Journal of Engineering and Applied Sciences 13 (Special Issue 6): 5322-5327, 2018
ISSN: 1816-949X

The Analysis of Kaizen Implementation for Increasing Production Capability: A Case Study of Musical Instrument Industry

[1]Amarria Dila Sari, [1]Muhammad Irfan Januar, [1]Taufiq Immawan and [2]D.S. Samsudin
[1]Department of Industrial Engineering, Universitas Islam Indonesia, Yogyakarta, Indonesia
[2]Yamaha Music School, Jakarta, Indonesia

Abstract: Music instrument manufacturers are always trying to increase productivity as the demand for piano products increases. The problems that exist in the production department (painting) has not been able to meet the demand for white piano production. This is due to the uneven distribution of workloads on 4 painting operators to produce more than 12 units of pianos per day. This study aims to measure the production capabilities based operator workload using a supported workload analysis time study methods and tools man machine chart to determine the efficiency of work between the operator and the conveyor by applying kaizen activity. Observations were made on the four operators that make the process of spray in the cabinet piano before and after the kaizen activity. Results from this study show that with the addition of one operator which makes activity among spray and conveyor operators become more efficient, thus, it can use existing capacity in addition to the operator workload becomes more balanced and is in a category underload. So, the company succeeded in increasing the production capability that was initially 12-14 units of white piano.

Key words: Kaizen activity, production capability, workload analysis, balanced, based, demand

INTRODUCTION

Yamaha Indonesia (YI) which was founded in 1970 is one company that is engaged in the manufacture and assembly of piano. This company always trying to improve productivity in order the resulting output can meet the demand. However, there are some requests that cannot be fulfilled due to lack of production capability. In this case it is the Production of White piano (PWH), especially in the process of spray. In the current period the ability to spray white piano is 10 units per day or 12 units if added the overtime. However, on the next period the company will receive a number of requests white piano 12-14 units per day.

Based on these problems it is necessary to implement kaizen activity on the workload of the operator. Kaizen is a process of continuous improvement, to eliminate waste, increase productivity, improve quality and efficiency (Gordian, 2014).

Employee's workload is divided into three conditions, namely the normal workload (fit), excessive workload (overload) and the workload is too low (underload) (Novera, 2012). The workload is too heavy or too light will result in inefficiency of work (Tridoyo and Sriyanto, 2014).

Control and management of the work load on the operator can be done through an analysis of workload. The purpose of the analysis is to determine the workload and estimate the level of optimization of the use of the number and composition of the workload in each work function (Handoko, 2000). Based on these problems, there needs to measure the workload of the operator to increase the capabilities of the white piano.

This research use Work Load Analysis (WLA) methods to provide information on the allocation of resources to complete the workload of employees (Rio, 2012). This method is supported by the method of time study that applied to measure the standard time a process (Patel, 2015). By implementing kaizen activity can improve the working efficiency of employees, so, it could be meet demand and enhance the production capability can be achieved.

Theoretical background: Several studies related to work load measurements have been done by Wibawa *et al.* (2014) on machine operators using workload analysis method which begins with work sampling method. Milyansari (2014) also, uses work sampling methods and NASA TLX on the power company. Measurement of mental workload using Nasa TLX method has been done by Puspawardhani *et al.* (2016) in plastic injection division of manufaturing company. Furthermore, research by Tridoyo and Sriyanto (2014) using the FTE Method on Motor companies. Moreover, Khandelwal *et al.* (2014)

Corresponding Author: Amarria Dila Sari, Department of Industrial Engineering, Universitas Islam Indonesia Yogyakarta, Indonesia

discussed the implementation of the 5S method using work time and energy expenditure analysis which has a positive effect on productivity improvement.

Time study: Time study is the analysis of specific jobs based on qualifications of workers in finding the most efficient manner in terms of utilization of time and effort (Chandra, 2013). Stopwatch method is a measurement of working time directly applied for the jobs of short duration and repetitive (Barnes, 1980). The steps that were performed during the work time measurements in progress according to Sutalaksana *et al*. (1979) as follow:

- Preliminary measurements
- Test of adequacy and uniformity
- Determine performance rating and allowance
- Calculate standard times

Workload analysis: Workload Analysis is a process to determine the number of man hours that use or required to complete a specific workload (Soeprihanto, 2001). From the number of man hours will produce a number of employees needed:

$$1\ \text{man} \times \frac{Q \times ST}{WD \times WH}$$

Where:
ST = Standard Time
WD = Working Days
WH = Working Hours

Production capability: According to Carpenter and Sanders (2007) capabilities refers to ability of a company to manage its resources to create product and services. Capability can be defined as a company's capacity to use the resources that are integrated with the aim of achieving the goals (Gozali, 2010).

Kaizen: According to Liker (2004) Kaizen goal is a better product (improving quality), cheaper (lowering costs), safer (increased safety), faster (fix lead time) and more easily (increasing productivity). The most important element in kaizen is aware to muda. According to Ohno in Liker (2004) Muda is some phenomena and effects that don't increase the value added.

Man machine chart: According to Kristanto (2011) the use of man machine charts aims to improve the condition of unemployed both of which occurred in man power and machinery. Information obtained from the man machine chart is the relation between cycle time of operator and time machine of operator handling. Man machine chart is used to determine the highest production level can be achieved according to the resources available (Kathiriya *et al*., 2014).

Yamazumi chart: According to Liker (2004) Yamazumi chart is a histogram containing the names of job elements in each model shown in SOP. The main function of Yamazumi chart shows the time relationship between manual work, machine work, running time and takt time (Halim *et al*., 2015).

MATERIALS AND METHODS

Subject and object: The purposive sampling technique is a non-probability sampling technique that is most effective when one needs to study a definite educational domain with well-informed experts within (Tongco, 2007).

Therefore, samples taken in the present study is the entire operator spray pianos that are 4 operators because it feels entirely fulfill the criteria's as follows:

- Operators who just perform piano white spray process
- Understand the process flow spray white piano
- Have work experience in the process of at least 1 year
- Healthy physical during the process of data collection

Objects that were observed in this study are seven models white piano which is divided into parts are small is ±13-19 cabinet per model (Fig. 1).

Fig. 1: Piano white model (Yamaha Indonesia)

RESULTS AND DISCUSSION

Standard time measurement before Kaizen: Based on Table 1, it can be seen that there were 21 activities conducted by the operator 2 with the total cycle time was 34.40 min with the performance rating was 1.16; the total normal time was 39.91 min. Then, the normal time allowance value is calculated by the operator at 29.5%, therefore, the operator is obtained standard time was 56.61 min to produce one unit of the piano.

Man machine and Yamazumi chart before Kaizen: There are 3 of 12 table capacity in the spray room. Position of 3 operators are divided by 2 that is one operator in spray room especially for process spray and 2 operators outside of spray room for the other activities. At this chart is done with a maximum capability of the spray operator that is 46 cabinets. The results of man machine chart in overall spray activity in painting booth or PB-5 can be shown in Table 2.

The results of man machine chart showed there are inefficient process that occurs, on process topcoat spent 17.66 min conveyor off, process undercoat spent 15.51 min conveyor off and 5.13 min conveyor off on process white sealer. Process shut down conveyor indicated that the activities undertaken by the operator spray with conveyor running inefficiently, since, the speed of the conveyor that cannot be offset by an operator in spray room.

Production capability before Kaizen: Capabilities measurement based on operator standard time performed by determining potential output. The results are shown in Table 3:

$$\text{Output} = \frac{\text{Total working hour/days}}{\text{Standard time}}$$

Based on Table 3 can be known that the potential output of piano PWH production when operator work during 460 min per day is 8.13 units per day while the operator work during 630 min per day, so that being 11.13 unit per day.

Workload analysis before Kaizen: Workload calculation done based on total standard time per operator per day and work time per day. Here are the results of workload analysis on the initial conditions:

Based on Table 4 show workload analysis in normal time for operator 1 is 0.76 which means underload because under rate 1 while for operator 2, 3 and 4 overall at above rate 1, so that including overload category. In contrast to the results for the analysis workload over time are entirely included under load category except operator 2 is 1.1 which includes categories overload. Based on these conditions, the workload among operators is not balanced.

Table 1: Standard time before Kaizen

Activity	CT (Cycle Time)	NT (Normal Time)	ST (Standard Time)
Handling before TC panel	9.34	10.84	15.37
Handling after TC panel	1.43	1.66	2.36
Handling before UC panel	0.35	0.40	0.57
Handling after UC panel	2.11	2.45	3.47
Handling before AP6EL	2.12	2.46	3.49
Handling after AP enamel	1.42	1.64	2.33
Spray TC panel	2.14	2.48	3.52
Spray UC panel	5.98	6.94	9.84
Spray AP enamel	0.91	1.05	1.49
Total ST	34.40	39.91	56.61

Table 2: MM chart result before Kaizen

Activity	Conveyor on	Conveyor off
Top coat	41.17	17.66
Under coat	31.52	15.51
White sealer	17.03	5.13

Table 3: Capabilities measurement based on operator standard time before Kaizen

Total work (h/day)	Standard time (min)	Potential output (min)
Normal time (460 min)	56.61	8.13
Over time (630 min)		11.13

Table 4: Workload analysis before Kaizen

OP	Spray room	Total standard time/day	WLA normal time	WLA over time
1	PB-2	348.35	0.76	0.55
2	PB-5	638.83	1.39	1.01
3	PB-5	622.31	1.35	0.99
4	PB-5	599.02	1.30	0.95

Kaizen activity: In this study, several Kaizen activities related to the improvement production capabilities that will be done. The first activity is addition 1 operator especially for spray room PB-5 with consideration the results of workload analysis that show 3 operator spray PB-5 including overload category. Based on these problem, it is necessary to increase the operator because the workload is too heavy or too light will result in inefficiency of work (Tridoyo and Sriyanto, 2014). Additional 1 operator of course will change split working activity or process on spray room PB-5 to eliminate inefficiency of work.

The work inefficiency can be seen based on man machine chart result on Fig. 2 that the conveyor is often switch off by 1 operator spray. It means the addition of 1 new operator will assist activities in the spray room so there will be 2 operators that make the process of spray in 1 rit process according to Ambrosini *et al.* (2009) on dynamic capabilities theory states that change begins from the process of reconfiguration capability which refers to be change of resources.

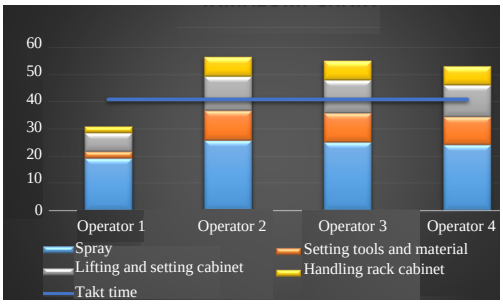

Fig. 2: Yamazumi chart before Kaizen

Table 5: Standard time after Kaizen

Activity	CT	NT	ST
Handling before TC panel	7.31	8.48	12.02
Handling after TC panel	0.91	1.06	1.50
Handling before UC panel	0.22	0.26	0.37
Handling after UC panel	1.63	1.89	2.67
Handling before AP6EL	0.87	1.01	1.43
Handling after AP enamel	1.09	1.26	1.79
Spray TC panel	1.36	1.58	2.24
Spray UC panel	4.68	5.42	7.69
Spray AP enamel	0.58	0.68	0.96
Total ST	24.19	28.06	39.80

Table capabilities also maximized to 4.5 cabinets per table that was originally only 3.8 cabinets per table. So that, the capabilities per rit process with 12 tables become 54 cabinets per rit process that was originally only 45.6 cabinets per rit process. Increased capability per table can certainly be done by improving the rail conveyor bearings in order to be able to sustain 12 table sprays with the existing 54 cabinets above.

Standard time measurement after Kaizen: Based on Table 5, it can be seen that there are 21 activities undertaken by operator 2 with total cycle time is 24.19 minutes and performance rating is 1.16, then the total normal time is 28.6 min. Then the normal time is calculated with allowance operator spray 29.5 %, so we get the results of the operator standard time is 39.80 minutes to produce 1 unit of piano.

Man machine and Yamazumi chart after Kaizen: Process spray in spray room PB-5 that originally done by 1 operator in the spray area, after kaizen activities make the process on spray area done by 2 operators. The results of man machine chart in overall spray activity in painting booth or PB-5 can be shown in Table 6. The results of human machine chart show that the whole process spray in PB-5 running without process switch off the conveyor. The times for each respective process on topcoat spent 41.17 min, undercoat spent 31.52 min and white sealer spent 17.03 min. The standard time difference of each

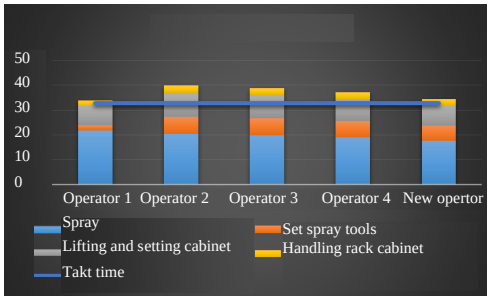

Fig. 3: Yamazumi chart after Kaizen

Table 6: MM chart result after Kaizen

Activity	Conveyor on	Conveyor off
Top coat	41.17	0
Under coat	31.52	0
White sealer	17.03	0

Table 7: Capabilities measurement based on operator standard time after Kaizen

Total work h/day	Standard time (min)	Potential output (min)
Normal time (460 min)	39.80	11.56
Over time (630 min)		15.83

Table 8: Workload analysis before Kaizen

OP	Spray room	Total standard time/day	WLA normal time	WLA over
1	PB-2	474.05	1.031	0.75
2	PB-5	559.10	1.215	0.89
3	PB-5	544.64	1.184	0.86
4	PB-5	520.54	1.132	0.83
New	PB-5	481.99	1.048	0.77

operator as well as for analysis related to the operator's standard time whether still under takt time or not. Based on the above picture, all operator's default time is above takt time (Fig. 3)

Production capability after Kaizen: The result of the calculation of the production capability after the additional 1 operator on process spray PWH can be seen in Table 7:

Based on Table 7, can be known that the potential output of piano PWH production when operator work during 460 min per day is 11.56 units per day while the operator work during 630 min per day, so that, being 15.83 unit per day.

Workload analysis after Kaizen: The results of calculation workload analysis after the addition 1 operator. Based on Table 8, the result of workload analysis in normal time for all operators are more than 1 therefore the categories are overload. While the results of workload analysis in over time for all operators including underload category.

CONCLUSION

Before kaizen activities, potential output on operator spray piano PWH is 11.13 unit piano per day so that has not been able to fulfill 12 unit demands of piano PWH per day. This is evidenced by the amount of time wasted because the conveyor is often turned off in the spray room PB-5. Then after doing kaizen activity by adding the composition of 1 operator in the spray room on process spray PB-5, conveyor was never stop until one rit process running. So, it is capable of producing 14 units per day piano, moreover still has the potential to produce up to 15.83 units per day.

The result of operator workload control is quite good, able to balance the work load between PB-5 spray operators and PB-2 spray operators and operator workload can be in under load condition. Therefore, it can help balance the workload of the operator in accordance with the requirements of existing enhanced capabilities.

REFERENCES

Ambrosini, V., C. Bowman and N. Collier, 2009. Dynamic capabilities: An exploration of how firms renew their resource base. Br. J. Manage., 20: S9-S24.

Barnes, R.M., 1980. Motion and Time Study: Design and Measurement of Work. John Wiley & Sons, Hoboken, New Jersey, USA.,.

Carpenter, M.A. and W.G. Sanders, 2007. Strategic Management: A Dynamic Perspective; Concepts and Cases. Pearson, London, England, UK., ISBN:9780131453531, Pages: 687.

Chandra, P.V., 2013. An effort to apply work and time study techniques in a manufacturing unit for enhancing productivity. Intl. J. Innovative Res. Sci. Eng. Technol., 2: 4050-4058.

Gordian, B., 2014. KAIZEN as a strategy for improving SMEs' performance: Assessing its acceptability and feasibility in Tanzania. Eur. J. Bus. Manage., 6: 79-90.

Gozali, H., 2009. [Industry analysis and competitive advantage through the development of resources and capabilities in the application of economies of scale and experience curve in the Aluminum alloy manufacturing industry (In Indonesian)]. Ph.D Thesis, University of Indonesia, Depok, Indonesia.

Halim, N.H.A., A. Jaffar, N. Yusof, R. Jaafar and A.N. Adnan *et al*., 2015. Standardized work in TPS production line. J. Technol., 76: 73-78.

Handoko, H.T., 2000. [Personnel and Human Resource Management]. 2nd Edn., BPFE Publisher, Yogyakarta, Indonesia, (In Indonesian).

Kathiriya, J.J., V.D. Amareliya and S.H. Kapadiya, 2014. Production process analysis on manufacturing of Hydraculic gear pump. Mech. Eng. Intl. J., 1: 39-55.

Khandelwal, A., R. Prathik, R.P. Kikani and V. Ramesh, 2014. 5S implementation and its effect on physical workload. Intl. J. Res. Eng. Technol., 3: 437-440.

Kristanto, A.A., 2011. [Man power efficiency in mass production using movement studies in automotive component supplier companies]. Master Thesis, University of Indonesia, Depok, Indonesia.

Liker, J.K., 2004. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer. McGraw-Hill, New York, USA.

Milyansari, W., 2014. [Workload analysis at PT. PLN (PERSERO) Rayon Ngagel, Surabaya (In Indonesian)]. J. Ilmiah Mahasiswa Universitas Surabaya, 3: 1-19.

Novera, W., 2012. [Workload analysis and employee requirement academic and student administration section (case study of administrative unit department at Institut Pertanian Bogor)]. Master Thesis, Faculty of Economics and Management, Bogor Agricultural University, Bogor, Indonesia. (In Indonesian)

Patel, N., 2015. Reduction in product cycle time in bearing manufacturing company. Intl. J. Eng. Res. Gen. Sci., 3: 466-471.

Puspawardhani, E.H., M.R. Suryoputro, A.D. Sari, R.D. Kurnia and H. Purnomo, 2016. Mental workload analysis using NASA-TLX method between various level of work in plastic injection division of manufacturing company. Proceedings of the 2016 International Conference on Advances in Safety Management and Human Factors, July 27-31, 2016, Springer, Florida, USA., ISBN:978-3-319-41928-2, pp: 311-319.

Rio, A.S., 2012. [Determination of the optimal number of employees in line spunbond with Work Load Analysis (WLA) method at PT. Surya Sukses bloom Prosper]. Ph.D Thesis, University of Pembangunan Nasional Veteran, Surabaya, Indonesia.

Soeprihanto, J., 2001. [Assessment of Employee Performance and Development]. BPFE Publisher,Yogyakarta, Indonesia, (In Indonesian).

Sutalaksana, I.Z., R. Anggawisastra and J.H. Tjakraatmadja, 1979. [Technique of the work]. Master Thesis, Industrial Technology Studies Program Institut Teknologi Bandung, Bandung, Indonesia.

Tongco, M.D.C., 2007. Purposive sampling as a tool for informant selection. Ethnobotany Res. Appl., 5: 147-158.

Tridoyo, T. and S. Sriyanto, 2014. [Workload analysis with full time equivalent method to optimize employee performance at PT. Astra International TBK-Honda sales operation region Semarang]. Master Thesis, Diponegoro University, Semarang, Indonesia. (In Indonesian)

Wibawa, R.P.N., S. Sugiono and R.Y. Efranto, 2014. [Workload Analysis as a consideration of employer incentives (case study in Ppip field Pjuly 28, 2018T Barata Indonesia (Persero) Gresik) (In Indonesian)]. J. Rekayasa Manajemen Sistem Industri, 2: 672-683.