MUDA IN THE TELECOMMUNICATION AND INFORMATION INFRASTRUCTURE OF THE SMART GRID

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ABSTRACT

When a company implements a decision that does not create value for customers, its expenditure is a waste of resources. Waste can reduce the profitability of every business, thus power distribution companies should detect waste in their activities. When a company constructs the telecommunication and information infra structure of the smart grid or even a simple remote metering system, there is a chance to pay for waste instead of value. In current paper, we will introduce the lean methodology to find the cause of this waste. In addition, the impacts of waste on power distribution business profitability will be discussed.

INTRODUCTION

Customers are not willing to pay for expenditure of resources which does not create value for them. Therefore, this expenditure is a waste. Lean approach maximizes the customers' value while minimizes the waste, so that it is an effective way to increase business profitability. The ultimate objective of lean approach is implementation of perfect value-creating process for customers with zero waste. The Japanese word "muda", which means futility, is used for some types of waste in lean methodology. Overproduction, waiting, transporting, over processing, unnecessary inventory, excess motion, defects and underutilization of employees are eight types of muda which can be found in any business. Lean approach is primarily developed for manufacturing processes and many researchers have used this approach for enhancing manufacturing processes and supply chain management [1]-[5]. However, it is possible to use lean thinking for non-industrial applications. McDonald has explained how lean methods can be used for solving IT (Information Technology) problems [6]. Lean thinking has been used to improve smart grid performance. EnerNOC Inc and Virginia tech research group have started a project to monitor energy usage data and analyzing trends in this data to identify waste in manufacturing energy consumption [7].

Power loss is the most obvious type of waste in power distribution but waste is not limited to it. Especially, there are many sources of waste in smart grid which cannot be detected without scrutiny. In this paper we will focus on telecommunication and information infrastructures. over-processing, Collecting unnecessary data, communication protocol mismatch and decision delay are a few examples of waste in this field. For each waste, engineering teams should find an effective approach to eliminate or reduce its effect on profitability.

WASTE CLASSIFICATION

Waste, which is called muda, can be found in most businesses. Muda can be categorized into seven plus one classes:

1.Over-production

In manufacturing processes, Over-production happens when products are produced before customers' requests or more than current demands. Over-production is not limited to manufacturing. When data is processed before it is needed, there is a risk of over-production, especially if data changes over the time. This muda can generate another muda, the excessive inventory. In addition, it can hide another muda, thus over-production is called the trickiest muda.

2. Excessive Inventory

Inventory muda occurs when we collect more materials or information than required. Inventory muda increase the storage space requirements. In addition, excessive inventory may cause obsolescence.

3. Waiting or Delay

Delay muda happens when customers, employees or other processes await the current activity to complete. The waste of waiting can disrupt value stream. Thus it is a very serious waste in any businesses.

4.Transportation

When a material, a product or data is transferred, there is a risk of being damaged, lost or delayed. In addition transportation does not add value to products or services. Therefore, when transportation is unnecessary, it is considered a kind of waste.

5.Over-Processing

Over-processing happens when more work is done on a material or data than required. Extra inspection, generating unusable reports, Re-entering data in multiple information systems and excessive precision in measurement or action are example of this waste.

6.Motion

In manufacturing processes, movement of machine parts and employees should be minimized and without an

unnecessary effort. Generally, any unnecessary mental or physical motion which does not add value is considered waste such as searching for information.

7.Defect

Defect is the most obvious type of muda. Errors, mistakes and all conditions which are not compatible with standards or requirements are defects. Data entry errors and incorrect data gathering are examples of defect muda.

8. Underutilized human potential

Some researchers have added latent skills to seven famous form of muda. Although companies employ their staff for predefined jobs which require special skills, they have other abilities which can be used to improve business activities. When managers do not activate employees' dormant skills, they waste these resources.

PRINCIPLES OF LEAN

The core idea of lean is maximizing value while minimizing waste. By using lean approach, it is possible to create more value for customers and reduce resources consumption [8]. Lean implementation consists of five essential parts:

Identifying customers' value:

The first part of lean approach is defining services and products value from the customer perspective. Other activities which neither add value nor support value generation can be removed. In many cases only a low percentage of activities actually add value to customers.

Identifying value stream:

Business activities are linked together to deliver value to end users. Once managers understand the value stream which flow in this chain, it is possible to detect the waste.

Eliminating waste:

Waste Elimination helps companies to allocate all resources to value adding activities and to root out undesirable delays and interruptions.

limiting activities to what is pulled by the customers :

Company managers should limit company's activities to those that satisfy customers' requirements.

Pursue perfection:

When the most visible layers of waste are detected and removed by process reengineering, more layers of waste become visible. Therefore, waste removal should be an endless activity. The ultimate goal of this approach is developing a perfect value creation stream that has zero waste.

MUDA IN SMART GRID

Understanding what waste is and where it can be found are crucially important for applying lean approach in designing and utilization of a smart grid. As mentioned before, the first step in lean approach implementation is identifying customers' value. Customers' basic requirements can be worded in three sentences:

1- Customers need electricity with guaranteed quality. Therefore frequency fluctuation, variations in the voltage level and harmonic level should be controlled.

2- Customers need continuity of service. It is important to minimize supply number and duration of interruption.

3- Customers need to be informed how much energy they have consumed and how much money they should pay. This information should be accurate and up to date.

Furthermore, power distribution companies should have access to following information to maintain services and increase profitability:

1- Theft of electricity and power losses in all section of distribution network.

2- Level of energy which is bought from power plants.

3- Power factor and reactive power

3- The history of service interruption including place of failure and cause of it.

4- Condition of street lamps and distribution network components

5- Payment condition of electricity bills and subscriptions.

In the next step, value stream should be identified. Figure 1 represents parts of simplified value stream related to electricity bills. Two types of waste can be found in this process:

1- All data which is collected by remote metering is not used and will be deleted after predefined time period. to eliminate this muda we should reconsider data collecting and processing procedures. If it is possible to use this data to improve billing activity effectiveness and efficiency, it should be used, otherwise; this data should not be collected at all. Sometimes, engineers ignore this waste because only a few customers are connected to remote metering system and capacity of IT infrastructure is more than enough, but in future the number of remote meters will be increased radically and the tendency to follow established methods will lead to extra investment in high capacity storage units, high speed communication systems and powerful servers. Installation and maintenance of these facilities cost distribution companies thousands of dollars, but does not add value.

2- If company staff are sent to read meters instead of remote metering, the risk of human error is not ignorable. When either company send a person for reading that meter again or generate incorrect bill, the result is muda.

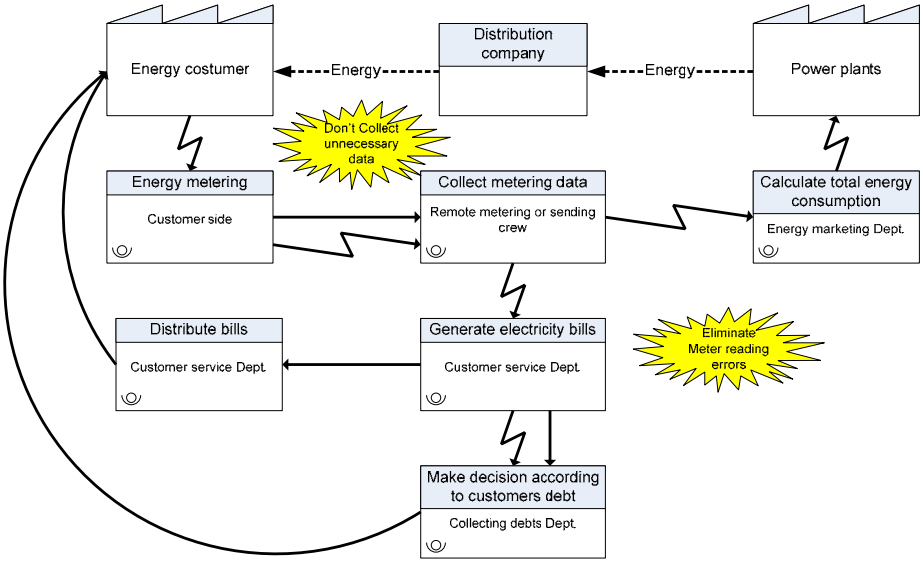

Figure 1: simplified value stream related to electricity bills

Elimination of waste in the smart grid can be done through the implementation of Lean methodology, but identifying and removing the waste should not be center of attention; on the contrary, it should be the result of focus on value stream, otherwise processes will be improved but customers do not wish their results.
All muda in a smart grid cannot be found and eliminate in single action and by few people. Elimination of waste in an organization should be implemented gradually and through encouraging all personnel to participate in related projects. Especially, after finding waste in a smart grid infrastructure, all staff should help each other to eliminate it as soon as possible.

RESULT

In order to finding waste in a smart grid we have examine many activity related to remote metering, outage management, GIS and other related tasks. Only few features of smart grid have been implemented in Alborz province power distribution company. Therefore, most of waste is based on DFMEA (Design Failure Mode and Effects Analysis) and have not been detected in field examination.
Our study has shown that the most obvious sources of waste in communication and IT infrastructure can be categorized into following classes:
1- Defect: When circumstances are not compatible with standards or costumers' requirements because of errors, mistakes or failure, we call it defect. Three types of defect can be found in smart grid:
1-1: Software defect that happens when a software does not work properly.
1-2: Hardware defect that happens when components of communication, data storage or any part of IT infrastructure do not work correctly.
1-3: People defect occurs when a person tries to accomplish a task without enough skills, understanding or authority to handle it properly [6].
For example, defect muda happens when decision support system, remote devices or data gathering system do not work properly because of software bugs, failure of communication components or data mismatching.
This muda is the most important waste in the smart grid that can lead to inspection and debugging costs. In addition, if field technicians are dispatched for manual operations instead of normal automated operations, excess motion muda and safety costs are added to total waste.
2- Waiting: Waiting wastes time and energy of organization staff. When each critical procedure is inactive because of communication, data gathering or data processing delay, waiting muda occurs. Nowadays, waiting muda is decreasing due to modern and high speed communication and processing systems which are available for commercial usage.
3- Over-processing or over-quality muda: When estimation is enough for practical decision making but we decide to process a lot of data for unnecessary accuracy, this muda takes place. For example, it can happen in distribution network restoration after local black out. There are many time consuming mathematic methods for optimal network restoration. Using these methods instead of fast heuristic approaches, which lead to very good solution without cumbersome calculation, may cause over-processing muda.
4- Over-production: When a distribution company uses expensive and sophisticated software or communication systems where simpler systems would be sufficient, over-production muda happens. Generating report with excessive details, which is not used by customers and staff are another example of this type of muda.
5- Excessive Inventory: unnecessary redundant database is one of the obvious aspects of this muda. Distribution companies are using many isolated software for geographical information system (GIS), outage management, automatic remote metering and billing applications. Each software has its own database that should be kept up to date. If a company use these separated databases instead of an integrated one, data

mismatch and defect muda will be inevitable. Another aspect of excessive inventory is purchasing and installing communication and network components that can be used in the future. Nowadays new devices with lower price and higher performance are introduced regularly and old unused devices will be obsoleted in a few years.

6- Transportation: Data transfer in information technology media does not need trucks, but it is not absolutely free. Installation and maintenance of this media is rather expensive. In addition, data can be damaged and communication links can be out of service. Thus it is vital to minimize unnecessary data transfer in the network.

Figure 2 represents cause and effect diagram of waste in a smart grid. There are a lot of secondary causes that have been omitted because of diagram simplification.

CONCLUSION

Waste in communication and IT infrastructure can reduce the efficiency and effectiveness of smart grid. Usage lean methodology not only helps distribution companies to eliminate the waste but also highlights the value stream in activity of companies. Although we have not implemented lean approach in a smart grid, we hope that using this approach may help us to design a more efficient smart grid.

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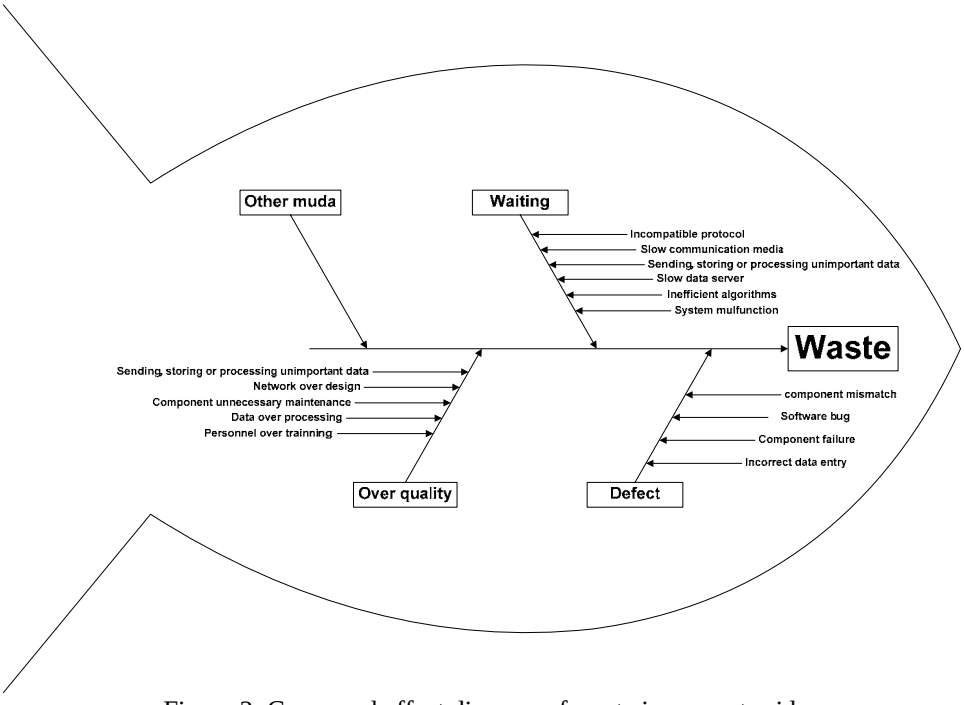

Figure 2: Cause and effect diagram of waste in a smart grid