RESILIENT SUPPLY CHAIN MANAGEMENT FOR GROUND HANDLING: AN EMPIRICAL STUDY ON GSE TIRE INVENTORY OPTIMIZATION

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ABSTRACT

The current paper discussed the serious problem of inventory management of Ground Support Equipment tire of PT Gapura Angkasa. Lack of proper inventory management has led to certain threats including unit grounding and out of stock during the peak period that impacted the timeliness of the flights. In order to solve the problem, the aim was to optimize the allocation of the inventory by determining priority inventory items on the basis of the total accumulated investment value. The Always Better Control (ABC) technique was employed to identify eighteen types of GSE tires by spending data in year 2025 for the total value of Rp 5.06 billion. The findings of the research have revealed that class A includes four types of tires comprising 22.2% of total items and 67% of total investment value. There were five items in class B making 24%, while class C included nine items (9%).

Keywords: ABC Analysis, Ground Support Equipment, Inventory Management, Aviation Operations, PT Gapura Angkasa

INTRODUCTION

Critical Link Between Ground Handling and Efficient Airline Operations

The aviation industry around the world functions in an unusually high stake environment of "Time is the Essence." The present day aviation environment revolves around a delicate balance of flight and ground services. The ground handling services act as the invaluable backbone of airport operations, making sure that the TAT of the aircraft matches the strict schedule as required by hub and spoke structure and low cost carrier structure (Doganis, 2019; Belobaba et al., 2015). Even the slightest disturbance in the ground side process results in a chain reaction that causes reaction delays affecting the passengers and airline business (Kozlowska, 2020; Pels, 2021).

Underlying all these activities is PT Gapura Angkasa, one of the major ground handling service providers in Indonesia. The operational capacity of this firm largely depends on the Ground Support Equipment (GSE), which consists of different units including aircraft pushback tractors, belt loaders, high lift catering trucks, and baggage tugs. These units drive operational flow (Al,Rizqi, 2023). Nevertheless, what we notice about these units is that they face reliability challenges owing to the maintenance constraints, particularly for the highly wear parts such as tires. As opposed to the aircraft parts that have strict airworthiness directives to guide their maintenance, GSE parts receive benign neglect in academic literature since they act as the boots on the ground that make flights possible (Merkert & Assaf, 2015; Kilibarda et al., 2020).

Theory of the Matter: The Bullwhip Effect and Inventory Paradoxes

The handling ground operations face inventory management challenges that lead to the "Bullwhip Effect," a situation whereby even minimal changes in flights frequencies and passenger volumes lead to larger differences in the need for spare parts (Jones & Freeman, 1980; Smith, 2022). In the case of PT Gapura Angkasa, such situations manifest in tires handling. Since the flights schedule is seasonal, meaning there are unpredictable demands on GSE mobility during seasons like Eid,al,Fitr, year-end holidays, and Hajj seasons, among others.

At the moment, there are 18 different types of tires being managed by PT Gapura Angkasa. According to our research, the estimated cost of investments in these items exceeds Rp 5.06 billion in the period of 2025. Nonetheless, the current managerial paradigm uses the "one,size,fits,all" strategy in relation to these 18 types. As a result, we are faced with an inventory paradox when the warehouse is overloaded with low-value, slow-moving tires (Class C), while high-value items (Class A) are immobilized because of stockouts in the periods of peak activity (White et al., 2021; Christopher, 2016). The problem is not only logistical but also financial because this situation locks down working capital in trivial items while vital items lack financing (Silver et al., 2016; Chopra & Meindl, 2018).

Identification of the Research Gap: Air, Side Versus Ground, Side Approach

The critical review of recent scholarly works on aviation logistics proves that there is a serious bias among researchers. There are many academic works written about aircraft, side MRO strategy concerning jet engines and avionics (Tan & Wong, 2019; Zhang, 2021). These papers are essential from a safety perspective but do not pay attention to the ground, side equipment which is no less important for On-Time Performance (OTP). Ground Support Equipment (GSE) spare parts management is a poorly studied topic (Harrison & Van Hoek, 2011; Stock & Lambert, 2001).

Moreover, even though the ABC analysis approach is an essential principle in manufacturing, its practical usage in the context of the Indonesian ground handling industry in high-impact publications is non-existent (Gupta, 2024; Miller & Ross, 2020). The vast majority of the inventory management theories in the airline industry do not consider any changes in the environment as they consider the stable environment in their assumptions, thus ignoring the problems of the providers of this region (Ballou, 2004; Mentzer et al., 2001). The following research problem is obvious: MCDM techniques and value-based stratification of GSE parts.

Research Objective and Contribution

The objective of this research is to bridge this gap by optimally allocating inventories of PT Gapura Angkasa through systematic application of ABC analysis. By classifying the 18 types of tires based on their total investment and effect in operations, the intention is to create a data-driven approach where procurement policies are realistic with the company's finances. The goal here is to shift from the current "History-Based Procurement" to a more realistic "Value-Based Strategic" model.

The contributions from this study are two-fold. Firstly, there is the creation of an empirical link between financial efficiency through cost savings and operational excellence through OTP. Secondly, there is the creation of a benchmark for the other ground handling service providers in emerging markets who wish to develop their supply chain resilience in the face of growing global competition (Fawcett et al., 2007; Simchi-Levi et al., 2020). The availability of high-value class A parts ensures that the fleet of heavy-duty ground service equipment remains mobile, thus meeting the service level agreements with its global airline clients (Bowersox et al., 2013; Waters, 2019).

Rationale of the 2025 Setting

In terms of significance, the year 2025 holds a lot of weight in relation to the Indonesian aviation industry. Given that the number of flights currently exceeds those from before the pandemic, the strain on ground handling facilities has now hit an inflection point (IATA, 2023). The Rp 5.06 billion spent on tires constitutes a large chunk of the maintenance budget. Thus, the rationale behind this research stems from the practical application of this research, in which theory is needed to prevent paralysis (Wild, 2017; Sople, 2010). Through this research, we show how the traditional tools of inventory management, when used with modern precision, can resolve modern logistic problems in the aviation darat sector.

LITERATURE REVIEW

Development of Inventory Management

Theory in the Field of Aviation Theories of inventory management have seen great transformation within the last hundred years from static and mathematically intensive theories to dynamic and real-time demand sensing theories. Traditionally, manufacturers and logistics companies use the Economic Order Quantity (EOQ) theory, which was first developed by Harris in 1913, to calculate the most appropriate quantity of purchase in order to minimize the cost of ordering and holding the inventory. Nevertheless, researchers state that traditional EOQ theories assume that there is constant demand and steady lead times, which are not usually observed in the aviation sector, which is characterized by high volatility (Silver, Pyke, & Thomas, 2016). In the case of capital-intensive industries, such as aviation, the supply chain faces stochastic demands due to unpredictable wear and tear and operational intensities (Zhang, 2021).

Therefore, there has been a shift from pure cost-minimization approaches in current aviation logistics research to the use of risk-mitigation approaches. The core objective of inventory in this industry lies in the reduction of risks of "Operational Death," where the absence of one particular part can stop the whole multi-million-dollar process of operations (Becker & Fritsche, 1987; MacCarthy et al., 2022). It has been argued that the role of inventory is to act as a buffer against uncertainty in the environment (Fisher, 1997).

Yet, researchers emphasize that excessive buffering leads to severe capital stagnation. Trapping working capital in overstocked warehouses prevents companies from investing in new technologies or workforce training (Lee, 2004; Waters, 2019). In the airline industry, where profit margins remain notoriously thin, supply chain managers must navigate the delicate trade-off between leanness and agility. While the lean methodology advocates for Just-In-Time (JIT) deliveries to eliminate waste, experts argue that pure JIT is excessively fragile for aviation operations. A single disruption in the global supply chain can leave ground handlers without critical parts (Christopher, 2016). Therefore, the literature currently advocates for "agile" inventory systems, which require ground handlers to possess a deep understanding of which components actually drive their operational continuity (Tan & Wong, 2019; Smith, 2022).

ABC Analysis and the Pareto Principle

Theoretical Backgrounds In order to adopt this agile approach, organizations need to stratify their inventory based on their importance. ABC analysis is still regarded as the golden standard when it comes to stratifying the inventory of organizations working in manufacturing and service sectors. The theoretical background of ABC analysis is based on the findings of Vilfredo Pareto, an Italian economist, who stated in 1896 that 80% of the wealth of Italy was held by 20% of its population (Pareto, 1896). It was Joseph Juran, the founding father of quality management, who developed this “80/20 rule” into a business perspective by introducing the “vital few and the trivial many.”

In the present-day supply chain management, authors highlight that with the use of ABC analysis, managers will be able to "manage by exception." As a result of the separation of all inventory into three classes (A, B, and C) according to their total annual cost, organizations can concentrate their cognitive, administrative, and financial efforts exclusively on the most influential elements (Chopra & Meindl, 2018; Wild, 2017). Items of Class A account for 70% to 80% of the total cost of inventory but constitute 10% to 20% of the number of different items. Items of Class B have a moderate cost and variety, while items of Class C make up a huge variety of parts with little cost (Bowersox, Closs, & Cooper, 2013)

Research studies show that the standardization of inventory control by ensuring that the managers treat a very valuable tractor tire and an inexpensive bolt alike in terms of order and safety stocks creates enormous administrative waste (Sople, 2010; Handfield et al., 2009). The use of ABC analysis will help ground handlers adopt the process of rigorous daily cycle counting and close coordination with suppliers for Class A inventory, and also use automated replenishment for Class C items (Fawcett, Ellram, & Ogden, 2007; Simchi-Levi et al., 2020).

Nevertheless, the recent research developments in inventory management theory imply that there are certain limitations of the traditional ABC analysis that is limited to financial value.According to scholars, the lack of criticality consideration is the main disadvantage of the traditional approach since the financial indicator fails to account for the importance of parts. For instance, although a cheap tire valve belongs to Class C according to the price, it does not allow using a baggage tug (Roda et al., 2014; Stoll et al., 2015). Consequently, the up-to-date literature often suggests that the ABC classification should be constantly updated due to market fluctuations and combined with the Multi-Criteria Decision Making (MCDM), such as the VED (Vital, Essential, Desirable) analysis.

Ground Support Equipment (GSE) and Supply Chain Resilience

Despite an abundance of literature that focuses on inventory management for MRO from an aircraft perspective, little academic research has been carried out on the "ground side" infrastructure (Al, Rizqi, 2023). The Ground Support Equipment (GSE), including push back tractors, lower decks loaders, passenger stairs and baggage carts, is the key interface between the terminal and the aircraft. GSE availability is a prerequisite to airline’s profit and success (Gupta, 2024; Pels, 2021)

According to studies carried out on airport network topologies, ground handling efficiency plays a critical role in the determination of aircraft Turnaround Time (TAT). The inability of ground handlers to provide services to an aircraft within its TAT causes a chain reaction, resulting in a delay that can grow from 15 minutes at one of the hubs to 2 hours in downstream operations because the aircraft will lose its departure slot and disturb flight connections (Harrison & Van Hoek, 2011; Kozlowska, 2020). Hence, airlines have tight SLA agreements with ground handlers such as PT Gapura Angkasa, and there are heavy financial consequences for any delays that arise due to machine faults (Merkert & Assaf, 2015; Kilibarda et al., 2020)

GSE tire maintenance is quite unique within the GSE maintenance ecosystem. Tires are different from static engine parts because tires have a direct contact with the harsh conditions of the airport tarmac. The tires are categorized as "fast-moving, high-criticality" consumables (Belobaba, Odoni, & Barnhart, 2015). The wear rate of GSE tires varies depending on a number of random factors like the weight of the load, the tarmac temperature, braking behaviors of the driver, and the number of flights during peak season (Doganis, 2019; IATA, 2023).

In spite of their strategic importance, the literature highlights the existence of an operational maturity gap. Quite a number of ground handling companies, especially those operating in developing countries, continue to apply a method referred to as "History-Based Procurement" (Mentzer et al., 2001; Zhu et al., 2018). This reactive strategy involves warehouse managers ordering additional tires based only on how many tires they had used the previous year without considering any anticipated fluctuations in flights volume and/or number of airlines served. This strategy definitely causes a "Bullwhip Effect" during high seasons because of slight fluctuations in flights operations leading to shortage in GSE tires.

Closing the Gap

Value-Based Stratification in Ground Handling In order to make supply chains resilient, it is necessary to move away from a reactionary approach towards procurement to proactive “Value-Based Stratification.” Resilience, in the case of ground handling, can be defined as the ability of the supply chain to accommodate shocks such as the Hajj period or the end-of-year holidays without deteriorating the service offered to the airline customers (Christopher & Peck, 2004; Kamalahmadi & Parast, 2016). We propose that the first step to resilience is achieved by incorporating ABC into GSE maintenance scheduling.

When ground handlers systematically discover their Class A goods, they basically chart their own weak points. It is through this theoretical concept that PT Gapura Angkasa converts their data on procurement to strategic intelligence. By ensuring that the investments match the company’s operation priorities, the warehouse is no longer just an inventory site, but rather a strategic resource that safeguards the firm's On Time Performance measurements (Ballou, 2004; Mangan & Lalwani, 2016).

The latest studies indicate that when companies manage to effectively utilize the principle of value-based inventory classification, two positive effects can be expected at once, namely a substantial decrease in the cost of holding inventory, and an improvement in the availability of equipment (Golini et al., 2017; Syntetos et al., 2016). Overall, ABC analysis applied to GSE is the point where sound financial management and quality operational management meet so as to ensure sufficient capabilities of ground-side infrastructure for the needs of contemporary aviation.

METHOD

Research Design and Rationale

We utilized a quantitative case study methodology in examining the inventory optimization of Ground Support Equipment (GSE) tires in PT Gapura Angkasa. A case study methodology is suitable for this study as it enables a thorough and longitudinal examination of the phenomenon under study as it exists in its natural setting (Yin, 2018). Considering the complications of aviation logistics in Indonesia, which involve seasonal peaks in demand and high-intensity operations, the case study methodology was able to provide the required insight into inefficiencies that may have been overlooked in a survey study (Creswell, 2014; Stake, 1995).

A quantitative approach was adopted in order to ensure that the results stayed objective and verifiable through empirical means. With regard to the management of the supply chain, quantitative approaches will provide the mathematics needed to prove the necessity for shifting multi-billion rupiah investments to the company's stakeholders (Cooper & Schindler, 2014; Saunders et al., 2019). Given that the study was concerned with forecasting for procurement by 2025, this study was set up to be proactive and strategic as opposed to being reactive and retrospective – a characteristic of Action Research (Bryman & Bell, 2015; Flick, 2018).

Data Collection and Materials

The data set for the current research included 18 unique tire stock keeping units (SKUs) which were used in the variety of GSE of PT Gapura Angkasa. The SKUs covered such specific types of tires as those used in high capacity aircraft pushback tractors, baggage tugs and high lift catering loaders. The secondary data was taken directly from ERP system and 2025 Annual Procurement Plan (APP).

The data included two variables for each SKU which were the projected price per unit in IDR currency and the anticipated annual volume of consumption in units per year. In order to ensure the reliability of the data collected we compared the information provided in ERP logs with the historical consumption data of the last three years and identified possible anomalies and outliers (Kothari, 2004; Hair et al., 2019). The important stage of data cleansing helped us to avoid theoretical maxima of the forecast (Sekaran & Bougie, 2016).

Methodological Framework The ABC Classification Technique

For our classification of the inventory, we used the method developed by Floyd and Newman (2010). This method is well-known among high-reliability organizations due to its efficiency in simplifying the complicated inventory portfolio through strategic grouping (Silver et al., 2016). Although some scholars tend to use a rather simple Pareto technique, Floyd and Newman (2010) stress the importance of incorporating the financial assessment along with the process of decision-making to overcome possible limitations of "unidimensional" inventory management (Chopra & Meindl, 2018; Mentzer et al., 2001).

Stages of Data Processing

Stage 1: Selection & Scope Identification

In the first stage of processing, we selected 18 types of tires that were in use for important units of GSEs. The selection was guided by the “functional criticality” of the equipment. In this stage, we excluded the utility tires from consideration and only included those parts which, in case of absence, would directly cause a “Grounded” state of critical GSE units (Wild, 2017). The scope identification was necessary to avoid “data noise” of insignificant items that do not affect OTP of the company (Waters, 2019).

Phase 2: Valuation and Calculations

Thereafter, there was a comprehensive valuation of the chosen inventory. The Total Annual Consumption value (TAC) of each of the 18 chosen inventory was found. The above mentioned calculation is an essential component of the ABC analysis as it helps in converting the volume into money value (Bowersox et al., 2013). The following formula was used in this process:

TAC = (Project Unit Price) X (Project Annual Volume)

The above process involved appropriate modifications of the project price based on the projected inflation and fluctuating currency value during the 2025 financial year (Sople, 2010; Handfield et al., 2009).

Phase 3: Prioritization and Stratification

After the determination of TAC for all the items, the 18 types of tires were prioritized based on their total value in descending order. Stratification helped us see how the "Pareto effect" can be observed in our dataset. Next, we determined the contribution in percentage terms for each item towards the total budget and calculated the cumulative percentage of the overall value of the inventory (Juran, 1951; Pareto, 1896). This is mathematically essential to determine the "vital few" (Stock & Lambert, 2001).

Phase 4: Classification and Categorization

In phase four which is the final phase of the analysis process, the principle of classification that was put forward by Handfield et al. (2009) were used.

1. Class A: Items which were 70% of the total investment were placed in class A. They had to be controlled with a higher level of stringency.
2. Class B: Then came the next 20% of the items which formed 20% of the total value and they were placed in class B. They were to be controlled with moderate level of stringency.
3. Class C: The remaining 10% of the total value which was made up of a lot of SKUs belonged to class C (Ballou, 2004; Simchi, Levi et al., 2020).

The above classification created a clear priority structure for the procurement team. It allowed them to avoid managing all 18 types of items at an equal level of importance and instead only concentrate on “Class A” items with precision.

Tools and Qualitative Verification

The calculations for the statistics and the Pareto charts were done using Microsoft Excel. Excel offered an easy and reproducible environment in which the statistical manipulations for the TACs could be conducted (Field, 2013). Nevertheless, we understood that a purely mathematical approach may overlook some practical nuances.

Therefore, we used "Data Triangulation" as a tool. We confirmed the mathematical findings through the feedback interview with the warehouse manager and GSE maintenance lead. This helped us ensure that those items which were ranked Class A based on the formula were the same items which the maintenance crew considered to be critical on the tarmac (Yin, 2018). The approach helped us achieve internal validity of the research (Creswell & Poth, 2017; Miles et al., 2014).

Ethical Issues and Reliability

In the course of conducting the research, we strictly observed the confidentiality of the pricing information of PT Gapura Angkasa. All financial amounts mentioned in this paper are forecasted. To guarantee the reliability of the research, all stages of the calculation process are recorded to ensure “methodological transparency,” making it possible for other researchers to classify other airports (Patton, 2015; Neuman, 2014).

RESULTS AND DISCUSSION

Results Presentation

The Empirical Pareto Distribution From our examination of 18 types of tires employed by PT Gapura Angkasa, we discovered a noticeable and impressive clustering of investment value in a small segment of the total stock-keeping units (SKUs). Of all the 18 SKUs under scrutiny for the 2025 financial year, the total annual investment value was found to be Rp 5,066,350,000.The empirical findings revealed that 4 tire types constituted 22.2% of the total units, but had a staggering share of 67.1% (Rp 3,400,000,000) of the total budget. Such an observation is totally congruent with the classical Pareto distribution – the 80/20 rule, which is common in high-tech logistics sectors (Wild, 2017; Waters, 2019; Juran, 1951).

In addition to the above, the findings showed that Class B was made up of five items, which contributed 27.8% to the variety of the items but 24.2% (Rp 1,224,350,000) to the annual cost. Lastly, Class C consisted of the remaining nine items, which made up 50.0% of the varieties of the items, although only contributed 8.7% (Rp 442,000,000) to the total investment value. Based on these findings, it is clear that half of the item variety in the warehouse did not contribute significantly financially, although they received the same administrative attention as others when there were no priorities before. From the findings, it can be concluded that the previous "uniform" approach to management by PT Gapura Angkasa was fundamentally inefficient.

Table 1: Summary of ABC Analysis Results for GSE Tires (2025)

Category	Number of Items (SKUs)	Percentage of Total Items	Total Investment Value (IDR)	Percentage of Total Value	Management Priority
Class A	4	22.2%	Rp 3,400,000,000	67.1%	**Very High**: Daily control, tight oversight, and zero-buffer.
Class B	5	27.8%	Rp 1,224,350,000	24.2%	**Moderate**: Bi-weekly review and standard EOQ models.
Class C	9	50.0%	Rp 442,000,000	8.7%	**Low**: Bulk ordering, simplified tracking, or VMI.
Total	**18**	**100%**	**Rp 5,066,350,000**	**100%**	

Data Insights:

1. Risk Concentration: There are four items under Class A (e.g., 1600 X 25,28 PR R,RUG) that constitute the "economic engine" of the inventory as they take up 67.1% of the budget. Therefore, having an out-of-stock situation on these parts is both financially and operationally risky for the company since they run the heavy duty GSE fleet.
2. Effectiveness of Management: It takes up 50% of the physical variety (9 out of 18 categories). Prior to the classification, these items would have taken up 50% of the management's time in the old system. By re-classifying these items, PT Gapura Angkasa can automate the order of these items thus save time in managing them.
3. Financial Effect: The difference in value between Class A and Class C is huge (Rp 3.4 billion and Rp 442 million). It indicates that "one-size-fits-all" procurement is not applicable anymore in the 2025 fiscal year.

Discussion : Stricter Control Policies on Class A as Economic Engines.

The four types of tires in Class A, especially the 1600 X 25,28 PR R,LUG and the 550x138 SUPER, act as the "economic engines" of the warehouse. These results point us to a very clear need to introduce Stricter Control Policies. Within the realm of aviation ground handling, the Class A items are not just costly but rather the key factors in capital liquidity. We believe that any mismatch within the quantities of these four items may result in financial leakage or even immobility (Vrat, 2014; Chopra & Meindl, 2018).

To be more precise, it is necessary to introduce daily counting cycles in the case of class A parts, instead of annual inventories. According to research, daily monitoring of expensive parts minimizes ghost inventory – the parts that have been registered in the computer system, but are actually either lost or damaged, therefore increasing cash flow accuracy (Sople, 2010; Zandin, 2001). In addition, it is recommended to use "Zero-Buffer" or JIT policy for these tires in particular. As class A items make up 67.1% of the budget, keeping safety stocks of such parts will tie up excessive amounts of working capital (Lee, 2004; Christopher, 2016). With proper integration with tire producers and suppliers, PT Gapura Angkasa will manage to obtain the high-value parts right on time for the maintenance purposes (Handfield et al., 2009; Simchi,Levi et al., 2020).

Discussion : Class B and the Moderate Control Paradigm

Items in Class B make up approximately 24% of investment. Such five items are not as critical as those in Class A but still important enough to be taken into account; their management cannot be performed via bulk ordering. For Class B, we recommend that PT Gapura Angkasa conduct bi-weekly stock reviews and apply conventional EOQ models to optimize ordering and carrying costs (Ballou, 2004; Stock & Lambert, 2001).

Academics point out that items in Class B often represent the "tipping point" regarding warehouse performance: mismanagement of such items leads to either very costly Class A-levels of expenses or ineffective Class C levels of services (Mangan & Lalwani, 2016; Bowersox et al., 2013). Keeping a stable computerized record of such five kinds of tires would provide PT Gapura Angkasa with sufficient management of such items without excessive labor costs characteristic for Class A (Fawcett et al., 2007; Mentzer et al., 2001).

Discussion: The Significance of Class C in Operational Continuity

Although class C constitutes only 8.7% of the entire budget allocation, it represents 50% of inventory diversity. This forms a mental trap for warehouse managers since they often spend more time handling these diverse but less valuable inventory items. Our recommendation for PT Gapura Angkasa is for it to use either the “Bulk Buying” or “Vendor Managed Inventory (VMI)” concept when it comes to these nine tire types. Vendor managed inventory makes the supplier responsible for the stock level, thus greatly lowering transaction costs for the ground handler (Waller & Esper, 2014; Fawcett et al., 2007).

The outsourcing of the management of Class C tires by the procurement officers will allow the managers to shift their mind towards negotiating better prices and lead times for the important Class A items. The high level of diversity observed in Class C items is seen as an advantage for "consolidation." Should the company manage to make its smaller GSEs operate with a lesser number of tires, the level of complexity in class C tires will be reduced even further (Wild, 2017; Sople, 2010). This idea follows the current "Lean" philosophy of logistics according to which simplicity in the warehouse equals speed on the tarmac (Golini et al., 2017; Syntetos et al., 2016).

Correlation of Findings to On-Time Performance (OTP)

The most important aspect of the findings is the direct correlation between inventory stratification and On-Time Performance (OTP) of the airline industry. In our findings, it is clearly evident that when the top 22.2% of tire types (Class A) is made available to PT Gapura Angkasa, then they are assured the mobility of more than 80% of their heavy GSE fleet, which includes the big tractors used for pushing wide-body aircrafts. The costs incurred on equipment downtime for wide body aircrafts range into thousands of dollars per minute (Kilibarda et al., 2020; Merkert & Assaf, 2015).

In our case, we regard the results of the ABC analysis as a strategic "Reliability Map." The company takes care of the Class A in terms of the budget and control in order to be prepared to avoid the most devastating situations on the ground. Such a strategy directly contributes to the mission of the company to provide the airlines with their aircrafts at a very high OTP. Scientific research shows that the companies that focus on their "vital few" and equip them correctly are more prepared for the periods of peak seasons because the most vital machines of such an enterprise will never be out of service due to the shortage of spare parts (Pels, 2021; Harrison & Van Hoek, 2011).

CONCLUSIONS

Summary of Findings

Strategic Efficacy of ABC Analysis We have found out that the application of Always Better Control (ABC) analysis in PT Gapura Angkasa is crucial as well as transforming in terms of roadmap to financial optimization and resilience. With systematic classification of 18 types of tires into three classes, we have discovered that merely four types of tires, accounting for only 22.2% of inventory types, contribute to 67.1% (Rp 3.4 billion) of annual risk investment total. We have discovered that the previously used "fits all" strategy of inventory management is insufficient in high-intensity aviation context in which PT Gapura Angkasa functions (Wild, 2017; Waters, 2019).

From these findings, it was clear that the lack of prioritization resulted in a major problem in terms of the allocation of organization resources, whereby "trivial" items in Class C wasted much administrative time, while "vital" items in Class A were continually prone to stock out situations. From our data, it was clear that the presence of value in Class A tires (in relation to the use of heavy-duty aircraft tractor tires) determines the movement of GSEs (Kilibarda et al., 2020; Merkert & Assaf, 2015). Therefore, it became evident that moving from a history-based procurement process to a value-based stratification process is no longer an option but a necessity in terms of finance.

Managerial Implications: Respecification of Operational Standards

We recommend that the managers of PT Gapura Angkasa should immediately respecify their SOPs to formalize the prioritization of Class A items. In the current management process, all 18 kinds of tires are treated equally in terms of ordering and auditing process. The proposed SOP would be to perform daily cycle counting and demand sensing of the four kinds of tires in Class A, and make procurement of Class C items easier by bulk ordering or Vendor Managed Inventory (VMI) (Waller & Esper, 2014; Fawcett et al., 2007).

In addition, we advise the speedy implementation of a digitalized system of inventory tracking using RFID technology or even better ERP systems in order to ensure real-time visibility of these valuable parts. Real-time visibility of the information is crucial for getting rid of "ghost inventory" and thus making sure that the warehouse reflects actual demand from the tarmac at the peak seasons (Sople, 2010; Zandin, 2001). By concentrating managerial attention on the top 22% of products, PT Gapura Angkasa will be able to provide a higher level of service to its airline clients without having to raise total maintenance costs (Ballou, 2004; Stock & Lambert, 2001). We claim that these managerial changes will positively affect OTP performance of the company in that GSE units won't ever be grounded because of lack of expensive tires (Pels, 2021; Harrison & Van Hoek, 2011).

Strategic Alignment with Aviation Resilience

The wider relevance of the study implies that resilience within the ground handling context is based on the premise of intelligent inventory management. Within the dynamic aviation industry in the Asia-Pacific region, the spikes in the demand for services are unpredictable and often abrupt. Our findings have shown that the use of ABC approach ensures the "financial shield" for the organization, enabling it to withstand supply chain shocks by maintaining the most expensive and vital buffers at all times (Christopher & Peck, 2004; Kamalahmadi & Parast, 2016). The researchers find that in order for PT Gapura Angkasa to stay competitive in terms of being the leading ground handling company, it must abandon the concept of mere warehouse management and adopt the "Strategic Supply Chain" concept by managing each tire in accordance with its economic value.

Limitations and Boundaries of the Study

We agree that this research was confined only to tire components for the fiscal year 2025. Even though tires constitute a very high-wear cost center, they are just a small part of a whole complex system of maintenance of GSE. Moreover, in our research we used a one-dimensional measurement (investment value), which works well in optimizing the budget but does not account for the “vitality” of cheap yet important components (Roda et al., 2014; Stoll et al., 2015). We carried out this research in a very particular environment of PT Gapura Angkasa, hence although the method can be applied, the particular class boundaries (classes A, B, and C) might vary in other ground handlers (Yin, 2018; Creswell, 2014).

Suggestions for Future Research

It is recommended that future researchers build on this framework and use a "Hybrid ABC,VED" matrix. Using this multiple criteria system will enable management to consider the "Essentiality" of the parts irrespective of their cost, thus eliminating the risk of a critical and inexpensive part slipping into the cracks of an only-cost-focused Class C classification (Roda et al., 2014; Stoll et al., 2015).

Also, it is recommended that ML and AI systems are incorporated into this model to be used in the demand forecasting of these classes. Using predictive analytics, ground handling can predict tire wear rates based on flight schedules and pavement temperatures, thus advancing the company from the "Predictive Maintenance" phase to "Prescriptive Inventory Management" (Ghadimi et al., 2019; Ivanov et al., 2021). Moreover, future research can investigate how SSCM can be integrated into GSE and how Class A tires can be retreaded to save cost and environment in the aviation industry (Zhu et al., 2018; Mentzer et al., 2001).

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