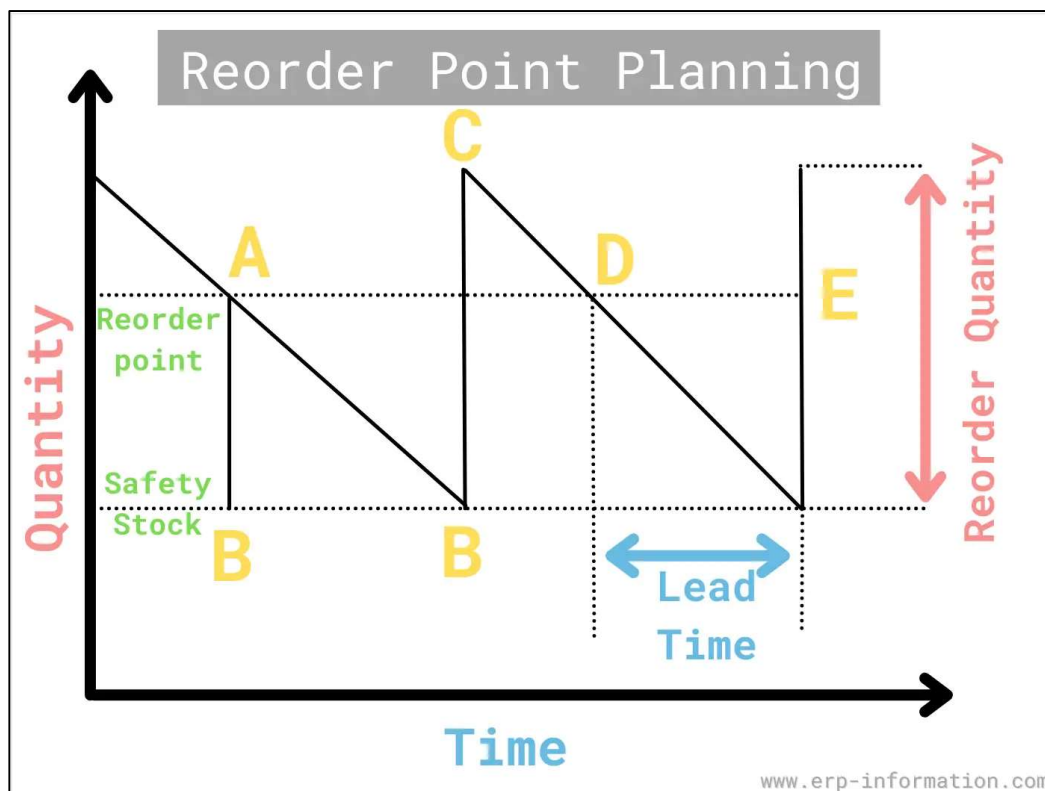


Figure 2 – Overview of Reorder Point Planning, Courtesy of (Hedge, 2023)

A similar method is Kanban, which is a visual signalling system that uses card, or other markers to indicate when to produce or reorder inventory. Kanban aims to improve efficiency and reduce waste by ensuring that inventory is only produced when needed and in the right quantity (Ahmad Naufal, 2012). A comparison of these methods can be seen in Figure 3, which shows a saw tooth curve to determine order points, while accounting for lead times and safety stock. Forward planning can be conducted to ensure there is enough kits based on the maintenance schedule and other events based on the lead times. The reorder point system is useful for managing raw materials and finished goods, while Kanban is better suited for managing work-in-progress inventory (Yang, 1998).

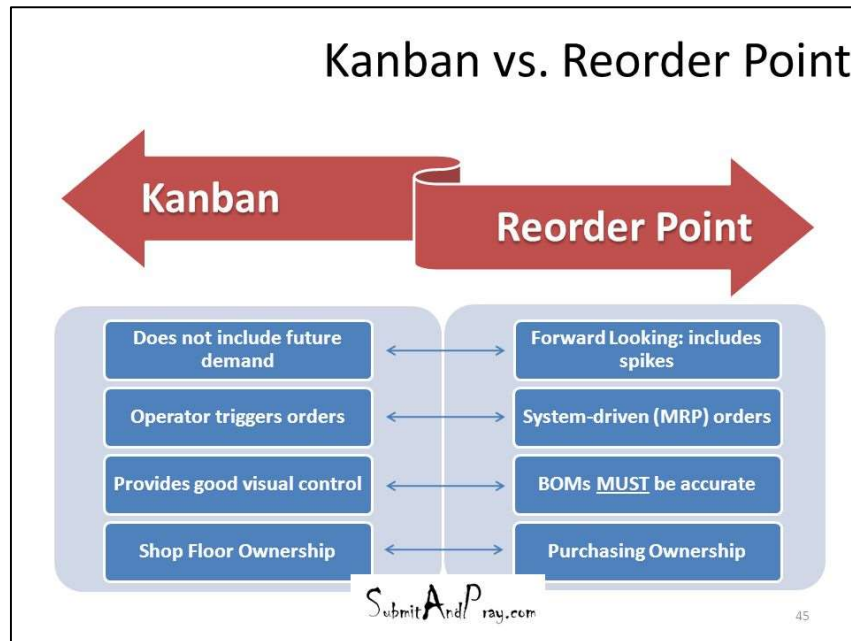


Figure 3 - Overview of Kanban vs Reorder Point, Courtesy of (Romain, 2015)

2.3. Solutions Toon Air Can Adopt

2.3.1. Satellite Warehouses

To reduce and avoid delays in getting parts to the destination airports, Toon Air can establish satellite warehouses at or near the destination airports (Barry, 2022). Evidently, the decision on how many satellite warehouses to be utilised would be determined on cost. It would not be feasible to have these warehouse at or near every airport in Greece due to the sheer number of airports. The routes should be analysed and prioritise the most popular route or to centre the warehouse in the top five busiest routes. This would allow the company to have the inventory closer to where it is needed and reduce the time required to transport parts to the airport.

2.3.2. Identification of Parts

The new system should have a better mechanism to identify obsolete parts and prevent them from being ordered unnecessarily. All parts within the warehouse should be systematically identified (Laney, 2017). During the periodic maintenance schedules, a wide range of parts are ordered for one time use. If parts have been changed due to regulatory reasons, and bulletins released from the manufactures, it may be possible to exchange the parts in questions for the newer parts meeting the new regulations. The identification of parts would streamline this process, reducing time spent looking for part and batch identification numbers.

2.3.3. Utilisation of Bill of Materials

Due to this, some of these parts may not be stocked items, and may not be involved in the inventory control system. Once the maintenance is complete, there may be unused

parts which can be used for possible future breakdowns and should be inventoried. Utilisation and management of the bill of materials will make ordering parts and placing work orders simpler. It is crucial to keep the bill of materials (BOM) up to date to prevent inventory inaccuracies (Barry, 2022). When receiving parts kits, the parts should be checked to ensure the received goods are what is stated on the purchase order, and the parts are free from damage.

2.3.4. Available Software for Inventory Management

To ensure the security and accuracy of warehouse inventory parts, Toon Air can implement several critical practices. Access to the inventory can be limited, only allowing authorised employees to enter. Parts can be centralised and consolidated into the main warehouse to make it easier to control and manage (Barry, 2022). An Enterprise Resource Planning (ERP) warehouse functionality or a Warehouse Management System (WMS) can be used instead of spreadsheets to ensure accuracy and efficiency. Barcodes and scanning functionality can be utilised to improve inventory accuracy by assigning stock locations to each part (Muhammad A. Razi, 2003). ERP systems can be powerful when utilised effectively, as the database can withhold a large array of data. Figure 4 shows an example of what data sources can be used in an ERP system.



Figure 4 - Overview of an ERP System, Courtesy of (Zwets, 2020)

2.3.5. Critical Spares

Critical spares could be kept at several airport destinations but would need several considerations. Cause and effect analysis should be undertaken to determine the common failed components and the most popular routes. From this, the critical spares can be determining which stock is being distributed at several airports. Spares for processes with

reduced performance that impact revenue should be accessible within 0-2 hours, while spares for processes with downtime affecting production and compliance should be available within 2-4 days (Sha Zhu, 2022). Spares that have no immediate impact on revenue or compliance can be obtained at the lowest cost.

2.3.6. Improving Communication

To improve communication between the warehouse and the end-users, the organisation can consider implementing better collaboration tools such as a shared database, a mobile application, or a web portal. This will also help ensure that the warehouse staff have a better understanding of what spares are required and when (Mouronte-López, 2017). The reorder points of each part should be reviewed and ensured that they are set appropriately.

2.3.7. Monitoring Performance

Key Performance Indicators (KPIs) should be used to track maintenance work orders, stock control, the cost and number of rarely used parts, the cost of buying critical parts not in stock, and supplier delivery performance (Paakki Jouni, 2001). A key indicator is On Time In Full (OTIF) which gives an overall result in the quantity of parts delivered to the warehouse on time compared with the planned deliveries. This ensures parts are readily available, of a high-quality standard and the maintenance is taking place in a timely manner.

2.4. Purchase Ordering System

Toon Air must discourage engineers from ordering parts directly from suppliers, as it can lead to a lack of visibility and control over the procurement process. Instead, the company should require all orders to be placed through the purchasing department, which can provide better visibility and control over the procurement process. Work orders need to be created for all parts issuance so that inventory remains accurate. The work order process needs to be simple and ensure there are no ways to get parts without a work order. Figure 5 outlines how a purchase order process can be implemented. Work orders requested in advance can be pulled and staged for pickups or delivered to the purchasing department. This will reduce the maintenance departments wait time at the parts warehouse for work orders to be fulfilled (Zixuan Chen, 2023). When orders are received, a delivery note should be received with the goods. This should then be booked in to the inventory system where the details of the order can be compared against the purchase order and invoices received. This allows for traceability throughout the process. A benefit of purchase orders is having terms and conditions outlined within the order. The order should clearly state what work is to be completed, which defines each parties' boundaries.



Figure 5 - Example of a Purchasing System, Courtesy of (Adams, 2023)

2.5. Future Integration of Additive Manufacturing

With the acceleration in 3D printing, it may soon be possible to print the required parts instead of holding inventory. This would save on overheads and labour costs (N. Knofius, 2021). However, as this technology is still relatively new, it may be decades until a system like this is implemented.

3. Outsourcing the Management of Spares

3.1. Introduction to Outsourcing

Outsourcing involves contracting out a business function or service to a third-party provider. Outsourcing is a practice usually undertaken by organisations as a cost-cutting measure (Andy A. Tsay, 2018). In Figure 6 a schematic is displayed to show where outsourcing can be used.

For Toon Air, this would involve outsourcing the management of the parts warehouse and to supply the parts to the engineering functions, which would be handled by a third-party organisation.



Figure 6 - Visualisation of Outsourcing and its Benefits, Courtesy of (KB, 2022)

3.2. The History of Outsourcing

In 1989 outsourcing was first recognised as a business strategy and then became an integral part of business economics through the 1990s (Gallimore, 2022). However, outsourcing practice was subject to considerable controversy in many countries as those opposed argued the loss of domestic jobs, particularly in the manufacturing sector which was due to this strategy. Although, supporters of the strategy argued it creates an incentive for business opportunities and allows companies to allocate resources to the organisations most effective areas along with outsourcing, this helps maintain the nature of free-market economies on a global scale (Handfield, 2006).

3.3. Benefits of Outsourcing

3.3.1. Cost Reduction

A benefit to outsourcing is the reduction in labour costs. By contracting the work out to a third party, it can often be less expensive than hiring full-time employees to perform the same tasks. This can be due to the outsourcing companies being located in countries with lower labour costs or may have more efficient processes in place (Sayed Elhoushy, 2020). It is also common for companies to have discounts on OEM parts which wouldn't be available to Toon Air, as a resellers cost. There can also be cost reductions by avoiding expenses associated with overheads, equipment, and technology. From the diagram shown in Figure 7, several examples are shown to demonstrate the benefits of outsourcing.

3.3.2. Access to Specialised Expertise

It is often difficult to acquire to skill sets with vast knowledge. It can be argued that the new generation of engineers have a lower skill set than the previous generation, and it is hard to replace a skill set that has a vast number of years' experience (Platt, 2016). By outsourcing to companies who have the skills, or work on these procedures' day in day out, it allows for access to the specialised expertise which isn't found in house.



Figure 7 - Advantages of Outsourcing, Courtesy of (Johnston, 2022)

3.3.3. Increased Efficiency and Productivity

Outsourcing can increase efficiency by focusing on core business activities while leaving non-core functions to external service providers, increasing efficiency and productivity. This strategy may also lead to faster turnaround times, increased competitiveness within an industry, and the cutting of overall operational costs (Sebahattin Yildiz, 2014).

3.3.4. Flexibility and Adaptability

Another benefit is allowing flexibility in the organisation as it allows companies to scale up or down quickly in response to changing business needs. An external provider may have specialised knowledge or technology that Toon Air lacks, allowing for better service and support (Belcourt, 2006). Outsourcing can allow Toon Air to adapt more quickly to changes in demand or technology, as external providers are often better equipped to keep up with the latest developments in their field.

3.3.5. Risk Management

Finally, Outsourcing can help companies manage risk by shifting some of the risk associated with certain business functions to external service providers. For example, an outsourcing company may be responsible for ensuring compliance with certain regulations (Heiko Gewald, 2009).

3.4. Risks Associated with Outsourcing

While outsourcing offers several benefits, it's crucial to acknowledge the potential risks associated with outsourcing to optimise efficiency and prevent disruptions. One major risk is the loss of control over warehouse parts and their supply, which could be a concern for Toon Air if these functions are critical (Belcourt, 2006).

In addition, if the outsourced provider doesn't maintain the same level of quality control as Toon Air, there could be quality issues. Communication may also be a challenge, especially if there are language or cultural differences.

Outsourcing could expose Toon Air to security risks, especially if confidential information or data is shared with the provider. Furthermore, compliance with legal and regulatory requirements may be a concern if the provider operates in a different jurisdiction with distinct laws and regulations (Heiko Gewald, 2009). Further examples on the risks of outsourcing can be seen in Figure 8.



Figure 8 - Risks of Outsourcing, Courtesy of (Ahydik, 2020)

3.5. Special Considerations

If Toon Air are to outsource, then special attention should be given to several areas. The first area is to carefully select a provider that has the necessary expertise, experience, and technology to manage the parts warehouse and supply parts effectively. Several organisations should be compared to evaluate each organisations pros and cons as well as price. It is recommended to visit the companies warehouse and factories to understand the working environment and what measures are in place for quality assurance.

There should be clear service level agreements (SLAs) with the outsourced provider to ensure that performance expectations are met, and any issues are addressed promptly. There needs to be clear lines of communication to ensure issues are communicated and resolved effectively (McBrien, 2022). A comprehensive contract should be developed which outlines the expectations, deliverables, timelines and payment terms for the outsourcing project. This ensures both parties are clear on responsibilities and obligations.

Toon Air should establish quality control measures to ensure that the outsourced provider is meeting Toon Air's quality standards. Finally, Toon Air should establish security protocols to protect sensitive information and data from unauthorised access or theft. This may include confidentiality agreements, limiting access to data and implementing data security measures.

4. Performance Measures Required for Outsourcing

4.1. Service Level Agreements

Implementing performance measures is critical to ensure the success of outsourcing the parts warehouse management. The SLA should be established between Toon Air and the outsourcing company to specify the expected level of service, including delivery times, stock availability, and accuracy of orders. The outsourcing company should be regularly monitored to ensure they are meeting the agreed-upon SLA.

4.2. Evaluating Inventory Accuracy and Cost Saving Metrics

Having precise inventory records is essential to guarantee the timely availability of appropriate parts. The level of inventory accuracy determines how efficiently the outsourced provider manages the warehouse parts which could be evaluated using metrics like cycle count accuracy, order accuracy, and inventory turnover. Conducting regular cycle counts enables the measurement of inventory accuracy by counting a subset of the inventory to compare it with the recorded inventory. Order accuracy, on the other hand, can be assessed by monitoring the percentage of orders that are accurately fulfilled and shipped on time (Maria Di Mascolo, 2014).

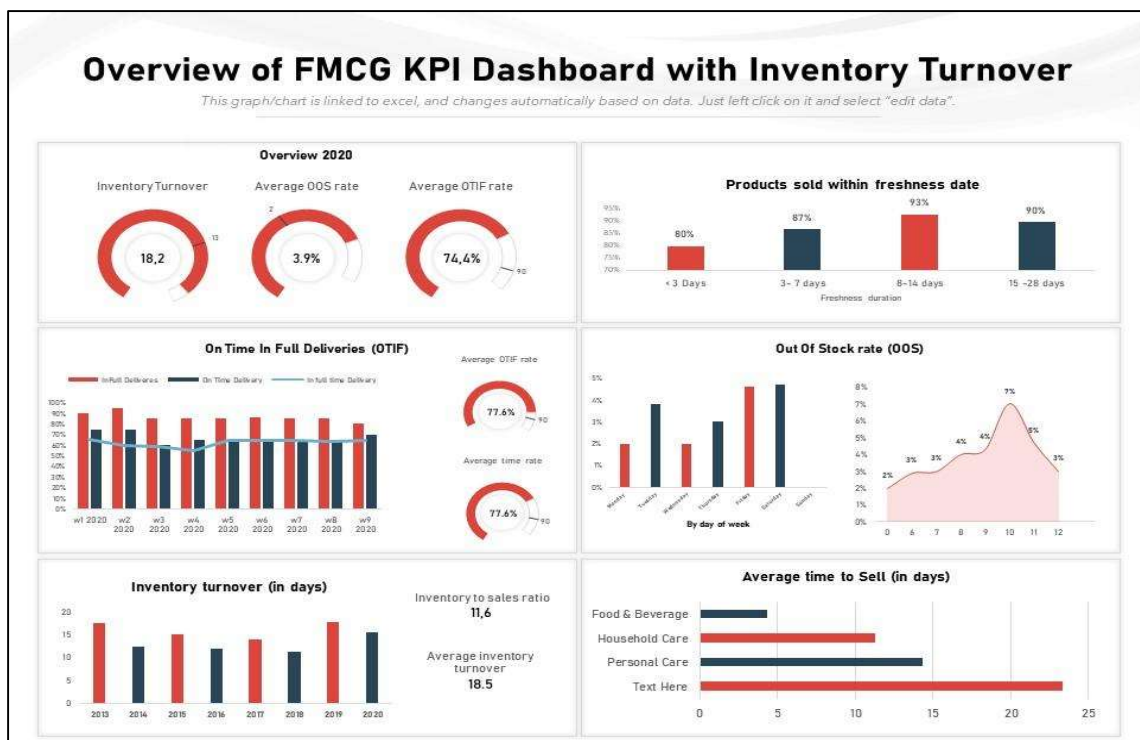


Figure 9 - Example of Types of KPI's That Can be Used, Courtesy of (Gupta, 2021)

Toon Air's main objective for outsourcing is to reduce costs and it's important to track various factors to ensure that this goal is being achieved. These factors include reduced inventory holding costs, obsolescence, and labour costs. Measuring cost savings involves comparing the money saved through outsourcing to the expenses associated with in-house

warehousing. Different metrics, such as labour cost savings, inventory cost savings, and transportation cost savings can be used to assess this. Displaying the data in high level graphs will allow ease on interpretation for all stakeholders. Figure 9 shows examples of different metrics that can be utilised. To determine labour cost savings, the cost of in-house warehousing should be compared to the cost of outsourcing. Inventory cost savings can be calculated by comparing the expenses of holding inventory in-house, to those of storing inventory with the outsourced provider. Transportation cost savings can be evaluated by comparing the expenses of shipping with the outsourced provider to those of shipping in-house (Lopienski, 2021).

4.3. Implementing Quality Control Measures

To ensure the accuracy of inventory counts and the proper labelling and storage of parts, it is essential to conduct regular audits of the outsourcing company. Additionally, quality control measures should be implemented to assess the outsourced provider's ability to meet quality standards for the stored parts. This evaluation may involve metrics such as defect rates, product returns, and customer complaints. The quality of the parts delivered by the outsourcing company should be measured to ensure that they meet the required standards and are competitive with the airline's fleet. Defect rates can be determined by calculating the percentage of products that are returned due to defects (Angappa Gunasekaran, 2015). Similarly, product returns can be evaluated by measuring the number of returned items. Finally, customer complaints can be monitored by measuring the number of complaints received.

4.4. Measuring Customer Satisfaction

Regular monitoring of customer satisfaction is essential to ensure that the outsourcing company is meeting the requirements of both maintenance engineers and the airline as a whole. Customer satisfaction reflects the outsourced provider's ability to meet the needs and expectations of the company's customers, and it can be evaluated using various metrics such as customer survey results, repeat business, and customer retention rates. Conducting regular surveys to gather feedback from customers is an effective way to track customer survey results. Measuring the percentage of customers who place additional orders is an efficient way to track repeat business. Similarly, customer retention rates can be evaluated by measuring the percentage of customers who continue to do business with the company over time (Somnath Lahiri, 2022).

4.5. Measuring Turnaround Time and Order Fulfilment

To minimize aircraft downtime and increase aircraft utilization, reducing lead times is crucial. To achieve this, Toon Air should measure the average lead time for parts delivery and collaborate with the outsourcing company to continually enhance this metric. The time it takes to receive, pick, pack, and deliver a part to the maintenance engineers should be closely

monitored to ensure that it complies with the agreed-upon SLA. Turnaround time measures the outsourced provider's ability to process and deliver parts promptly, and this can be evaluated using metrics such as order processing time, time to ship, and time to receive. Order processing time can be tracked by measuring the duration taken to process an order from receipt to shipment. Time to ship can be tracked by measuring the duration taken to ship an order after it has been processed (Vijay Pereira, 2019). Similarly, time to receive can be evaluated by tracking the time it takes for the customer to receive the order after it has been shipped.

The ability of the outsourced provider to fulfil customer orders can be measured by order fulfilment metrics. These metrics may include on-time delivery, order fill rate, and order processing time. On-time delivery can be assessed by comparing the delivery date promised with the actual delivery date. Order fill rate can be determined by comparing the number of orders received with the number of orders shipped. Order processing time can be measured by tracking the time taken from the receipt of an order to its shipment (Surender Munjal, 2019).

5. Recommendations

5.1. The Importance of Efficient Parts and Supply Management

The efficient management of parts and supplies is crucial for the smooth operation of any airline. The decision to outsource the management of its parts warehouse and supply chain for Toon Air is a strategic move that could potentially improve the efficiency and reduce costs. However, outsourcing involves several risks, requires careful planning management and all options should be analysed before proceeding. This includes selecting the right outsourcing partner, developing robust service level agreements, and monitoring performance to ensure that the outsourcing partner is delivering on its promises.

A clear SLA should be established, and performance measures implemented to regularly monitor the outsourcing company's performance. Additionally, attention should be paid to staff training and communication, ensuring that everyone involved in the parts management process is onboard and understands their responsibilities.

5.2. Implementing an Effective Inventory System

Toon Air would also need to implement a more effective inventory system which includes proper identification and disposal of obsolete parts, a smoother process for ordering and recording parts, and increased collaboration between maintenance engineers and the purchasing department. A centralised purchasing system is advised to manage all procurement activities to enable the airline to leverage economies of scale, negotiate better process and reduce the risk of maverick spending.

Finally, Toon Air should embrace a culture of continuous improvement to ensure that the materials management function is constantly improving. This includes encouraging feedback from stakeholders, analysing performance data, and implementing corrective actions where necessary.

By implementing these measures, Toon Air can successfully outsource the management of its parts warehouse and supply chain, improve the supply of spares to end-users, and achieve significant cost savings while maintaining high levels of customer satisfaction.

Bibliography

1. Adams, J., 2023. *What Is Purchasing Order Template And How To Use It?*. [Online] Available at: <https://www.goodfirms.co/inventory-management-software/blog/purchase-order-template-how-use-it> [Accessed 20 March 2023].
2. Ahmad Naufal, A. J. N. Y. N. H., 2012. Development of Kanban System at Local Manufacturing Company in Malaysia–Case Study. *Procedia Engineering*, Volume 41, pp. 1721-1726.
3. Ahydik, O., 2020. *The Risks of Outsourcing That You Could Have Avoided*. [Online] Available at: <https://eleks.com/blog/risks-of-outsourcing/> [Accessed 20 March 2023].
4. Andy A. Tsay, J. V. G. I. J. N. J. T. M., 2018. A Review of Production and Operations Management Research on Outsourcing in Supply Chains: Implications for the Theory of the Firm. *Production and Operations Management*, 27(7), pp. 1177-1220.
5. Angappa Gunasekaran, Z. I. K.-L. C. L. F. T. P., 2015. Performance measures and metrics in outsourcing decisions: A review for research and applications. Volume 161, pp. 153-166.
6. Barry, B., 2022. *7 Spare Parts Inventory Management Best Practices*. [Online] Available at: <https://www.fcbco.com/blog/spare-parts-inventory-management-best-practices> [Accessed 20 March 2023].
7. Belcourt, M., 2006. Outsourcing — The benefits and the risks. *Human Resource Management Review*, 16(2), pp. 269-279.
8. Dariusz Milewski, T. W., 2022. Regression analysis as an alternative method of determining the Economic Order Quantity and Reorder Point. 8(9).
9. G. Cook, J. G., 2008. *Airline Networks: A Comparison of Hub-and-Spoke and Point-to-Point Systems*, s.l.: s.n.
10. Gallimore, D., 2022. *History of outsourcing: From the 18th century to the modern times*. [Online] Available at: <https://www.outsourceaccelerator.com/articles/history-of-outsourcing/> [Accessed 20 March 2023].
11. Gupta, G., 2021. *40 Inventory Management KPI Templates For Retailers To Track And Monitor Resources*. [Online] Available at: <https://www.slideteam.net/blog/40-inventory-management-kpi-templates-for-retailers-to-track-and-monitor-resources> [Accessed 20 March 2023].
12. Handfield, D. R., 2006. *A Brief History of Outsourcing*. [Online] Available at: <https://scm.ncsu.edu/scm-articles/article/a-brief-history-of-outsourcing> [Accessed 20 March 2023].
13. Hedge, A., 2023. *What is Reorder Point (ROP) system? – Formula, Calculations*. [Online] Available at: https://www.erp-information.com/reorder-point.html#google_vignette [Accessed 23 March 2023].

14. Heiko Gewald, J. D., 2009. Risks and benefits of business process outsourcing: A study of transaction services in the German banking industry. *Information & Management*, 46(4), pp. 249-257.
15. Johnston, M., 2022. *The Benefits of Outsourcing Your Critical Business Process*. [Online] Available at: <https://beanninjas.com/blog/the-benefits-of-outsourcing-your-critical-business-process/> [Accessed 20 March 2023].
16. KB, J., 2022. *What Is Outsourcing In Business And How Does IT Work?*. [Online] Available at: <https://www.stellardigital.in/blog/what-is-outsourcing-in-business-and-how-does-it-work/> [Accessed 20 March 2023].
17. Laney, N., 2017. *7 Things to Consider for Successful Spare Parts Management*. [Online] Available at: <https://www.sigmathermal.com/blog/spare-parts-management/> [Accessed 20 March 2023].
18. Lopienski, K., 2021. *23 Warehouse KPIs and Metrics to Improve Performance*. [Online] Available at: <https://www.shipbob.com/uk/blog/warehouse-kpis/> [Accessed 20 March 2023].
19. Maria Di Mascolo, G. A. C. M. T. R., 2014. *Warehouse performance measurement: classification and mathematical expressions of indicators*. Netherlands: s.n.
20. McBrien, J., 2022. *7 Factors to Consider When Outsourcing*. [Online] Available at: <https://optibpo.com/blog/factors-to-consider-when-outsourcing/> [Accessed 20 March 2023].
21. Miguel Gutierrez, F. A. R., 2021. Undershoot and order quantity probability distributions in periodic review, reorder point, order-up-to-level inventory systems with continuous demand. *Applied Mathematical Modelling*, Volume 91, pp. 791-814.
22. Mostafa Parsa, A. S. N. S. D. F. Z. A., 2019. Green hub-and-spoke network design for aviation industry. *Journal of Cleaner Production*, Volume 229, pp. 1377-1396.
23. Mouronte-López, M. L., 2017. Optimizing the Spare Parts Management Process in a Communication Network. *Journal of Network and Systems Management*, Volume 26, pp. 169-188.
24. Muhammad A. Razi, J. M. T., 2003. An applied model for improving inventory management in ERP systems. *Logistics Information Management*.
25. N. Knofius, M. C. v. d. H. A. S. & W. H. M. Z., 2021. Improving effectiveness of spare parts supply by additive manufacturing as dual sourcing option. *OR Spectrum*, Volume 43, pp. 189-221.
26. Paakki Jouni, J. H. T. P., 2001. Improving global spare parts distribution chain performance through part categorization: A case study. *International Journal of Production Economics*, 133(1), pp. 164-171.
27. Platt, J. R., 2016. *Generations: What Can Older and Younger Engineers Learn from Each Other?*. [Online] Available at: <https://insight.ieeeusa.org/articles/generations-what-can-older-and-younger->

[engineers-learn-from-each-other/](#)

[Accessed 20 March 2023].

28. Romain, E., 2015. *Pull and Kanban in SAP*. [Online]
Available at: <https://slideplayer.com/slide/4167982/>
[Accessed 20 March 2023].
29. Sayed Elhoushy, I. E. S. G. A., 2020. The impact of perceived benefits and risks on current and desired levels of outsourcing: Hotel managers' perspective. *International Journal of Hospitality Management*, Volume 91, p. 102419.
30. Sebahattin Yildiz, Z. H. D., 2014. The Benefits, Risks and Effects on Performance of the Outsourcing: A Comparative Study of Seasonal and Permanent Hotels. *Procedia - Social and Behavioral Sciences*, 109(8), pp. 514-521.
31. Sha Zhu, W. v. J. R. D., 2022. Critical project planning and spare parts inventory management in shutdown maintenance. *Reliability Engineering & System Safety*, Volume 219, p. 108197.
32. Somnath Lahiri, A. K. S. C. K. S. E., 2022. Performance implications of outsourcing: A meta-analysis. *Journal of Business Research*, Volume 139, pp. 1303-1316.
33. Surender Munjal, I. R. S. K. K., 2019. Offshore outsourcing and firm performance: Moderating effects of size, growth and slack resources. *Journal of Business Research*, Volume 103, pp. 484-494.
34. Tommy K.Y. Cheung, C. W. W. A. Z., 2020. The evolution of aviation network: Global airport connectivity index 2006–2016. Volume 133, p. 101826.
35. Vijay Pereira, S. M. A. I., 2019. Outsourcing and offshoring decision making and its implications for businesses - A synthesis of research pursuing five pertinent questions. *Journal of Business Research*, Volume 103, pp. 348-355.
36. Yang, K. K., 1998. A comparison of Reorder Point and Kanban policies for a single machine production system. *The Management of Operations*, Volume 9, pp. 385-390.
37. Zixuan Chen, A. W. H. S. T. W. A. N. H., 2023. Modelling supplier selection and material purchasing for the construction supply chain in a fuzzy scenario-based environment. *Automation in Construction*, Volume 150, p. 104847.
38. Zwets, B., 2020. *Does a standardized ERP system even exist?*. [Online]
Available at: <https://www.techzine.eu/blogs/applications/47571/does-a-standardized-erp-system-even-exist/>
[Accessed 20 March 2023].