

# Process improvement by cycle time reduction through Lean Methodology

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**Abstract** - In present world, every customer needs their products to get on time with good quality. Presently every industry is striving to satisfy their customer requirements. An aviation concern trying to accomplish continuous improvement in all its projects. In this project the maintenance service for the customer is analyzed. The maintenance part service is split up into four levels. Out of it, three levels are done in service shops and the fourth level falls under customer's privilege to change the parts in their aircraft engines at their location. An enhancement for electronics initial provisioning (eIP) is done for fourth level. Customers request service shops to get their requirements through Recommended Spare Parts List (RSPL) by eIP. To complete this RSPL for one customer, it takes 61.5 hours as a cycle time which is very high. By mapping current state VSM and takt time, future state improvement can be done in order to reduce cycle time using Lean tools such as Poke-Yoke, Jidoka, 5S, Muda etc.,

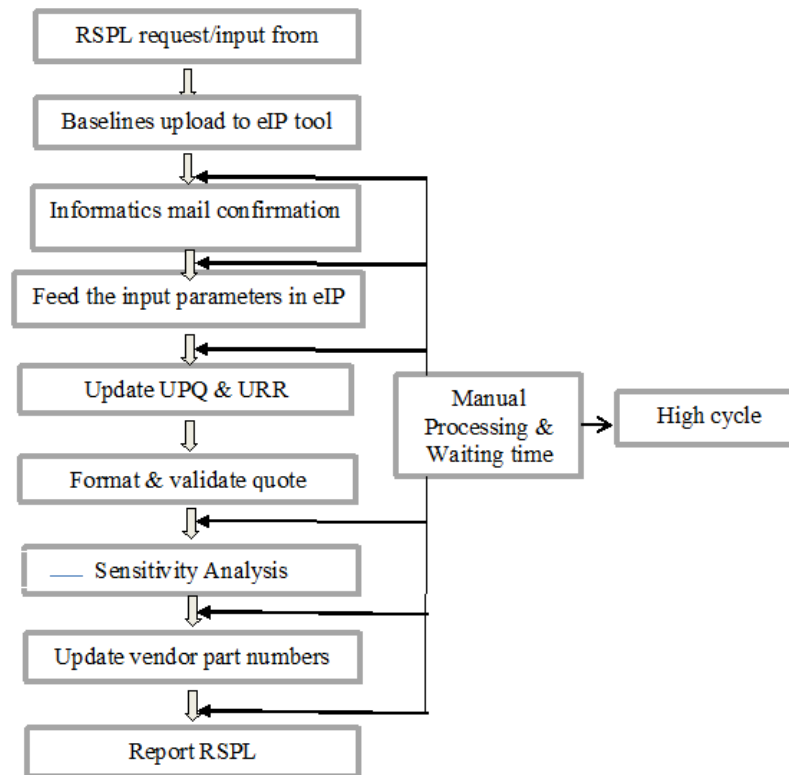
## 1. Introduction

Lean manufacturing is a technique, philosophy using to eliminate the hidden wastes that present in the companies. It is the most useful quality tool in manufacturing sector. In this paper the lean implementation is made in service sector for an aviation service sector. The Process Electronics Initial Provisioning (eIP) that generates Recommended Spare Parts List (RSPL) is taken for implementation. Initial Provisioning is the process of recommending, selecting and procuring equipment, parts, and material to the range and depth necessary for support of a customer's fleet operation for an initial period. The quantitative problems identified for the process RSPL at Service industry are as follows. Delivery time is 61.5 hours which is more than a week. High waiting time. Manual validation. Error due to over utilization of man power and proper work standard procedure is not prepared for the process. Visual management is not there. High processing time due to time stamp is not captured in informatica confirmation mail in successful upload of baseline. Errors in the process due to Increase in manual intervention, No Engine model validation while uploading baseline. The objectives are to reduce the non-value activities in the generation process by using proper lean tools. To reduce the Dock to Dock time to meet the demand. To reduce the generation cost of the RSPL. To utilize the man power efficiently. To prepare work standard procedure for the processes. To improve the accuracy of the RSPL reporting. To analyze root cause for the errors.



## 2. Process flow of E – Initial provisioning

The generation of recommended spare parts list flow chart is plotted in the figure 1. First the Initial Provisioning request will be received from external customers for particular engine model. The



**Figure 1.** RSPL Process flowchart

respective engine model's baseline technical data is manually updated as per the inputs received from the Product Support Engineering and is uploaded to eIP system. Then the informatics runs in the back end and it inserts the new records to the eIP system records by replacing the old records. After 2 or 3 hours eIP system will generate a confirmation mail on the update of new records. Then the input parameters fed to the eIP system to request RSPL. The next process is updating Unit Pack Quantity (UPQ) and Unscheduled Removal Rate (URR) and thereafter, a recommended spare part list output is formatted and quote indicator is validated. Then the sensitivity analysis is done based on the requirement and recommended by quantity is validated. The respective vendor part numbers updated against the part numbers. Eventually, recommended spare parts list is reported in the required format to the customers. Initial Provisioning Commercial Spares, it contact with a new customer, or an existing customer who has purchased a new product/model. It is an initial opportunity to make a favorable first impression with the customer that could result in securing long-term material orders/agreements. A RSPL is the product of Initial Provisioning, it is the list of parts that recommend to customers to purchase at the point of entry into service. A RSPL includes many data attribute fields including the cost of the parts as well as the recommended buy quantity RBQ of each part. eIP has two major components, RSPL generation process and RBQ generation process. The RSPL generation process dictates which parts appear on the RSPL and the RBQ generation uses the various data attributes (take from both Initial provisioning commercial and Tech Data) to determine the quantity of

the recommended parts the customer should purchase. eBaseline will move the data attribute management aspect of the RSPL generation process out of eIP/Tech Database and move it into the electronic Bill of Material (eBOM) tool. The proposed methodology for lean implementation for the process Recommended Spare Parts List is as follows. a) Data collection b) Select the electronics initial provisioning tool c) Identify the process to implement Lean d) Observe the process flow e) Plot the current state Value Stream Mapping f) Identify Value added and Non value added activities g) Analyze the eIP functional problem, which arises in the current state map h) Data analysis and development of solution stage and Implementation i) Plot the future state Value Stream Mapping J) Identify the roadmap for further improvement.

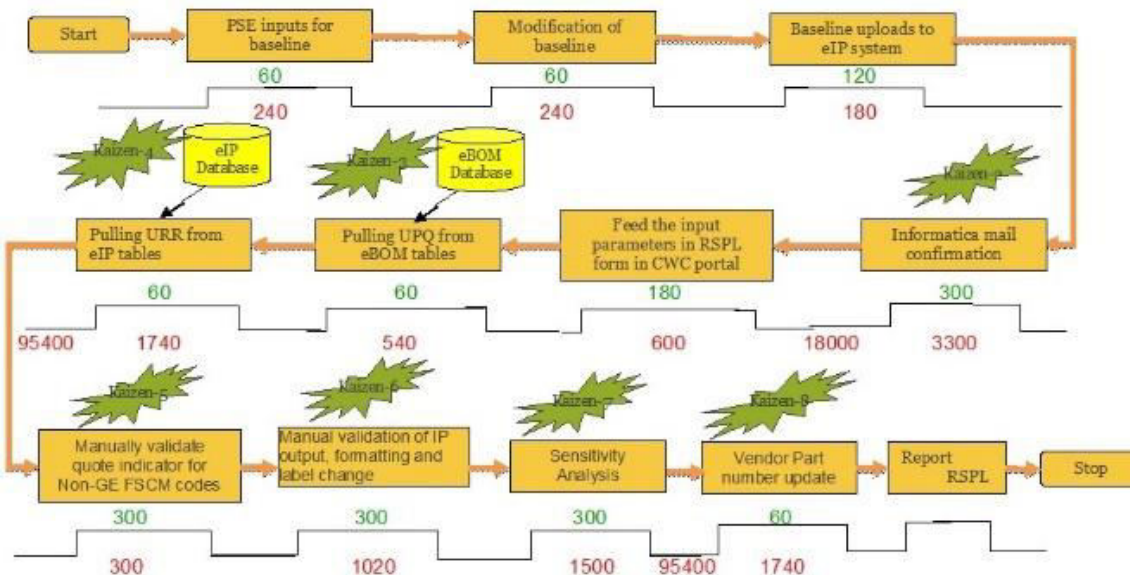
### 3. Literature survey

V. Crute et al., (2003) [7] in this paper the key drivers for Lean has been discussed in aerospace and examined the assumption that cross-sector transfer has been examined by assuming difficulties. Individual plant context with sector specific factors difficulties were explained in the case study. It has been concluded that lean implementation is not difficult when compared to automobile industries. The key drivers specified for lean manufacturing are a) plant specific b) best performing determination should differ in different departments. c) Concentrate on product than the functional. d) New strategies has to follow instead of following past manufacturing cases. e) Should have culture supports and learning through experimentation to get good response. f) Extra resources can opt to complete the job instead changing the layouts. E. Andres Lopeza (2015) [3] this paper gives a practical guideline to implement lean service by considering waste concepts, values and some inherent characteristics. A conceptual model has been created with two cycles named conceptual cycle and practical cycle. In this, various lean techniques were analyzed and categorized into the two cycles. It gives how to begin a lean implementation in a service sector by understanding of service, inherent aspects and close knowledge of customer value. Finally it gives a practical guideline for the introduction of lean philosophy in service organizations. P.P. Wang (2014) [6] an ontology based product service configuration approach has developed and discussed in this paper. It deals with three categories namely value attributes of product service, the modular system of product service, the proposed approach to product-service configuration. The above three categories were demonstrated by an example of configuring service packages of civil aircraft materials. Mass customization is discussed with product service and that gave high satisfaction to customer. To provide customization-oriented menu, the product-service modularity method is proposed with ontology-based configuration method. G. F. Barbosa (2014) [4] In this paper a frame work has been prepared by using the lean concepts and compared with the specific application of projects case study in automated production. It gives an information about the automation benefits for engineers. This paper explains the interconnection between customer satisfaction and manufacturing strategies favored by the lean manufacturing rules. Brandon Stump (2012) [1] this paper deals about integration of flexible, quick response manufacturing and theory of constraints in mass customization (MC). A boat case study has been discussed and their pre and post implementations were compared. Low level and high level mass customization are compared. For high level MC the flexible, quick response manufacturing are suggested as an appropriate choices to improve. Mohammad Ali Maasouman (2016) [5] this paper deals lean manufacturing effectiveness over input and outputs measures. Two manufacturing cells data were collected through questionnaires, historical data (both quantitative and qualitative) and analyzed as a case study. Scoring system were given for non-conformance and the performance were analyzed to show the lean effectiveness. Finally a visual maturity model with methodology was prepared to implement the lean manufacturing gradually at shop floor. Chee-Cheng Chen (2007) [2] in this paper a performance measurement system called an integrated dynamic performance measurement system (IDPMS) has been created to meet requirements for today's manufacturing environment. Its integrating three areas named company management, process improvement, and the factory shop floor. This performance measurement system introduced in planning and establishing a manufacturing performance to delight customers. The proposed method is analyzed with two product groups

(Desktop power and Telecom. power) and proved it could help firms in selecting and rewarding the best manufacturing teams. The above literature survey discussion clearly shows the lean implementation for a company is results in the reduction of lead time. By the tool Kanban and 5S the inventories between the processes are get reduced. So for this project the lean implementation is taken to reduce the lead time and the tools also used to reduce the supporting activities for lead time.

#### 4. Current state value stream map for the process RSPL

The right area to implement the Lean is discussed and selected with the help of the company executives,



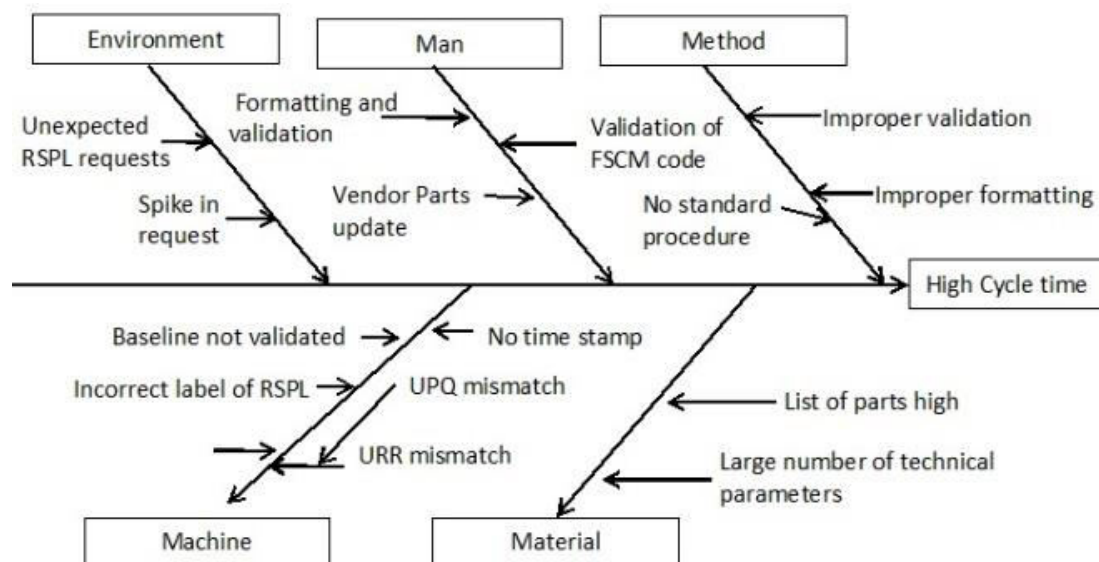
**Figure 2.** Current state VSM

those who are involved in the eIP process. Next the typical process is selected from the Electronics – Initial Provisioning, which is identified by as improvement areas. To create a current state map, a detailed discussion was conducted with the team members and manager. The Process Recommended Spare Parts List is selected and the number of RSPL required is 5 RSPL/month. The Cycle time is 61.5 hours. Working hours per shift/day is 8 hours (1800 hours/Year). lunch break is 30 min. Number of working days per week is 5 days/week. Takt time is calculated by the ratio of available working time per shift (in sec) with the customer demand per shift. By calculation Takt time =  $540000/5=108000s$  (30 hours), from the current state VSM shown in figure 2. The following times were observed. Value added time = 900s, Non-value added time = 219600s, Total processing time = 12600 s, Total cycle time = 221400s.

#### 5. Improvements

To reduce the bottleneck operations and the non-value added activities, some of the lean tools are selected. First the Visual management tool is introduced by doing Proper display system for process flow. Do and don't do pictures are placed in every process to avoid the error process. 5S tool has been implemented and reduced e-waste. Poke yoke is introduced by designing error detection and prevention into RSPL generation process with the goal of achieving error free IP runs. It is difficult and expensive to find all defects through the inspection methods, and correcting it with solutions. Designed eIP system to a partially automate instead of full automate in the generation process to reduce the expense and to automatically stop when errors are detected. After Jidoka, processors can frequently monitor multiple baselines (reducing labor costs) and many quality issues can be detected

immediately. A strategy (Kaizen) is introduced to make continuous improvements by initiating all the employees to work together. By this kaizen, the cross functional work will be initiated and it could eliminates the wastes continuously in manufacturing process. Another common approach is to ask 5 - why tool. By asking why each time, the solution for the problem will be discovered easily. It helps to eliminate the problem truly by applying corrective action to the root cause of the problem. The cause and effect diagram for the high cycle time to generate RSPL as shown in the figure 3. Man: Anyone who is involved with the



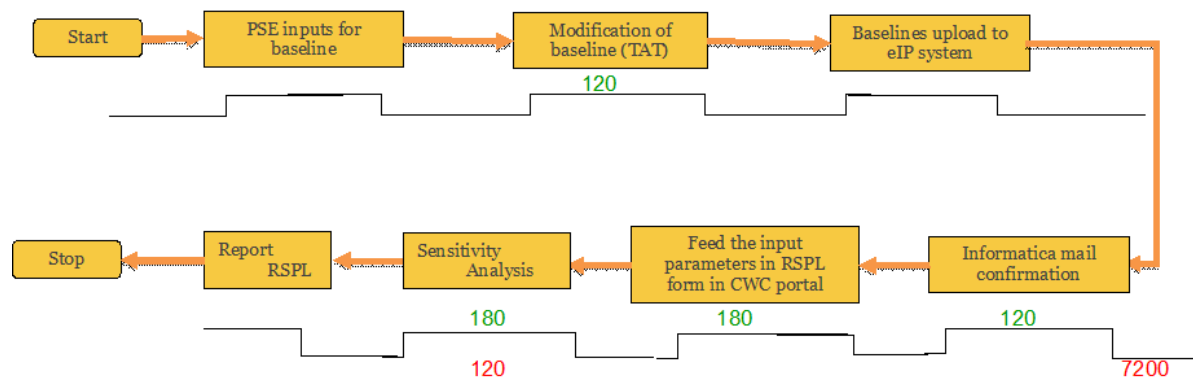
**Figure 3.** Cause and effect (Fishbone) diagram

process. Methods: How the process is performed and the requirements for doing it. Machines: Any type of equipment required to accomplish the job. Materials: Raw materials, pens, paper, etc. used to produce the product. Measurements: Data generated from the process that are used to ensure its quality. Environment: The natural conditions, such as, temperature, and culture in which the process operates.

## 6. Future state value stream map

The implementation is carried out with the future state value stream map in the electronics – initial provisioning process for the generation of recommended spare parts list. After the successful implementation, the non-value added activities which identified from the current state value stream

map

**Figure 4.** Future state value stream map

is reduced. The lead time, value added time, non-value added cycle time and added processing time observed from the current state value stream mapping are 3690 min, 30 min, 3660 min and 210 min. Mistake proofing and automation identified in the Future state value stream mapping. The bottleneck (high processing and waiting time) process is reduced to 132 min to meet the takt time 256 min. The planned RSPL generation time has to be 90% to 95% of the takt time. So the processing and waiting time are reduced to 90% of the takt time to run a smooth flow process. The future state VSM is shown in figure 4.

## 7. Results and discussion

The general parameters comparison is shown in the table 1. By the results the cycle time, error, non-value added time, generation cost are reduced. Proper work standard procedure is introduced in the process for generating RSPL. This activity reduced the waiting time in the generation process.

**Table 1.** Results of Lean implementation

Study Parameters	Before implementation	After implementation
Total processing time (s)	12600	720
Total non-value added time (s)	219600	7320
Total Value added Time (s)	900	600
VA/NVA ratio	0.82	8.37
Bottleneck operation : Manual processing and Waiting time		
Cycle time (s)	221400	7920

## 8. Conclusion

The lean tools are successfully introduced for service industry to improve their quality of service. The following points are shown as conclusions from the result and discussion. It is concluded and shows cycle time reduction is achieved by incorporating the lean tools in the Aviation industry. The methodology carried out in lean implementation could serve as a guideline for implementing lean concepts. The project carries genuine advantage of focusing on eliminating all kinds of non-value added activities in the service industry. It focuses the cycle time reduction by eliminating nonvalue-



added time through VSM to identify improvement points and 5S, Jidoka, Muda, Visual management, Poka yoke, Cause and effect, Work standard procedure to eliminate inefficiencies. The empirical results drawn from the project implementation serve to demonstrate that an operative decision has helped to improve the lean parameters, in particular to reduce the cycle time and increase the value added time and shows the transformation of a former service organization into a better lean organization that has set a lowest cycle time.

### 9. Scope of future work

Automating the Sfile and Vfile generation processes. Construct the RSPL and RBQ calculation procedure spare part class wise to understand the Electronics – Initial Provisioning tool functionally. The waiting time is reduced in the future state with the help of automation tool. But still, there is a scope in informatica confirmation mail generation. This waiting time waste will be greatly reduced if the organization introduces informatica to run in every 30 minutes.

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