

Optimization of available resources and methods of capitalizing human capital on industrial process lines efficiently

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Abstract: - Efficiency and accuracy on the production lines enables an improved production and utilization of available resources within industries. Due to time constrain in the production process, the workers have to keep on their toe's to ensure daily goals are met as set by the management. In the race for achieving set goals, human capital is the prime concern, even machineries also considered as a role player in the production lines. Measuring man power utilization is very slanted due to the standards and policy's set by the management. Generally faults and mistakes done on the process line are always overwritten by adulterated production information's to cover up any unwanted consequences. Such factors lead towards the down falls of the management in maximizing their available resources. Management should be skilled on resourcing for available production information's and to accurately interpret these data in order to identify the various faults at production level especially on workers to immediately rectify in order to improve efficiency. An accurate data management system will ensure these miseries will be highlighted and counter measures are seen to ensure sustainability of these industries for the long term.

Key-Words: - Man power utilization, optimization of human capital, industrial production line, data management system.

1 Production nature in industrial shop floor

The production or process lines in Industries worldwide is comparatively common with each other, apart from their industrialized nature of the product which makes it difference. A production line is commonly known as a set of sequential process which is established on an industrial shop floor. Generally materials are placed through a refining process to produce an end product, which is suitable for onward consumption or components are assembled together to complete the process as finished goods or products. Production process involves moving partially completed products to workers which is placed on pallets manually or on a conveyor to the next process on the production line. The fundamental system in a production line is further improved and redesigned based on the industrial desired. Most industries have their own method and way on manufacturing their products

from raw material to the final product,

A production process or a manufacturing process is known as transformation of raw material or components into finished products. The most basic levels in a production process involve procurement, fabrication and assembly, testing, packaging and distribution. In certain industries this may defer base on the manufacturing nature and production process.

The production or manufacturing lines of industries worldwide can be categories into three types, which are automated production lines, semi automated production lines and manual production lines. The nature of a production line is depending on the complexity of the manufacturing parts, production volume, restricted or hazardous manufacturing process, the sensitivity of the product and cost. Authorities in industries plan and layout their production lines according to their specific

production requirements. To perform this task, the combination of humans and machineries is a very common source of manufacturing resources which is in practice world wide. The practice of both humans and machines is various types of production lines are demonstrated as in Fig. 1.

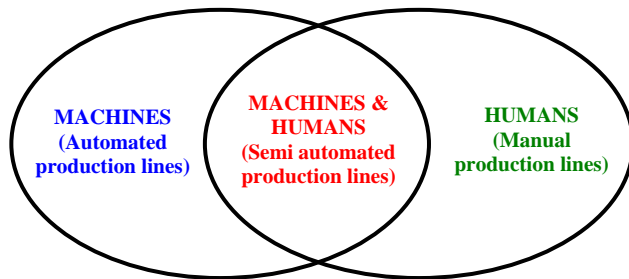


Fig. 1. Types of production lines

From the olden days, humans have manipulated the production lines from light industries to heavy industries due to their competence on specific processes. Humans in the production lines are called workers or operators who perform simple repetitive tasks as designed to permit very high rates of production per worker. The workers are specially trained to perform these tasks to their best capability to ensure optimum quality of goods or products. Fig. 2 shows a worker performing his task on a manual process line.



Fig. 2. Manual manufacturing process

The modernization in industries has revoke and introduced new technologies to ease human life in the production lines. Most of the industries have installed machineries to accompany human workers

which is know as semi automated process lines to accomplish better production rate base on customers demand. A worker performing his task with the help of a machine is as shown in Fig. 3.



Fig. 3. Semi automated manufacturing process

Fully automating the production process is considered the most significant way of producing products to an optimum level. Automated process lines are designed to operate with fewer workers as a cost cutting measures in the long run. Apart from that, such production processes is designed to full fill mass or moderate production output and is ideally suited to serve large, relatively homogeneous populations of consumers. The automated process line which uses a robot to perform repetitive task as designed is shown in Fig. 4.



Fig. 4. Automated manufacturing line

Machineries for automated or semi automated production process such as robots are capable of working for long duration at a consistent rate of

production output. Thus, such process lines demands expert and professional people in designing and maintaining the system.

2 Human factors towards inefficiency in production lines

Analysis are carried out by the management on production line problems almost daily and counter measures are brought to light to further strengthen the performance of this production line. Analysis is made easy when data is translated into various categories base on critical factors which affects the production lines. The factors affecting production lines can be categorized into three as shown in Fig. 5. Each of these factors will results in various consequences towards the production lines.

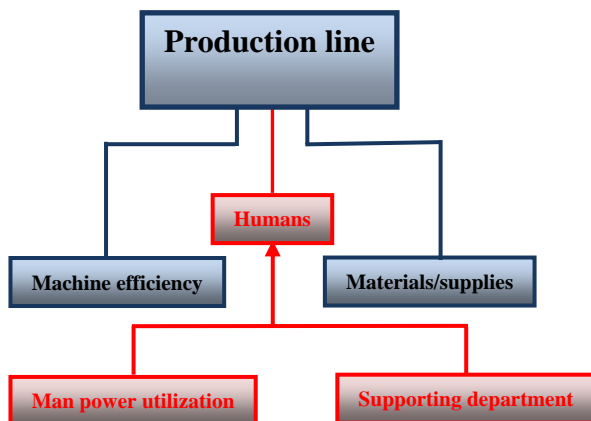


Fig. 5 Three major factor affecting production lines in industries

2.1 Manpower utilization

Humans play a major role on the industrial shop floor especially when it comes to meeting targets. Humans in the production floor can be divided into two categories which are workers or operators on the production line and the workers in the supporting department.

2.2 Supporting department

The amount of time taken to solve faults on production line plays an important role in maximizing the production output. On the race to meet targets there will be unwanted breaks caused by machines that will delay the production. In addition, time is also wasted in the calling process

and the department's availability to correct faults.

In general, manpower capitalizes most of the process on industries from the management to the layman (operators). An industrial environment is one in which there are a large number of people from various departments working together to meet set goals. When it comes to unmet goals, fingers should also be pointed to the supporting department as they also contribute to this matter. The supporting departments play their role in maintaining the consistent pace of work on the industrial shop floor.

There are three basic departments in industries which are the Total Quality Management (TQM), Production Planning and Control (PPC) and Maintenance. The TQM involves all the quality matters of the parts produced. The PPC involves in planning the production process and supplies base on orders. The maintenance department is responsible on all the technical matters on the industrial shop floor. Most of the industries face problem due to unforeseen damages that the company will face if a task is not done on scheduled basis.

2.3 Operators and workers

Human performance varies from time to time depending on their capability and duration of work. When the performance of a worker drops, the production output also drops. Improper monitoring of workers will result in low standards of production output and will increase the maintenance of machineries. The major factor contributing to this is the attitude of the workers themselves. Most of the workers tend to perform in an average manner and for most of the time they will be less productivity and this will result towards wastage of the planned production time. The only solution for this problem is to have better supervision on them during working hours which is quite difficult when it comes to a big scale industry [1].

3 Production breakdown

The urge for optimization of machine efficiency and man power utilization in industries is vital, yet with the existing system practiced it is not within anticipation of the management [2], [3]. Most of the management is concern on meeting their daily targets without knowing their true capacity. Usually industries operate in multiple shifts as their

production duration.

Some industries operate in two 12 hours shifts or operate in three 8 hours shifts a day. The planned shift length can be divided into two, which is the Planned Downtime and Planned Operation Time. Planned downtime is duration of time where the management has decided to stop the production process due to certain commitments such as preventive maintenances, improvement projects, low in production order and etc. Planned operation time is the proposed time for production process by the management. Generally the planned operation time can be divided into two which is actual operation time and unplanned downtime. Both these factors are the major concern for the management when it comes to measuring machine efficiency and man power utilization. Industries try to maximize the actual operation time and minimize the unplanned downtime to improve their capacity in all means [2], [4]. The production duration can be categorized as shown in Fig. 6.

Planned Shift Length		
Planned Operation Time		Planned Downtime
Actual Operation Time	Unplanned Downtime	

Fig. 6. General production breakdown

4 Measuring manpower utilization

On average, human performance is not consistent. It is more likely to diverse every single moment. Over flooding of humans on the industrial shop floor is common and man power is not used to the optimum. Human waste of production time can contribute to less productivity. The obvious solution is by implementing better supervision on workers during production hours and a reminder to meet set targets.

Sufficient production data is used in assisting operators especially in informing operator of their performance to date. Apart from that the data will also be able to guide the operator to maintain a consistent pace throughout the day and this will result in a better implementation of work morale among the employees. Once the operators have been tuned to react according to the management's set

goals, this will automatically eliminate wasted time and hence produce more units per hour [5].

The amount of time taken to solve the faults on production lines plays an important role in maximizing the production output. Close attention on production line is necessary by appointing someone watching the whole shop floor without a blink of the eye to avoid all the problems from getting to the peak. On the race to meet the targets, there will be unwanted breaks on the machines where it will delay the production process. The process to convey message to the respective departments on the faults is another obstacle in the existing industrial environment. The stops cause losses in production output. Adding to it is the calling process base on the departments availability is another factors of unmet production output.

Essentially human capitalize nearly all the process on the industrial shop floor from the management to the layman (operators). Visualizing an industrial environment which includes a big number of people from various departments working together in meeting the set goals. When it comes to unmet goals, fingers are not to be pointed to an individual, whereby the supporting department also has their contribution on this matter. Monitoring of supporting departments in industries is another factor which should be taken in account for improving the production performance. By knowing their performance, the departments can be aware of the problems arising and counter measures can be taken to further improve their working quality. The supporting departments play an equal role as the production team in order to maintain the consistence pace of work on the industrial shop floor [5].

There are three basic departments in industries which are the total quality management (TQM), production planning and control (PPC), maintenance and adding to that is others (vendors) also is added to the list as one of the major contribution on production interruption. Most of the industries face problem due to unforeseen damages that the company will face if a task is not done on scheduled basis.

The TQM involves all the quality matters of the parts produced. When a machine is not calibrated base on specification or irregular inspection on the parts produced it will result in higher rate of rejection or parts near to perfect. Rejection is a restricted word in industries because they will lead towards cost factor. Rejection can be categorized

into two which is reject rework and this usually falls on parts that can't be repaired to maintain base on the customer's specification. The second reject is reject scrap which is total lost part and these parts are waste materials. Such facts will affect the output when it comes to tight end.

The PPC involves in planning the production process and supplies base on orders. When parts are not ordered base on demand then the production process will be effected when the raw parts are running short. The most crucial task of this department is to plan the production process base on daily targets. Wise production line management is important for this team to sustain.

The maintenance department is responsible for all technical matters on the industrial shop floor. Preventive maintenance is the important task for this department whereby the machine has to be checked on timely basis to ensure optimum performance of the machines. This is to reduce machine parts replacements. Apart from that the most critical matter on industries is safety. When a machine is out of shape, the higher chances for the human who operates it will be injured.

4.1 Operator or workers utilization

Operators or workers utilization falls under man power utilization which includes any factors that cause the production process to operate at less than the maximum possible speed base on the time study or cycle time. The major factor on measuring the performance of human workers is the operator's inefficiency. Base on figure 6 the man power utilization is measured from the duration of actual operation time. For manual process lines, the availability of man power is the ratio of actual production output to target production output as in (1).

$$\text{Availability} = \frac{\text{Actual Operation Time}}{\text{Planned Operation Time}} \times 100\% \quad (1)$$

For manual process lines, the performance of man power is the ratio of nett production duration to target production duration as in (2). The nett production duration is the fully productivity duration of a certain worker on the production line.

$$\text{Performance} = \frac{\frac{\text{Actual Production Output} \times \text{Operators}}{\text{Ideal Cycle Time}}}{\frac{\text{Target Production Output} \times \text{Operators}}{\text{Ideal Cycle Time}}} \times 100\% \quad (2)$$

For manual process lines, the quality of products produced by the workers is the ratio of good pieces produced by the worker to total pieces produced as in (3).

$$\text{Quality} = \frac{\text{Good Pieces Produced}}{\text{Total Pieces Produced}} \times 100\% \quad (3)$$

For manual process lines, the overall utilization of man power is the multiplication of availability, performance and quality which is without percentage of each as in (4).

$$\text{Overall Utilization of Man power} = \text{Availability} \times \text{Performance} \times \text{Quality} \quad (4)$$

For semi automated process lines, man power utilization is slightly different from (7) whereby the operators ideal cycle time is the minimum cycle time that the process can be expected to achieve under optimal conditions for a given process. This is due to the combination of humans and machine to perform a specific task on the same work station. Man power utilization should be separated from the machine performance for easy analysis. Therefore when it is multiplied by total pieces produced the result is actual operation time. Man power availability for semi automated process lines is calculated as in (5) [2], [4], [6], [7] - [10].

$$\text{Availability} = \frac{\frac{\text{Actual Operation Time} - \text{Machine Availability}}{\text{Planned Operation Time}}}{\text{Time}} \times 100\% \quad (5)$$

For semi automated process lines, the performance of man power is the ratio of nett production duration of the worker to actual production duration of the worker as in (6). The nett production duration is the fully productivity duration of a certain worker on the production line.

$$\text{Performance} = \frac{\frac{(\text{Operators Ideal Cycle Time} \times \text{Total Pieces Produced by worker})}{\text{Actual Operation Time} - (\text{Machine Ideal Cycle Time} \times \text{Total Pieces produced})}} \times 100\% \quad (6)$$

For semi automated process lines, the quality of products produced by the workers is the ratio of good pieces produced by the worker to total pieces produced by the worker same as in (3).

For semi automated process lines, the overall utilization of man power is the multiplication of availability, performance and quality which is without percentage of each as in (4).

4.2 Performance of supporting department

Supporting departments in industrial are divided into 3 basic departments and the performance should be measured individually before analyses are carried out. Performance of the supporting department is calculated as in (7) whereby the down time for a specific department is subtracted from planned operation time and divided by planned operation time. This formula is a common formula for all types of process lines in industries.

$$\text{Performance of Supporting Department} = \frac{(\text{Planned Operation Time} - \text{Down Time})}{\text{Planned Operation Time}} \times 100\% \quad (7)$$

For some industries who exclude the preventive maintenance from measuring the actual performance of the supporting department can be calculated as in (8). Some management include the preventive maintenance in the performance of the supporting department since this is one of the factors which causes the production process to be stopped for a specific length of time. Apart from that the preventive maintenance is also a part of the task for the supporting department which is done on schedule basis.

$$\text{Performance of Supporting Department} = \frac{(\text{Planned Operation Time} - (\text{Down Time} + \text{preventive maintenance}))}{\text{Planned Operation Time}} \times 100\% \quad (8)$$

5 Analysis for man power utilization on process lines

5.1 Analysis using the existing method on manpower

The analysis for man power utilization is calculated as in (9). Such a simple calculation which is in one figure is not sufficient for further analysis to be carried out.

$$\text{Man Power Utilization} = \frac{(\text{Ideal Cycle Time} \times \text{Total Pieces Produced})}{\text{Actual Operation Time}} \quad (9)$$

Such calculation is very common and widely in practice in most industries for measuring the man power utilization. Understanding the equation in (9) is a simple metric which highlights the performance of a certain worker. For details analysis the management have to still conduct separate study or method to find the root cause of the problem when targets are not met. The management focuses on the utilization of machines compare to the man power utilization since the invested capital is high compare to workers is small.

5.2 Analysis using the proposed method on manpower

The analysis for man power utilization as calculated in (4) would be very practical for detail analysis to be carried out by the management. The individual calculation of each factors involved in the process lines can be inter related with a certain worker.

The calculation in (5) will indicate the percentage of the worker being utilized for a certain shift. This is the first factor which should be in the consideration of the management when it comes for details analysis for man power utilization. If the figure in (5) is low, then the management has to make wise decision to improve the availability of the worker during the production time.

The calculation in (6) will indicate the percentage of the workers performance for a certain shift. This is the second factor which the management need to consider during detail analysis is done. The performance of the worker indicates the efficiency and velocity of job done by the worker for a ceratin shift. If this factor is less comparing to the other

factors, then the management have to take wise steps to increase the efficiency of the workers to meet the consistence pace as set by the management.

The calculation in (3) will indicate the percentage of the product produced by the worker on a certain shift. This is the third factor which should be considered in detail analysis. If the percentage is less comparing with the other two factors then the management has to improve the working method and frequently monitor the workers closely. Since rejection cost lost for the management in many ways and is always to be minimized especially when high productive is concern. Proper training and guidance will ensure products are in standard specification at all time of production.

5.3 Analysis using the proposed method on supporting department

The calculation in (7) will indicate the percentage of the supporting departments. Management should also consider the individual performance of each department when analysis is done towards a better production process. Most of the industries foreseen the lost and wastage caused by the supporting departments. When individual performance is measured for the entire related supporting department will indicate their contribution towards the failure of the production process.

Most of the time each department have direct contribution on the successfulness of the daily production target set by the management. This data and information will also be useful for the respective departments as well to improve the efficiency to reduce time wastage.

5.4 Summary for the proposed method

Understanding each of these factors helps the management to improve factors affecting unmet targets and for a better utilization of man power within their available resources. Such data should also assist management in optimizing their usage of man power efficiently. Actions should be taken to remedy the faults of each section in order to meet a much better target and yield [16].

When such factors are visualized in detail, root cause of problems and faults are clearly visible and create the room for improvement for the management. Simple factors are made easy when the correct method and ways to overcome is attempted

wisely in the shortest time.

6 Conclusion

One of the greatest strength of industries is human capital, whereby they are considered as the major role player on the development of our industries. With relevant and valuable production data on one hand, it helps the management to efficiently monitor the workers and drive towards optimum man power utilization which is in line with the set requirements of industries. Information on human capital will further strengthen the true capacity of the workers performance not only on the production lines but also to the supporting departments involved in the production process. When man power utilization is being optimized this will engage morale towards a better production yield.

With the limited resources available on the industrial shop floor, the practice of production data on each factor is crucial and necessary. The awareness of man power utilization is essential for industries especially when it comes to decision making. Industries now have begun to value the influence of the human capital in its ability to improve the utilization of workers. The simple metrics of the shown above brings to light all the valuable information required by the management.

The production data should be very well interpreted and fully utilized in order to optimize available resources within the industrial sector. This will reduce wastage and increase the production yield. By taking these necessary steps industries can improve and maintain more efficient production lines within the available resources. Sustainability of the industries is also ensured if the cost of manufacturing is reduced in all means especially by optimizing the human capital on production lines of industries.

7 Future works

The research highlights the powerful factor which is always foreseen by the management in most of the industries. A production monitoring system which is capable to capture the relevant data for measuring the above mentioned factors is to be designed.

The device should consist all the factors related to human capital measurement including the individual

performance of the supporting department in the industrial shop floor. The development of such a system will be very practical and useful for the management in industries to conduct simple analysis with the collected data.

Electronics based system which can be integrated with addition sensors to measure the failures from the production line as there should be less human intervention on the production data collection process.

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Oriental Summit Industries Sdn. Bhd.
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A.I. Automation Sdn. Bhd.
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9 Biographies



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Abdul Hamid bin Hamidon @ Hamid Don was born on 3 March 1950. He received his Bachelor of Electrical Engineering from Monash University, Australia and Masters of Science (Electronics) from the University of Wales

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