Case Study: Productivity Improvement in Surgical Manufacturing Company

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Abstract: PT MED Batam (PT-MB) has been chosen by its headquarter office, to receive new transfer product, to be manufactured in Batam Indonesia. While it is good business opportunity, PT-MB faces productivity issue. With the benchmark of transfer site, its productivity is still 63% compared with them, during the monitoring phase of 6 months period (July – Dec 2020). To solve the problem, PT-MB should increase productivity to match with transfer site. Based on this condition, the main objective from this research is to find business solutions to increase capacity through productivity raise from 5M (Man, Machine, Material, Method, Measurement), to gain trust and capture more product transfer from headquarter. The business solutions are derived using the root cause analysis, utilizing the fishbone diagram and why-why analysis. The findings have led to identify 8 business solutions, in which covering from Man (training), Method (SOP), Measurement (SOP), Machine (TPM and Critical Spare Part), and Material (Material Lead Time and Supplier Communication). Having completed on some business solution implementation, we can achieve 7.94 units/hour by Jul 2021. Overall improvement compared with Dec 2020, productivity has increased from 5.7 units/hour to 7.94 units/hour, improved by 39.3%, in which very significant improvement. By Jul 2021, the gap is 11.7% compared with target 9 units/hour. We are confident, with 3 months towards October 2021, and some of business solutions are still in-progress for implementation, we will achieve our target of 9 units/hour.

1 INTRODUCTION

PT MED Batam (PT-MB) is a pharma-medical devices company. Its main product is contact lenses and surgical device. Start from mid-2019, PT-MB has received product transfer of Surgical product from their headquarter (HQ) in the United States of America (USA). The products are Fiber Optics, Laser Probes, Base IOL, and Multi Piece IOL. The long-term business strategy is to make PT-MB for secondary Surgical Production site, outside Unites States. Below figure shows the transfer site location of surgical product.

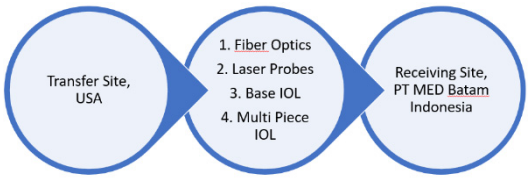

Figure 1: Types Surgical Product Transferred to PT-MB.

Figure 1 explains product transfer strategy between US transfer site with PT-MB site. The business strategy is to make PT-MB to be the only plant outside USA, to be able to produce Surgical products. Therefore, the transfer project is becoming the first priority for PT-MB to succeed, as the continuation of upcoming other products of Surgical will be based on the success of this first transfer project.

The business challenge is, the first Surgical transfer product, which is Fiber Optic is having low productivity issue during its 6-month monitoring mass production process. There is significant gap between transfer site's productivity and PT-MB site's productivity. Therefore, to be able to close the gap of productivity performance, will be imperative for the near future Surgical product to PT-MB.

Fiber Optic is an endo illuminator light guide. This is a product transfer between the Transferring Site (TS), in USA to PT-MB Manufacturing as the Receiving Site (RS).

Fiber Optics is an endoscopic device that transmits visible light from a light source to the eye to provide internal illumination for clinical

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procedures. The device specified is intended for use in vitreoretinal procedures.

Fiber Optic was transferred to PT-MB on mid-2019 and started mass-production on July 2020. PT-MB sent few members of team, comprises of line operators, leaders and engineers to have training in transfer site, USA for 3 months training. Then, similar material, machinery, equipment and standard operation were established in PT-MB Plant. The process of product transfer, including all steps of machine and equipment approval and validation, pre-production qualification and document approval were completed by June 2020. The phase of mass-production Fiber Optic was then started on July 2020, under 6 months monitoring and full support from Transfer Site.

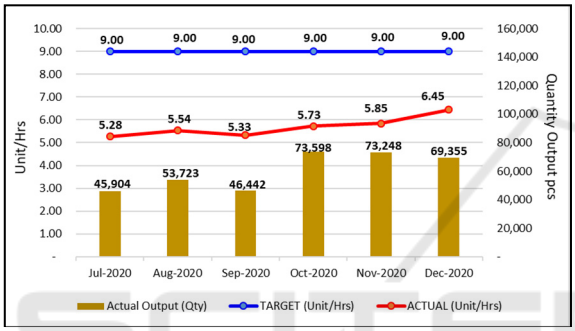

Figure 2: Chart Productivity Trend Fiber Optic Period Jul 2020 until Dec 2020.

Figure 2 shows that the productivity target from Transfer Site USA is 9 pieces/hour. Whereas the average PT-MB productivity is 5.7 pieces/hour. Therefore, the current productivity is still 63% from Transfer Site USA. This gap created the monthly average loss of output 60,000 pieces of product. The performance during the monitoring 6-month mass-production was not satisfactory.

Item	Jul-2020	Aug-2020	Sep-2020	Oct-2020	Nov-2020	Dec-2020	Total Loss
TARGET (Unit/Hrs)	9.00	9.00	9.00	9.00	9.00	9.00	
ACTUAL (Unit/Hrs)	5.28	5.54	5.33	5.73	5.85	6.45	
Actual Output (Qty)	46,900	56,290	47,500	75,190	74,160	70,040	
Output Loss (Qty)	33,085	35,213	32,642	42,872	39,978	27,700	211,490
Output Loss (Amt)	$ 779,136	$ 829,262	$ 768,719	$ 1,009,632	$ 941,478	$ 652,331	$ 4,980,557

Figure 3: Chart Productivity Trend Fiber Optic Period Jul 2020 until Dec 2020.

Figure 3 above shows the productivity trend of Fiber Optic from July 2020 until Dec 2020. This 6-month period is under project monitoring and considered as initial mass production phase. Even though it shows the improvement trend over the period of 6-months initial production, it is not fast enough. With the initial production rate, from July 2020 to December 2020, total loss of production quantity is 211,490 pieces of products, with the opportunity loss amount of 4,980,557 USD.

2 CONCEPTUAL FRAMEWORK

Based on business issue identified, conceptual framework is designed to achieve the goal of this research. A conceptual framework is defined as a network or a "plane" of linked concepts that together provide a comprehensive understanding of a phenomenon or phenomena (Jabareen, 2009).

The conceptual framework related to the productivity will use the People Process and Technology introduced in 1964 in Leavitt's model (Prodan M, 2015). This framework aim to balance of people, process and technology, to drive into action: people to perform a specific work assigned by the organization, using technology to improve the processes. In addition, based on Kumaduhal's hierarchy of productivity factors' perspective (Kumar, Duhan, & Haleem, 2016), Top Management Perspective becomes the baseline level I in the factor enhancing the productivity. Therefore, the elements effecting the productivity are divided into 4 main categories. They are:

1. Management Factors (Top Management Perspective)
2. Human Factors (People)
3. Methodology Factors (Process)
4. Technological Factors (Technology)

Figure 4: Chart Conceptual Framework for Productivity.

1. Management Factors (Top Management Perspective)

In an organization, efficient product has been produced by management skill (Carneli, 2003). Therefore, productivity is proportionally related to

the management factors. A direct and simple management type of organization should be adopted. Total participation of employee in the form of two-way communication and suggestion scheme to be initiated. It can enhance the mutual understanding between workers and management. In addition, management by objective is recommended to be adapted. With Management by Objective (MBO), the workers and their managers can have discussion and agreement on the activities, targets and goals to be used as criteria for the performance review and evaluation. It also will allow the alignment between the organizational goals and individual target setting, so that the workers can have the visibility of their contribution to the goal of the organization. It is therefore will increase the productiveness of the organization.

2. Human Factors (People)

In an organization, the people are those who do the work. Without people, nothing can happen. Productivity is directly affected by human factors. The right person must be posted to the suitable workstation, which is put the right man on the right place. Adopting the concept of making people before product, employee must be given proper training and development. Training need analysis must be generated to identify the right skill to be given to the right process. Job enrichment and multi skill are to be provided for the high potential employee. It offers for the new and more critical processes to be handled, for the exposure of the opportunity for greater recognition, growth and responsibility. This will create positive challenges for them and motive them to increase the productiveness of the organization. In summary, the process improvement model on the people dimension, look after (Prodan M, 2015):

- People know what and how to perform activities
- They have the right skills and knowledge for the job
- They are motivated and engaged to achieve higher performance
- They are encouraged to improve day by day and they are involved in improvement projects

3. Methodology Factors (Process)

Productivity relies on the production methodology or process being adopted. A series of actions need to happen and be done to achieve certain goal. People will not be effective if the method or process is not in place for them to do the work. The method of working should be simplified, documented and standardized. Work study must be adopted, to identify inefficient and unnecessary processes, to cut out idle time so that only value-added process remains. Proper production planning and control should be implemented, so that the right quality and quantity of raw material can be identify, the change model frequency can be minimized and the right quantity and model required by customer can be produced on timely manner. Operation excellence team establishment will further be strengthening the organization, by focusing on how to bring the operation level as efficient as possible, with the highest productivity as main target.

4. Technological Factors (Technology)

Productivity very much depends on the technology. The technology provides the tools that the people can use to implement the process. The utilization and adaptation of the new technology provides revolutionary way of the process. Automation, mechanization and rationalization are the major contributors to productivity. The key success of utilizing the new technology lies on the ability to identify and creatively make the modification, so that it will be suitable to be used with the current process, to bring the productivity improve to the next level, with minimum cost of upgrading.

3 ANALYSIS

Root Cause Analysis (RCA) is a method that is used to address a problem or non-conformance, in order to get the “root case” of the problem (Vorley, 2008). It is a series of common-sense techniques which provides systematic approach to identify and understand the underlying problem. Definition of root cause itself, the cause that, if corrected, would prevent recurrence of this and similar occurrences (Mahto & Kumar, 2008). The root cause does not only applicable to the recent occurrence, but also can be generalized for common factor. It is something fundamental and can be logically identified and rectified.

We use Fishbone diagram or Cause Effect Diagram to analyze current business issues of low productivity. Cause and Effect diagram (CED) was pioneered by Professor Kaoru Ishikawa, a quality management pioneer, in the 1960s. It was published in his 1990 book, "Introduction to Quality Control." It was originally developed as a quality control tool, however it has become widely used as a technique to identify root cause in any problem situation. CED

uses a diagram-based approach for thinking through all of the possible causes of a problem.

There are four steps to using the tool:
1. Identify the problem, that is Low Productivity
2. Work out the major factors involved, considering from 5M (Man, Method, Measurement, Machine, Material) factors
3. Identify possible causes
4. Analyze generated Cause Effect diagram.

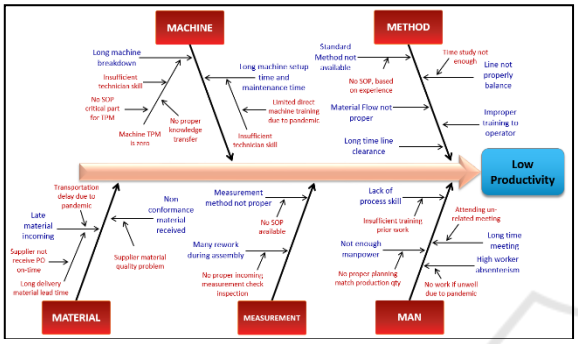

Figure 5. Cause Effect Diagram for Low Productivity.

Figure 5 above describes the root cause analysis using Cause and Effect diagram of Low Productivity for Fiber Optic product in PT-MB. As explained, we analyzed using 5M framework (Man, Method, Machine, Material, Measurement). In every item, we did further analysis using why-why question method, until finding the bottom why question-answer. The possible root causes are then marked with the red color.

Having analysed from current condition and collected data, the causes were verified and summarized into verification matrix table shown on appendix 2.

From verification matrix table, we can conclude that the root causes identified are:

a. Production operators were not trained properly, due to limited number of trainers.
b. Process time study was not measured and therefore, its standard time was not established.
c. No Standard Operation Procedure, merely based on experience, as most of the process and issues, are stored inside the brain of senior associates in transfer site.
d. Total Preventive Maintenance (TPM) is not available. The TPM frequency was not complete and its step-by-step was not well-documented.
e. Long delivery material lead time and supplier does not receive PO on-time. Purchase order (PO) is generated manually to supplier. It takes time to study and re-group the supplier, as well as to establish the connection with the supplier's person of contact. While those are in-progress, PO generated were often late, causing supplier late in executing the material supply.

Table 1: Root cause summary.

No	Potential Root Cause	Verification	Conclusion
1	Insufficient Operator Training	Reviewed initial training plan for project transfer. Discrepancy is found. Planned 14 associates for US training and become trainer. Actual, there was only 2 associates for trainer, due to difficulty to get US VISA approval to go to US for project transfer training.	Root Cause
2	Time study not enough	Proper time study measurement is not done. Bottleneck process(es) was not yet identified.	Root Cause
3	No SOP, only based on experience	Reviewed all SOP which were available. All processes have been covered, either by SOP and/or Work Instruction. However it was scattered. Need to put into comprehensive and well-documented SOP.	Root Cause
4	No SOP on critical part for TPM	Reviewed on TPM schedule, with interviewing transfer site associate. Replacement only done when the machine is start running intermittent, and having frequent stop. There is no comprehensive schedule on TPM and identification on critical spare parts.	Root Cause
5	Machine TPM is zero		Root Cause
6	Supplier not receive PO on-time	Reviewed on purchase order (PO) step-to-step making. Purchase order (PO) is generated manually to supplier. It takes time to study and re-group the supplier, as well as to establish the connection with the supplier's person of contact. While those are in-progress, PO generated were often late, causing supplier late in executing the material supply.	Root Cause
7	Long delivery material lead time		Root Cause

Table 1 shows 7 item identified root causes related to low productivity for Fiber Optic product manufacturing at PT-MB.

4 RESULT AND CONCLUSIONS

Based on the business issue and analysis to the existing business situation, continue with the root causes analysis, we come to several conclusions, in which relates to the improvement of current situation:

1. PT-MB has its competitive advantage of lower manufacturing cost and flexible manpower resources to get more product transfer from transferring site. However, low current productivity creates some loss opportunity to sell more product back to transfer site. The business issue has become critical and priority to be solved, involving all the stake holders.

2. Based on root cause analysing using Fishbone diagram, we found 7 root causes that are related to the business issue. The root causes have been further analyzed for the business solution, and further checked using cost and benefit analysis for its implementation.

3. There are 8 business solutions proposed to improve the productivity at Fiber Optic area, as shown on below table 2.

Table 2: Root Cause Analysis and Business Solution

No	Root Cause	No	Business Solution
1	Insufficient operator training	1	Establish Key Process Job (KPJ) classification
		2	Implementation of video training and periodic review training
2	Time study not enough	3	Study and implement on the line balancing, with emphasize on waste movement reduction and/or elimination
3	No SOP, only based on experience	4	Establish bi-weekly process knowledge sharing session with transfer site
4	No SOP on critical part for TPM	5	Setup TPM program, with identification of machine critical spare part
5	Machine TPM is zero		
6	Supplier does not receive PO on-time	6	Establish single point of contact between site and supplier
7	Long delivery material lead time	7	Setup 3-month material inventory safety stock policy
		8	Localized material supplier into South-East Asia region supplier

4. Having completed on some business solution implementation, we can achieve 7.94 units/hour by Jul 2021. Overall improvement compared with Dec 2020, productivity is increased from 5.7 units/hour to 7.94 units/hour, improved by 39.3%, in which very significant improvement.

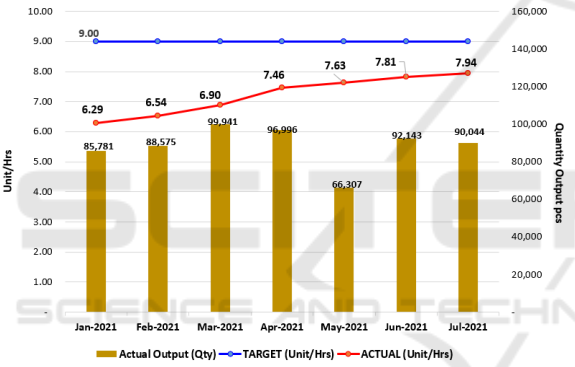

Figure 6: Chart Productivity Trend Fiber Optic Period Jan 2021 until Jul 2021

Based on our target of 9 units/hour, we still have gap 11.7%. We are confident, with 3 months towards October 2021, and some of business solutions are still in-progress for implementation, we will achieve our target of 9 units/hour.

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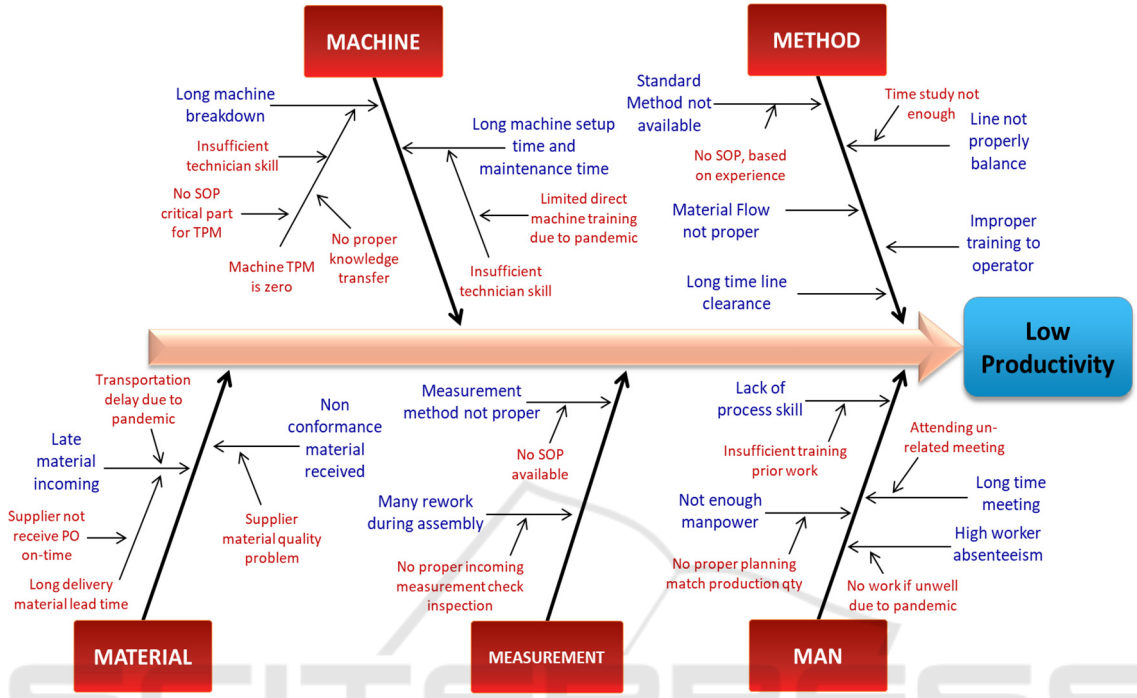
APPENDIX

Fishbone Diagram (Cause Effect Diagram) for Low Productivity



Root Cause Verification Table

Category	Potential Root Cause	Verification	Conclusion
Man	Insufficient Operator Training	Reviewed initial training plan for project transfer. Discrepancy is found. Planned 14 associates for US training and become trainer. Actual, there was only 2 associates for trainer, due to difficulty to get US VISA approval to go to US for project transfer training.	**Root Cause**
	No proper planning to match with production capacity	Reviewed planning horizon and production capacity plan. Monthly production planning matches with production capacity.	Symptom
	Absenteeism due to No work if unwell policy during pandemic	New policy for health risk mitigation: if unwell do not come to work. Reviewed absenteeism, covered by additional work force standby for backfill.	Symptom
	Attending unrelated meeting	Reviewed all meeting and its duration. It is aligned with anticipated loss time.	Symptom
Method	Time study not enough	Proper time study measurement is not done. Bottleneck process(es) was not yet identified.	**Root Cause**
	No SOP, only based on experience	Reviewed all SOP which were available. All processes have been covered, either by SOP and/or Work Instruction. However it was scattered. Need to put into comprehensive and well-documented SOP.	**Root Cause**
Machine	Limited direct training on machine due to pandemic	Reviewed training plan on project transfer. Machines training to be done from remote using video.	Symptom
	Insufficient technician skill	Reviewed recruitment process for technicians. It is aligned with the user requirement, and machine On-Job-Training program covers the requirement.	Symptom
	No proper knowledge transfer	Reviewed training plan on project transfer. Machines training to be done from remote using video.	Symptom
	No SOP on critical part for TPM	Reviewed on TPM schedule, with interviewing transfer site associate. Replacement only done when the machine is start running intermittent, and having frequent stop. There is no comprehensive schedule on TPM and identification on critical spare parts.	**Root Cause**
	Machine TPM is zero		**Root Cause**
Measurement	No measurement SOP available	Reviewed all SOP which were available. All processes have been covered, either by SOP and/or Work Instruction. However it was scattered. Need to put into comprehensive and well-documented SOP.	Symptom
	No proper incoming measurement check inspection	Reviewed incoming check items. It is aligned with incoming inspection SOP, in which checking based on supplier data.	Symptom
Material	Supplier material quality problem	Reviewed on monthly supplier performance. Monthly review on supplier performance is done, and periodic supplier audit is carried out.	Symptom
	Supplier not receive PO on-time	Reviewed on purchase order (PO) step-to-step making. Purchase order (PO) is generated manually to supplier. It takes time to study and re-group the supplier, as well as to establish the connection with the supplier's person of contact. While those are in-progress, PO generated were often late, causing supplier late in executing the material supply.	**Root Cause**
	Long delivery material lead time		**Root Cause**
	Transportation delay due to pandemic	Reviewed on logistic supply routing. Due to pandemic, the schedule for material transportation by sea freight becomes uncertain. Shipment by air freight has been activated since the beginning of pandemic situation.	Symptom