Performance Enhancing in the Manufacturing Industry: An Improvement KATA Application

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Abstract – **As manufacturing firms (MFs) experience increasing competition in the global economy, it is vital to seek competitive advantage through the continuous improvement of performance within manufacturing processes. This requires a systematic approach to enhance performance by engaging staff at all levels to effectively take part in performance-enhancing efforts. The implementation of Toyota Kata has been proven to be highly successful for continuous improvement in a MF. Toyota Kata provides a holistic system of methods for improving performance, which contains processes and behavioral patterns for strategically aligned goal setting, problem solving, coaching, management and training. It is a simple and human factor focused approach, which covers the management of performance improvement efforts. This manuscript presents a case study performed in a wooden frames manufacturing firm for the implementation of Improvement Kata. Lead time has been selected as the performance indicator. The study describes current challenges, Improvement Kata implementation methodology, and the lead time improvement results.**

Keywords – **Toyota Kata, Performance Improvement, Lead-Time, Continuous Improvement, Operational Excellence**

I. INTRODUCTION

As continuous improvement is a preliminary need for an organization to enhance its performance, many industrial organizations implement different systems to support their improvement activities, based on Toyota's experiences [12]. Improvement approaches, together with different kinds of performance enhancing methodologies, are widely reported in the literature [9, 10]. Small improvements are implemented, as in Kaizen [8] and larger improvements, such as in Kaikaku [11], engaging employees from different areas and levels of organizations [7].

Some of the pioneering research by Steven J. Spear has led Mike Rother to research and explore the details of how Toyota has systematically improved its way of working and managed its improvement activities [1, 2]. Rother [1] has coined the phrase "Toyota Kata" for Toyota's way of working, to enable other organizations to adopt the core of Toyota's continuous improvement methodologies and apply them in different industrial organizations [1].

At the core of Toyota Kata, there is the notion of target condition, which is guided by the overall statement in the form of a vision. The target condition is eventually achieved via the continuous efforts that have been put into the improvement of performance. In addition, a 'Kata' is a structured routine that is practiced purposefully to form new skills and supporting habits [4]. For instance, "Through many repetitions of the Kata it is possible to imprint the behavioral patterns to an extent that they become second nature" [5]. Hence, it is worth implementing Kata in different industrial setups.

Furthermore, neuroscience research reveals that, due to the plasticity of the human brain, it is possible to rewire it to new ways of thinking and new habits, through the repeated practice of a routine (Kata) [3]. The focus of 'Toyota Kata' is to provide routines (Katas) to practice, which, over time, via a significant number of repetitions, enable the human brain to be rewired in such a way that systematic improvement and management of that improvement becomes second nature [5, 6]. Hence, in the context of a MF, the aforementioned enables the MF's overall performance to be enhanced by adapting to changing circumstances faster and better than the MFs, which are not practicing 'Toyota Kata'.

The 'Toyota Kata' is practiced with the support of real-time problems and challenges, which makes it economically viable to practice to the extent that 'Toyota Kata' becomes second nature [6]. For instance, a core idea of 'Toyota Kata' is that everyone's work consists of two parts [1]: "the actual work" and "improving the work". Toyota Kata is a systematic approach to enhancing performance by engaging staff at all levels to effectively take part in the performance-enhancing efforts. This empowers workers to make changes in their ways of working, but it also minimizes resistance to change due to the fact that the improvement ideas are introduced by the workers themselves. This also enhances psychological safety among personnel, as the improvement does not intend to endanger their job security. In general, the routines are associated with static behaviors and considered as the opposite of dynamic behaviors, which need frequent changes and adaptability. However, the behavioral routines that have been indicated in 'Toyota Kata' are tailored for changing, improving, and learning. This allows personnel to go beyond their comfort zone to

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encounter new challenges or circumstances. In such new circumstances, it is possible to take refuge in the knowledge, even though the solution is not clear. The 'Toyota Kata' approach enables the use of behavioral and thinking patterns (Note: provided that personnel are skilled/trained in using them), facilitating the personnel to discover the solutions. Such an approach allows work to be performed effectively with a level of uncertainty that does not burden personnel emotionally to the extent that it becomes an obstacle to effective performance enhancing [3].

'Toyota Kata' consists of a four-part system: 1. Vision; 2. Challenge; 3. The Improvement Kata; 4. The Coaching Kata. The first two parts are related to understanding the direction of improvement activities (vision and challenge), and the last two are behavioral routines (Katas) for improving and teaching/coaching/managing improvement.

The research question in this study is: "Is Toyota Kata an effective methodology for developing the ability of teams of workers to assume the responsibility for improving – and continuously finding solutions to improve – production performance?" The study was conducted in a wooden frames production cell, and lead time has been selected as the key performance indicator.

II. BACKGROUND AND INDUSTRIAL CHALLENGE

A. *Production Unit Description*

A.1 Company

The company, which is the subject of the following analysis, operates in the decoration sector; its core business is the production of around 3-meter-long wooden molding sticks. Besides the production units associated with the production of the long moldings (carpentry section and painting section), there is a specific section, in which this project was conducted. Those production cells dedicated to the production of canvas for painting, to the production of wooden frames in batches, and to the production of one-of-a-kind wooden frames were investigated.

A.2 Production Unit Case

This particular production unit is responsible for the manufacture and assembly of one-of-a-kind wooden frame products specified by the customer. Five workers are assigned to this area (one being the team leader). The main items of equipment are: one cutting machine, one underpinning machine and three workbenches form the final assembly workstations. Other equipment is also used to prepare some of the components, such as a glass cutting machine and a foam board cutting machine.

A.3 Products

The products are essentially wooden frames with anything that the customer wants to put in them. Each product is unique in dimension, in chosen molding and in specific assembly details and gadgets.

A.4 Product Operations

The standard sequence of operations is: 1 – Open and approve the production order; 2 – Collect molding from warehouse; 3 – Cut the molding into four pieces with specific dimensions; 4 – Retouch the edges with ink; 5 – Sub-assemble the frame; 6 – Carpentry operation (only few products require this operation); 7 – Final assembly (assemble the picture in the frame, plus glass, plus other gadgets); 8 – Expedition.

A.5 Initial Condition

Fig. 1 presents the initial layout, in which operators were performing their tasks before the implementation of improvements. One operator was dedicated to the cutting machine and to the retouch table (O1), another operator was dedicated to the stapling machine to sub-assemble the empty frame (O2), the other operators were dedicated to final assembly (O3, O4, O5) (the most complex operation). The operators assigned to the final assembly operations also have to perform other operations such as glass cutting and foam board cutting as components required by the final product specifications.

All operations were carried out in the cell, except for the jobs requiring carpentry operations. Those jobs had to go outside the cell, being sent to the carpentry section, and then return to the cell to finish the work. The main causes of long lead times were the work in the process accumulation on the retouch table, on the underpinning machine and before the final assembly. The large majority of the work in progress (WIP) was accumulated before the final assembly. The space occupied by the input material, supplied by customers to be included in the final product, was also a problem since more and more material had to be stored in the cell.

B. *Industrial Challenge*

The demand for these one-of-a-kind products was continuously increasing, and the lead times were also increasing, since more and more inventory was created in the cell. The lead time varied greatly, from 30 minutes to several days, and for that reason customers were complaining and production was becoming chaotic and stressful. The critical situation was vizualized from the point of view of WIP, which should be minimalized to decrease the lead time (the first step of Toyota Kata implementation – Vision). A challenge was to find a solution which would ameliorate the situation in the cell (the second step of Toyota Kata implementation – Challenge). The cell required an immediate change; that was the main motivation for KATA implementation.

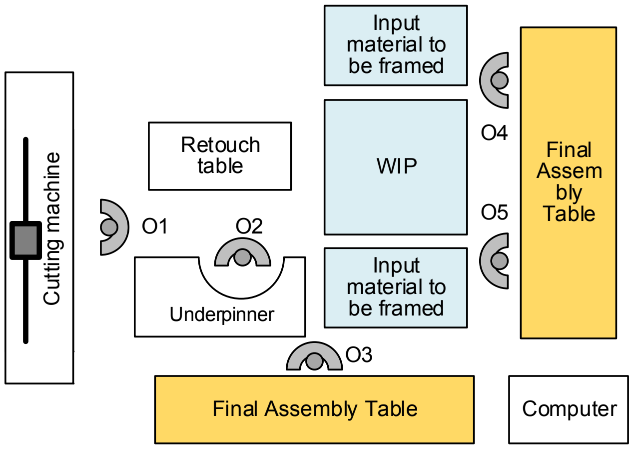

Fig. 1. Initial layout.

III. METHODOLOGY

The aim of this research is to validate the assumption that the Toyota Kata methodology leads teams of workers to develop the ability to assume the responsibility to find solutions in order to continuously improve production performance. The research was conducted in a production cell in the following way: (1) the workers were trained in Toyota Kata methodology; (2) the starting conditions were established; (3) the target condition for the lead time was agreed between team members and the coach; and (4) daily meetings took place with the team leader and the coach to check the plan–do–check–act (PDCA) cycle and eventually to establish new target conditions. The researchers observed the main steps and the evolution of the team and its performance.

This project started with a four-hour training course on Improvement Kata and Coaching Kata. The company's top managers, middle managers and some workers attended this training course. During the training session, the Improvement Kata and Coaching Kata concepts were also addressed with the help of a small game.

A specific board for the Kata visual management was created and placed next to the production unit (see Fig. 2). With the help of a coach (following Toyota Kata methodology), the maximum lead time was selected at the beginning as the performance indicator to improve. The lead time is measured from the time the production order is accepted by the production cell supervisor until it is dispatched from the cell to the client.

The team established the current condition as 23 hours' maximum lead time. In fact, this maximum lead time value did not include those jobs requiring carpentry operations, whose lead time in some cases could be as much as six days. The reason why the carpentry operations had to be excluded from the maximum lead time indicator is that the cell team had no control of carpentry operation lead times. Carpentry operations are performed outside the production cell in another section of the factory controlled by other people. This was noted as a possible future project.

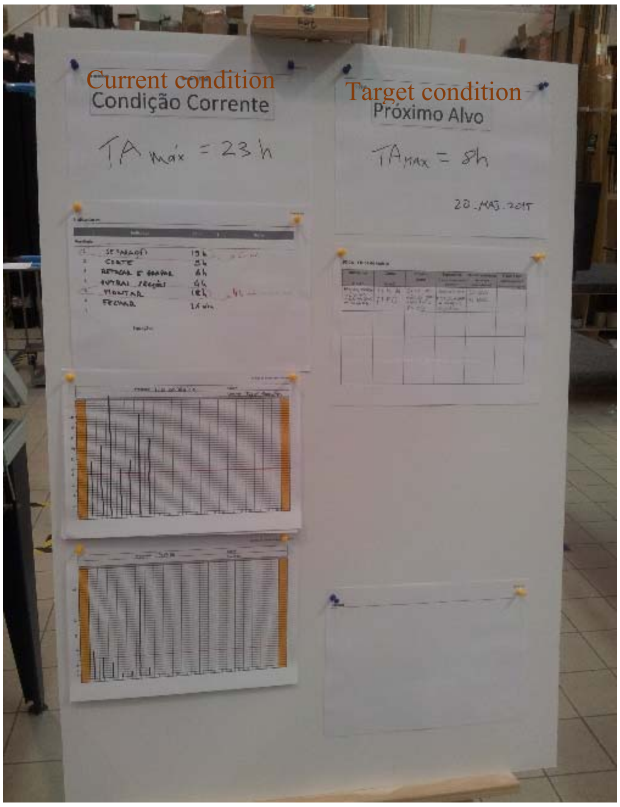

Fig. 2. Kata board.

On the board the team displayed the current condition in terms of maximum lead time and its target condition, as well as: records of lead times achieved, records of the lead times for specific operations that they were currently working on, records of PDCA cycles and other relevant information.

IV. ANALYSIS AND RESULTS

A coach came to the area almost daily to spend about 10 minutes with the team leader, talking about the improvements which had been made and the next improvements proposed by the team to implement. The team tried different ways of reducing the lead time on a daily basis and gradually understood that they had to find ways of reducing work-in-process.

Many experiments were performed implementing changes in task assignment, operator's relocations, layout, table sizes, WIP limitations, etc.

Although, at the beginning, the target was the reduction in maximum lead time, after July 2015 the team realized that the target should be the reduction in mean lead time, defined as follows (1):

$$Mean\ Lead\ Time = \frac{\sum_{i=1}^{n} LT_i}{n} \tag{1}$$

where LT_i – Lead Time for product I, n – number of products produced in a period.

According to the Improvement Kata methodology, the team had to collect lead time information for each production step (see section A.4). In order to make the process systematic and in compliance with the Improvement Kata, the team had to select only one operation step to be focused on for improvement for a period of time. After improving one operation step, the team moved the focus to another operation step and so on.

There came a moment when the team found the need to make bigger changes in the way they were operating the cell. The team recognized that, in order to reduce the lead time even further, they had to apply one-piece-flow. Because the operation times varied considerably, they decided on a "rabbit chase" approach [13], where each team member had to be able to perform all operations. In the rabbit chase mode, each operator takes a product and performs all the operations, moving from station to station with the product until it is completed, then starts with another product and so on. Since operators were not able to perform all operations, the team decided to make an extra effort by spending two weeks learning all the operations through team mates.

After all team members had been trained to perform all the operations in the cell, they started to apply the rabbit chase approach to reduce the lead time drastically. Fig. 4 shows the evolution of maximum and mean lead times from April 2015 to Feb 2016; the reduction in mean lead time is visible in September and October. This drastic reduction is also visible in Fig. 5. A sharp reduction in lead time occurred when the team decided to change to one-piece-flow with the rabbit chase operation mode. After that, the team found the need to change the layout; after several attempts, it ended up as shown in Fig. 3. Another consequence was the reduction of the retouch table size, since more WIP no longer had to be kept on the table.

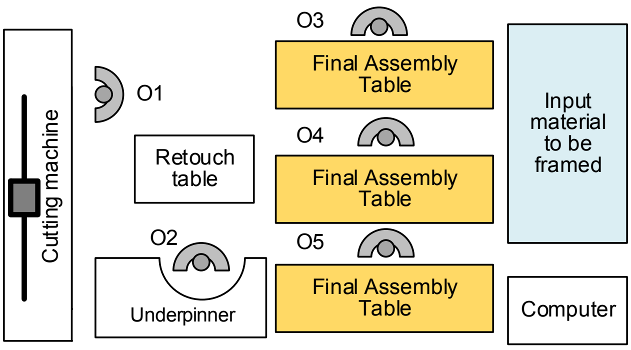

Fig. 3. Final layout.

As can be seen in the final layout presented in Fig. 4, the WIP has disappeared completely. The operators are no longer assigned to a single workstation; instead, each worker takes an order and performs all the operations required on that order, using a rabbit chase approach. This new approach was very successful in team motivation and overall performance.

Fig. 4 shows respectively the values for maximum and mean lead times from April 2015 to February 2016. In October it was possible to reach a minimum of 10.51 hours for maximum lead time. This indicator increased a little in the next months because the objective was no longer reducing the maximum lead time but the mean lead time. The performance in terms of mean lead time did not decrease between May and August because the focus was to reduce the maximum lead time, but then its value decreased consistently and in February reached a minimum of exactly 0.97 hours.

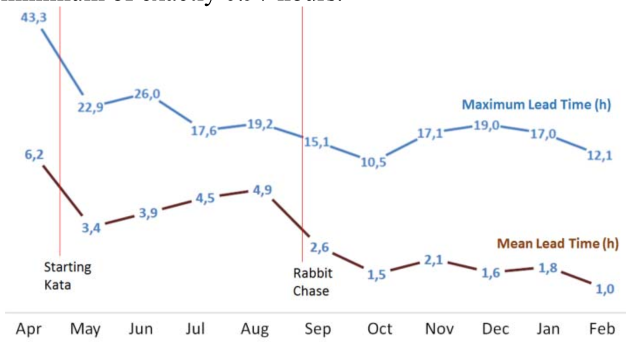

Fig. 4. Maximum and mean lead times' evolution.

Additionally, Fig. 5 shows individual lead times registered from April 2015 to December 2015. The purpose of this graph is to show how disparate the lead times can be for different products. The concentration of dots in the lower area of the graph becomes very clear at a certain point (around September 2015), resulting from the adoption of one-piece-flow and from the improvements in layout.

V. DISCUSSION AND CONCLUSION

A. Main Findings

Toyota Kata is mainly concerned with creating a continuous improvement culture in organizations where everybody contributes on a daily basis with small improvement steps. Continuous improvement is one of the duties of all employees; it is not only the responsibility of a specific department or a specific continuous improvement team. In the Toyota Kata implementation case presented in this article, the team of workers ended up assuming the routines of continuous improvement, finding their own solutions in order to reach the target condition. Team members learned that they could be active in problem-solving actions and in control of the changes, not having to wait for someone to come up with new ideas to implement. They have been empowered to implement changes and to become responsible for results. Additionally, by means of the rabbit chase implementation, operators' skills were improved and, in the case of an operator's absence, other operators can perform the work without any problems.

Actually, those responsible for the project had previously tried to convince the team members to implement one-piece-flow, but they were not convinced by his arguments so they did not try to implement it. With this methodology the team members, in the process of being involved in their own improvements, in an appropriate environment, performing their own experiments, ended up doing a very impressive job.

B. Assessment of Measurable Benefits from Improvement Kata Implementation

The implementation of Improvement Kata methodology in the production cell described in this article resulted in very important measurable benefits. At the beginning of the Improvement Kata implementation, the team in the cell selected the maximum lead time as the performance indicator to improve, but then they discovered that this indicator was strongly dependent on external factors. The mean lead time was then the performance indicator chosen for improvement, and the results gradually appeared. The mean lead time was around 6.2 hours in May 2015, and this indicator decreased to 0.97 hours in February 2016. This 84% reduction in mean lead time drastically improved the service quality perceived by customers. The maximum lead time, excluding the extreme cases of special products requiring complex operations outside the cell, went from 43.3 hours in May 2015 to around 12.1 hours in February 2016: a reduction of 72%.

At the same time, the number of orders increased by more than 30%, while the same number of employees was maintained in the cell.

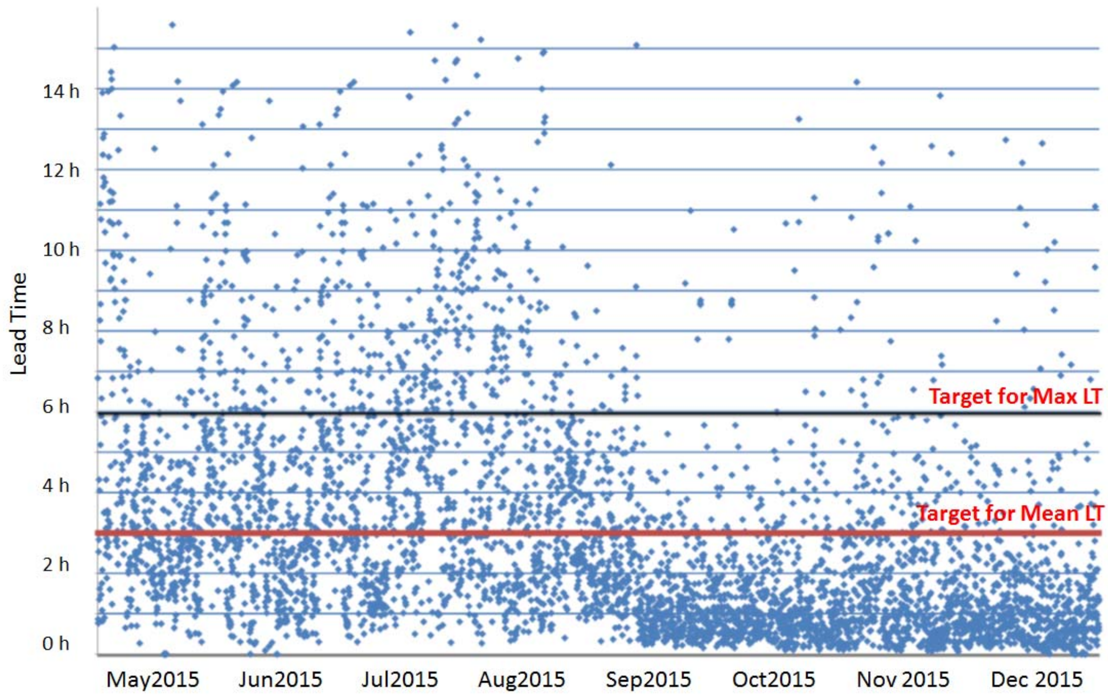

Fig. 5. Individual lead times from May 015 to December 2015.

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