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1. Summary.

Good inventory management is central to successful organisation whatever the operation, and it follows on from this that procurement and supply chains must also be tightly controlled. The commercial aviation industry relies heavily on efficient running of maintenance operations in order to minimise aircraft 'grounding' and subsequent impact on financial viability and customer reputation. This document is concerned with addressing challenges identified within Toon Air relating to purchasing and supply. It attempts to provide options for improving the current system and ways of ensuring that the quality improvement cycle becomes embedded within the company.

Toon Air, a small UK airline facing increasing competition, has been suffering from several challenges within its current purchasing and supply operations which is resulting in delays to aircraft maintenance and increased costs. A review of operations identified a number of issues with current inventory management such as delays in obtaining necessary parts for maintenance at destination airports, a high level of inventory investment exacerbated by technical obsolescence and unresponsiveness of the current ordering system, all of which result in loss of capital investment, frequent stockouts and aircraft downtime. Proposed changes such as the introduction of a well-managed inventory management system with flexible dynamic re-order points relating to usage, supplier investment to keep up to date with technical & regulatory changes, and decentralisation of critical parts would result in a much more efficient operation and increase the viability of the business. Further issues relating the purchasing process, such as bypassing specified processes and lack of purchase orders demonstrates a lack of control and requires formalised documentation and training to ensure optimal purchasing decisions, and importantly accountability is in place to prevent any risk of legal dispute.

Suggestions for change do not end at addressing the measures detailed above, as with increasing competition, Toon Air need to consider whether to pursue outsourcing elements of parts management, to enable a focus on the businesses core competencies. Although this may seem like a straightforward option as a resolution to several issues, successful implementation takes time and investment to select a reputable supplier, build sustainable relationships and creation of a contract that stipulates both contract giver and acceptor's terms.

Building of a robust maintenance management system however is not achieved by undertaking a single review and implementing suggested changes. To ensure the systems introduced are sustainable and improve the current processes, outcome measures need to be agreed and clearly defined, and performance review, with the use of such tools as audits, undertaken on a continual basis. In this way a cycle of continuous quality improvement can be

embedded within the culture of the business to ensure that Toon Air remain up to date and viable in an ever-increasing competitive market.

2. Introduction.

The aviation industry is facing increased pressure as the introduction of more low-cost airlines creates additional competition. Maintaining financial viability alongside customer satisfaction are two key end points that industries need to focus on in order to survive. The impact of optimal inventory management and efficient supply chain for spare parts is well recognised, resulting in maintenance of functional aircraft at minimal with minimal cost and efficient use of resource. Toon Air is an example of where failure to invest in inventory management and the subsequent spares supply chain has led to issues with the current maintenance system, and subsequent grounding of aircraft, both of which is costly from a financial and organizational reputation perspective.

A review of current practices has identified several issues around inventory management, procurement practices, and operational inefficiencies within Toon Air's maintenance system.

Key issues identified include:

- Inventory located at a distant warehouse leading to delays in obtaining necessary parts for maintenance at destination airports. Aircraft downtime and reduced utilisation, as substitute planes need to be flown in along with the required parts.
- High level of inventory investment is exacerbated by technical obsolescence due to design changes and evolving regulations, leading to a significant portion of the inventory becoming unusable over time adds to inventory costs and inefficiencies.
- Inventory management system based on fixed reorder points and kit formations for maintenance, is inadequate due to variable lead times and demand patterns, often results in stockouts of key components, leading to maintenance delays and operational disruptions.
- Engineers bypassing the purchasing department to directly order parts from suppliers raises concerns for accountability, compliance, and potential inefficiencies in procurement processes.
- Lack of formal purchase orders for many items, especially high-value items, indicates a lack of structured procurement practices, without proper terms and conditions in place introduce risks, potential disputes, inconsistent pricing, and difficulties in tracking orders and expenses.

Improving the current system is not limited to the above issues, with much of the aviation industry moving to outsourcing for the purchasing and supply of spare parts. Toon Air therefore needs consider whether there would be benefit to moving to this business model and how operations need to change to successful implement such a model.

The following document considers how to address the current issues being faced by Toon Air and if considered, how the company could successfully implement outsourcing. Furthermore, to ensure proposed changes are effective, considerations are given to how the company can monitor performance and implement further quality improvement measures where necessary.

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3. Improving Supplying Spares.

Managing inventory is a critical aspect for business operations. The main objectives are to minimise holding costs where possible, whilst preventing stockouts, and ensuring efficient use of resources. Poor inventory management affects business performance, both in terms of effectivity and finance. Effective inventory management assists the business to meet demand, reduce costs and is a key element in improving operational efficiency (Daniel Atnafu, 2018).

There are several opportunities to consider which could address the current issues being experienced by the business in relation to the supply of spares. Currently all inventory is stored at a singular dedicated location, leading to issues relating to timely delivery to destinations. This can be significantly improved by de-centralisation of all spares inventory and streamlining the supply chain (Satair, 2024). Establishing satellite warehouses in strategic locations near destination airports where key, critical or emergency spares can be stocked, will lead to a significant reduction in lead time of materials to engineers (Al-Momani, 2020).



Figure 1 - Critical Spares Flow Chart

(SDI, 2024)

In order to support the process of deciding which spares can be classed as key and critical (Al-Momani, 2020), there are numerous considerations to be made including:

- predictive maintenance techniques; requires analysing historical data, maintenance schedules and failure patterns (Al-Momani, 2020).

- collaboration with equipment manufacturers; whilst working closely with suppliers/manufacturers, key and critical spares can be identified by necessity and volume (Ghaith M. Al-Abdallah, 2014).
- establishment of feedback loops; allows bottlenecks and inefficiencies in the supply chain to be identified and addressed (Jadoon, 2023) (Krishnan, 2023).

For each process it is possible to subsequently optimise inventory materials and levels, ensuring the correct spares are available in the correct location when required, in turn reducing aircraft idle time (Baraka, 2022). It is also essential to regularly review and refine these processes based on lessons learned and feedback from end users, maintenance teams, and relevant stakeholders to continuously improve the reliability and responsiveness of spare parts provision (Al-Momani, 2020).

Further improvement opportunities for ensuring optimum stock levels involves implementing safety stock and dynamic reordering points (Faikar Ridwan Harimansyah1, 2020). Once essential and critical spares have been established, stock levels must be maintained with a buffer for variability, accounting for component lead time and demand uncertainty. Rather than relying on fixed reorder points, adjustments are made based on real-time data for lead-time, demand variability and stockout risk to optimise inventory levels, ensuring key components are available, even when unexpected delays occur in the replenishment process (Baraka, 2022) (Anon., 2018). Additionally, supplier collaboration is essential to reduce lead times and improve supply chain responsiveness. By establishing strategic partnerships with suppliers, negotiating agreements for expedited delivery can help reduce the impact of lead time variability (Ghaith M. Al-Abdallah, 2014).

To address the business' challenges and issues with high inventory levels and technical obsolescence, there are several solutions for consideration. The first stage involves optimising inventory and implementing techniques such as ABC analysis (Pareto Rule), where inventory is categorised into; A - high value items, typically most expensive and account for 10%-20% of inventory; B - medium value items that account for 20%-30% of inventory; or C -low value items that account for 50%-70% of inventory (Daniel Atnafu, 2018).

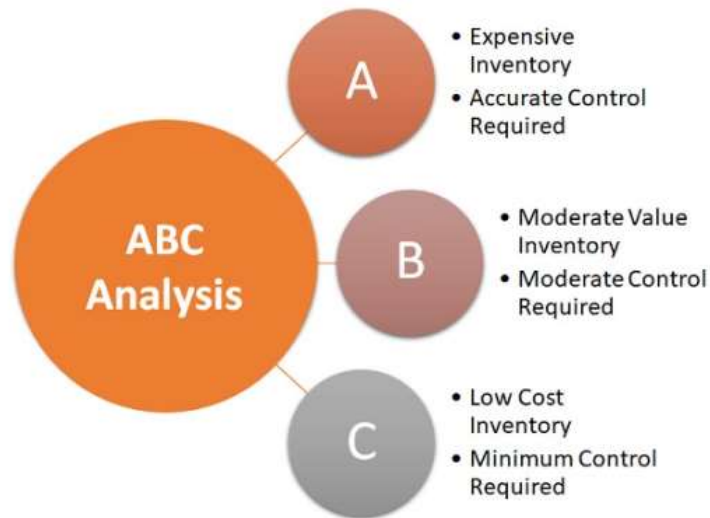


Figure 2 - ABC Analysis Model

(MBAskool, 2024)

Such categorisation enables the business to identify which items are most significant and allows for resources such as time and money to be allocated more effectively. In doing so, inventory management strategy is improved by increasing efficiency and decision making, focusing efforts on high-value items and streamlining processes related to procurement, storage and distribution, whilst providing the business with valuable insight into the inventory makeup, highlighting areas of attention. This provides an added benefit of improving the risk management strategy by mitigating potential stockouts for critical items and reducing inventory levels of low value items (Gregersen & Herbert-Hansen, 2018).

The business should also consider implementation of strategies such as lifecycle planning and inventory management, where clear and concise protocols are established to deal with component life-cycle, design changes and regulatory updates (ERP Solutions, 2019). Emphasis should be placed on product life-cycle stages, expected usage duration, and anticipated design changes, phasing out obsolete parts and managing transitions to new designs (Greenwood Aerospace, 2023). In order to maintain optimal inventory investment for the correct materials, regular reviews and audits (promoting continuous improvement) of the inventory is required to ensure inventory level performance, along with soliciting feedback from end users, maintenance teams, and other stakeholders (Al-Momani, 2020)

To further support the above, engaging in collaborative planning and forecasting with suppliers (Gregersen & Herbert-Hansen, 2018), to anticipate such trends, design changes, regulatory updates and technological

advancements can assist with anticipating future challenges and opportunities, enabling proactive adjustments to inventory levels and procurement strategies in response to changing requirements (Greenwood Aerospace, 2023). Furthermore, by adopting obsolete inventory management techniques, and developing strategies for managing the business' obsolete inventory, identified components are disposed of by methods such as liquidation, recycling or repurposing a timely manner to minimise carrying costs and free up capital for investment in more relevant inventory (Faikar Ridwan Harimansyah¹, 2020) (Al-Momani, 2020).

Although it is accepted that engineers may have a superior understanding of the required components, it is essential that procurement procedures are established and followed; bypassing of established procurement channels can lead to a fragmented procurement process. Ordering items without a purchase order undermines proper control and oversight of procurement activities, this can result in several issues for the business, such as a lack of centralised control over purchasing, and subsequent stockouts, duplication, inconsistent purchasing practices, and difficulties in tracking expenditures, inventory levels and monitor supplier performance. Ordering parts directly from suppliers without following established procurement procedures and without an official purchase order can increase the risk of non-compliance with organisational policies, contractual obligations, and regulatory requirements, which can lead to a higher risk of disputes between the business and supplier regarding pricing, delivery terms, quality standards, and liability (En, 2020). In the absence of a contractual framework, resolving disagreements or addressing issues related to defective or non-compliant products becomes more challenging and could escalate into costly litigation (Manship, 2023). Additionally, this can result in suboptimal procurement decisions, missed opportunities for volume discounts or bulk purchasing savings, and overall higher procurement costs for the business (Aviation Spares & Repairs, 2024).

Currently encountered issues can be resolved by establishing a standardised procurement processes that strikes a balance between technical considerations and procurement efficiency, with clear protocols for requisitioning, approval, and tracking of spare parts orders, along with an emphasis on the importance of compliance with said policies and procedures (Al-Momani, 2020). This can be achieved by fostering a collaboration between engineers and the procurement department, with open communication channels, cross-functional teamwork, and joint decision-making, enabling both technical expertise and procurement best practices to align with both technical and organisational requirements and objectives (Ghaith M. Al-Abdallah, 2014).

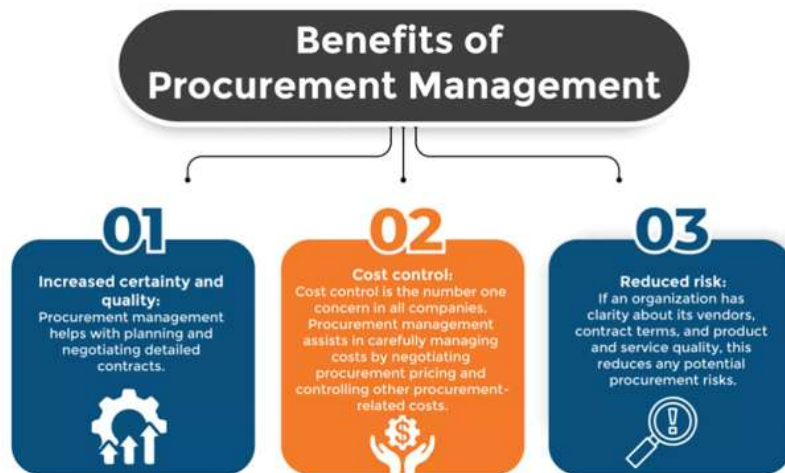


Figure 3 - Benefits of Procurement Management

(Simfoni, 2024)

Strengthening supplier relationship management practices to mitigate risks associated with informal procurement processes and capitalise on engineers' relationships with suppliers can be achieved by fostering strategic partnerships with key suppliers, establishing preferred supplier agreements, and implementing performance monitoring mechanisms to maintaining a centralised oversight and control of the procurement process, whilst ensuring that supplier relationships contribute to overall procurement effectiveness (Ghaith M. Al-Abdallah, 2014) (Jadoon, 2023). Furthermore, by strategically sourcing inventory with key suppliers, improved efforts can be made for sourcing high-value items, volume discounts, whilst streamlining procurement processes for low-value items, minimising administrative burden and transaction costs (Krishnan, 2023).

1139 (1554)

4. Outsourcing.

Outsourcing the management of the parts warehouse and supply of parts to the engineering functions involves entrusting tasks to a third-party service provider, rather than handling them internally within the business. This can offer several potential benefits, such as cost savings, increased efficiency, access to specialised expertise, and allowing the business to focus on its core competencies (Stephen M. Rutner, 1999). However, outsourcing also requires careful consideration and attention to various areas to ensure its success.

Choosing the right outsourcing partner is crucial. Allocating the business' inventory and distribution of spare parts will require selection of an appropriate vendor with a proven track record in parts management and supply chain logistics, preferably in the aviation industry (U.S. Department of Transportation, 2003). Creating, and agreeing to, contracts in the form for example of service level agreements (SLAs), must be established, outlining performance expectations, response times, and escalation procedures. Considerations, in relation to parts availability, must be given to defining within the SLA delivery times, and service quality to ensure alignment with the business' objectives and expectations (McFadden, 2012). It is also critical for the business to evaluate the outsourcing partner on their experience, capabilities, reliability, and reputation in delivering similar services (U.S. Department of Transportation, 2003). Clear contractual agreements must be established between the business and the selected outsourcing vendor, defining responsibilities, and accountability (Manship, 2023). Additionally, agreements must be established for managing the obsolete inventory, with provisions for handling obsolete parts, including disposal methods, liability, and cost-sharing arrangements (Satair, 2024).



Figure 4 - Service Level Agreement

(Mutabazi, 2023)

Whilst the business' engineers have established strong relationships with suppliers, effective supplier relationship management is essential to ensure consistency, reliability, and cost-effectiveness in parts procurement. The outsourcing partner should work closely with the engineers to gather an understanding their supplier preferences, and leverage these relationships to negotiate favourable terms and pricing. Additionally, the outsourcing partner will be required to work closely with suppliers, establishing clear communication channels, negotiate favourable lead times and develop contingency plans to address delays (Rajendran, 2023). Mitigating the impact of lead time variability on inventory management, and selecting suppliers with reliable delivery performance is essential to ensuing timely delivery of parts and minimising potential disruptions caused by variable lead times. Effective supplier relationship management is also critical to ensuring timely access to component design changes (Aviation Spares & Repairs, 2024), and regulatory updates (Audley, 2023), whilst also negotiating favourable terms for phasing out the accumulation of obsolete inventory, in favour of new and updated components (Satair, 2024).

Accurate demand forecasting is a crucial element for the outsourcing partner. This should involve analysis of the business' historical inventory consumption patterns along with communicating and collaborating closely with the business to better understand demand patterns, and with the maintenance engineers to better understand maintenance activities and schedules. Future requirements of inventory and part demands can be anticipated, with additional considerations needed for key components with variable lead times. Inventory levels can be adjusted accordingly, preventing overstocking and stockouts, whilst mitigating the risk of obsolete inventory. Additionally, implementing a robust inventory management system by establishing mechanisms for real-time tracking and visibility across the supply chain from warehouse inventory to parts delivery at destination airports, can ensure transparency enabling proactive management of stock levels and distribution (Faikar Ridwan Harimansyah1, 2020).



Figure 5 - Demand Forecasting

(Thomas, 2023)

Fostering open communication and collaboration between all parties is essential to ensure success of outsourcing. Establishing efficient communication channels and protocols with maintenance engineers at all locations of the business is crucial to facilitate efficient operations, timely updates and address any issues or emergencies that may arise. Maintaining regular dialogue and feedback is also key to evaluating performance and to continuously improve the outsourcing operation, promoting a culture of continuous improvement to enable optimisation of the challenges of the business and outsourcing partner. By regularly receiving feedback from stakeholders and evaluating performance metrics, indicators, and the effectiveness of the implemented processes, improvements can continually be made to address any gaps in the system, improve reliability, efficiency, customer satisfaction, reduce costs, and minimise the risk of obsolescence, whilst enhancing service levels and compliance with procurement policies and regulations (Aviation Spares & Repairs, 2024). Additionally, feedback and evaluation can also be utilised to track the progress and identify areas for improvement for supplier performance, inventory stock and stockout rates, procurement performance and purchase order cycle time (Audley, 2023).

It is necessary for the outsourcing partner to maintain compliance with the business' policies and regulatory standards, whilst maintaining strict quality control measures, ensuring that all parts meet the required standards and specifications (U.S. Department of Transportation, 2003). The outsourcing partner must establish policies and procedures (Aviation Spares & Repairs, 2024) for procurement activities, including the use of purchase orders, adherence to legal and regulatory requirements, data protection, intellectual property rights, contractual obligations, terms and conditions, and implement controls to enforce compliance. Additionally, the outsourcing partner must ensure all procured inventory adheres to regulatory guidelines. Quality inspections must be conducted to verify the authenticity and integrity of parts, addressing any quality issues promptly preventing disruptions to business and maintenance operations (Audley, 2023).

789 (2343)

5. Performance Measures Implementation.

There are a number of performance measures that can be implemented to ensure that Toon Air can effectively monitor the performance of the outsourced parts warehouse and take proactive steps to address any issues that may arise. In this way Toon Air can ensuring the outsourcing partner meets the businesses requirements and expectations, ultimately improving aircraft utilisation and operational efficiency.

Implementing inventory turnover rate performance will measure the efficiency in which the inventory is being managed. High inventory turnover rate typically indicates effective inventory management, with used inventory being replenished, maintaining required inventory levels. Conversely, low inventory turnover indicates that a business may be overstocked, which can result in capital being tied up, higher storage costs and further increases the risk of obsolescence (U.S. Department of Transportation, 2003). Implementing stockout rate performance, where the frequency and duration of stockouts are measured will address this issue. Lead time variability performance, where the variability in lead times for ordering and receiving parts is measured, can further enhance inventory turnover performance, by ensuring that the correct re-order points are allocated to the inventory, based on their specific demand and order lead times (McFadden, 2012).

Measuring and evaluating supplier relationship and compliance, by assessing the performance and adherence of suppliers to agreed-upon standards, requirements, and expectations is essential for the business (Tayeb, 2012). Regularly monitoring the performance of suppliers should be in place to ensure that the established criteria and key performance indicators (KPI's) such as defect rates, on-time delivery rates, complaints, quality, ethical and regulatory standards are consistently met (McFadden, 2012). Conducting periodic performance reviews with suppliers is essential for providing feedback on their performance and compliance, and assessment of adherence to contractual agreements, whilst discussing areas for improvement (U.S. Department of Transportation, 2003). Collaborating with suppliers to identify opportunities for improvement and implementation of corrective actions as needed will help foster open communication and enhancing collaboration outcomes (McFadden, 2012). Additionally, focusing on nurturing positive relationships with suppliers helps build a strong relationship, based on trust and communication, essential traits for long-term success in supplier management (Rajendran, 2023).

Conducting surveys to gather feedback from maintenance engineers and other stakeholders regarding the availability of parts at destination airports is key to measuring and ensuring the performance of inventory outsourcing. Critical information such as, on time delivery rate of required inventory at destination airports can be obtained, in turn should

demonstrate a decrease in aircraft downtime and disruptions to maintenance schedules (Tayeb, 2012). Implementing performance measures and maintaining open and continuous communication with maintenance engineers and stakeholders, the outsourcing partner can effectively monitor and improve the efficiency and effectiveness of inventory and warehouse operations, ultimately ensuring smooth and uninterrupted maintenance activities, leading to increased aircraft utilisation (McFadden, 2012).

Additionally, inventory management of the business' obsolete inventory must be assessed. By implementing performance measures, such as obsolete inventory disposal, where disposed or liquidated inventory is measured providing insight into the financial impact, and the effectiveness of obsolescence management strategies, an assessment of the effectiveness of implemented processes can be made. Continuously monitoring obsolete inventory forecasting, which evaluates and measures the accuracy of forecasts for identifying obsolete inventory items will a) provide an indication over the effectiveness of such processes, and b) offer an opportunity to provide early intervention for improvements to forecast accuracy, a key factor in planning and management of inventory levels, minimising obsolescence, reduce associated costs, and optimisation of inventory management practices to improve overall efficiency and profitability (McFadden, 2012).

Implementing performance measures focusing on procurement control, compliance, and cost management can be implemented to increase compliance with purchasing procedures, ensuring employees are aware of, and compliant with procurement protocols, whilst ensuring correct documentation and terms are in place. Evaluating time taken from identifying the need for an item to release of a purchase order, will highlight delays and ensure intervention where necessary to assure timely procurement (U.S. Department of Transportation, 2003). Furthermore, there is also benefit to be gained from assessing adherence to procurement policies and procedures, distinguishing between high and low-value orders, ensuring appropriate scrutiny is being applied to high-value orders, to mitigate risks and optimise efficiency and financial performance (McFadden, 2012).

657 (3000)

6. Recommendations.

Toon Air face significant challenges with efficiency and effectively managing its inventory and spare part distribution. Delays with aircraft maintenance resulting in reduced aircraft utilisation due to stock unavailability, as well as high inventory investment and obsolescence, has highlighted several areas for improvement for the business. Optimising inventory management requires a multifaceted approach encompassing warehouse decentralisation, proactive inventory management, system improvements, enhanced procurement practices, and standardisation of purchasing processes. Implementing these strategic disciplines, Toon Air can enhance operational efficiency, reduce aircraft downtime and achieve cost savings, ultimately ensuring uninterrupted service delivery and maintaining a competitive edge in the aviation industry.

The decision to outsource elements of the spare parts management will not be a quick process, and may therefore form one on the longer-term strategic changes, however by engaging a specialised service provider, Toon Air can benefit from expertise in inventory optimisation, forecasting techniques, and supplier management. The decision to outsource spare parts management stems from the recognition of several key issues within the current system, transitioning to outsourcing spare parts management offers Toon Air a strategic opportunity to address its current challenges, improve operational efficiency, and position itself for sustainable growth in the aviation industry. By partnering with a specialised service provider, Toon Air can streamline its inventory management processes, optimise procurement practices, and enhance service reliability, ultimately driving greater value for its customers and stakeholders.

Addressing the centralising of inventory at a warehouse 30 miles away from the nearest airport is paramount. While centralisation can offer benefits of streamlining inventory management, it introduces logistical challenges, particularly where parts are urgently required at destination airports. Satellite warehouses closer to key airports must be established, ensuring timely availability of spares. Implementing a robust tracking and logistics system will also aid in efficient transportation of parts to destination airports, minimising aircraft downtime.

High inventory investment and technical obsolescence demands attention. A proactive approach should be adopted by the company to manage inventory by closely monitoring aircraft regulations and design changes. This may involve an in-house approach or consideration of outsourcing to an external company, or potentially a hybrid style approach. In any case, implementing a rigorous obsolescence management system, including regular reviews of inventory and

timely disposal of obsolete parts will help optimise inventory investment, mitigating the risk of holding obsolete inventory. Furthermore, improving the inventory management system is essential to ensure parts availability aligns with maintenance requirements. Addressing the variability in lead times and demand patterns, the business or outsourcing partner should leverage advanced inventory management techniques such as demand forecasting and dynamic re-order points, this can be achieved by Investing in an integrated inventory management software that provides real-time visibility of stock levels and automates replenishment processes enhancing efficiency and minimise stockouts.

Addressing engineers bypassing the purchasing department to order parts directly from suppliers requires a collaborative approach, however, is something that can be achieved in a relatively short time. While engineers' expertise and relationships with suppliers can expedite procurement, it also poses risks, such as lack of transparency and compliance. The business or outsourcing partner should establish clear procurement protocols and provide training to engineers on the importance of adhering to purchasing procedures. Strengthening communication channels between engineers and the purchasing department will facilitate efficient procurement while ensuring compliance with procurement policies. implementing a standardised purchasing process with clear terms and conditions for all orders, regardless of value, is essential to mitigate risks and streamline procurement operations. Enforcing strict adherence to purchase order requirements and leveraging technological solutions such as electronic purchase order systems can aid and enhance transparency and accountability in the procurement processes.

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