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Prioritizing Muda: A Sandcone Model for Lean Waste Elimination

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Abstract:
Lean principles aim to improve processes by identifying and eliminating waste at the source. Increased competitive pressure has pushed companies towards performance improvement and cost reduction. Lean gains prominence from the success of Toyota Automobiles and has since been adapted in various industries and sectors. However, alike any other improvement methodology, the success of lean implementation is also high debated. Failures in lean implementation are attributed to backsliding, lack of commitment and management focus. While analysing and identifying the lean wastes are highly researched and discussed, prioritization and selection of the appropriate lean waste for improvement is ill defined. This paper proposes a theoretical model in lines with the widely adapted sandcone model of operational performance. The model would provide a means through which lean waste can be prioritized and selected for improvement, to create operational capabilities and sustain lean practices in the organization.

1. Introduction

Lean has its roots from Toyota Production System (TPS), a Japanese manufacturing technique and principle that integrate work environment with culture. The term "Lean" was coined by John Krafcik and the principles were popularized as "Lean manufacturing" by James Womack in 1990, through his book "The Machine that Changed the World" (Krafcik, 1988). Since then, the lean principles and practices has been rapidly adapted into various industries and sectors. Liker in 1996 described lean as "a philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the production flow". In general, lean strives to eliminate waste in the production process and improve the operational performance. Lean takes a holistic system approach in creating efficiency and integrates various best practices and concepts such as Just in Time (JIT), Total Quality Management (TQM), resource planning, continuous improvement, cellular manufacturing, visual monitoring, etc (Oduoza, 2008). It gained prominence with the rise in competitive pressure to deliver high quality product to demanding customers. Its ability to reduce wastes, in concurrence, with creating value addition to customers, is considered to be the main factor for its rapid proliferation into various industries (Ruy Victor and Luis Cesar, 2014). However, few companies were successful in implementing the lean practice. Mora in 1999, suggests that "only some 10 percent or less of companies succeed at implementing TPM and other lean manufacturing practices" (Sanjay and Peter, 2006). While the number of tools, techniques and technologies for process improvements has dramatically increased, the low success rate of adapting lean can be attributed to the lack of management commitment, lack of holistic strategy for implementation, cultural change, lack of employee involvement, etc (Hines, Holwe and Rich, 2004). Lean Enterprise Institute conducted a survey in 2008 to understand the constraints for implementing lean concepts and cited backsliding, resistance by middle management and lack of knowledge as the most common inhibitors. Bacdayan (2001) attributes failures to poor project selection and execution. Identifying and selecting the projects for improvement is considered to be one of the critical factors for success of continuous improvement (Antony and Banuelas, 2002). Yet not much thought has been given to this discipline. Poor project selection would lead to poor resource allocation and deviation from the strategic objective (Bower and Gilbert, 2007).

2. Lean Wastes Elimination

Taiichi Ohno identified seven wastes in processes that when eliminated would improve the performance. His waste categorization include overproduction, producing more items than ordered by the customers, Waiting, the process or people waiting due to delay in supply, constraints in capacity of the machines or due to equipment downtime (Imai, 2012). The third waste is unnecessary transportation. Unnecessary movement of material, parts, WIPS and finished goods to and fro the storage and process area adds to wastage in time, effort and cost. Over processing or incorrect processing is defined as the fourth waste. It results from providing products of high quality than requested by the customer or taking additional steps to perform the process due to poor tools or inadequate design. Excess inventory is categorized as the fifth type of waste, which is defined as the excess raw material or work in progress item or finished goods stored. The sixth waste is the unnecessary movement of people. People moving around for raw materials, tools and other items contribute to confusion and disorganization of work area resulting in less efficiency operation. The seventh and the final waste according to Ohno is the "Defect" or production of products which does not confirm with customer specification (Imai, 2012). While organization adapts different ways to reduce or eliminate lean waste, the most popular methodology is "Kaizen" events.

Kaizen, in Japanese, mean "continuous improvement". "Kai" meaning change and "Zen" meaning good, Kaizen events are identified as a structured improvement mechanism that involve both managers and workers, to create small yet incremental improvements in the operation without heavy investment. Melnyk et al in 1998 identified seven characteristics that differentiate kaizen events from other process improvement methods. One of the most important characteristics is that the events are goal oriented. Some common metrics for lean kaizen sessions include defects, throughput, lead time, work-in-progress, set-up time, productivity etc (ray et al, 2006). All these metrics has the direct relationship with operational performance, yet, were not mentioned in any order. Other salient featured of kaizen event is the cycles of performance improvement. As kaizen represent continuous improvement, kaizen team would focus on waste elimination which would successfully improve an identified metric and then would repeat the process for a different metric.

In spite of being adapted widely by organizations, the success of kaizen events are highly debated (Laraia et al, 1999). The short term, team based event is criticised for attempting the symptoms and not the causes of the operational issues. Reasons for failure of kaizen events include management commitment, employee commitment, poor critical success factor selection, larger scope, etc (Burch, 2008). As kaizen events are metric based improvement program, selection of metrics or critical success factors are highly important for successful implementation. Achieving these critical factors or metrics is performed through waste elimination, hence, selection of waste for elimination should be done to improve and sustain operational performance.

3. Waste Elimination and Operational Performance

Abundant researches and studies are conducted to understand the waste classification and identification. Yet, little importance was given to the selection and prioritization of lean waste. Fuzzy logic based decision support system was proposed by Vinodh and Chintha (2011) to aide in identifying and prioritizing lean improvement opportunities. Ramesh and Kodali (2012) proposed analytical hierarchy process to identify prioritize value stream for improvement. Other common way of prioritizing waste elimination is through brainstorming and collective decision making. A modified form of FMEA is provided by Ruy Victor and Luis Cesar (2014), to prioritize lean waste elimination. The waste FMEA or W-FMEA method mirrors the FMEA technique in identifying the waste cause and its effect on operations. Waste is categorized based on occurrence, detection and severity to obtain waste priority number (WPN), which would order the waste to be eliminated in descending order.

Organizations typically contain measure for quality, dependability, flexibility and cost. These measures together defined the operational performance. Studies analysing the link between lean practices and operational performance shows varied results. Some of the research focus on individual performance dimension while others tries to understand the relationship holistically. Flynn et al (1995) analysed the impact of lean practices on multi-dimensions of operational performance to understand their interrelationship. It is identified that quality has the strongest association with lean principles. Flexibility is strongly dependent on leadership, customers and technology. The research also identified that implementing lean principles in a staged process – one improvement after another – would not result in high performance. They proposed simultaneous implementation of lean practices yet fall short of defining any structure or order. Chavez et al (2013) studied the relationship of lean practice and operational performance and concluded that lean practices positively impact operational performance. However, the level of impact is dependent on the industry clock speed – industry evolution. They conclude that lean practices has a strong relationship with various operational parameters and can also eliminate trade-offs between them. Yet they failed to explain the order in which lean practices or waste elimination should be considered for maximizing operational performance.

Skinner (1966) proposed trade-off model where improvement in one operational parameter is done at the cost of other parameters. However, Ferdows and De Meyer (1990) proposed a cumulative model of improvement for operational parameters, which has become widely known as Sandcone model of operational performance. They propose that to create lasting improvement in organizational capabilities, organizations must continuously improve operational performance parameters in a defined order. They suggest organizational should first focus on improving the quality of the product. Once quality is achieved, investments should be made to improve dependability but not at the expense of quality. Organizations should continue to invest in quality improvement while some efforts are focused on dependability. Flexibility and cost reduction would follow suite respectively. Thus, they suggests that " cost improvements which result from this pattern of allocation of management attention and resources will be more lasting and ultimately the company will be able to enjoy improved performance in quality, dependability, flexibility and cost efficiency simultaneously".

4. Sandcone Model for Lean Waste

Lean focuses on eliminating waste and has been found to improve operational performance. Hence, to sustain the practices of lean in the organization, improvements should be identified and prioritizing in accordance with operational performance parameters. The current practice of identifying improvements and its metrics trades off one parameter for another. While this may lead to a one time improvement, the ability to sustain it is difficult. As an alternative, we propose "Sandcone mode of waste elimination", drawing parallel with Ferdows and De Meyer's "Sandcone model of operational performance". According to Ferdows and De Meyer's to create organizational capabilities and to sustain them, organization should focus on improving quality, dependability, flexibility and cost cumulatively, in order and should not trade one parameter for another. Thus, for lean improvement to sustain, improvements or waste elimination should be undertaken to focus on quality, dependability, flexibility and cost cumulatively, and in the order defined.

Among the seven wastes, defects are directly related with quality dimension. Defects interrupt the production process and involve efforts and resources for rework. In high speed work environment, if not identified and arrested, defects would cost great wastage of resources resulting in defective products. Thus, opportunities should be identified to eliminate defects from the operational processes.

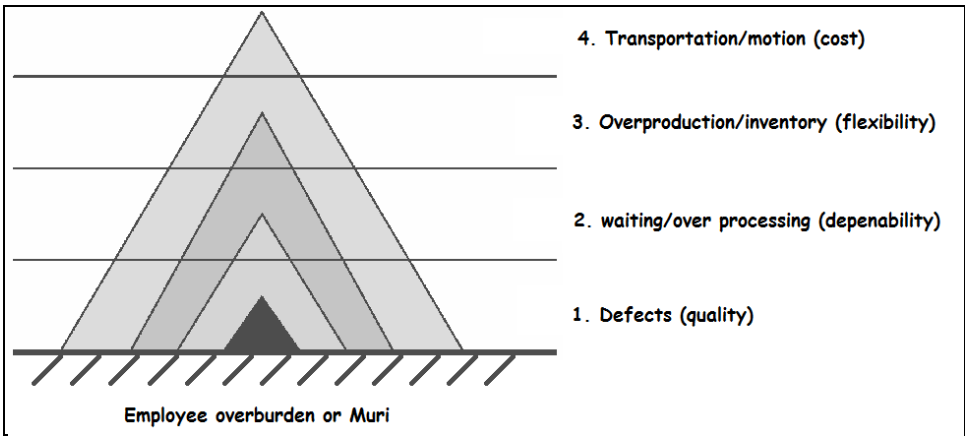

Figure 1: Sandcone model for lean waste elimination.

Once sufficient quality is achieved, some effort may be spent to improve and eliminate wastes related to dependability. Dependability means delivering product to the customer at the time and place as promised. Waiting in the process area for raw material or due to faulty machines or due to imbalance in the process flow, would result in increase in production time, which would ultimately affect the dependability dimension. Over processing waste in the process result from excessive checks and reviews. While in an attempt to improve quality, excessive controls and reviews are put in place, resulting in over processing. At other times, over processing may occur due to lack of information or taking a long approach due to lack of machine capability. But taking a long production process, over processing, would result in longer production time, ultimately affecting the delivery of the product. Thus, in addition with focus on quality, lean improvements should not focus on areas where dependability can be improved by eliminating waiting and over processing.

With results obtained from the efforts spent on improving quality and dependability, some efforts should now be spent on improving flexibility of the operation. Flexibility refers to the speed in which the operations may adapt to changes in the customer requirement. The change may be in terms of quantity or quality. However, this may not be achieved if sufficient raw material is not available or the machine to produce the product is engaged in producing other products. Thus, flexibility in operation is highly influenced by over production and inventory waste. According to Masaaki Imai (2012), "being ahead o the production schedule is regarded as worse than being behind it". He argues that by being ahead of schedule, the operation produce more than necessary to meet customer demand. Consumption of raw material, wasteful use of employees and addition of new capacity increases the need for storage and handling. It also results in inventories which tie up the capital. Tied up capital and raw material would make it difficult for operations to be flexible. Thus, eliminating waste of over production and inventory should be done to improve the flexibility of the operation. Just-In-Time (JIT) focuses on reducing inventory and creating one piece flow which would improve the flexibility of the operation. Thus, to improve the flexibility dimension, lean improvements should focus on eliminating inventory and over production.

Efficiency in cost can be obtained by improving quality, dependability and flexibility. However, further efficiencies can be obtained by focusing specifically on cost reduction activities. Wastage through transportation and motion of people, adds no value to the operations but results in wasteful use of resources. Transportation involves handling and movement of materials, resulting in cost due to fuel usage and creating opportunities defects. It also contributes to inventory in terms of transportation vehicles. On the other hand, motion of people leads to confusion and cluttering. According to lean principles unwanted movement of people results in wasteful use of productive labour hours, thus increasing the cost of production. Thus, in addition to improvements in quality, dependability, flexibility, improvement in cost can be brought in by reducing waste associated with transportation and motion of people.

The Sandcone can sustain and grow in creating operational capabilities provided the footing in which it is made is essentially solid and strong. We refer this "footing" as employee capacity. Employees should have sufficient capacity in terms of knowledge, skill, attitude and time to undertake improvement initiatives. If this capacity is not there, investment in improvements would sink-in resulting in failure. In lean terms, lack of employee capacity is associated with "Muri". Muri refers to overburden or strenuous condition, in the work process, for employees and machine alike. Workers resistance and lack of perseverance are some of the major factors contributing to backsliding and failure of lean initiatives. Thus, to create and sustain lean improvement in the organization, it is necessary to remove over burden on the employees and create a solid footing where improvements can be raised.

5. Conclusion

Typical lean improvements involve waste analysis and identifying their percentage contribution to the work environment. Improvement team would then take up the waste which is contributing most, for elimination. However, such method may not be rendered effective as the largest contributor may not be the one that impacts the most. A modified form of FMEA was proposed considering not only the occurrence but also the severity and the ability of detection as a means for prioritizing waste elimination. However, such an approach would trade off improvement in waste category for other. The sandcone model of waste elimination

proposed in this theoretical paper combines the idea of lean wastes with sandcone model of operational performance. The construct suggests that lean projects should focus on improving the quality by eliminating defects. Elimination of waiting time is done next to increase dependability, followed by elimination of inventory and over production. Ultimately, cost reduction should be performed through elimination of waste due to transportation and motion of people. The improvement should be performed cumulatively and in the order mentioned, so as to eliminate trade-offs. Kaizen events may also adapt the model giving primary importance to quality, followed by dependability, flexibility and cost. However, before undertaking any lean initiatives, it is necessary to eliminate "muri" or employee burden. Kaizen team should be identified as such the capacity is not affected. Employees should be communicated of the need for improvement and leadership commitment should be ensured. With staff reduction occurs as part of lean improvement, ways of reutilizing the staffs should be considered before lay off.

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