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LEAN WASTES: CLASSIFICATIONS FROM DIFFERENT INDUSTRY PERSPECTIVES

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Abstract

Lean has now emerged as a core concept for improving efficiency and productivity in many industries. Identification and elimination of wastes is at the core of Lean Thinking. The purpose of this paper is to provide an insight into the various types of wastes in different industries. A literature review was carried out with an objective to identify and categorize waste/non-value add activities in different industry settings. This categorization of wastes would be useful while applying Lean principles in different industry settings.

Keywords:

Lean, Waste, Classification

1. INTRODUCTION

Lean concepts, originated first in the automobile factory floor of Toyota as Toyota Production System (TPS) was the beginning of Lean practices in manufacturing and subsequently it was developed further to reduce and eliminate wastes in the processes within the organization [1],[2],[3]. Krafcik, first used the word "Lean" to describe the new production techniques introduced at Toyota after World War II [4]. Since Womack, Jones, and Roos [2] announced this concept as a new production paradigm, several industries have dedicated great attention to the possibilities of applications to their environments.

Lean has now emerged as a core concept for improving efficiency and productivity in many industries. Lean manufacturing focuses on bottom-up, worker-led improvements and a process wide approach to production and there are many instances of organizations across a range of industries and countries who have successfully implemented lean and have reduced costs and improved quality [2],[5].

Waste elimination is the basis of Lean Thinking [6]. According to Liker [6], Lean is a manufacturing philosophy that shortens the time line between the customer order and shipment by eliminating waste.

The objective of this paper is to study the relevant lean literature to understand the types of wastes / non-value add activities in different industry settings and present waste categories from the perspective of different industries.

The remainder of the paper is structured as follows: First, the author presents a brief overview of lean wastes. In the next seven sections, the waste categories in different settings are presented: Wastes in manufacturing, Wastes in product development, Wastes in office setting, Wastes in internal service system, Wastes in software development, Wastes in construction and Wastes in services. At the end, the author concludes how the waste classification can be useful.

2. LEAN WASTES

Identification and elimination of waste or non-value added activities are at the core of lean philosophy and are often referred to through discussions involving 'muda' - the Japanese word for waste [3], [6], [7], [8], [9],[10], [11], [12]. Waste includes activities which do not add value to customers and organizations. For the customers, waste is a cost that they are not willing to pay. It is important to increase the awareness of employees on the concept of waste, as well as on the ways to identify and reduce waste.

The essence of lean production is elimination of all types of wastes for fulfillment of customer requirements in a better way [13]. According to Ohno [14], only the activities that are needed to produce the product are called as real work, and the rest is defined as waste. Koskela [15] defined waste in construction sector as "any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities than those considered in the production of a building". According to Polat and Ballard [16], waste is any activity which can be eliminated without reducing customer value.

Waste from lean perspective is defined as works or activities that add no value to a product or service from the perspective of the customer. This basic definition of waste remains same in manufacturing and service environment. There can be two types of wastes [17]:

- Type I waste: these are activities that add no value to the customer, but are necessary, in the current operations framework for delivering the product.
- Type II waste: these are activities that do not create value and can be eliminated immediately, such as waiting and unnecessary transport.

In many instances, when lead-time is critically examined, the composition of value-added activities and non-value-added activities are found to be 5 and 95 per cent, respectively. Elimination of waste is very important as it can account for between 55 and 95 per cent of the manufacturing process. Many researchers have studied wastes / non-value added activities in various industry settings which are presented below.

3. WASTES IN MANUFACTURING

Ohno [14] first classified manufacturing wastes or non-value added activities into seven categories:

- Defective products production
- Over-production ahead of demand
- Waiting for the next process step

- Transportation of materials
- Inventory more than the absolute minimum
- Unnecessary movement by employees during the course of their work
- Over-processing of parts due to poor tool and product design.

According to Ohno [14], any of these waste activities can be removed from a production system without a loss to the product value for the customer; the elimination of the wastes would increase the productivity and decrease the expense associated with the production line. While aiming for absolute elimination of wastes, the following two points must be borne in mind.

- Efficiency improvement must be tied to cost reduction
  - To achieve this, only the things needed must be produced, using minimum resource.
- Efficiency improvement at each step and at the same time for the plant as a whole
  - To achieve this, organization must look at the efficiency of each operator and each line, then look at the operators as a group, and then at the efficiency of the entire plant (all lines).

Womack and Jones [17] identified a new category of wastes to this list. This relates to underutilization of people and in particular their ideas and creative input for improving the processes and practices. Subsequently, other activities have been suggested to be included as new categories to Ohno's waste classification. These new waste categories are behavioral waste – human behaviors that add no value and can be eliminated, complexity, dangerous working practices, excess information, figuring what to do or how to do it, making do [18], not taking advantage of people's thoughts, wasting good ideas; not using people's talents, under-utilization of people's skills and capabilities [19] .

4. WASTES IN PRODUCT DEVELOPMENT

The lean concept was first applied to product development environment by introducing ideas and tools of lean manufacturing. Many researchers focused on two research topics-definition of waste and practical way of value stream mapping. This was based on the idea that addressing these topics would lead to realization of the five lean principles.

Womack and Jones introduced two new categories 'complexity' and 'time lag' to Toyota's seven categories of waste in manufacturing and deleted 'over processing'. Slack [20] tried to prioritize the nine types of waste by conducting surveys of product development organizations, questioning each category's frequencies. He also analyzed each category's effect on value. The definition of categories of waste has continuously been discussed by exploring the differences between manufacturing and product development environment. Morgan [21] looked at the waste from the perspective of systems engineering and changed the categories and definitions of wastes. He introduced 11 categories of waste, replacing all but 'waiting'. It was based on the idea that non-synchronization leads to low performance in product development processes. Recognizing interdependency among the categories of waste defined by forerunners, Bauch [22] re-defined ten categories of waste by analyzing interactions among the categories.

5. WASTES IN OFFICE SETTING

In comparison to manufacturing, a typical office setting deals with paper work, phone calls and meetings, etc. Transportation wastes are uncommon in an office setting but often have a lot of information related wastes. Unnecessary paperwork, missed phone calls, data translation errors, and poorly run meetings with too many participants are all common forms of office wastes.

It is possible to categorize office waste using manufacturing waste categorization scheme; but other schemes designed with the office setting in mind yield more meaningful findings. Lean consultants from Kaufman [23] global have created one such waste categorization scheme designed for the office setting. As per this scheme, wastes are grouped under four main categories: people energy waste, process waste, information waste and people work waste.

People energy waste results from a failure to harness an employee's potential. The possible causes of people energy wastes are: poor focus, poor structure, no ownership, excessive control, tampering, assignment issues, and improper goal alignment.

Process wastes are the wastes from inefficient structure, interaction, and execution of complex business processes. The possible causes of process wastes are: checking, work-around, non-standard, unbalanced flow, and sub-optimization.

Information wastes arise from inefficient data flow between activities and across connections. Causes of information wastes are due to: poor hand-offs, translation, missing information, irrelevant information, and inaccuracy.

People work wastes are similar to the waiting, motion, and over-processing counterparts found on a factory floor. The causes of people work wastes are as follows: waiting, motion, processing. This categorization scheme for waste suits knowledge workers in an office setting as they can relate to these categories more often than Ohno's manufacturing types of waste.

6. WASTES IN INTERNAL SERVICE SYSTEM

Maleyeff [24] has classified wasteful activities into seven groups: delays, reviews, mistakes, duplication, movement, processing inefficiencies, and resource inefficiencies. According to Maleyeff [24], the most common problems included a lack of standard procedures, long service times, communication breakdowns, and poor personnel management.

7. WASTES IN SOFTWARE DEVELOPMENT

Poppendieck and Poppendieck [25] initially classified software engineering wastes as extra processes, extra features, partially done work (inventory), task switching, waiting, motion, and defects. This classification is a translation of wastes from manufacturing to software development. Later on, Poppendieck and Poppendieck [26] suggested a classification of waste as follows:

- Partially done work, is 'inventory of software development'. It is not guaranteed that partially done work really solves the customer's problem either. Instead, it ties up resources.
- Extra features consume resources when tracked, compiled, integrated, and tested. The more of these non-value adding "just-in-case" features, the more complexity and potential defects there are.
- Relearning wastes, resources that add no value for the customer. Rediscovering a known but forgotten thing is rework. Ignoring knowledge that people bring to the workplace, in its turn, destroys utilizing their potential.
- Handoffs leave the major part of knowledge behind in the mind of originators. Tacit knowledge is difficult to transport to other people through documentation. In brief, documents cannot contain all of the information that the other people in line need to know.
- Task switching between jobs or tasks takes time, much because of re-orientation and re-focusing. In addition, lack of immediate access to other developers and other representatives disrupts concentration.
- Delays slow down realizing value for the customer. Waiting for people to be available who are being busy in other areas causes waste. Critical decision-making in developing requires a good understanding of the situation from the developer. Moreover, it requires someone with knowledge in the room to answer the remaining questions. Lack of this understanding and knowledge results in a new decision problem: should the developer stop in order to try to find out the answer, switch to another task, or just make a guess without stopping.
- Defects in the code take resources to fix them. Even small defects, revealed after weeks are typically more serious problems than big defects found immediately.

According to Middleton [27], partially done work (or inventory) is specifically critical. Inventory is critical because:

- It hides defects that are thus discovered late in the process [27].
- The time has been spent on artifacts in the inventory (e.g., reviewing of requirements) and due to change in the context the requirements become obsolete and thus the work done on them useless [28].
- It impacts other wastes. For example, a high level of inventory causes waiting times. This is quite common in case of waterfall model of development as the designers have to wait until the whole requirements document is approved [28]. Long waiting times increases the risk of obsolescence of completed work. Moreover, high inventory in requirements engineering can be due to that a high number of extra features have been defined.
- It slows down the whole development process.

8. WASTES IN CONSTRUCTION

Formoso et al. [29] classified construction wastes into two types: unavoidable (or natural) waste in which case the cost of prevention of the waste is higher than the production cost; and avoidable waste, in this case the cost of waste is higher than the cost of prevention. Construction wastes can be categorized according to its source or stage in which the root causes of the waste occur [29]. Bossink and Brouwers [30] classified construction waste causes into six sources: design, procurement, materials handling, operation, residual and others. Garas et al. [31] grouped construction wastes into two: time wastes which include waiting periods, stoppages, clarifications, variation in information, rework, ineffective work, interaction between various specialists, delays in plan activities and abnormal wear of equipment. The other type is material waste which comprises over ordering, overproduction, wrong handling, wrong storage, manufacturing defects and thefts or vandalism.

9. WASTES IN SERVICES

Sarkar [32] elaborated on eight different types of wastes in the service sector. These service wastes are classified as:

- Waste of overproduction – processing more or sooner than required
- Waste of motion – movements that are unnecessary and are not required for completing a job
- Waste of inventory – excess items or supplies
- Waste of transportation – movement of materials which is more than just-in-time processing,
- Waste of waiting – individuals and items being idle in operations, (6) waste of employees under-utilization,
- Waste of defects, and
- Waste of over-processing – the efforts that do not add value for customers.

10. CONCLUSION

The finding of the study reveals that waste activities and the classification in non-manufacturing are not same as manufacturing waste activities. There are some waste activities which are similar in nature but there are other non-vale added activities, which are different from manufacturing wastes.

The contribution of the article would be of interest for both researchers and practitioners. For researchers, the waste classification presented in this article is a theoretical contribution. In relation to practitioners, the waste classifications would help in identification and elimination of non-value added activities. The findings of the article would be useful to the organizations who are interested in continuous process improvement following lean principles.

There are opportunities to do further study to understand and find out the relationship among various waste categories. Waste identification is just the first step. It is to be kept in mind that wastes cannot be removed without understanding its causes. Further study can be carried out to find out the impact analysis of different waste types.

REFERENCES

[1] M. Holweg, "The genealogy of lean production", *Journal of Operations Management*, Vol. 25, No. 2, pp. 420-437, 2007.

[2] James P. Womack, Daniel T. Jones and Daniel Roos, "*The Machine that Changed the World*", Free press publisher, 1990.

[3] T. Melton, "The Benefits of Lean Manufacturing: What Lean Thinking has to Offer the Process Industries", *Chemical Engineering Research and Design*, Vol. 83, No. 6, pp. 662-673, 2005.

[4] Tony Bendell, "A review and comparison of six sigma and the lean organizations", *The TQM Magazine*, Vol. 18, No. 3, pp. 255-262, 2006.

[5] James P. Womack and Daniel T. Jones, "*Lean thinking: Banish the waste and create wealth in your corporation*", Free press publisher, 2003.

[6] Jeffrey Liker, "*The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*", McGraw-Hill Education, 2004.

[7] F. A. Abdulmalek, J. Rajgopal and K. L. Needy, "A classification scheme for the process industry to guide the implementation of lean", *Engineering Management Journal*, Vol. 18, No. 2, pp. 15-25, 2006.

[8] D. I. Ben-Tovim, J. E. Bassham, D. Bolch, M. A. Martin, M. Dougherty and M. Szwarcbord, "Lean thinking across a hospital: redesigning care at the Flinders Medical Centre", *Australian Health Review*, Vol. 31, No. 1, pp. 10-15, 2007.

[9] C. D. Chapman, "Clean house with lean 5S", *Quality Progress*, Vol. 38, No. 6, pp. 27-32, 2005.

[10] Pascal Dennis, "*Lean Production Simplified*", Productivity Press, 2007.

[11] S. A. Rooney and J. J. Rooney, "Lean Glossary", *Quality Progress*, Vol. 38, No. 6, pp. 41-47, 2005.

[12] R. Shah and P. T. Ward, "Lean manufacturing: Context, practice bundles, and performance", *Journal of Operations Management*, Vol. 21, No. 2, pp. 129-149, 2003.

[13] J. Womack, "Manufacturing has moved to lean- It's time construction does too", *Proceedings of the 10th Winter Conference in Archistruction*, 1999.

[14] Taiichi Ohno, "*The Toyota Production System: Beyond Large-Scale Production*", Productivity Press, 1988.

[15] L. Koskela, "Application of the New Production Philosophy to Construction", Center for Integrated Facility Engineering Technical Report # 72, pp. 1-75, 1992.

[16] G. Polat and G. Ballard, "Waste in Turkish Construction: Need for Lean Construction Techniques", *12th Annual Conference of the International Group for Lean Construction*, 2014.

[17] James P. Womack and Daniel T. Jones, "*Lean thinking: Banish the waste and create wealth in your corporation*", Free press publisher, 2003.

[18] L. J. Koskela, "Moving on - beyond lean thinking", *Lean Construction Journal*, Vol. 1, No. 1, pp. 24-37 , 2004.

[19] K. Suzaki, "*The New Manufacturing Challenge: Techniques for Continuous Improvement*", Free Press publisher, 1987.

[20] Robert A. Slack, "The lean value principle in military aerospace product development", Lean Aerospace Initiative Report RP99-01-16, 1999.

[21] James M. Morgan, "High Performance Product development; A Systems Approach to a Lean Product Development Process", Doctoral Dissertation, University of Michigan, 2002.

[22] C. Bauch, "Lean Product Development: Making Waste Transparent", Diploma Thesis, 2004.

[23] A. Kaufman, "Office Kaizen: Making Lean Work in Service Environments", A Kaufman Global White Paper, 2007.

[24] John Maleyeff, "Exploration of internal service systems using Lean principles", *Management Decision*, Vol. 44, No. 5, pp. 674-689, 2006.

[25] Mary Poppendieck and Tom Poppendieck, "*Lean Software Development: An Agile toolkit*", Addison Wesley Professional, 2003.

[26] Mary Poppendieck and Tom Poppendieck, "*Implementing Lean Software Development: From Concept to Cash*", Addison Wesley Professional, 2007.

[27] Peter Middleton, "Lean software development: two case studies", *Software Quality Journal*, Vol. 9, No. 4, pp. 241-252, 2001.

[28] K. Petersen., C. Wohlin and D. Baca, "The waterfall model in large-scale development - state of the art vs. industrial case study", *Proceedings of the 10th International Conference on Product Focused Software Development and Process Improvement*, pp. 386-400, 2009.

[29] C. T. Formoso, E. L. Isatto and E. H. Hirota, "Method for waste control in the building industry", *Proceedings of the 7th International Group for Lean Construction-7*, 1999.

[30] B. A. G. Bossink and H. J. H. Brouwers, "Construction wastes: quantification and source evaluation", *Journal of Construction Engineering and Management*, pp. 55-60, 1996.

[31] L. G. Garas, R. A. Anis and El A. Gammal, "Materials wastes in Egyptian construction industry", *Proceedings of the 9th International Group for Lean Construction-9*, 2001.

[32] D. Sarkar, "*Lean for service organisations and offices: a holistic approach for achieving operational excellence and improvements*", American Society for Quality and Dorling Kindersley Publishing, 2008.