IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X
PP 19-23
www.iosrjournals.org

Material Requirement Planning in Aircraft Maintenance

Binil John[1], T. Paul Robert [2]

ABSTRACT: Aviation field always come across a common issue throughout the world while planning their materials in inventory. Cost of maintaining unwanted inventory can hit the revenue of the airline operations. So a near optimal solution is preferred for achieving this. Materials planning can be divided into two models i.e. stochastic and forecasted model. Most of the airlines throughout the world follow stochastic models such as Max-Min, Reorder point (ROP) method, etc. with the aid maintenance software packages widely available in market. It is found that they try to fit the same methodology in almost complex dependent demand products in aviation where demand is discrete. The appropriate method for this scenario i.e. Material Requirement Planning (MRP) is found to be not considered. MRP is nothing but a computerized inventory control and production planning system which helps in scheduling the planned order releases along with appropriate lot sizing.

Keywords: Inventory control, Maintenance, Materials, Material Requirement Planning (MRP), ABC analysis.

I. INTRODUCTION

Accurate material planning is always a difficult part for decision makers irrespective of the domain. While coming to aviation domain, it becomes complicated. An aircraft is made of millions of parts. Even then it is mandatory to track each and every part as a part of regulations. These regulations are strictly monitored by regulatory authorities of their respective country for ensuring the safety and airworthiness of the aircraft. In the present era, few many software vendors are providing solutions for airline's operation to resolve this issue.

II. PROCEDURE FOR PAPER SUBMISSION

A. Aircraft maintenance program

Aircraft maintenance is done by the aircraft operators themselves or by third party Maintenance Repair and Overhaul (MRO) organizations. Few airlines own their own MRO organization for carrying out maintenance. The Maintenance is classified mainly into two: Line maintenance i.e. maintenance activity done when aircraft land each time; and Hanger maintenance when aircraft is taken to hanger for major inspections. Beyond this Maintenance is further classified as A-Check, B-Check, C-Check and D-Check. Each of this check varies based on the maintenance interval as well as maintenance tasks associated with it.

Binil John is doing Post Graduation at Department of Industrial Engineering of College of Engineering Guindy, Anna University, Tamilnadu. Email: biniljohn999@live.com)

B. Objective of the study

- Literature survey
- Develop an MRP table incorporating various scenarios associated with aircraft maintenance.

C. Aircraft materials:

Aircraft materials are mainly classified into seven as follows:

- Repairable
- Components
- Consumables
- Expendables
- Tools
- Kit
- Raw Materials
- Miscellaneous

ABC classification (Part annual consumption value of stocks) of materials is done by much inventory management software as follows:

- A-Type for 20% of components that constitute about 70% of value
- B-Type for 70% of components that constitute about 20 % of value
- C-Type for 10% of components that constitute about 10% of value

XYZ (Current Stock Value of Parts) and FSN (Average Stay & Consumption rate of Parts) classification are also done based on various requirements.

The stocks are stored in warehouses. These stocks follow certain picking strategy such as:

- FIFO (First In First Out)
- Min Zone/Bin
- LIFO (Last In First Out)
- Max Zone/Bin
- Min Lot
- Min remaining Shelf life
- Min remaining Life
- Max remaining Life
- Manual

D. Need for Material Requirement Planning (MRP)

Due to the incorporation of software solutions in aircraft maintenance, material planning has become easier. Even then, it is found that the planning method they followed is inappropriate to the actual planning requirements.

Majority of the software packages available in today's market follows planning methods like Max-Min and Reorder point (ROP) method. These methods shows its benefit only when the materials are coming under A-class or B-class since maintain their inventory is too costly. When we consider the same methodology for other class materials, the planning becomes complicated. Most importantly, these methods are not appropriate to situations where dependencies exist among materials.

Here Material Requirement Planning (MRP) comes into picture. MRP can be used in situations where the demand is discrete and dependent. Complexity of the product is also accepted in MRP method. All these behaviours such as discreteness, dependency and complexity are visible in aircraft maintenance.

III. LITERATURE SURVEY

Trachta et al. [1], have Applied repairable-item inventory modeling in the aviation industry. The objective was to Current planning methods of maintenance, repair, -and overhaul providers (MRO providers) as well as research findings published to date do not cover the requirements of the commercial aviation industry. This paper presents a spare part inventory planning method that calculates cost-optimal inventory levels for warehouses in a two echelon supply chain for spare parts supply in the aviation industry and takes into account various input and output planning parameter, such as budget and inventory level limitations. They concluded that consideration of two echelons of the supply chain represents an important improvement in inventory forecasting in the commercial aviation industry. The applied repairable item planning method's calculation of inventory levels for all the warehouses guarantees minimal total cost.

Candell et al. [2], have carried out a study on eMaintenance—Information logistics for maintenance support with an objective describing requirements and expectations that are important in a global-support environment, and also to propose some central components in an eMaintenance framework that integrates maintenance and ICT perspectives. They concluded that an eMaintenance Platform structured, designed and implemented from a service-oriented perspective with focus on the business process, increases the ability to fulfill requirements such as context-awareness, situation- awareness, and seamless information integration between processes (e.g. operation and maintenance), improved knowledge-sharing, flexibility, extensibility and cost-reduction.

Fritzsche et al. [3], have done a study on an integrated logistics model of spare parts maintenance planning within the aviation industry. The objective is to guarantee a high supply of spare parts by an optimal interaction of various network levels and thus to reduce unscheduled maintenance events and minimize total costs. It can be seen from the simulation study that total costs of an airline can be significantly reduced under a well-chosen maintenance strategy, the constant interchange of information between the three levels and an elaborated forecast

method. With the help of excellent underlying prognostics data (collected historical data or sensor data) significant improvements in the performance of an airline's PHM are possible.

Adel et al. [4], have prepared a predictive model for Evaluation of forecasting methods for intermittent parts demand in the field of aviation. The paper deals with techniques applicable to predicting spare parts demand for airline fleets. The experimental results of 13 forecasting methods, including those used by aviation companies, are examined and clarified through statistical analysis. The results of this study show the use of the SES and MTBR methods to be questionable as they consistently create poor forecasting performance which remains poor as the demand variability increases. Accordingly, it is recommended that companies reconsider using them.

Ghobbar et al. [5], have done a study to identify the sources of intermittent demand for aircraft spare parts within airline operations. Here they investigate the sources of demand lumpiness, as a function of flying hours that may affect the parts demand rate. Experimental results of demand lumpiness, measured by the square coefficient of variation (CV2) and the average inter-demand interval (ADI), are examined and clarified through statistical analysis. The results indicate that the variability in the data increases with the level of aircraft utilization and flying hours.

Adel et al. [6], have conducted a survey on material requirements planning system for aircraft maintenance and inventory control to showcase the importance of implementing MRP in Aviation M&E / MRO software products via Survey. Majority of the operators are satisfied with MRP implementation.

IV. MRP TABLE FOR AIRCRFAT MAINTENANCE SCENARIO

Apart from normal manufacturing sectors, aircraft maintenance faces various scenarios while carrying out materials planning. Major situations they face during material planning are incorporated in the Table I. This situation includes Shelf life expiry, stock transfer, Scheduled maintenance, unscheduled maintenance, sales, unserviceable return of parts, repairs, scheduled receipts, purchase order, external repair order, and internal repair order and planned order releases. This list varies based on the maintenance organization.

TABLE I MATERIAL REQUIREMENT PLANNING FOR AIRCARFT MAINTENANCE

Part #	**Part description**	**Part Type**	**Purchase LT**	**Repair LT**	**Stock UOM**	**Total Demand**			**Safety Stock**
76351-09600	MAIN GEARBOX	Component	2	1	SI	27			3
#	**Requirement details**	**Inventory**	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**	**Total Quantity**
1	Sales Forecast	NA	2	0	4	0	1	5	12
2	Shelf Life Expiry	NA	0	3	2	1	0	1	7
3	Stock Transfers	NA	0	0	0	0	1	0	1
4	Gross Purchase demand	NA	2	3	6	1	2	6	20
5	Scheduled Maintenance Forecast	NA	1	0	0	1	0	1	3
6	Unscheduled Maintenance Forecast	NA	0	0	0	1	0	0	1
7	Expected Un-servicable Returns	NA	0	0	0	2	0	1	3
8	Gross Repair	NA	1	0	0	4	0	2	7

	demand								
9	Gross Demand	NA	3	3	6	5	2	8	27
10	Scheduled Reciept	NA	0	0	3	0	0	0	3
11	On Hand Inventory (Projected)	3	3	3	3	3	3	3	18
12	Net Demand	NA	3	3	3	5	2	8	24
13	Purchase Orders (after Authorize)	NA	2	3	3	1	2	6	17
14	External Repair Orders	NA	1	0	0	3	0	0	4
15	Internal Shop Orders	NA	0	0	0	1	0	2	3
16	Parts Under Receipt (Planned order Receipts)	NA	3	3	3	5	2	8	27
17	Planned Order Releases	NA	3	1	6	6	2	0	18

V. CONCLUSION

Since most of the airlines throughout the world are striving hard to reduce their inventory, the scope of this study is vast. If this study is implemented in all C-class materials as well as few selected B-class materials, the possibility of reducing the inventory in warehouse can be achieved without compromising the maintenance activity.

ACKNOWLEDGMENT

I am greatly indebted to my supervisor, Dr. T. Paul Robert, Professor & Head, Department of Industrial Engineering, College of Engineering, for his valuable and continuous suggestions and guidance in every phase of the project work.

I express my sincere thanks to the faculty members of my prestigious Department of Industrial Engineering, Anna University, for their constant support and encouragement in project work.

I would to record my heartfelt thanks to my friends for their help, motivation and support throughout the project work.

REFERENCES

[1] Kirsten Trachta, Florian von der Hagenb, Daniel Schneidera, ”Applied repairable-item inventory modeling in the aviation industry” a. Bremen Institute for Mechanical Engineering, University of Bremen, Badgasteiner Str. 1, 28359 Bremen, Germany b. Lufthansa Technik AG, Weg beim Jäger 193, 22335 Hamburg, Germany.

[2] OlovCandell a,1, RaminKarim b, , PeterSo¨ derholm c,2 “eMaintenance—Information logistics for maintenance support” a Saab Aerotech,AircraftServicesDivision,SE-58188Linko¨ping, Sweden b Division of Operation and Maintenance Engineering, Lulea˚ UniversityofTechnology,SE-97187Lulea˚, Sweden c Division ofQualityTechnology,EnvironmentalManagementandSocialInformatics,Lulea˚ UniversityofTechnology,SE-97187Lulea˚, Sweden

[3] Adel A. Ghobbar∗, *Chris H,* “An Integrated Logistics Model of Spare Parts Maintenance Planning within the Aviation Industry Evaluation of forecasting methods for intermittent parts demand in the field of aviation: a predictive model”, *Friend* City University London, School of Engineering, ACME, Northampton Square, London, EC1V OHB, UKReceived 1 September 2001; received in revised form 1 March 2002

[4] Adel A. Ghobbar*, Chris H.* "Evaluation of forecasting methods for intermittent parts demand in the field of aviation: a predictive model" *Friend* City University London, School of Engineering, ACME, Northampton Square, London, EC1V OHB, UKReceived 1 September 2001; received in revised form 1 March 2002

[5] A.A. Ghobbar*, C.H. Friend "Sources of intermittent demand for aircraft spare parts within airline operations", Department of Aeronautical, Civil and Mechanical Engineering, School of Engineering, City University London, Northampton Square, London EC1V 0OB, UK

[6] Adel A. Ghobbar*, Chris H. Friend "The material requirements planning system for aircraft maintenance and inventory control: a note", School of Engineering and Mathematical Sciences, City University London, Northampton Square, London, EC1V 0HB, UK

Binil John is a Post-graduate student pursuing ME Industrial Engineering from College of Engineering Guindy, Anna University, Chennai. He is under-graduated in BE Aeronautical Engineering from Anna University.

Dr. T Paul Robert is the Head and Professor of Department of Industrial Engineering at College Of Engineering Guindy, Anna University, Chennai.