Job Tracking System for Performance Management in Aviation MRO

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***Abstract*—The performance and competitiveness of the Maintenance Repair & Overhaul MRO industry is dependent on the productivity, efficiency, availability, and utilization of their resources. To ensure the resources are efficiently utilized and the planned work is well performed, the managers need to monitor and track the process and the activities of the MRO jobshop for each work order. This can be achieved through the tracking of the component received by each department of the MRO and capturing the time and material consumed in each repairing or overhauling activity. The purpose of this paper is to introduce a method of Job Tracking System (JTS) used as Performance management System in jobshop. A set of Key Performance Indicators based on cause-effect is proposed to help the managements in judgement and decision making in the workflow and production path.**

Keywords- Key Performance Indicators, Manpower Planning, MRO, PMS.

I. INTRODUCTION

Over the recent years, the aviation industry has become one of the main players of the world's leading economy. Therefore, the organizations in the aviation industry have to ensure a continuous improvement to maintain a good standard of market expectations and remain in business and competition. However, the Maintenance Repair and Overhaul (MRO) industry is an impressive factor that has increased the competitiveness in the airline business. Since the MRO service provider supports airlines to keep their planes operative, this will always put them under pressure to enhance their productivity, reduce the cost and improve quality. According to [1] the costs of having planes idle during maintenance are estimated at US-$ 23,000 per hour. Therefore, repairable components of airplanes have to be immediately released back into the inventory after the repair is completed to be installed into an aircraft whenever needed. The tracking of the aircraft component in the MRO jobshops is important for the management as they can know and track the status of each component and its stage of repairing or overhauling. It is intended that the process of obtaining the data of ingoing activities in the jobshop will enable the organization to measure their performance. However, the Performance Measurement System (PMS) is used exclusively for measuring the degree of accomplishment of defined objective based on the expected results.

Intensive study has been conducted regarding PMS for managing organizations [2-5]. Examples of the most well-known PMS frameworks are the balanced scorecard [6] and strategic maps [7]. According to [8], performance measurement systems often use time, cost or quality to measure project management activities. Performance measurement provides meaningful information to the management on the correct decision to be taken and provides feedback to the employee on how they are performing in their work [9]. [10] states that what to measure and how to measure in a practically feasible and cost-effective way is the core issue in performance measurement.

Despite all these, many organizations are poorly measuring their performance. Without adequate data, the correct and precise measure cannot be achieved. In addition, most organizations make the mistake of measuring what is easy to measure, rather than what is required to be measured [11]. Many more techniques have been shown for the benefit of PMS. Therefore, practitioners and researchers are emphasizing on the need to build a PMS that can be suited to the organization's objective strategy and associated KPIs to reflect a solid measurement and result of performance. In spite of this fact, many organizations' do not pay much attention to such an important fact. [12] argue that the aim of a PMS is to capture data to support and coordinate the process for decision making and taking action throughout the organization. This paper introduces a performance measurement tool based on the Job Tracking System (JTS) in the MRO of the aviation industry. In addition, Key Performance Indicators (KPI) are proposed for the MRO process as well.

II. BUSINESS SCENARIO

In the public eye, an aircraft is just an airplane, but from the viewpoint of the MRO engineers and technical staff it is a combination of repairable components, since the aircraft structure is divided into the body, components and parts. This enables flexibility in dealing with failure, in case of a malfunction. The failed component can be identified and replaced with a functioning spare unit within a reasonable time frame. It may take many hours to repair the failed unit but the aircraft is available to operate according to its schedule. Then, the component MRO jobshop performs the MRO activities needed to return the failed units into operative condition (repairing or overhauling).

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Due to the complexity of aircrafts' components and the need for strict adherence to authority requirements of safety and quality, aircraft components are relatively expensive. It is generally cheaper to repair than to scrap them off and purchase a new unit as a replacement. Figure 1 illustrates the loop in the process of replacement of the component (failed or limited life) removed from the aircraft.

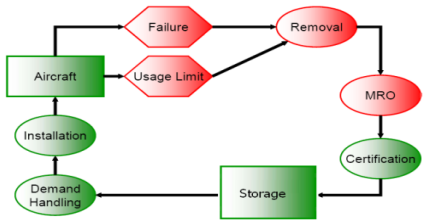

Fig. 1. Key Processes: Loop of the Component Support

The component taken out from the aircraft is known as unserviceable component in both repair cases: overhaul or to produce new life. For the unserviceable component to be certified as airworthy, it has to go through eight steps namely Troubleshooting, Disassembly, Cleaning, Inspection, Repair, Reassembly, Testing and Storage. When an unserviceable component is removed from an aircraft to be sent to a jobshop, carrying the unserviceable tag and the reasons of its removal, a number of operations is performed on it to be serviceable and then certified as airworthy. The aircraft maintenance is a complex task; hence, it is divided into various categories, namely line maintenance, heavy maintenance, engine maintenance and component maintenance.

The scope of this paper will be focus on component maintenance, where the main purpose is to measure the jobshop performance and productivity through the JTS. The component's maintenance work process can be divided into three sections, namely Production Planning, Production, and Material. Unserviceable components arrive at the jobshop into the incoming bench carrying the unserviceable job card tag. The tag contains very detailed information about the component, i.e. part number, serial number, job number, work order and many other information. The planning section at first opens a record in the JTS for each component for tracking purposes; the priority and estimation time is determined based on experience and historical data, and then specific jobs are assigned to specific labors. In the production section, whenever the components are loaded for repair or overhaul according to urgency, the JTS is updated from the start of the job throughout all activities and operations until job completion. After that, the component is sent to the material section where the master data of the material is updated. At this point, the record of the component in the JTS will be closed.

III. CASE STUDY

The organization in the case study is one of the largest MRO service, delivering a comprehensive range of aircraft services, such as the F50, B737 Classic and B747 series, A330, A320 families and B777. Currently supporting the MRO services for more than 100 airlines, the challenge facing the component jobshop is the large amount of data regarding the component details resaved by the mechanical and avionic jobshops and the workforce of technicians and engineers since all the data were in paper document format. The performance measurement and reporting in such a case is time consuming and more complex. Moreover, the accuracy of data is a big issue, as stated by [13]. The best performance measures are based on data that cannot be manipulated, and these measures must be credible. The JTS was built to solve those issues and to track the status of incoming and outgoing components in the jobshops and workforce as well. The JTS makes it easier to retrieve the relevant data on how effectively the resources are utilized. To ensure we are selecting the appropriate set of KPIs, the targets of the companies were collected and classified according to the general targets in business, and rated or evaluated. The steps in identifying the relevant KPIs are:

- *Collecting and classifying the enterprise's defined targets*
- *Collecting and classifying the influencing factors*
- *Qualifying the variable's degree of influence in relation to the enterprise's targets*
- *Selecting and applying the KPI with the highest rating*

A. Phase 1: Component Tracking System

Due to the high costs of aircraft components, it is not logical to store huge amounts of spare components in order to ensure the availability of the items; instead, any component that is removed is repaired quickly and returned to the store or services. Under those circumstances, the JTS is designed to track a large amount of information and data about a work status, component process and progress on a daily basis. Capturing data from every work order completed such as the number of hours burned, the person who performed the work, man-hour utilization, parts and materials issued, etc., provides the management with a real picture of the internal business environment.

The issue at this point is to use the JTS as a performance measuring tool to optimize the throughput and maximize resource utilization. The data are structured in five categories, namely Main Data (Job Basic Data), Capability Data, Process Data, Staff Data and Material Data. Furthermore, all the data categories are linked to the main data and each other through specific data field. Basic Job Data contains details about the components such as job type, job number, part number, description, serial number, component class, estimation time, etc. However, Process Data only contains daily work progress and other details such as planned and clocked hours, target date, etc.

In Staff Data, all the details needed for performance measurement are listed such as staff number, availability, clock-in and clock-out, skill, certification license, the number

of jobs completed and the time consumed to finish the jobs. Capability Data is an important portion in the JTS that contains a complete list of the components that have been certified and approved by the aviation authority and it ensures the tools required for component troubleshooting and testing are equipped in the jobshops. Similarly, Material Data contains the recording of all transactions in the material department such as the materials issued, parts / material usage, price and availability.

Figure 2 shows the jobshop job record interface as a part of the JTS where through it much data as mentioned above can be achieved and viewed, new jobs can be created for unserviceable components received and job search as well as job status can be viewed and checked.

Fig. 2. Jobshop Job Record

Now after implementing the data structure in a systematic way, the variables and factors which influence organizational targets are selected and they will appear as performance metrics.

B. Phase 2: Key Performance Indicators (KPIs)

The use of Key Performance Indicators (KPIs) is an important management tool in a complex and competitive business environment such as the MRO. At this point, we present a KPI for measuring the organization's defined strategic objectives and whether the objectives have been achieved or otherwise.

In the MRO market, it is known that labor cost is a very important factor which should be considered for competitiveness. According to [14] survey, labor cost is 85% for heavy maintenance and 35% for components,. This raises the issue of effectively managing labor productivity, efficiency and utilization which strongly reflects how the MRO jobshops are performing in terms of manpower. Such real data can be easily achieved from the JTS since every work order is planned for each labor and tracked trough all the steps and activation. Figure 3 shows the proposed set of KPIs and some recommended targets for this indicator as defined within a PMS to measure the gap between the achieved and the strategic targets of the organization.

Initially, to drive the KPI metrics form, the discussion on the strategy of the participating organization takes place with the top management, senior managers and engineering managers where the company strategies, policies and rules are included to ensure that the forwarding steps of the metrics selection will suit the company's strategy and strongly agree with the metrics driven form. This is so that the strategy can go further with no conflicts. Moreover, the metrics are developed for the activity and fit to the business process flow. Therefore, the involvement of the business leadership and process owner in driving the performance measure metrics from the activities will lead to more focus on the critical success factors. Since the MRO business can be influenced by global businesses which dramatically changes most of the time, the metrics are structured to enable changes in the organizational targets which can be affected by several factors such as impact of price changes. In addition, the metrics measures have been derived and developed by a team. Initially at that point, a large set of KPIs are selected, and then each KPI is rated through interviews and meetings with the top management, senior managers and engineering managers of a jobshop floor. The highest rated KPI is then selected to be used for performance measurement; the rating is carried out using the Analytical Hierarchy Process (AHP) method which is out of the scope of this paper see [15].

KPIs

Customers

Indicators	Units	description	targets
Job Turnaround Time Rate	Days	Total days need to complete job from star to completion	< 7 days
Turnaround Time Hit Rate	%	Percentage of work orders completed Before due date	>95% WO
Backlog	units	Number of incomplete job older than 14 days	< 600 units

Logistic & Supports Measure

Indicators	Units	Description	targets
No. of activities Starting on time	No	The time schedule accuracy in estimating the start time of each activity.	
Quality of scheduling	%	Percentage of uncompleted WO due to material or man-power	< 2%
Average time difference in (LOGR and LOGC)	time	The time between Logistic support Required and Logistic Complete	

Staff Performance Measure

Indicators	Units	description	targets
man hours available	%	Percentage of (total man hours paid – absence from work) / total man hours paid	
Productivity	%	Plan Man-Hour/Available Man-Hour	
Efficiency	%	Plan Man-Hour/Actual Man-Hour	> 80%
Utilization	%	Actual Man-Hour/ Available Man-Hour	
Safety accident and incident	%	Percentage of total wide accidents per employee during a period of time	

Fig. 3. Summary of the KPIs for the MRO

Thus, from the KPIs defined within a PMS based on Cause-and-Effect which is applied to identify the different business aspects, then, the evolution of the enterprise are benchmarked and graphically drawn. The key performance indicators for customers monitor the turnaround time (TAT) for all work order. The TAT is a very important KPI for logistics and operations involved from the perspective of the customer. Therefore, the TAT has to be calculated and reported. The turnaround time hit rate reflects the percentage of task completed before the target date, and this shows how well the organization performs. TAT hit rate is a very useful KPI in a jobshop and maintenance environment since it reflects how fast the job can be done by the technical staff. For example, when the component arrives at the jobshop, the repairs need to be completed within seven days to meet the TAT target and if the repairs are completed in two days, then the TAT hit will be

5 days. This will result in a high satisfaction of the customer, reduction in backlog buffer and a better inventory management. Additionally, backlog calculates all the identified work to be done but still not completed. It indicates the number of outstanding work as compared to the resources available to complete the work. It is important to point out that the size of a backlog has to be well defined by the top management. On one hand, too large of a backlog may indicate insufficient labor, ineffective work practice mechanisms, and thus, additional help is needed to get the work done. On the other hand, too small a backlog may indicate that there is too much labor for less work load or not enough work identified. Internal business process performance indicators help monitor the availability, productivity, efficiency and utilization of manpower. Utilized man-hour for each component is captured from the start date until the finished date. Planned and clocked hours are used to calculate staff productivity, efficiency and utilization (PEU). Usually in the case study organization the work starts at 8:45 a.m. and finishes at 5 p.m. and the available daily Man-Hour time is six hours 30 minutes per employee (8 hours-15 minutes rest, 1:15 lunch time). For measuring the (PEU) the planned Man-Hours, available Man-Hours and actual Man-Hours need to be captured by the JTS.

The total plan hours is equal or closer to processed standard Man-Hours, taking into consideration the unplanned Man-Hours leading to losing time and resulting in overtime and non-added value problem, the actual Man-hours is that of the real consumption of time for the work to be completed. For instance, if it is planned that five jobs need to be done in three hours and those jobs consumed four hours by a particular labor, then the actual Man-hours is four hours. Let us say that in a certain working area in the jobshop, the planned hours is 490, the available hours is 549 and the actual is 544, then the Productivity = 89%, Efficiency = 90% and the Utilization = 99% in a particular week.

At the same time each labor can view his/her report how productive he/she was for last week. Moreover, to guarantee work is started and completed on time as planned, the material required for rapier/overhaul is delivered on time, logistics and planning metrics are very important factors that need to be considered in any PMS. In planning and scheduling the metrics, the LOGR and LOGC KPI used to measure the average time difference between the Logistic support is required, as it sets to work order in case of no spare parts. The Logistic support is considered completed after completion of these supporting activities.

IV. CONCLUSION

The systems we demonstrated in this paper strongly help the managers to retrieve the data for reporting once the work is completed. All detailed data from the shop floor required for performance measurement such as work status labour, materials, and component routings can be achieved. Tracking the component in all repairs and overhauling steps guarantee accurate and up-to-date information for a completed task, and the remaining work required to complete the task.To manage the expensive resources such as the man-hour, each work order needs to be planned, scheduled and assigned to specific labour through the JTS in order to ensure resource utilization and improve the quality of the business processes. The set KPIs we proposed in this paper can be used in many maintenance departments and jobshops. The KPIs in one hand allow the management to report the past outcome for both cases of good and bad performance, and on the other hand, it can also be used to identify where improvements should be made and which resources are poorly utilized.

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