

**KNOWLEDGE MANAGEMENT TO BOOST PRODUCTIVITY IN MANUFACTURING**

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**ABSTRACT**

Data are the crucial element for productivity improvement and the evaluation or measurement process in the manufacturing sector because the data can tell the real situation about the production site. The data are useful for productivity improvement by using certain lean manufacturing's tools such as Value Stream Mapping (VSM), Single Minutes of Exchange Die (SMED), Total Productive Maintenance (TPM), and others. The data are also necessary for performance measurement. In this paper, we discuss the necessary data that should be included in a knowledge repository for manufacturing where the data then will be used by an assessment tool. The assessment tool is an important factor because knowledge management has a deep relationship with performance evaluation and measurement. Data Management to boost productivity in manufacturing can be divided into five phase and consists of in fourteen steps.

**Keywords:** Knowledge Management, Performance Measurement, Productivity, Lean Manufacturing.

**INTRODUCTION**

During the Industrial Revolution, the way of how the products were produced had been changed. Instead of the products being produced manually, machines started to take the place of the labour. However, with the rapid changing of the product being produced due to customer needs and demands, the way to manufactured products need to be more productive and efficient.

An Old management adage quoted that "You can't manage what you don't measure". Unless we measure something, we do not know if our organization is getting better or worse.

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We cannot make any improvement if we do not know what is getting better and what isn't. However, we cannot measure what we do not have. Therefore, performance measurement of an organization started from the collection of data.

Proper data collection and knowledge management system can facilitate the implementation of lean manufacturing tools, especially the activities with complexity and varieties of types. Various types of performance measurement tools can be applied using collected data to measure either the organisation is getting better or worse.

In every organisation, new data are created each day that can be reused and applied in future instances. Data are the main component of the evaluation or measurement process. In other words, data are a crucial element for management. Without adequate data, management cannot make any decision for better improvement of their organisation. On the other side, inadequate data leads to incorrect judgments in management that could cause result in profit losses. Therefore, the available data in the organisation should be identified and gathered in the more efficient way possible.

The main objectives for lean manufacturing are to perform production with zero defects, to reduce costs, to meet customer requests at the moment and amount desired, to hold no excess inventories by concentrated on the elimination of waste and non-value added activities as much as possible. The focus is on the elimination of seven types of waste: transportation, inventory, motion, waiting time, over production, over processing and defects (Shah and Ward,2003). Lean manufacturing also uses just-in-time strategies where products are delivered in small quantities and have short lead times.

The Toyota Production System (TPS) is production system developed by Toyota in between 1948 and 1975 and had a great impact on the manufacturing industry, especially the automotive industry. Many companies are adapting TPS with a modification to suit their needs. TPS specified the seven types of waste for lean manufacturing as: 1) overproduction, 2) inventory, 3) transportation, 4) defects, 5) processing, 6) motion, and 7) waiting.(Shingo,1989).To overcome these problems, some techniques such as Kaizen, 5S, Total Productive Maintenance (TPM), Value Stream Mapping (VSM), Single Minutes of Exchange die (SMED), and few others have been proposed.

The aim of this paper is to provide a guideline on the types of data that should be collected for each lean manufacturing activity, how the data should be used to increase productivity in the manufacturing sector. Lean manufacturing based on knowledge contributes to better productivity as well as time and cost savings. Better efficiency of any lean manufacturing activities can be achieved by taking advantage of the available knowledge gathered during the implementation of lean manufacturing.

## **Lean Manufacturing's Tool**

### **Value Stream Mapping (VSM)**

In the industries such as automotive manufacturing industries that involve a lot of processes and vendors, the accumulated waste from processes involved will give a high impact on the entire production process. Value Stream Mapping (VSM) is widely used in the production line due to its capability in eliminating waste in the system by analysing the current state of information and the flow of material while designing a future state of production in a way to find the opportunities in improvement. VSM can be used to point out wastes and its causes by coming up with graphical mapping of all material and information flow.

### **Single Minutes of Exchange Die (SMED)**

Single Minutes of Exchange Die (SMED) is an approach to utilised to reduce setup time and provide quick equipment changeover and rapid die exchange (Desai & Warkhedkar, 2011). Set-up time can be reduced by converting the internal set-up time to external set-up time. Internal setup is a process that can be performed only when a machine is stopped such as mounting or removing dies while external setup is a process that can be conducted while a machine is in operation such as such as transporting old dies to storage or conveying new dies to the machines. This approach allows manufacturers to switch from one product to another rapidly and produce products in small batches with short lead time. The implementation of SMED also can lead to increasing production flexibility in changing model and delivery time requirement, and eliminating the waiting time for one lot to complete its process before another lot can be processed.

### **Total Productive Maintenance (TPM)**

TPM (Total Productive Maintenance) is known worldwide as a technique of the maintenance management. This technique was originally modelled after the U.S. style of Preventive Maintenance (PM) by adding some elements of Japanese management style. According to (Nakajima & Shirase, 1992), TPM activities are performed based on a structure called "TPM 8 pillar" which are;

1. Individual Improvement
2. Autonomous Maintenance
3. Planned Maintenance
4. Development Management
5. Education and Training
6. Office TPM
7. Quality Maintenance
8. Safety, Health, and Environment

TPM minimise the unavailability of machinery due to breakdowns and slowdowns, thus, optimising the effectiveness of total production. At the same time, TPM aims to increase employee morale and job satisfaction by involving everyone in the organisations, from top-level executives to shop floor employees. However, small and medium enterprises found that it difficult to implement TPM into their organisations due to problems such as a period is long, high cost being required, and the contents being complicated.

## **PERFORMANCE MEASUREMENT**

Performance of production system must be measured on a regular basis because its tied to a goal or an objective or the target of the organizations by providing information such as, how well the organization is doing, is the organization meeting their goals, are the organization's processes in statistical control, and where improvements are necessary. Performance measurements are a necessary exercise to manage and control the production. Without dependable measurements, intelligent decisions cannot be made. Therefore, many performance evaluation techniques have been developed to meet the requirements of various business processes. Among them include Key Performance Indicator (KPI), Data Envelopment Analysis (DEA), and Game Theory.

Another widely used practice to measure the performance is through the Benchmarking process. Benchmarking is the search for the best industry practices that will lead to the improvement of business performance through the implementation of these best practices. Benchmarking practices can be classified as internal benchmarking, competitive benchmarking, functional benchmarking, and generic benchmarking depending on the nature of the object of study of benchmarking and the partners against whom comparisons are made. Internal benchmarking is a process of comparing the performance of units or departments within an organisation. The advantage of internal benchmarking is its efficiency and relative ease in introducing and obtaining data as well as conducting site surveys. However, since internal benchmarking does not necessarily define industry best practices, this process does not often lead to quick improvements.

Measurement requires a comparison or reference to validate its value (Kaydoss, 1998). Without a reference for comparison, measures are simply meaningless numbers. Consequently, if something is to be measured, one of the first consideration is an appropriate base comparison. A measurement can be compared to itself at some other point in time or to the same measurement in another system. Thus, it is important to determine who is our benchmarking partner because it will put ourselves against the best practice.

Information obtained from performance measurement is necessary for making intelligent decisions about what the organizations do as well as for comparing the performance against both internal and

external standards that could derive the strengths and weaknesses of the organization. This information may also be used for reviewing the performance of an organisation which is an important step for quality and productivity improvement activities as part of the 'Plan-Do-Check-Act' cycle (U.K Department of Trade and Industry, 2006).

### **MANUFACTURING'S DATA**

To measure the productivity in the manufacturing sector, first, we need to know what kinds of data are needed. However, the data are different according to what we want to measure. For example, if we want to measure the effectiveness of the SMED activities, we perhaps do not need to know how long it takes to deliver the product to the customers. Therefore, it is important to know the right data for the right activity. Perhaps, determine what kind of data should be recorded are the first things that need to be emphasised.

Production activity is a complex set of processes with multiple inputs, production processes, outputs, and customers. Generally, inputs for a production system are classified into man, machine, material, money, and method, or commonly referred to as 5M. Input are the resources consumed by the production and output are the results produced by the production. The input as well as the output will generate many information. Well-managed input and output information is essential for acquiring accurate results of the efficiency and effectiveness of the production.

Appendix 1 shows the types of data that usually be recorded in the manufacturing sector. However, not all the data listed in the table should be recorded. It depends on what is the need of the company. The data were categorised into nine categories, namely as Delivery, Money, Machine, Man, Production, Quality, Safety, Health & Environmental, and Time.(Mansor, Ohsato, &Sulaiman, 2010)

### **KNOWLEDGE MANAGEMENT**

In every organisation, not limited to the manufacturing sector, new data are created each day that can be reused and applied in future instances. Normally, this data can be classified as unprocessed data or raw data that carries no meaning on its own. It must be interpreted and take on meaning becoming information. Data are the most important component in manufacturing to improve the process. The data can be said as the lowest level of abstraction, followed by information, and finally, knowledge.

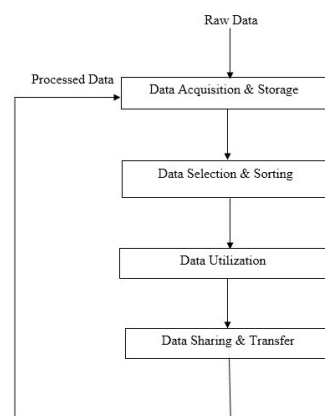
Knowledge can be categorised into two types; tacit knowledge and explicit knowledge. Since tacit knowledge is a subjective knowledge that can not be verbalised and difficult to transfer to another person, this study put the focus on explicit knowledge which can be translated into languages and

can be easily transmitted to others. Knowledge can come from three sources: external sources, internal sources (own employees of the organisation) and assessment exercises.

The process flow for the data can be divided into four phases; acquisition and storage, sorting and selection, utilisation, and sharing as shown in Figure 1. A data repository to store raw data should be designed to use and able to access when necessary. Data should be arranged properly in order to achieve better utilization within the organisation. Selection of incorrect data leads to misunderstandings concerning the organization's activities. The data need to be fully utilised to improve performance using any of lean manufacturing tools. The data that stored in a warehouse without be fully utilised will only lead to a waste of knowledge. The data as shown in Appendix 1 as the general data that related to manufacturing activities.

The lean manufacturing's tools that been previously described can be used to utilise the data. The company can choose which is the best tool for their industry, or they can combine few tools to boost their productivity. However, all the improvement made must be measured to ensure that all the efforts are done in proper manner. Several tools can be used to measure the performance or the effectiveness of the activities that have been done.

Furthermore, data sharing plays an important role in implementing and executing a data management system. If an organisation cannot share or transfer data within the organisation, the most important property of the organisation (knowledge) may be missed easily. The results of data utilization are most important information for the next improvement and this will be a non-stop cycle as shown in Figure 1. Since this exercise deal with only the explicit knowledge, the process of sharing and transferring is much easier compared to tacit knowledge.



**Fig.1.** Data Management Flow

Figure 1 can be elaborated in fourteen steps of the knowledge management for manufacturing. These fourteen steps, which can be divided into five phase include:

Phase zero: Planning

- (1) Identify which activity need to be measured.
- (2) Identify comparative companies or benchmarking partners.
- (3) Determine the type of data needed.
- (4) Determine method of data collection.

Phase one: Data Acquisition & Storage

- (5) Record the data.
- (6) Determine the storage mechanism.
- (7) Store the data.

Phase two: Data Selection

- (8) retrieve data from storage.
- (9) select and organise data according to phase zero

Phase three: Data Utilization

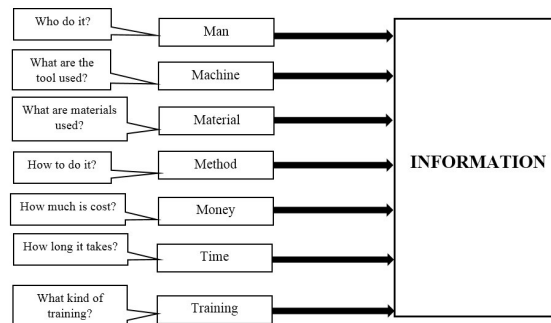
- (10) apply the data for productivity improvement
- (11) measure the improvement done
- (12) use the information from step (11) for decision making etc.

Phase four: Data

- (13) Transfer and share the data from phase three
- (14) Store back the results from step (11) and (12) into step (7)

Meanwhile, manufacturing activities are a complex set of processes with multiple inputs, production processes, outputs, and customers. Generally, Inputs for a manufacturing system are classified into man, machine, material, money, and method, or commonly referred to as 5M. Input are the resources consumed by the production and output are the results produced by the production.(Mansor, Shah, and CheHussain, 2013) added the element of training and time in input because training is an important activity in developing knowledge for employees and time plays a role in minimising the inputs. The input as well as the output will generate many information. Well-managed input and output information is essential for acquiring accurate results of the efficiency

and effectiveness of the production. As shown in Figure 2, all related input in manufacturing need to go through the conversion process into information.



**Fig.2.** Input for manufacturing

## RESULTS AND DISCUSSION

Accuracy is a matter that should be emphasised in the data collection and data recording. At the same time, the correct selection of data should also be taken into account before implement any lean manufacturing's tool or any performance measurement's tool.

The data can tell the real situation about the production site and also can be used to generate a new knowledge through assessment exercises. However, knowledge is only useful when it being used either to improve decision-making processes and productivity or to generate other new knowledge. Improper knowledge management will lead to the wrong perception about the production. Therefore, the process to interpret the data into the information and the knowledge is also need for further research.

## CONCLUSIONS

In this paper, we have discussed the necessary data that should be included in a knowledge repository for manufacturing where the data then will be used by an assessment tool. The assessment tool is an important factor because knowledge management has a deep relationship with performance evaluation and measurement. Knowledge warehouse can avoid important information from becoming useless. Therefore, knowledge management for manufacturing activities strongly indicates a paradigm shift from the conventional manufacturing system to knowledge based manufacturing or "K-Manufacturing".

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[Accessed: july, 2006] [1]  
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**Appendix 1.** List of data that related to manufacturing

Category	Data
Delivery	<ul style="list-style-type: none"> <li>• Inventory Days</li> <li>• On Time Delivery to Customer</li> </ul>
MONEY	<ul style="list-style-type: none"> <li>• Total Maintenance Cost,</li> <li>• Breakdown Maintenance Cost</li> <li>• Preventive Maintenance Cost</li> <li>• Operational Expenditure</li> <li>• Capital Expenditure &amp; Major Spare Park</li> <li>• Total Manufacturing Cost</li> <li>• Manufacturing Cost Per Unit</li> <li>• Amount of Cost down/ Cost Reduction</li> <li>• Amount of Money for Inventory</li> <li>• Amount of Money for Quantity Losses</li> <li>• Kaizen Cost,</li> <li>• Cost of Idle Production/ Operation,</li> <li>• Cost of Late Delivery</li> <li>• Overtime Cost,</li> <li>• Downtime Cost,</li> <li>• Downtown or Lost Production Costs per Hour</li> <li>• Initial Cost of The equipment,</li> <li>• Lost Efficiency Cost,</li> </ul>

	<ul style="list-style-type: none"> <li>• Maintenance Labor Costs on Work Order</li> <li>• Maintenance Material Costs on Work Order</li> <li>• Quantity Cost,</li> <li>• Replacement Cost For The Equipment</li> <li>• Direct Maintenance Cost</li> <li>• Total Maintenance Cost</li> <li>• Total Maintenance Material Cost,</li> <li>• Utility Cost</li> <li>• Unplanned Maintenance Cost</li> <li>• Planned Maintenance Cost,</li> </ul>
MACHINE	<ul style="list-style-type: none"> <li>• Number of Machines/ Equipment</li> </ul>
MAN	<ul style="list-style-type: none"> <li>• Number of Direct Maintenance Employees</li> <li>• Number of Indirect Maintenance Employees</li> <li>• Number of Workers/Operators</li> <li>• Number of Technician</li> <li>• Number of supervisor</li> <li>• Number of Employees</li> </ul>
MORALE	<ul style="list-style-type: none"> <li>• Number of Employee Suggestion</li> <li>• Operator Skill</li> <li>• Number of Absent / Absent Rate</li> </ul>
PRODUCTION	<ul style="list-style-type: none"> <li>• Availability</li> <li>• Breakdown Reduction Rate</li> </ul>

	<ul style="list-style-type: none"> <li>• Man-hour Spent on Emergency Jobs</li> <li>• Number of Downtown</li> <li>• Number of Minor Stoppage</li> <li>• Total Man-hour Worked</li> <li>• Overall Equipment Effectiveness</li> <li>• Performance Rate</li> <li>• Total Work Order</li> <li>• Total Amount of Product Produced</li> <li>• Total Number of Breakdown</li> <li>• Number of Equipment Failures</li> <li>• Number of Preventive Work Order</li> </ul>
QUALITY	<ul style="list-style-type: none"> <li>• Customer Return Rate</li> <li>• Number of Customer Claim / Complaint</li> <li>• No.of Rejected product</li> <li>• Quality Rate</li> </ul>
SAFETY, HEALTH & ENVIRONMENT	<ul style="list-style-type: none"> <li>• Number of Accident</li> <li>• Amount of Waste Disposed</li> <li>• Number of Environment Accident</li> <li>• Recycle Rate</li> </ul>
TIME	<ul style="list-style-type: none"> <li>• Time Spent on Maintenance</li> <li>• Number of Working Day (per week/month/year)</li> <li>• Total Working Time</li> <li>• Planned Downtime</li> <li>• Loading Time</li> </ul>

	<ul style="list-style-type: none"><li>• Operating Time</li><li>• Design Cycle Time</li><li>• Mean Time Between Failure (MTBF)</li><li>• Mean Time to Repair (MTTR)</li><li>• Number of Correction Order</li><li>• Number of Emergency Order</li><li>• Downtime Losses (Time)</li><li>• Downtime Caused by Breakdown</li><li>• Hours Worked As Overtime</li><li>• Total Maintenance Hours</li><li>• Total Breakdown Hours</li><li>• Time Takes For All Repair Works</li></ul>
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