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Lean waste classification model to support the sustainable operational practice

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Abstract. Driven by growing pressure for a more sustainable operational practice, improvement on the classification of non-value added (waste) is one of the prerequisites to realize sustainability of a firm. While the use of the 7 (seven) types of the Ohno model now becoming a versatile tool to reveal the lean waste occurrence. In many recent investigations, the use of the Seven Waste model of Ohno is insufficient to cope with the types of waste occurred in industrial practices at various application levels. Intended to a narrowing down this limitation, this paper presented an improved waste classification model based on survey to recent studies discussing on waste at various operational stages. Implications on the waste classification model to the body of knowledge and industrial practices are provided.

1. Introduction

In an attempt increasing profitability and minimize operating cost, companies globally are implementing endeavours to reduce/eliminate the occurrence of any activity which has no value addition but contributing into an operating cost. One of the viable way to achieve above goal is by implementing a lean operation [1] that not only reduces the wastes but also enhances the effectiveness and efficiency of any process leading to a sustainable operation. Attempting being lean means minimizing the occurrence of non-value-added activity by increasing capability to uncover the modes of waste. Initial endeavour to implement a leaner operation is introduced by Taiichi Ohno by presenting the Toyota Production System that introduces the concept of Seven Waste. Although the use of the Seven waste mode of Ohno is becoming versatile in its application, it is only covering waste during in process (in process type waste) and excluding other types of waste such as human and environmental -related waste. In addition, the applicability of the Seven Waste of Ohno model is limited to manufacturing oriented waste only and at a companywide setting. Motivated by this opportunity, the goal of this paper is to propose an improved model for waste typology for a leaner operation by using survey to the recent references discussing on waste classifications. The structure of the paper is in the followings, in section 2, overview and typology of waste is presented and followed with survey to recent references discussing on waste categorizations. Section 3 relates to the proposal

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on improvement of the waste taxonomy with inclusion on additional waste not covered by Ohno [2], and Simboli et al. [3]. Discussions on the taxonomy of the improved waste classification waste model and its implication is provided in section 4. Conclusions and new research opportunities for further investigation are presented in section 5.

2. Waste in Lean Philosophy- Overview and Typology

As the name imply, waste is defined as anything that do not provide value to customer. The existence of waste may lead to the increasing increasing the cost and time to the customers pertaining to their demands/goals/objectives. In a production context, there are three kinds of value related activities implemented. The first is Value Added (VA) activity concerning on transforming product and services to customer. The second one is the Necessary Non-value-added activity (NNVA) relates to the wasteful unavoidable activity. The third is a Non-Value-Added activity, a kind of activity that truly waste and should be eliminated [4] at the earliest. Depending on its industry types, the modes of waste may vary from industry to industry. The modes of waste in manufacturing may slightly differ on the modes of waste in a product development stages. In similar situation, in the service industrial settings, the original seven waste modes of Ohno that strongly correlated with manufacturing types can't be transferred directly into service settings due to the characteristics of service. The existence of waste causing system unable to achieve its operational excellence, thus the root cause of waste must be identified and alleviated.

3. Lean Waste Identification and Classification Progress

Becoming the driver to the resource consumption, the occurrence of waste is negatively contributing to sustainability. The waste creating many negative consequences such as productivity and profit losses, customers' dissatisfactions, threatening human life and so on. Originally coming from the birth of the Toyota Production System in 1980s by the introduction of the Seven waste; the classification and the mode(s) of the waste is continually evolving considering the versatility of the application of Toyota Production System or Lean Operation System in various sectors such as service, product development and software development and at both of companywide and supply chain level. Historically introduced by Taichi Ohno in 1980s, there are 7 kinds of waste; Overproduction, Waiting, Unnecessary transport, Incorrect Processing, and Defects. As the time elapsed since its application, due to versatility of application in non-manufacturing settings the original Seven waste of Ohno is insufficient to cope with waste elimination efforts. For example, the seven-original waste of Ohno are unable to capture the occurrence of waste due to behavioural and environmental issues. In addition, time dimension related to waste occurred in communication is not included in the Ohno Model. Therefore, the modes or categories of waste may be expanded to cope with other type of waste escaped from the coverage of the Ohno classification model. The modes of waste are then increased by various scholars by adding the additional waste concerning to the environmental, behavioural and communicational waste. Considering on the new views on waste determination for a leaner operation, the classification of the new modes of waste is then given as in Table 1.

Table 1. Classification of the new modes of waste adding to the Ohno Model.

No	Waste Mode	References	Waste Applicability Setting
1	Overproduction		
2	Waiting		
3	Unnecessary Transport		
4	Incorrect Processing	[5][2][6]	
5	Excess Inventory		Companywide
6	Unnecessary Movement		
7	Defect		
8	Unused people creativity		
9	Environmental Waste	[7][8]	

No	Waste Mode	References	Waste Applicability Setting
10	Behavioral Waste	[9][10]	
11	Failure Demand, Flow Demand, Flow Excess, Flawed Flow	[11]	
11	Outdated Information, Centralized Decision Making, Over specification, Lack of Customer Involvement, Inappropriate assumption	[12]	
12	Avoiding Decision Making, Information Distortion, Limited Information Access, Information Uncertainty	[13]	Companywide
13	Lack of stakeholders' involvement, Lack of Shared Understanding, restricted information access, Scattered Information	[14]	
14	Digital Waste, duplicating efforts, overdesigning, Excessive Overhead, Poor Planning, Poor Measurement, Poor Coordination	[15]	Supply Chain

According to the additional waste classification model as depicted in Table 1, based on defining waste as non-value adding activity, the Seven Waste model of Ohno is added by considering environmental impact [3]. Woscheke et al. [10] and Hick [11] add the additional waste "behavioural waste" concerning to the absence of the waste category dealing with human behavioural characteristics causing the occurrence of non-value-added activity. Considering the application of lean principle in information and communication sectors, several references expanding the waste categories including on communication and information waste [11][12][13][14]. Using waste categorization using application setting as basis, Su [15] provides category of waste under supply chain context.

4. Observations and Implications of the Progress of Waste Categorization Models

Since introduced in the last two decades, the concept of waste as non-value adding activity has been used as foundation of study and practices in alleviating waste toward a leaner operation. However, a critical evaluation of waste concept as introduced by Thurer et al. [16] argues that foundation on defining waste as non-value-added activity is reducing visibility to waste differentiation since according to their study, there is a kind of waste that can't be eliminate without creating additional waste. In their waste classification model, the concept of Buffer Waste is proposed. In an attempt to improve definition of waste toward universally acceptable and consistent definition of waste, Lean Waste then redefined as "Any system input (transformed resources, transforming resources) that is not transformed into a system output that is valued by customers (fulfilled customer demand, this is neither unfulfilled nor exceeded) just-in-time". Following this definition, the new classification of Waste is proposed. Those are Waste type I related to the type of waste that can be eliminated without creating another waste, and waste type II, another kind of waste that can't be eliminate without creating another waste. Waste type I is called Obvious Waste and Waste type II is named as Buffer Waste. By using this new waste categorization model, typology of new waste dimension is introduced extending to the structural model of the Shingo Waste Classification Model. Apart of their work, in relation of findings of Thurer et al. [16], we observe that the categorization of waste of both of Ohno [2] and Thurer et al. [16] models overlooked on human behavioural dimensional aspect in waste classification and locus of waste occurrence settings whether a certain waste is occurred during in process stage or out of process stage. This new waste categorical dimensions are added considering to

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the situation that a particular product or service causing the occurrence of non-value-added events consuming extra amount of resources when used or consumed. Accordingly, the improved waste classification model is then displayed as in Table 2.

Table 2. An improved waste classification model (source own research).

No	Dimensional Basis of Waste Category	Waste typology
1	Process Basis	Over processing, Transportation, inventory, quality defects
2	Waste Typology	Obvious, Buffer
3	Operational Basis	Overproduction, waiting, unnecessary motion
4	Behavioural Basis	Negative Behavioural Waste
5	Locus of Waste Occurrence	In process waste and out of process waste

The improved waste classification of waste as proposed in Table 2 implies that current methodology for evaluating, accessing critically of waste using modification of the risk appraisal tool, the FMEA (Failure Mode and Effect Analysis) must be revisited again toward becoming an effective and efficient waste criticality assessment and mitigation tools. Considering the locus of the waste occurrence that can be out of process implies on our thinking for not only considering on environmental but also societal impact of the wastage during product and or service usage in the form of *loss to society*; a term borrowed from Taguchi Robust Design philosophy. In addition, the existence of method to measure criticality of behavioural waste for a more holistic waste criticality assessment is becoming imperative. Linked with endeavour to improve performance by eliminating waste, there is also becoming important to develop a kind of waste -based performance measurement tool using available performance measurement tool such as Balance Scorecard and Performance Scorecard.

5. Conclusions

Preventing and mitigation adverse effect of the occurrence of lean waste is one of the pre-request for realizing sustainable operation. The existence of waste is disadvantageous since it is causing negative consequences to the organizations. In this paper, a survey to recent studies of waste categorization based on value adding concept is presented, and followed by critical evaluation. Based on survey to previous waste classification category and modes, our views suggest to the need on improving waste classification model using behavioural dimension and locus of waste occurrence. In our proposal, additional waste dimensions are proposed and followed by implications on developing improved tools and methodology considering characteristics of waste for waste alleviation. Opportunities are existing demanding for future investigations. For example, establishment of complex Failure Mode and Effect analysis (FMEA) model considering interrelationship among obvious and buffer waste extending the work of previous studies [17][18][19] are still unknown in literature. Furthermore, development of a metric as means to measure a composite risk impact model which consider operational, behavioural, environmental and societal losses as surrogate of the Risk Priority Number (RPN) in conventional FMEA is vacant in references. Another opportunity is concerning to the development of lean waste risk-based performance evaluation tool in compliment with the work of [20].

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