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Designing and Implementing Effective Inventory Management System for Drone Parts and Components

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INTRODUCTION

Drone inventory management is gradually becoming a reality in the logistics sector. While software management systems and scanners still play a vital role in daily operations, drones have the potential to revolutionize annual inventory tasks. By employing warehouse drones, the tedious process of stopping operations to manually scan items can be eliminated, allowing the facility to continue functioning smoothly. Logistics stands to benefit greatly from drone usage, with companies like Google and Amazon already exploring drone delivery options. Drones can also be employed for inventory management, automating the detection of inventory disparities and reducing the need for dedicated manual labor. Drones can be controlled via remote or programmed flight paths, capturing information from barcodes or RFID tags. Integrating drones with warehouse management systems (WMS) ensures accurate data transfer and enhances overall stock control, leading to improved operations and traceability. With ongoing advancements, drones offer a promising solution for easier, faster, and more efficient inventory management in warehouses.

Industry Profile

The global commercial drone market was valued at USD 29.86 billion in 2022, projected to grow at a CAGR of 38.6% from 2023 to 2030. Drones have diverse applications, including filming, emergency response, construction, and real estate. They enhance property surveying, project alerts, safety, and accident prevention in construction sites. Use cases for drones have expanded, with continuous innovation in software solutions and manufacturing. Drones are also used for monitoring, surveillance, security, search and rescue missions, and infrastructure inspection. Technological advancements have improved drone capabilities, integrating AI, ML, and data analysis for real-time decision-making and efficient operations. Drones have gained significance during the COVID-19 pandemic, facilitating healthcare transportation and delivery of test samples and medical supplies. Over 18 countries have utilized drones for pandemic-related purposes, according to UNICEF.

Drone Applications and Components

Drones are used or could be used in the following industries: agriculture (for crop health, treatment, scouting, irrigation, and damage assessment), disaster management (for locating survivors, inspecting damage, and aiding rescue efforts), solar cleaning (for efficient maintenance of solar panels), loudspeaker communication (for public announcements and monitoring), load-carrying/delivery services (for supplying emergency aid), drone pilot training (for training aspiring drone pilots), inspection (for examining hard-to-reach structures), and providing aerial views. The various types of drones include agriculture drones, mapping drones, surveillance drones, solar panel cleaning drones, seed dropping drones, loudspeaker drones, stringing drones, hybrid drones, tunnel inspection drones, warehouse management drones, and solar panel cleaning tractors and automation machines.

The various components of a drone include drone motors (two clockwise and two counter-clockwise), drone propellers, drone flight controller, GPS module, electronic speed controller (ESC), power port module, obstacle avoidance sensors, 3-axis gimbal, drone camera, drone battery, drone antennas, downward ultrasonic obstacle avoidance sensor, flight LED, joysticks, main remote controller board, and main camera board.

OBJECTIVES OF THE STUDY

• To have better inventory management

• To have better handling of products

• To reduce lack of manufacturing process

• To reduce cost of production

LITERATURE REVIEW

- Agrell and Gustafson (2019) discuss how Industry 4.0 has transformed inventory management by utilizing analytics and IoT technology, enhancing visibility and control while highlighting concerns like data security and employment shortages.
- Kelle, Akcam, and Singh (2015) empirically review various inventory management methods and technologies such as ABC analysis, EOQ models, JIT, and RFID, assessing their usefulness, advantages, disadvantages, and adaptability to different sectors.
- Chen, Drezner, Ryan, and Simchi-Levi (2000) quantify the bullwhip effect in supply chains, developing a model to mitigate its impact and determine optimal inventory management practices.
- Li and Liang (2020) present a bibliometric analysis of inventory management research in China, identifying trends, themes, and research gaps in supply chain integration, decision support systems, and risk management.
- Tay and Lim (2020) review deterministic, probabilistic, and fuzzy inventory models with expiration dates, evaluating their adaptability and providing recommendations for further study.

These studies underscore the importance of efficient inventory management, advanced technology, and analytical approaches in reducing demand volatility and expiration risk within the supply chain.

RESEARCH METHODOLOGY

Research Design: Descriptive Research

Sources of Data:

- Primary data is based on observations made while participants were enrolled in Bruhat Logistics Pvt Ltd's summer internship programme.
- Secondary data from the export import weekly magazine and from EXIM procedures are used in this research. The information was also gathered from other websites and goods forwarding-related projects.

Sampling Technique: Purposive Sampling

Data Collection Tools: Primary data was collected by conducting structured interviews.

Data Analysis Tool: MCDM (Multi-Criteria Decision Making) refers to the tools, techniques, and methods used to support decision-making in complex situations where there are multiple criteria or objectives that need to be evaluated and balance.

DATA ANALYSIS AND INTERPRETATION

Illustrative Calculation

Point System for Ranking = Criterion Weight * Scale

For example:

- Point system for ranking = (0.1*5) = 0.5
- The total or combined performance of that option with respect to the criterion is determined by adding up all of the alternative point system values.
- Ranking has been established with mapping to the criterion by analysis of the total alternative score values, and interpretations are based on ranking.

Weighted-Sum Model:

- Weighted-Sum Model comprises a method that scores each alternative based on its rating on each criterion as a range of 0-100 and weights the criteria to represent their relative relevance.
- Each alternative that meets the requirement is combined using a linear additive equation to provide a "Total Performance Score" between 0 and 100. The alternatives are then ordered according to their total scores.

Cost	0.1
Lead Time	0.1
Quality	0.2
Demand	0.1

Flexibility	0.1
Customer Service	0.1
Sustainability	0.2
Risk	0.1

CRITERION NO.	**CRITERION**
C-1	Cost
C-2	Lead Time
C-3	Quality
C-4	Demand
C-5	Flexibility
C-6	Customer Service
C-7	Sustainability
C-8	Risk

Table.4.3: List of Criteria

ALTERNATIVE NO.	**ALTERNATIVE**
A-1	Inventory optimization
A-2	Vendor managed inventory
A-3	Check and control
A-4	Automated demand forecasting
A-5	Credit purchase
A-6	Review of product
A-7	consistency
A-8	Just in time

Table.4.4: List of Alternatives

MCDM POINT SYSTEM

CRITERION	**C-1**	**C-2**	**C-3**	**C-4**	**C-5**	**C-6**	**C-7**	**C-8**
WEIGHTAGE	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**
A-1	3	3	5	3	4	3	4	5
A-2	2	2	3	1	4	3	3	3

A-3	4	3	3	4	4	3	3	3
A-4	4	3	3	3	4	4	3	3
A-5	3	1	3	1	5	3	4	4
A-6	5	3	3	4	5	5	2	4
A-7	4	3	2	2	4	2	4	2
A-8	5	5	1	2	1	5	2	3

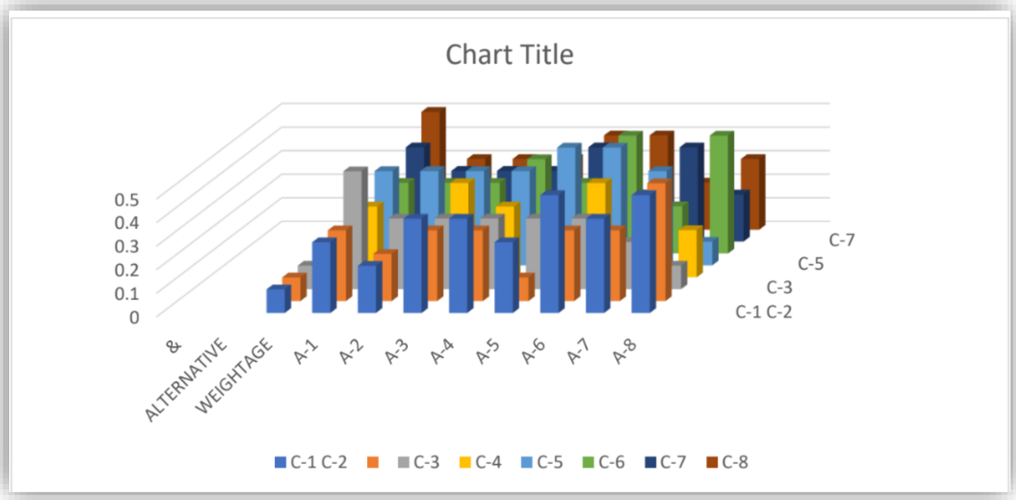
Table.4.5: MCDM Point system

- By using MCDM Point system calculations, multiply the weightage assigned to each criteria with the performance value. (i.e), 3*10/100= 0.3
- Then, we get weightage decision matrix. Add weightage performance value of each alternative to get performance score. (i.e), 0.3+0.3+0.5+0.3+0.4+0.3+0.4+0.5+0.5+0.3= 3.8 out of 5.
- Based on the performance score of each alternative, we can rank the alternative from high performance to low performance.

CRITERION	**C-1**	**C-2**	**C-3**	**C-4**	**C-5**	**C-6**	**C-7**	**C-8**
WEIGHTAGE	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**
A-1	0.3	0.3	0.5	0.3	0.4	0.3	0.4	0.5
A-2	0.2	0.2	0.3	0.1	0.4	0.3	0.3	0.3
A-3	0.4	0.3	0.3	0.4	0.4	0.3	0.3	0.3
A-4	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.3
A-5	0.3	0.1	0.3	0.1	0.5	0.3	0.4	0.4
A-6	0.5	0.3	0.3	0.4	0.5	0.5	0.2	0.4
A-7	0.4	0.3	0.2	0.2	0.4	0.2	0.4	0.2
A-8	0.5	0.5	0.1	0.2	0.1	0.5	0.2	0.3

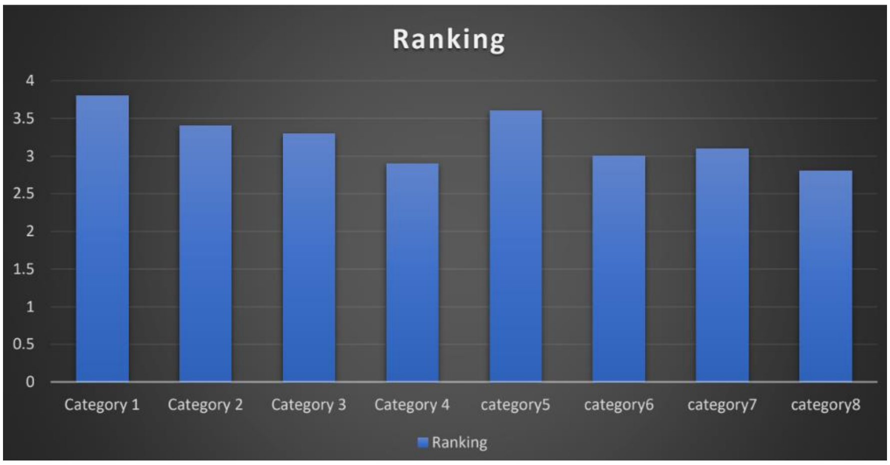
Table.4.6: Weightage Calculation

PERFORMANCE	**RANKING**
3.8	I
3.4	III
3.3	IV
2.9	VII
3.6	II
3	VI
3.1	V
2.8	VIII



RANK NO.	ALTERNATIVE
I	Inventory optimization
II	Review of product
III	Check and control
IV	Automated demand forecasting
V	Just in time
VI	Credit Purchase
VII	Vendor managed inventory

Table 4.7.: MCDM Ranking



SOLUTION

The least-ranked alternatives were picked as the more difficult implementation factors for their inventory management system for drone parts and components based on MCDM study. The right steps must be made to address those issues in order to accomplish effective goods forwarding.

FINDINGS

- It is clear from MCDM analysis that vendor controlled inventory performs the worst among the others and requires a fix for better functioning.
- Garuda Aerospace outperformed its competitors in inventory optimization and is ranked higher.
- It is clear that quality check and control is important to all operations and that it has a significant impact.
- According to MCDM analysis, the rank of credit buy ratings is decreasing.
- A key component of the system for managing inventory is automated demand forecasting.
- Just-in-time inventory management systems will lower inventory risk.

SUGGESTIONS

- They ought to enhance their automated system for forecasting demand.
- Their quality check was positive, but they must continue to enhance their standards if they hope to compete in the market.
- In some cases, just-in-time inventory management reduces risk and costs.
- They should be more flexible in comparison.
- The vendor management system is the main factor impacted; if it is transparent with that kind of system, inventory management performance may be higher.

CONCLUSION

In the future years, India's drone sector will have greater potential and job prospects, and it will play a critical part in the growth of the country's economy. The inventory management system challenges experienced by Garuda Aerospace Pvt. Ltd. Storage and inventory management are problems for Garuda Aerospace. The information management system identifies the difficulties in inventory management, and it is evident that these issues have been addressed and interpreted with the aid of the MCDM research technique. Based on the interpretation, the issues have been resolved. Garuda aerospace pvt ltd should upgrade their operational planning prospects with new technology and current standards in order to accomplish better inventory management system and meet out the degree of worldwide customer satisfaction.

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