

# Waste Elimination and Productivity Enhancement Framework for Aviation Maintenance Manpower through Value Stream Mapping

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**Abstract**— *The aviation industry is booming in a rapid phase due to the exponentially increasing demand for air travel both locally and internationally. In response, the complexity of the modern aircraft too has expanded in leaps and bounds to accommodate the dynamic and the robust demand in terms of size, range and reliability. In this essence, the dependency and the concern on aircraft maintenance element cannot be over emphasised. The aircraft maintenance process, a mandatory aspect for any airline depends on four main inputs; Maintenance Manpower, Aviation Supply- Chain, Maintenance Infrastructure and the Regulative compliances. It is essential that these resources are to be optimally coordinated and efficiently executed to attain minimal operational costs, maximum reliability, optimal safety and fixed delivery times, which are the principal prospects of any airline to attain competitive advantage. Technical manpower is one of the most volatile and stochastic resource which determines the overall maintenance work output and therefore needs precise planning, scheduling and execution. Unlike in other industries where human resource planning is more research based and have gone through vast developments, the aviation industry seems to be lagging behind to a certain extent due to the confined nature and the complexity of the operations which yearns more research for future progress. In view of addressing the above, this research is based on a heuristic analysis of the current aviation maintenance manpower utilization and planning patterns and tends to identify the non-value added activities and to optimally marginalize them. Then optimal solution is derived through Value Stream Mapping technique which is a popular tool in the operational management domain. A case study is analysed encompassing two medium size airlines to execute the above.*

**Keywords**— **Aircraft Maintenance Manpower, Non value added activities, Value Stream Mapping**

## I. INTRODUCTION

Aircraft maintenance is a highly labour extensive process where the skill level required is relatively higher than most of the other service industries. The reliability and the quality of a maintenance task depends on the executional durability of the labour force, standards of

the spare parts and consumables, operational environmental conditions and the regulatory framework. So the most unpredictable input is the labour force standards which tends to fluctuate regularly due to various reasons. Human error is a critical phenomenon which has an adverse impact on maintenance element and is very difficult to fully eliminate. Therefore a spare research area has been developed to study error induced productivity lapses which executes under the title "Aviation Human Factors". On the other hand, the optimality of the maintenance manpower planning and scheduling needs meticulous execution to attain cost benefits. The amalgamation of these two phenomena's is very rarely researched and is novel area to the aviation operational optimizations.

On contrary to the common belief, there is a vast difference between the competency and productivity where even the highly competent people would idle and be less productive due to several inductive conditions. A main lapse found in contemporary literature is that manpower is considered to be constant in terms of productive and the scheduling and planning is executed on such grounds to attain optimality. Apart from the competency of the work force the physical and psychological aspect matters as well. The drawbacks in efficiency of each personal will eventually build up to increase the losses. Such losses contain minor stoppages, idling, speed reduction, defect and rework, motion loss, line organization loss, distribution loss, measuring and adjustment loss, energy loss, etc. The efficiency of human resource is dependent on the manpower and the number of man hours that have been spent on productive work output. Here the term productive work output is highlighted by the fact that there are two types of job indulgence observed, one being value added activities and the other being non value added activities when evaluated with the expected outcome of the specific job concerned. The portion of non-value added activities will pile up waste and in most scenarios goes unnoticed.

As discussed above this research focus on identifying the value in each of the sub activities executed by the maintenance personnel and to evaluate the environmental factors which affects either to enhance or decrease the impact. Here the factorial analysis will be on both physiological and psychological domain to uncover

the proportional influence. The environments concerned will also be both organizational and personal. The main attention would be paid upon analysing effect of manpower reduction due to personal factors due to working environmental, physical and psychological issues.

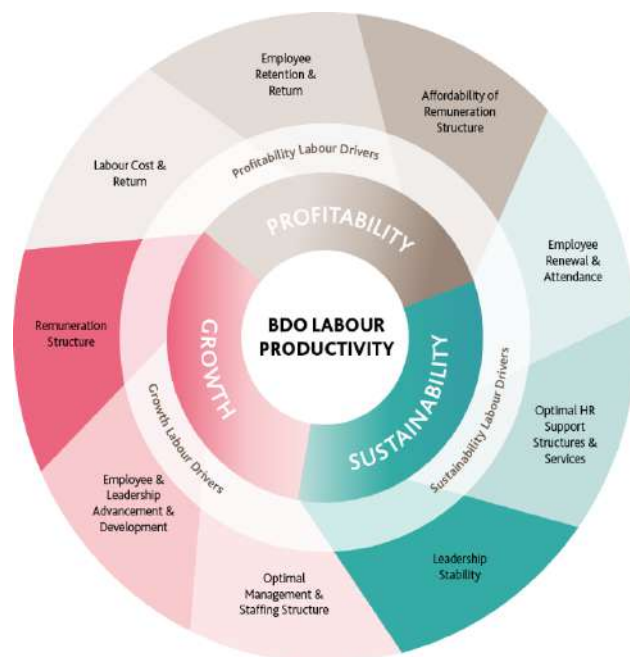


Figure1. Labour Productivity Improvement

## II. RESEARCH PROBLEM

Identify the non-value added activities which affect the aircraft maintenance manpower productivity and to formulate a heuristic framework to optimally marginalize those non value added activities.

## III. RESEARCH OBJECTIVES

1. Differentiating the maintenance activities in terms of value addition to the expected outcome.
2. Evaluate the environmental factors which affects the above.
3. Evaluate and identify the organizational factors which affect the value addition.
4. Formulation of a waste optimization heuristic framework through value steam mapping.

## IV. LITERATURE REVIEW

Since there are uncountable number of facts from smaller to larger which affect to the future of an organization, human resources hold a major position above all. When people work as sets of individuals or individuals in an organization to achieve the given tasks, they are responsible for the final outcome of their efforts and as well as the expected goals and the objectives of the organization.

Since the future decisions of an organization take it to the top of the world, involvement of the behaviour or the acts of each and every individual in the organization is highly essential because either it is a smaller or larger

organization, manpower of that organization can change the whole environment of future decisions. To maintain the organization as a well performed one, the board of management of it has to plan the manpower they have well.

When the future of the organization depends on the manpower it has, the top management has to get the decision that who are the most capable people to fulfil the given task in a given area and how many people have to take part of it because the productivity of the organization which directly affects to the future of the organization entirely depends on the decision of the top to lower management of that organization. Because of this, selection of the right worker for the right work in a specific area must become an objective of planning of manpower.

Any organization could not survive with only materials, equipment, plans, labours, management and other resources. It is a true fact that any company needs the involvement of all the above mentioned parties to survive in the world. But even though it has all the things above, if the management could not handle or plan how the labours work, who is suitable for the particular job all the things become useless.

According to the Management Study Guide, it is known as the manpower planning or the human resource planning. It shows that the planning of human resources in an organization is essential for the future of it. Human resource planning helps to implement the managerial functions like planning, controlling, organizing, directing and staffing becomes the key for them. Also it motivates the workers, increase effective management of personnel and increases the inter relationship of working people. But the most important fact that due to human resource planning, the productivity of the organization will be increased. Or in the simple meaning, management must know how to get the highest productivity in an effective manner by using the manpower they have since it is a result of minimum usage of time, money and energy of individuals in the organization.

According to TechTarget, human manpower productivity in an organization is known as the total efficiency of the sets of individuals or the personnel who works to achieve the expected goal and objectives of it. The general meaning of the manpower productivity is the ratio between outputs to the input of a given worker in a specific time period with respect to a set of workers who are doing the same work in same given time.

Refer to the article by Vicki Bell in 2006, she says that according to the two authors from the Institute of Engineering at the National University of Mexico who are known as Eugenio López –Ortega and Rita Saloma-Velazquez, there are so many external facts in a company which are a bother to the workers' daily routine. These two authors categorized the factors which are influenced for the productivity of workers in to four groups as

Personal factors, work team factors, technology factors and organizational factors.

When talking about the factors effecting to the worker's day today routing, personal factors takes priority among all other factors. Because no matter how much any other factors are well organized, one little personal factor of an employee can ruin the whole production line. These things depend on person to person because people have different personalities and due to that they must have different personal matters which will affect the future of the organization. Personal factors which are affecting to the daily schedule of worker can be his responsibility, educational level, personal hygiene, satisfaction...etc.

As mentioned above, every worker has their own responsibility to the work they have done during the production process. All the peoples' commitment must be there to fulfil the expected outcomes of the company. Everyone has and chosen for a specific duty to fulfil. But if someone is trying to do a work which does not belong to him/her it can be a great loss for the profit of the company as well as the worker's wealth. If the person who is going to do the given specific task does not have enough educational qualifications for that job, he cannot take the responsibility of it. So for the future of the company, the management has to bring the right person with enough capability to achieve the goal.

And personal hygiene matters of the employees are also essential and they must take care to have a well performed company. Every person has these types of problems in day today life. But when it goes to a company, top management has to give a solution in general for these matters. They can build necessary places near to the working places, they can schedule enough time to do changing of clothes, having meals...etc. By giving gifts, bonus, compliments and also motivation to find new technologies to do the work, the company can satisfy their employees.

In a company, everyone has to work as a team and there must be a leader to guide them; not a boss. With a good leadership, employee has a satisfying working environment with them because good leader is a person with creativity, confidence, straight forward, quick decision making and communication skills as the University of Notre Dame says. A good leader can take the organization from lower level to top level because he knows how to communicate with group of different people with different minds. Even though it is much hard to deal with a bunch of different people, a good leader can handle all these things with visions and goals.

Leader should be a good listener and a person with attitude. Because to the employees, he should be a trustworthy person to discuss their matters. That helps to relax the employees mind and because of that they can focus on what they have to do without any stress. Then they can give their maximum output to their working place.

Also to get a maximum output from the employees, company should give them a good training at the correct time. And also the company should be capable of providing a good working environment with good instrumentation, ventilation, safety and comfort to the people who are working for a long time period to achieve targets.

From all the above factors which are affected to the daily routing of employees, the final result is that customer gets a defected production in their hands. Because when the person who creates the final product has to face all the disturbances during production, he does not focus in building a perfect production according to customer satisfaction and he does not give his maximum effort for that. So even though the management expect 100% outcome from the employee during production, it is always in the minimum level of below 50%. This will head up company in a great danger because customers lose their trust upon the company due to late defected final products.

When the customer loses their trust about the product, they do not have any interest to buy it. This situation is directly affect to the wealth of the company and it brings the company from top level to lower level in the current business world. And also productivity is known as being organized. When a company is being more organized, the productivity of the company also increased. It is because when everything is placed in the correct place, worker does not need to spend his time to go everywhere to find them.

When there is a well-organized schedule and planning of noted down the work, during the shift changes next person does not need to start from the beginning that looking for what have been done by first person and from where he has to conduct the rest. It saves much time for complete the work of the person.

So the productivity is much more important in a workplace to take the company or the organization to the top of the current business world.

## V. METHODOLOGY

In order to acquire the required data to build a critical analysis on manpower optimization the research data collection and analysis is carried out in two phases.

### A) *Secondary data collection*

The first phase in data collection will be going through literature and building up a critical analysis between expert views and build up the relationships. In this phase understanding the formulations and functions for man power calculation will be done. The expanded understanding will be helpful in discussing the optimization plan.

### B) Primary data collection

At this stage a questionnaire will be distributed. In order to collect data in a global scale the questionnaires will be distributed among employees of aircraft maintenance facility of,

- Emirates Airlines
- Etihad Airlines

As these are global businesses the identity of each individual will be kept confidential and the data will be collected in a general mean as such, without individual comparison of company but taking all feedbacks as a whole.

In order to achieve this a viable sample will be selected that can be validated in giving a general conclusion.

With analysing the collected data and with the use of formulas and implementation of data the final output will be provided.

#### Value stream mapping

Value stream mapping is a lean-management method for analysing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer. The collected data would be utilized to assess the current state and an improved future state will be formulated through further analysis and expert opinions.

#### Sample size and the demographical restrictions

The sample selection is done to acquire less cost, less field time, improve accuracy and when it is impossible to study as a whole. As this research is delivered in a global scale a larger sample is required to achieve the most accurate outcomes with the size of the total population.

From the two basic methods,

- Non-probability sampling
- Probability sampling

The Probability sampling method can be convenient as per the population's each subject has a known probability of being selected. This allows application of statistical sampling theory to result in generalise and test hypothesis.

The basic demographic concerns are on the type of aviation personal taken into population selection. From all the aviation aspects the first sub category taken as maintenance personal and second sub category and selected sample is built under engineering personals and technicians thus the population is given a representative chance of gaining a probability.

## VI. RESULTS AND DISCUSSION

The questionnaires which are distributed focus among the given areas of data, which will be used for calculation of total manpower availability and the available productivity in the present. A more optimized mean of improvement in productivity will be looked forward in providing with this research.

As the expected complete sample size is placed in a higher number the basic discussion is carried out with the available data as a sub part of the exact sample. With these data the non-value added activities are highly

### 8. What is the average meal time for?

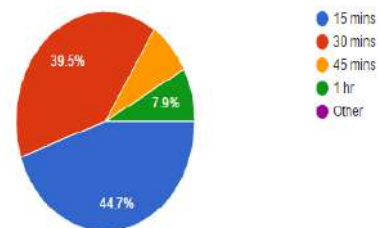


focused on improving to build up a greater productivity level. In accordance with the collected number of feedbacks (40) the following arguments can be made;

Figure2. Average Meal Time

This time can be consumed for value added tasks if the

### 9. Time taken for personal hygiene (38 responses)

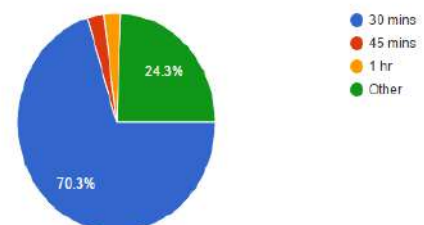


workforce can satisfy the requirement in a specific time frame. That can be a mean value of the general requirement.

Figure3. Personal Hygiene

As for the personal hygiene needs, that cannot be restricted haphazardly. As the health factors are considered in selection of workforce an unusual hygiene behaviour spent irresponsibly can be directed towards

### 10. Average briefing time (37 responses)



proper management by which the spare time can be added for other value added tasks.

Figure4. Briefing Time

Average briefing time can be given as the most common time space given for a number of tasks. When a large

sample is considered this number may increase up to an apparently large number and drawback.

11. Time spend for walking/travelling to other places from work place (Ex: - Tool bay, Inventory, Workshop)  
(35 responses)

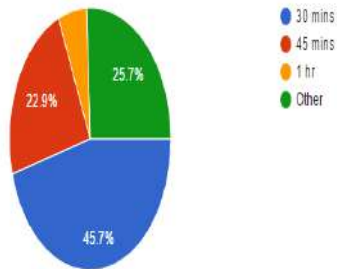


Figure5. Travelling Time

Travelling from one place to another even for unavoidable reasons build a lag in the productive time. This need to be avoided by the most effective placement of required places and tools.

12. Total time waiting for instructions (36 responses)

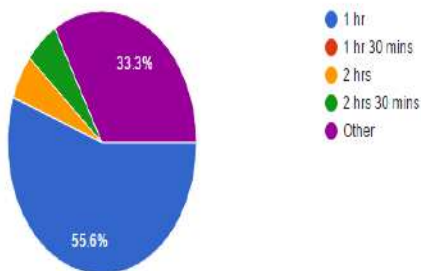


Figure6. Waiting Time

Employing that time for value added activities may bring up more productivity to the plant. Proper communication is always essential as each task will affect one another.

13. Time spend for safety drills (34 responses)

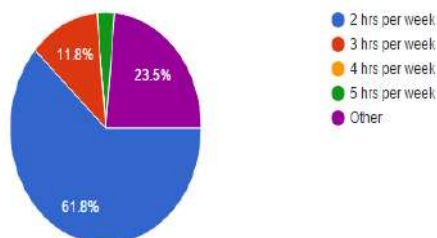


Figure7. Safety Drill Time

Safety is a main concern from individual up to a legal aspect. The greater the safety the more the confidence is built. Though this is a concern it need to be properly managed without effecting the other scheduled work that are being carried out.

14. Time to process a work order (34 responses)

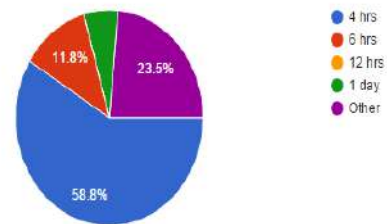


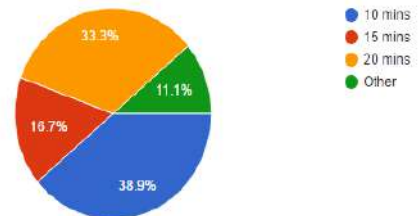
Figure8. Work order Process Time

The procurement process of inducting the required items, components, material, etc. is a major task that consume more time and lag in task completion due to the lack of inventory management.

Figure9. Shift Changeover Time

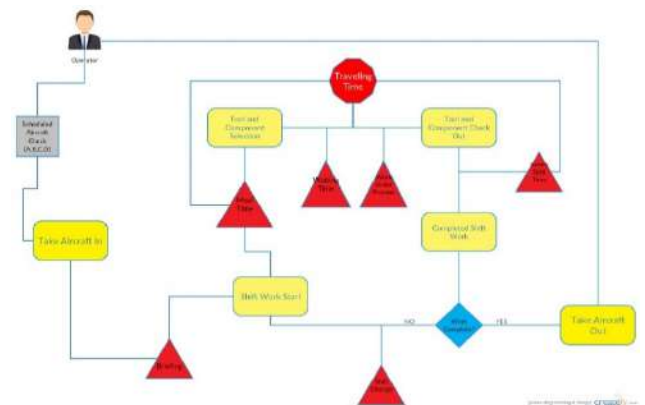
All maintenance tasks are mainly shift based work. The

15. Time taken for shift changes (36 responses)



changing of shifts should be well managed thus it will not spare more time without an employee to take over the work as soon as possible without any glitches on what need to be done.

Figure10. Current state Value Stream Map



## VII. CONCLUSION

The conclusion is built up with the aid of value stream mapping methods. Using the current Value Stream Map, the organization can identify their current state, and next future state which can directly affect to the future of the organization. The lean thinkers can improve the performances of the production with the customer satisfaction after implementing the Value Stream Mapping process. With this the second phase will provide



a streamlined process to minimize these areas that were identified.

With this the non-value added activities may be omitted or mitigated up to a minimum. In this way understanding and clear identification of value added activities and non-value added activities of an organization become easier.

In this research the analytical path is built up toward the basic needs of employees, whether it bring up unnecessary waste of productive time. With the available feedback it provide the likelihood of these activities to optimize the productivity.

According to the findings each highlighted area is prone to build up a lag in optimum productivity. As per the findings,

- Meal Time
- Personal Hygiene
- Briefing Time
- Travelling Time
- Waiting Time
- Safety Drill Time
- Work order Process Time
- Shift Changeover Time

Can be activities that bring down the productive time. These areas can be promoted in building a proper mean of improved work environment. Also can be named as Non-value added activities.

With the completed study a better understanding and presenting of the non-value added activities from value added activities whilst reaching the prime objective of this research to bring up the optimum manpower planning method with the highest productivity level in hand will be provided.

#### VIII. FUTURE WORK

As the process flow have taken place with respect to the feedbacks under the demographic factor of SriLankan employees the study will be carried out by developing a greater sample size with a complex combination of individuals.

This will be followed as phase II and a future probable VSM will be developed by overseeing the available waste areas in a broader state.

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