Analysing the potential effect of selected lean practices on performance in a service department of a tertiary institution

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It all starts here ™

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ABSTRACT

The service environment is not always the typical controllable environment that is desired by the business sector. Service is seen as the process that is normally at the end of the typical value chain which adds little value to an organisation. This is, however, not the case where service is the primary organisational objective or primary value proposition.

How many times have we heard that a good product is badmouthed only due to poor service delivery? We also see service as an unnecessary monetary burden because we feel that the product should care for itself after it has been obtained.

The question is whether service and service delivery can be optimized especially by using the same phenomenon called "*lean*" that has helped many production companies to obtain that edge needed for a superior competitive advantage?

This study tests the possible application of production *lean* principles to the service environment. The study also makes use of the *Value Stream Map (VSM)* to identify *wastes* and the effect of these *wastes* on the normal day to day operations of the service department mentioned in the case study.

Typical *lean* elimination tools such as *total quality management, 5S methodology* and others are also used in the case study and the possibility of applying these tools to the service environment is also discussed.

In the service environment resources are sometimes either not applied *efficiently* enough or service is not rendered *effectively* according to customer requirements. These tools can enable the service environment to optimise productiveness by removing *wastes* from the input (*efficiency*) and optimising output (*effectiveness*)

KEYWORDS: Service improvement; productivity, Value Stream Mapping; Service industry, Just in Time (JIT); *effectiveness*; *efficiency*; inventory, Service management

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LIST OF ABBREVIATIONS AND MEANINGS

JIT- Just in time

Kaizen- On-going improvement

Kanban-Pull system used to control inventories on demand

NVABN-Non value added but necessary

NVA - Non-value adding

TPM -Total preventative maintenance

TPS - Toyota Production System

TQM –Total quality management

VA - Value added

VSM Value Stream Mapping

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

The concept of *lean* production, which was later expanded to *lean* processes in a wider sense, originated in the Toyota production factory. It is in this factory that methods such as Just in Time (JIT), cellular manufacturing, Total Preventative Maintenance, single-minute exchange of dies and production smoothing had its roots and origin (Rahani & al-Ashraf, 2012:1727).

Kiichiro Toyoda, president of the Toyota Motor Company, recognized the need for improvement to compete with the Western automotive manufacturing companies and with the help of Shigeo Shingo, and Taiichi Ohno developed a system which has since been called the "Toyota Production System " or "*lean* manufacturing" (Abdulmalek & Rajgopal, 2007:224).

Lean practises are seen as the solution to a better, faster and more effective way of structuring value streams and supply chains. It is also suggested as an effective way to optimize operations. The practice of *Lean* operations means cutting operations to the bone as a way of optimization. In this study the aim is to test whether this method of optimization is applicable to service delivery and to investigate whether this method would be applicable to more unstructured environments such as the rendering of maintenance services. *Lean* manufacturing has generally been implemented in the manufacturing environment and there exists little evidence of the success of this application in the service industry. In a service environment, stakeholder satisfaction is not regarded as a final product, but success is rather defined in terms of a mix of elements, including time, costs, experience, *efficiency*, *effectiveness* and expected results.

Lean operation makes use of various tools to identify opportunities to capitalise on increased optimisation. Value Stream Mapping (VSM) has emerged as a popular tool to support and implement the *Lean* approach (Grewal, 2008:404).

1.2 LITERATURE REVIEW

The increasingly fierce competition in the market place has driven companies to continuously optimize and improve operations by means of doing things better, cheaper and faster (Pan *et al.*, 2010:733). Excessive cost is seen by Stevenson and Hojati (2007:110) as a big "waste". In*efficiency* is one of the major drivers of excessive cost.

Highly efficient production processes have become a necessity for manufacturing companies (Pan *et al.* (2010:733) but *efficiency* is also crucial in the service environment. By being efficient, companies can do more work with fewer resources. Fewer resources could improve their competitive advantage or increase earnings. The cost benefit of improved *efficiency* is one of the major drivers in turn-around strategies.

The effective management of *Lean* operations is captured with an activity called Value Stream Mapping (Seth & Gupta, 2005:45) .Abdulmalek and Rajgopal (2007:225) state that this approach is used to eliminate any unwanted processes or *wastes* that add no value and take steps to eliminate these *wastes*.

Again Abdulmalek and Rajgopal (2007:225) argue that Value Stream Mapping (VSM) is a valuable tool being used to identify the opportunities for various waste elimination interventions. Value Stream Mapping (VSM) has been used in the process and/or production environment for quite some time but little evidence exists about the application in a service sector where productivity, performance and customer satisfaction is contributing factors that determine the success of service delivery. VSM is a tool created by the *Lean* production movement for re-designing the productive systems (Lasa *et al.*, 2008:40). An example of successful application of VSM is described by Abdulmalek and Rajgopal (2007:236) as a practical illustration of the benefits of *Lean* principles. One of the many spin-offs of the *Lean* movement is that more "green" use of resources could also be achieved through *Lean* interventions, on top of the saving that it was originally designed for (Rothenberg *et al.*, 2001:229).

Lean management also dovetails well with total quality management initiatives, since reduced variation in the process would lead to a saving of resources (Arnheiter & Maleyeff, 2005:10).

Cox and Chicksand (2005:661), however, show the other side of the coin and argue that *Lean* management may not be applied equally successfully in all industries, especially service industries with supply chains.

1.3 SEVEN *WASTES* THAT ADD NO VALUE

The seven *wastes*, as documented by Hines and Rich (1997:47) are:

(1) Overproduction; (2) Waiting; (3) Transport; (4) Inappropriate processing; (5) Unnecessary inventory; (6) Unnecessary motion and (7) Defects.

Hines and Rich (1997:49) later renamed them as:

(1) Faster-than-necessary pace; (2) Waiting; (3) Conveyance; (4) Processing; (5) Excess stock; (6) Unnecessary motion; and (7) Correction of mistakes

There are **also seven Value Stream Mapping tools** suggested by Hines and Rich (1997:50):

(1) Process activity mapping, (2) Supply chain response matrix, (3) Production variety funnel,(4) Quality filter mapping, (5) Demand amplification mapping,(6) Decision point analysis, (7) Physical structure mapping

These tools will enable the owner to identify and illuminate *wastes* in the supply chain or value stream.

Lean Procurement is also acknowledged as another *Lean* tool in the supply chain and is seen as automation of the current manual processes. *Lean* procurement can be achieved by adopting a e-procurement policy (Jacobs & Chase 2014:349).

1.4 SEVEN *LEAN* IMPLEMENTATION TOOLS

Seven common *Lean* tools are suggested to be used in order to reach optimal production or processes (Abdulmalek & Rajgopal, 2007:224)

- Cellular production: Organize all similar processes together in one cell.
- Just in Time (JIT): Manufacturing or action is done on the pull demand from the customer.
- Kanban's: Signalling system used to enable JIT
- Total preventative maintenance (TPM): Routine work is done to prevent faults, and it is done to prevent downtime that can cause value stream errors
- Set-up time reduction: This is the time taken to prepare a machine for a specific action.
- Total quality management (TQM): Quality will improve the product but also the system. VSM can be seen as a method to increase quality.
- 5S methodology: Standard procedures and effective workplace organization. Work flow can be improved by organizing the workplace into a more practical and logical order.

According to Jacobs and Chase (2014: 347) *Lean* production focuses on removing as much waste as possible.

1.5 STEPS TO OPTIMIZE SYSTEMS AND TO ENABLE *LEAN* PRACTICES

There are three steps, according to Abdulmalek and Rajgopal (2007:225), to embark on *Lean* manufacturing (LM).

1. Step1 entails mapping the current processes by writing down every single operational step from the start of the production or service cycle up to the delivery of the product or service. This mapping should be plotted on a block dia-

gram to ensure clear times and detailed processes. This process should also include processes and/or functions that do not add value to the service or production.

2. Step 2 entails the mapping of how the new process would look after all *wastes* and non-value added (NVA) activities have been eliminated. These *wastes* could be the supply chain, inventory or any other non-value added activity. By removing these *wastes* the division or company could experience financial improvements, improved times and an increase in their competitive advantage.

3. The third and last step is to document steps that will eliminate or streamline these activities. This step also guides the implementation and monitoring of the entire process.

Rother and Shook (2003:6) added to these steps by suggesting that step 1 is preceded by the selection of one "family" and ended off by achieving *Lean*. The selection of this family entails selecting a" family" or division from an entire organization or in the case of this study a section within a department that needs optimisation.

Value Stream Mapping (VSM) is, however, seen by Abdulmalek and Rajgopal (2007:225) as mainly a "pencil and paper exercise" used to plot the processes. This exercise will identify sources of *wastes* and non-productive processes and in turn help to identify the appropriate *Lean* tools or processes needed to eliminate these *wastes* and to ensure *lean*er operations.

1.6 MOTIVATION OF TOPIC.

Numerous studies on the topic of *Lean* have been done and major successes with the approach have been documented. Many people see implementation of *Lean* as a total enterprise solution that cannot be implemented on departmental level, in a small business or in a single service department. The study will be done on a small department and the value of this VSM application on this small department will be tested.

1.7 PROBLEM STATEMENT

Studies on *efficiency* and *effectiveness* by Palmateer (2006:21) have supported the use of *Lean* management to increase productivity/performance. An entire or partial values stream (a family) can be analysed to investigate the presence of *wastes* within these value streams. One of several tools that could be used in this kind of analysis is Value Stream Mapping (VSM). The theory of *Lean* management and *Lean* production rests on the principle of identifying certain predictable *wastes*. Interventions to eliminate these *wastes* are undertaken to indirectly generate financial or quality benefits to the organisation to enable the organisation to gain a competitive advantage.

Pan *et al.* (2010:733) have shown that Value Stream Mapping (VSM) has proved to be a useful and easy technique to "shorten delivery times and reduce production costs".

These studies all focus on production, reduction in production *wastes* and shortening delivery times. Bowen and Youngdahl (1998:207) argue that the service operations environment continues to "advance" progressively by transferring manufacturing logic. This was in 1998 and we need test if this is still the case. Piercy and Rich (2009:57) support Bowen and Youngdahl (1998:207) and state that "several aspects of the *Lean* approach are becoming validated in the pure service environment".

Less emphasis is, however, placed on the softer issues and less prominent but rather important outcomes described as stakeholder satisfaction. Service industries rely a lot more on the human factor to present a service and are this human factor a big part of the client experience. More emphasis has lately been put on employee satisfaction, client satisfaction and indirectly also financial satisfaction. As previously mentioned the rendering of service is a mix of several aspects which all have to be present and fulfilled, to claim stakeholder and client satisfaction.

This study then also puts emphasis on the effect of *Lean* techniques on the outcome on satisfaction of the actual service and performance.

Recent changes in an existing service department of the NWU Potchefstroom Campus have offered itself to explore *Lean* and specifically waste identification. A budget increase of almost 380% and no additional staff mean that they should do things more efficiently and effectively. This department was previously responsible for all electronic projects and maintenance on Campus and Campus electrical maintenance has been added to the existing department as from 1/1/2014.

This single case, case study will be performed on the electronic repair and maintenance section of this department as budget constraints are a high risk for sustainable and good service delivery. This department has had a constant increase in their scope of repairs and services without the budget to support it accordingly.

Åhlström and Karlsson (1996:54) have acknowledged that changes will take place after *Lean* principles have been applied and need to be addressed with a managed change programme.

Other results may also include a change in management by process procedure. This is needed to obtain the pursuit of excellence (De Toni & Tonchia, 1996:121).

1.8 OBJECTIVES

The research objectives are divided into a general objective and specific objectives.

1.8.1 General objectives

Lean practices as well as lean management were born in the production environment but *wastes* are not restricted to the production environment and are just as much present in the service environment. The objective is to determine whether these production optimisation principles called *Lean* or waste identification and elimination can be applied to the service industry with reasonable success. If these applications can successfully be applied recommendations about possible solutions can also be made with the same waste elimination tools that are applied to the production environment

1.8.2 Specific objectives

- Determine the applicability of *Lean* tools and practices to the service environment.

- Determine the *wastes* present in a service environment.
- Determine whether Value Stream Mapping (VSM) can identify the areas of *wastes*.
- Determine whether *Lean* elimination tools can provide positive recommendations to the service environment

1.9 RESEARCH HYPOTHESES

A qualitative approach will assist the research to identify areas where there are issues or even perceptions of problems and *wastes* within this case study.

Discussions and interviews have been done to determine the presence and levels of frustration. These frustrations may be due to *wastes* and could cause less *efficiency* and *effectiveness* which in turn will have an effect on service delivery and production and performance.

The hypotheses tested the status quo of performance versus the potential effect on performance after suggested solutions.

1.10 HYPOTHESES

H_0: The proposed *Lean* procedures will have no significant impact on the levels of productivity and performance.

H_1: The proposed *Lean* procedures have a potential impact on the levels of productivity and performance.

1.11 RESEARCH DESIGN/METHOD

1.11.1 Design

A qualitative research case study approach was followed (Welman *et al.*, 2005:193) .

A single case, case study was used for data collection. This case consisted of a single repair and maintenance section within a service department. Data with respect to actual faults repaired by this section was used and a Value Stream Map of this operation drawn and investigated. Interviews with the staff and manager of this section

also provided their views on possible issues as well as the *wastes* that accompany their views. Wastes were identified according to the criteria set out in the theory. Correlation between these data-acquisition methods provided common issues present in the current system. Recommendations are made on possible methods to reduce or eliminate these *wastes*.

1.11.2 Method

The case study was taken from a single repair and maintenance section of this department and used as a sample for the case study. Data was collected by means of interviews with the sectional manager, field notes from interviews with the technicians and primary data from the current reporting system.

The acquired data from each of these data sources was well-documented, Wastes were identified from this data and categorised according to the perceptions of the manager, technical staff and the Value Stream Map.

The Value Stream Map displayed a typical day in the life of a technician. This value stream was then investigated for operational *wastes*. Each individual fault dealt with within this specific day was also investigated to determine *wastes* within the process of handling each and every fault.

These different *wastes* were compared to determine what *wastes present* a pattern. Suggestions are given as to how these *wastes* can be eliminated or minimized.

1.12 LITERATURE REVIEW

Keywords: *Lean*, total quality management, service, *Lean* tools, performance.

Sources: Internet, books, journals, Magazines, interviews

1.13 EMPIRICAL RESEARCH

1.13.1 Research participants

The entire repair and maintenance section participated in this study. The manager and technical team assisted in the study by taking part in group and individual discussions.

Both these groups gave their view as to how they see the current process and what they see as possible obstacles that limit a more effective and efficient department. These views were taken down as informal notes and documented.

1.13.2 Limitations

Availability of limited statistical data and the detail of this data could limit the outcomes of this study. Other limitations such as honest feedback from participants while doing interviews could also limit the study in terms of general and generic data. This data specifically targeted waste issues and the technical staff might well specifically fear the effect and result of their honest opinions.

The time limitation also put stress on in-depth data analysis and could also prove to be vital when conclusions are drawn and suggestions made.

1.13.3 Outcomes and success

The outcomes of this study are purely theoretical and will only deal with the personal views of the participants. This study identified certain *wastes* with the use of *Lean* identification tools. Suggestions of possible solutions to eliminate these *wastes* are to be made to the manager and staff. Their feedback will be used to assess the possibilities of introducing the suggestions and the potential success of these interventions.

1.13.4 Measuring instrument

Possible solutions to eliminate or reduce the given *wastes* are suggested in this paper and the solutions will also be given to the manager and staff.

The manager and staff will review these solutions and provide feedback on the potential outcomes of these solutions. This feedback will also provide the study with answers about the legitimacy of the *wastes* identified and effect on this section.

1.13.5 Research procedure

This research was done by collecting data from several sources. The sources were technical personnel, the section manager and data from an actual working day.

Wastes were identified after notes had been taken from interviews with the different personnel. A Value Stream Map was also drawn from data of errors made by the technicians.

These *wastes* were compared to determine which *wastes* are prominent in all the scenarios. After these *wastes* had been identified suggestions were to be made to address these *wastes* .These suggestions were given to the manager and staff to investigate and give feedback on the possible success of implementing the suggestions as well as the possibility of implementing it.

1.14 OVERVIEW

Chapter 1:

This chapter consists of the introduction, problem statement and description of key concepts. An explanation of the research objective and limitations of the study, hypotheses and a description of the research method are also being included in this chapter.

Chapter 2:

Literature review. This chapter gives a complete overview of the relevant literature. This includes the background of the principle of *Lean* management and tools such as Value Stream Map (VSM). Previous interventions are discussed and outcomes from these *Lean* management applications noted. Several other *Lean* management tools are discussed as well as the several *wastes* that need to be eliminated in the *Lean*

management process. The process of applying *Lean* principles, tools, methods and steps is discussed in detail.

Chapter 3:

Empirical research. In this chapter information with regard to the present and desired future state is laid out. Wastes are highlighted from the current state data. The areas where intervention could be applied have also been determined and suggestions made. The manager and relevant staff evaluated the suggestions and gave their feedback. This feedback will test of the possibilities of intervention implementation and possible outcomes.

Chapter 4:

The last chapter includes findings, conclusions and recommendations. After this discussion findings were made and conclusions with regard to the possible outcomes that could determine the success of the study. The study will be evaluated and final conclusions made. Depending on the results and finding recommendations could be made with regard to the principle of *Lean* management, the tools used and the effect on departmental operations.

1.15 CHAPTER CONCLUSION

We come to the conclusion that *wastes* are arguably a big factor to reckon with when it comes to production lines and optimisation of the production value stream. There are tools available that can help identify and eliminate these *wastes* and streamline the production chain.

The fact that these production tools can and should be applied to the service industry is argued for and against and the application should be made to the industry be tested and benchmarked if possible

2 CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter contains a search for theoretical evidence on terms like *Lean*, *wastes*, *efficiency*, *effectiveness* and productivity/performance. Links between these terms are drawn by proof from the theory and the possible effect on one another. Research on the theory in respect of the *wastes* presented the methods/tools available to identify these *wastes* and waste elimination tools available and provide a guideline for the further empirical study.

Value chain optimisation creates an opportunity for improved productivity and performance. This optimisation is seen as the increasingly near perfect balance between the input and output in this value chain. The search is thus on for methods and tools to eliminate *wastes* in both the input and output corners of this value chain. The optimisation in the link between *efficiency* (input) and *effectiveness* (output) should make provision for performance success. Therefore companies in the service industry could increase performance and productivity by optimising input and output.

2.2 *LEAN* PRINCIPLES AND THE SERVICE ENVIRONMENT

As early as 1998 Bowen and Youngdahl (1998:207) argued the case that "*Lean* logic" should still be taken from the manufacturing industry and transferred to the service industry .They refer to a very early publication by Levitt (1972) where he already argued that Production principles (in this case *Lean*) can and have been implemented in the service environment with success.

Lean principles had their origin in the manufacturing industry and in specifically the auto motive manufacturing industry. This principle originated in the Toyota production system (TPS) and was introduced by two engineers, Taiichi Ohno and Shigeo Shingo. They introduced the 2 pillars of the TPS called Right on time and automation (Ohno, 1984:135) . In early years the *just in time (JIT)* principle was introduces by this *Lean* concept and is still being used today.

American motor manufacturers produced big batches of completed vehicles from the production line which meant wasted inputs in terms of cars not being sold immediately. In turn money and resources were wasted with a big turnaround time in returns.

2.3 EFFICIENCY

The TPS introduced the principles called “just in time” (JIT) and elimination of “*wastes*”. They adopted the philosophy that was later renamed to the called “pull” Arnheiter and Maleyeff (2005:9) where orders are made on demand from the customers in the downstream of the value chain. This means that cars are manufactured according to order. This pull system was also called the *Kanban* system and was employed to overcome this overproduction or “push” system. Hines and Rich (1997:48) mention “Overproduction” as one of the *wastes* identified in the Toyota production system.

In this “pull” system Toyota could refrain from producing a model, colour, engine type and other features not required by the market and buyers. This overproduction normally resulted from performance systems such as the bonus performance enhancement system which was based on production outputs rather than *efficiency* .These “Push and Pull” systems are also mentioned by Åhlström and Karlsson (1996:45).They see a push system as the result of a detailed schedule being driven by demand forecasts and again it shows possibility of *wastes* in overproduction. In the pull system the inverse is actually happening and is output driven in reverse order. Materials and other resources are only drawn from the “pool” as soon as customer orders are received. Stock and other production items are thus put into the production inventory due to demand and inventory turnover is dramatically shortened. Turnover in inventory is a useful ratio that is used by investors to determine the *efficiency* of the value chain. The term Just in Time (JIT) comes to mind when we talk about inventory and inventory turnover.

This *efficiency* is well-defined by Bruce Tompkins. Bruce is the director of a US based *Lean* solutions company .He is stating that *efficiency* is seen as doing more with the available resources or doing the same with less resources and create *effec-*

tiveness (Tompkins, 2010:5) . He also mentions *wastes* such as access inventory, over-production (mentioned above) unnecessary motion, transportation and waiting. In the case made out by *efficiency* I can argue that *wastes* such as overproduction and excess inventory, to mention but a few, are the inverse of *efficiency*. Åhlström and Karlsson (1996:44) also stipulate the purpose of *Lean* as "to use fewer resources as compared with "traditional" production systems

There could be a case that *efficiency* can be optimized and speed increased to the satisfaction of the customer by eliminating *wastes* by making use of *Lean* principles (Bowen & Youngdahl, 1998:221).

Wall Street measures *efficiency* as the financial performance of organisations in times when demand drops and especially in a recession(Jacobs & Chase 2014:16) If demand drops and companies can still survive or even gain market share it means that these companies have found ways to be more efficient and could survive lower outputs.

2.4 EFFECTIVENESS

This brings us to *effectiveness*. The definition of *effectiveness* (output) states that the output (product or service) should be according to the initial requirements. The Oxford English Dictionary (1998) defines *effectiveness* as "The degree to which something is successful in producing a desired result; Example: success: the *effectiveness* of the treatment"

This indicates that although there is a need to be efficient in the production or service compartment the need for *effectiveness* can and should not be forgotten. The client still needs the service or product as required initially. To be efficient and effective can thus add to the value of the product or service by producing it more cost-effectively and quicker but still of high or even outstanding quality.

Hence a golden thread connecting and running between *effectiveness* and *efficiency* and performance/Productivity is present and must a way be found to optimise this relationship in order to create value and a competitive advantage.

To be effective is not only to achieve better bottom-line results but also to achieve stakeholder satisfaction. The changing world and competitive environment acts as a catalyst for the need to be more efficient. Paige Palmateer (2006:21) indicates other factors that could have an impact on the outcome of the annual financial report. These factors are listed as the inability to raise prices; raising health care costs (pay-roll influencers) globalization and complicated workforce needs. These factors could not only impact on the financial results, but could totally destroy a company and close it down.

2.5 PRODUCTIVITY/PERFORMANCE

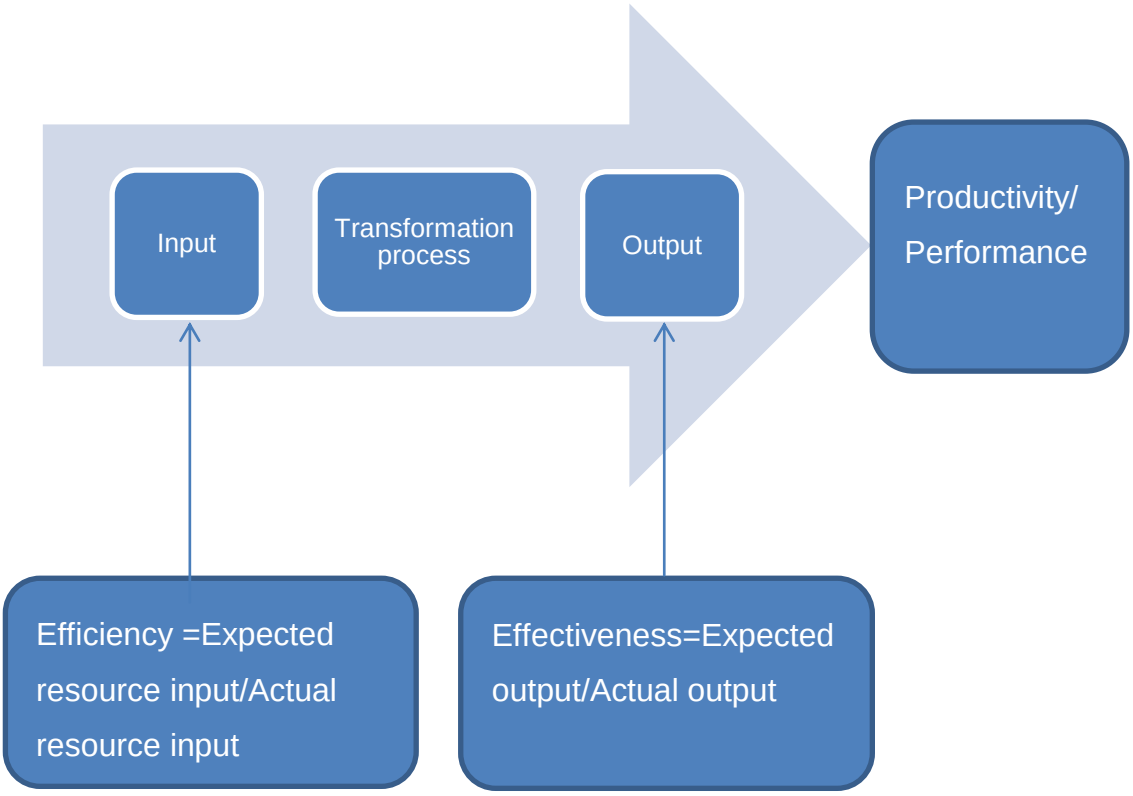

Figure 1: The transformation process (Jacobs & Chase 2014:15)

Productivity/Performance = Output/Input

= Effectiveness / Efficiency

= Value to customer/Cost to produce

= Doing the right things/Doing things right

The figure above indicates the interrelationship between *efficiency*, effectiveness and productivity/performance. The figure also implies that there is a direct relationship among these three variables and an increase in one of these variables requires or results in an increase in the other two variables

It is thus unavoidable to seek for better ways to do things more efficiently in order to stay competitive without compromising *effectiveness* or otherwise deviating from the customer's request .This result is known as productivity/performance and correlates well with the study. To obtain maximum productivity/performance we must maximise either or both *efficiency* and *effectiveness*. Productivity/performance can be explained with the phrases "doing the right things" and "doing things right" and consequently doing the right things right. By performing better than the status quo could not only create an opportunity for growth but also lead to increased stakeholder satisfaction and a better competitive advantage.

Theory suggests the use of *Lean* management tools to obtain optimal *effectiveness* and/or *efficiency*. The above literature has also shown that *efficiency* can be optimised by limiting or even eliminating *wastes*. The conclusion suggests accepting that *Lean* principles can enhance and optimise productivity/performance

2.6 *LEAN* AND SUPPLY CHAIN (INPUT)

Lee *et al.* (2008:975) have made a valid and interesting observation with respect to the overall value chain. They mentioned the bullwhip effect (figure 2 below) as an example of *wastes* such as overproduction. This is seen in the over-estimations of possible needs of products. This bullwhip effect escalates when a supplier at the end of the value chain estimates possible sales wrongly (over-estimates).This would mean that the entire preceding supply chain would over-produce and in the end waste resources on products that would in actual fact not sell. This problem is reduced by a tool called demand amplification mapping. This over-production indicates wasted resources (manpower and money) without the much needed and anticipated returns

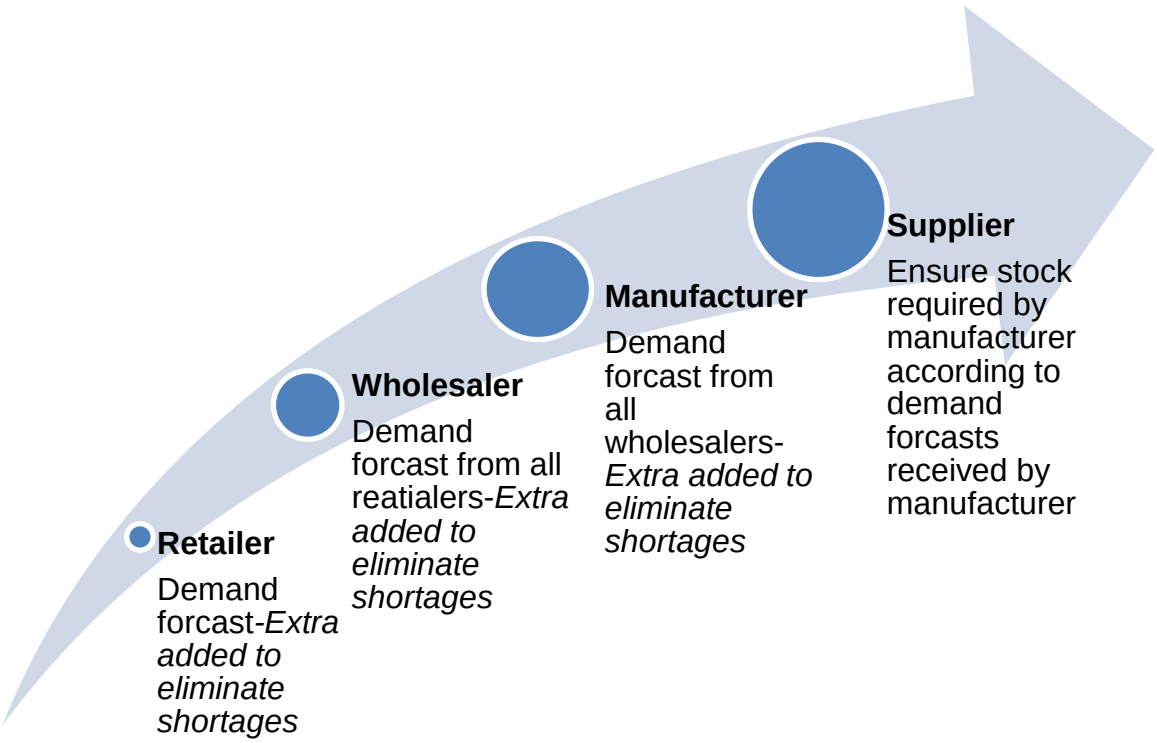

Figure 2: Bullwhip effect caused by overproduction due to an ineffective "pull" system-Demand amplification

This bullwhip effect is a clear result of the "push" function and it clearly illustrates the *wastes* produced employed by such a push system. The negative economic and competitive effect of resources that are not efficiently utilized will also escalate in the same bullwhip fashion as indicated above in figure 2.

2.7 WASTES

So far we have established that *Lean* management, *Lean* production, *Lean* processes and many other *Lean* applications can be applied to increase *efficiency* and *effectiveness*. This in turn can increase productivity, performance, profit, turnaround time, delivery times, improve quality and create value as well as increasing competitive advantage.

These are all buzzwords in the modern industry which can give a company that small edge over its competitors. We have also seen that all these advantages to improve *efficiency* are also directly related to productivity and performance because the service or product is not only meeting customer's requirements (*effectiveness*) but could

even exceed expectations and the end result could be realised even earlier or less expensively.

Research has also established that *wastes* are the main contributor to "non-*Lean*" practises and processes. We have already been introduced to some of these *wastes* but Hines and Rich (1997:47) draw our attention to the *wastes* that are commonly accepted by the Toyota production system (TPC):

(1) **Overproduction** - we have seen this in the Push vs Pull scenario

(2) **Waiting** - under and over-productive efforts in the same system causing delays

(3) **Transport** - all transport is seen as waste and must be minimized

(4) **Inappropriate processing** - complexity and lack of knowledge

(5) **Unnecessary inventory** - due to over-production and lack of planning

(6) **Unnecessary motion –** involvement of the ergonomics of production

(7) **Defects - c**ostly and quality implications which means reproduction

The relationship between *wastes*, *effectiveness* and *efficiency*:

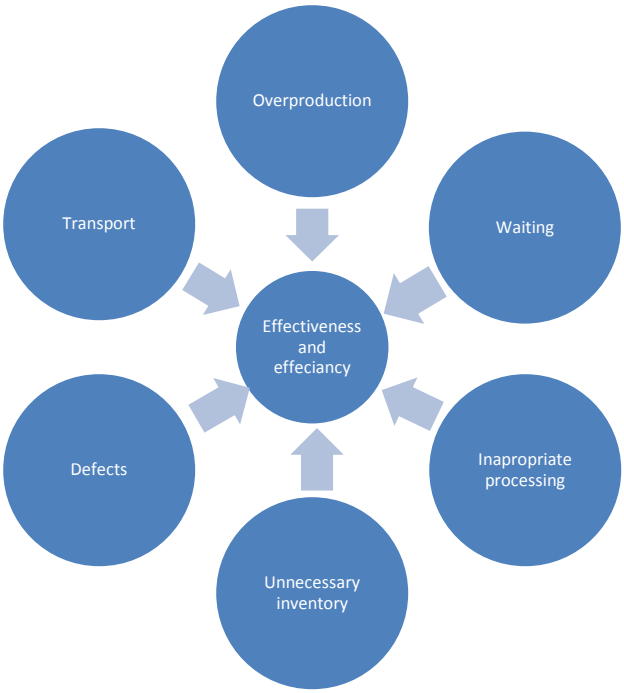

Figure 3: Effectiveness and efficiency shown as opposite polarities of waste

Figure 3 clearly shows the pressure that these *wastes* put on *efficiency* and *effectiveness*. Any of these *wastes* can create pressure on the effective and efficient use of resources and lead to under-performance or under-productivity.

2.8 *LEAN* MANUFACTURING PRINCIPLES

A few *Lean* manufacturing principles have been introduced in the past and as mentioned by Åhlström and Karlsson (1996:44) they are:

• Elimination of waste.

• Continuous improvement.

• Zero defects/JIT.

• Pull instead of push.

• Multifunctional teams.

• Decentralized responsibilities/integrated functions.

• Horizontal and vertical information systems

Although more recent studies support *lean* and quality principles, this fact was already mentioned in a summary of their book called *The machine that changed the world* (Womack *et al.* (1990:1) where they have already argued in the 1990s that *lean* manufacturing is seen as a means to produce a product of quality rather than mass.

In the study by Åhlström and Karlsson (1996:44) the fact that the 'purpose of *Lean* production is to use less resources as compared with "traditional" production systems" is reiterated. He does, however, acknowledge that quality cannot be scaled down while production is increased by *Lean* management and in particular waste elimination. This statement underlines the fact that *lean* is perfectly suitable to optimise *efficiency* because it concentrates on the available resources.

Abdi *et al.* (2006:192) support this waste elimination effort by stating that we must empower people at all levels in the organization by giving them skills and shared responsibility to "drive out *wastes*" systematically This empowerment can be obtained by teaching employees "interpersonal skills that will facilitate effective teamwork" (Abdi *et al.*, 2006:202).

It is clear that *wastes* are a big part of operating non-*Lean* processes and even non-*Lean* companies and is it clear that we have to eliminate *wastes* and in this study particularly in the service environment.

2.9 *LEAN* PRINCIPLES IN THE SERVICE ENVIRONMENT

According to Womack and Jones (cited by Abdi *et al., 2006: 193)* there are five additional principles (mentioned below) available that could lead to *Lean* practices and consequently to an increase in productivity and performance.

Principle 1: Specify Value by Service (*effectiveness*)

This principle is defined as rendering the product or service that was initially required by the customer. The aim here is to specifically focus on what the customer wants

which in turn could eliminate *wastes* such as unnecessary motion on unwanted services or features. The focus could then be on effective solutions and an increase in quality. By understanding the needs of the customer the organisation can action only the necessary motions to satisfy these needs and requirements.

Principle 2: Identify the Service Value Stream

This principle is aligned with principle 1 because satisfying the need of the customer is still the aim. In this principle we look at the actions or processes that are undertaken to turn the desired resources into the product or service.

The aim is to identify the value-adding actions and to optimize it from the view of the end user. Optimizing could involve little changes to the process or even re-engineering the entire process. These value streams can consist of a single flow of actions or the complete and entire value chain. The goal in mind is to obtain the maximum results (user requirement) with as few as possible resource inputs (waste elimination).

This is very true in service environments as the aim of serving sometimes comes at such a priority that all systems and processes are thrown overboard. In this instance it is not about leaving no stone untouched to provide the service but rather only touching the stones that are relevant .This will give you more time and consequently free resources due to the “untouched stones” and waste elimination.

Principle 3: Make the service flow

This principle is all about flow, about what critical path needs to be followed to obtain maximum results. This critical flow can eliminate *wastes* such as over-production, waiting and unnecessary motion such as waiting or even bottlenecks in certain departments

In the service environment communication is a critical substance that leads to the much needed success of the service rendered. Flow of service can be slowed down by unclear communication or unclear expectations. An unnecessary stoppage due to unclear client requirements prohibits the process from flowing fluently. These stop-

pages are seen as *wastes* that involve several resources and waste the time of these resources.

Principle 4: Supply at the pull of the customer

This principle may be a little bit more difficult to apply in the service environment. A service can only be rendered on request of a customer which directly creates a “pull” action. Services cannot be stored or put into an inventory and are therefore immediate actions.

This makes the previous principles so crucial. By identifying the need, streamlining the value stream and streamlining the actions we can render this service timeously and effectively. *Abdi et al. (2006: 195)* have also acknowledged this problem and have suggested flexibility as a means to a solution. The fact that no customer is the same means that the service must be rendered in such a flexible way that all customers are satisfied.

Principle: 5. In pursuit of perfection

This is the ultimate goal. Perfection insists on 100 production, 100% value and 100% client satisfaction. This means 100% *efficiency* and 100% *effectiveness*. It also means total waste elimination

Although there is no such thing as perfection and especially in the service environment it does not mean that we have to discard this desired state. It is the process that counts and all four previous steps are incorporated in this final principle.

It is all about reaching for perfection, getting total employee and management collaboration, creating customer value, continuously seeking improvement and creating a smooth flowing work process environment.

2.10 THE QUALITY PRINCIPLE

2.10.1 Total quality management (TQM)

Other principles to obtain *Lean* operating organisations are also actively being used. Such a method is called Total Quality Management. The total quality movement was first documented by Frederick W. Taylor in the 1920s, in his book titled *The Principles of Scientific Management* (cited by Botha, 2012:8). This is also mentioned by Åhlström and Karlsson (1996:44) as a *Lean* management principle (strive for zero defects).

Total quality did gain momentum in the 1950s in Japan .The stigma of “made in Japan” and poor quality did not add value to the products made in Japan and it was therefore imperative for Japan to increase quality. This encouraged Japan to adopt the philosophy of a total quality improvement and led to an increase in quality of their products and a commanding gain in market share.

In the process of total quality management the waste called “defects” are managed down to the principle called zero defects. This in turn increases *efficiency* as products or services are spot-on the first time and redo is eliminated. This eliminates one of the *wastes* called defects.

This also refers to the *effectiveness* side of this study. Quality means being effective by producing the service or product according to client request. The company must believe that they can only be successful when their clients are satisfied (Foster & Ganguly, 2007:160).

2.10.2 Six Sigma

Lean and Six Sigma can be mentioned in the same breath (Mi Dahlgaard-Park and Bendell (2006:255) but they remain distinct. *Lean* on the one hand focusses on waste removal through process analysis where Six Sigma is a more statistical approach. Both do, however, support quality as the main ingredient to *lean* manufacturing which has been used in the service delivery environment and also discussed in this study.

We can, however, describe TQM as a method to eliminate waste and increase satisfaction while SIX SIGMA concentrates on reducing costs by adopting a no-defect strategy (Botha, 2012:10)

The difference comes in when we take a look at the different methodologies that are being followed by the two methods.

The TQM methodology uses the PDCA methodology (George, 2010:36)

- Plan,
- Do,
- Check,
- Act,

and that of Six Sigma approach (DMAIC cycle) (Näslund, 2008: 72)

- Define,
- Measure,
- Analyse,
- Improve,
- Control

Both methodologies do have the same pattern where clear, definite and planned actions are undertaken, executed and improved on a continuous basis.

Although Six Sigma concentrates on reducing costs by eliminating *wastes* (zero defects) it is also seen as a *vehicle to achieve lean*. This relationship can be verified as *Lean* implying removing *wastes* (such as defects) to improve productivity, performance and improve quality. Quality is also seen as a method of removing *wastes* by reducing the defects and the waste it sustains do to “redo” of defect actions.

In essence we can see that both TQM and Six Sigma are nothing other than management tools to obtain maximum *efficiency* by means of reduction of poor quality.

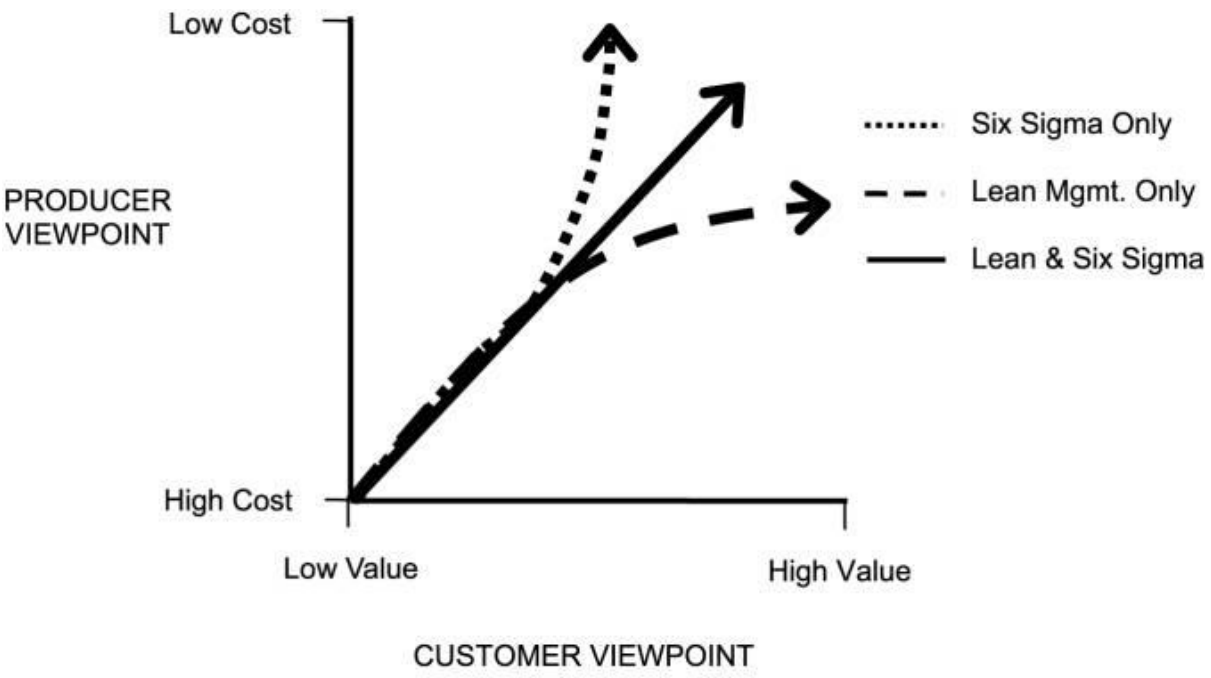

Figure 4: Lean and Six Sigma (Arnheiter & Maleyeff, 2005:16)

This figure illustrates the effect of a scenario where *Lean and Six Sigma are adopted in either a single or combined fashion. The outcome is clear and interpreted as follows:*

- *Lean* only - creates high value to the cost of the producer/service company
- Six Sigma – supports the producer/service company on a low cost benefit, but at the cost of high value to the customer
- Combined *lean* and Six Sigma - Provide a total solution by generating high value without the cost implication.

2.11 WHY IS QUALITY THEN PERCEIVED AS IMPORTANT?

We have seen from the above study that quality is part of the end product or the service experience. We have also seen that quality is part of *effectiveness* and in turn part of the productivity/performance equation where:

Effectiveness + Efficiency = Productivity/performance

Quality cannot be added at the end of this equation and is an integral part where it needs to be built in from the start, which in turn implies then that quality and *Lean* management are inseparable when productivity and/or performance are at stake.

Together quality, service, price, availability and other variables add up to customer satisfaction and in turn customer value. This quality approach does, however, involve all employee involvement and total employee commitment as we have already indicated in principle 5 above.

2.12 *LEAN* AND WASTE FROM A SERVICE PERSPECTIVE

Levitt wrote two articles (Levitt, 1972; 1976), “Production-line approach to service” and “The industrialization of service”, where he argues the “transfer of manufacturing logic to service operations” *(cited by Abdi et al., 2006:198). Reasonable* proof to believe that *Lean* principles adopted from the production industry can be applied to the service industry has thus been presented in this and other studies

Service cannot be stored, is reactive but needs to respond quickly and needs to be flexible. If we then look at *wastes* from a *Lean* perspective we may eliminate some production *wastes* as mentioned above.

These *wastes* can for the purpose of this study and depending on the service that is rendered, be left in the production corner and will not be applied to the service corner. Figure 5 below illustrates the *wastes* that will most probably not be seen in a service environment due to the fact that service cannot be stored or over-produced.

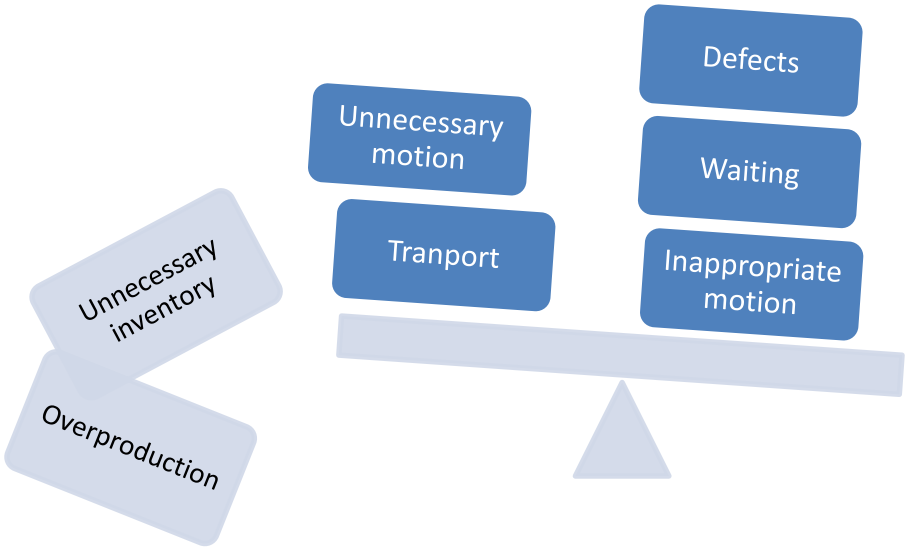

Figure 5: Wastes not applicable to the service environment

2.13 QUALITY AND SERVICE

Quality in the service environment is a perception as seen from the eyes of the client. This is difficult to measure as service is experienced in so many different ways.

Could we see a new waste such as misunderstanding client requirements for excellent service, start growing its roots? All these tools, application and principles are useless if we do not understand our client and what they see as exceptional service.

In order to provide a service of high quality Abdi *et al.* (2006:194) have proposed that service organisations need to :

- Clearly define the value chain
- Manage customer touch point throughout the process
- Clearly develop performance objectives
- Understanding the trade-offs between customer-service expectations and pricing

- Manage processes as Lean production lines (flows) and use leading-edge operational tools (Lean manufacturing principles, such as visual management, policy deployment, and standard work)
- Create a continuous learning cycle to constantly improve on current service outputs.

2.14 INDUSTRIAL PROOF THAT *LEAN* CAN BE SUCCESSFULLY IMPLEMENTED IN THE SERVICE INDUSTRY

Boeing company took the principle of *Lean* a step further .In a response to the Pentagon's instruction that the Boeing C-17 transport plane should cut its price by 25 % (Womack 2005:3), Aerospace filtered the principle of *Lean* through to its suppliers. In the same article it is stated the HI Temp (a supplier to Aerospace) incurred internal savings of up to 400 % after employing *Lean* standards and principles set out by Aerospace. Quality standards were also upgraded from 99.5 % to 99.7 %

Aerospace could announce with pride that they had achieved their goal: To help aerospace contractors boost quality while cutting costs and production time.

Lean is thus a method to achieve the elimination of other *wastes* such as time and resources. Effective use of resources is in turn a method to achieve *efficiency*.

So far it has established that *Lean* principles can reduce *wastes* such as overproduction and access inventory, increase *efficiency* and create value while costs are cut and quality is increased.

2.15 APPLYING AND MANAGING *LEAN*

The theory presented so far clearly presents *Lean* management as a certain technique that should, if implemented correctly, add value to a the service rendered or a product produced and in turn satisfying the needs of the stakeholders and client.

Another fact presented is that waste needs to be reduced or even completely eliminated to get the desired balance between available resources, optimal output, optimal productivity and performance.

All the above theoretical studies have all highlighted some common factors that need to be present in the *Lean* equation.

Figure 6 below presents a visual illustration of elements present in the *lean* lifecycle. Each element contributes to a total *lean* environment and none of these elements should be discarded. The continuous improvement step suggests that the entire process should start again to ensure constant improvement and prevent the system from becoming stagnated in a unproductive gear again.

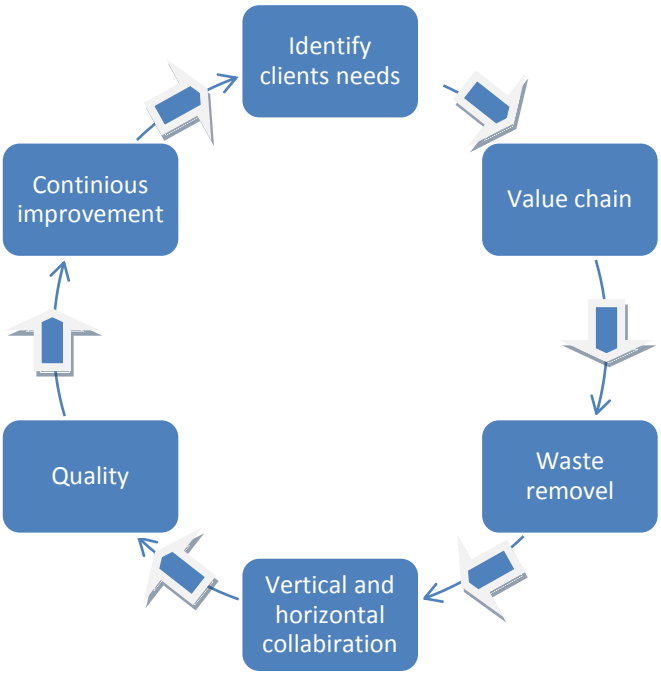

Figure 6: Key elements of the Lean principle

2.16 WASTE REMOVAL IN THE VALUE CHAIN

Integrated in the process depicted in Figure 6 lies the value chain and successively the waste removal process. The value chain seen as the steps taken to turn raw resources or materials into a service rendered to the client. It is thus imperative that waste removal will take place all over the value chain.

Hines and Rich (1997:47) suggested that the activities in the value chain can be categorized as:

- Non Value adding (NVA)

- Necessary but Not value adding (NNVA)
- Value adding activities (VA)

The Non Value Adding (NVA) activities are those that will be subjected to the waste removal process. These activities are seen as over-handling, duplications or processes that are done in series which can be done parallel to each other or needs to be eliminated.

Necessary but Not Value Adding (NNVA) activities can be explained as a service request via telephone that is logged into the system by the telephone operator. It is a double action, but it cannot be processed by the relevant people if it is not sent to them via the electronic system.

Lastly we look at the Value Adding Activities (VA) in the service industry. These activities are the actual labour or actions that subsequently deliver the service to the client.

2.17 WASTE IDENTIFICATION MAPPING TOOLS AND THEIR ORIGIN

This brings us to the relevant mapping tools supporting the Value Stream Map (VSM). Hines and Rich (1997:50) have described seven value stream analysis tools (VALSAT) as well as the origins as and uses.

1) Process activity mapping -Industrial engineering-Reducing *wastes*

(2) Supply chain response matrix - Time compression/logistics - Improve Supply Chain response

(3) Production variety funnel - Operations management

(4) Quality filter mapping - New tool which identifies quality issues and its their existence

(5) Demand amplification mapping - Systems dynamics

(6) Decision-point analysis - Efficient consumer response/logistics

(7) Physical structure mapping - New tool

These tools are broadly discussed in the same article. They have also shown us that tool 1 up to 7 are all production related mainly due to the supply chain being involved. Most services do have a supply chain involved somehow, but this is not the centre of service delivery neither a big contributing factor to service *wastes*.

Process activity mapping is a proven methodology used in the industrial engineering industry which in turn has a proven record of eliminating unwanted elements with big success.

2.18 5 STEPS FOR ACTIVITY MAPPING

Hines and Rich (1997:51) stipulate five steps that define this Process Activity Mapping approach as

(1) Process flow analysis or value stream

(2) Waste identification;

(3) Consider whether the process can be rearranged more efficiently

(4) Consideration of a better flow pattern,

(5) Determine the need for all actions in the workflow

These steps and several other processes previously mentioned overlap processes such as the *Lean* principles by Womack and Jones (cited by Abdi *et al, 2006: 193):*

- Specify Value by Service (*effectiveness*).
- Identify the Service Value Stream.
- Make the Service Flow.
- Supply at the Pull of the Customer.
- In Pursuit of Perfection.

AND also *Lean* manufacturing principles (Åhlström & Karlsson, 1996:44):

- Elimination of waste.
- Continuous improvement.
- Zero defects/JIT.
- Pull instead of push.
- Multifunctional teams with decentralized responsibilities/integrated functions.
- Horizontal and vertical information systems.

And

The key elements of *Lean* principles mentioned in figure 5

- Identify clients' needs.
- Value chain.
- Waste removal.
- Vertical and horizontal collaboration.
- Quality.
- Continuous improvement.

Common to all 3 these suggestions seem to be waste removal and value streams. Mapping is seen in most of these tools as a useful method and step by step process where activities are laid out in a logical way. After this mapping process it is easy to identify activities that are non-value adding, non-value adding but necessary and necessary activities.

In this process *wastes* are identified as the non-value adding activities. Times are allocated to each activity and are captured on paper. So far this has been an exclusive paper exercise and is totally dependent on quantifiable primary data .Again we are requiring data from several resources and as previously mentioned ignorance can foil the success of this exercise.

The next step needs more careful consideration as all the activities will be investigated to try and remove the non-value adding activities without having an impact on

the service being rendered. Experts need to work closely together and need to identify the possible effects of the removal of these activities on the total picture.

After these *wastes* have been eliminated a new map should be drawn up to lay out the new value stream and new processes. This is now becoming the new way of delivering service.

2.19 REASONS WHY *LEAN* IMPLEMENTATION FAILS

Liker and Rother (2013:3) acknowledge the fact that *Lean* implementation can fail due to other reasons than those obvious ones. They mention that Toyota has also endured this problem and introduced the five-question analysis to reduce the effect of resistance to this change.

- What is your target condition?
- What is the current condition?
- Identify the obstacles between the current and desired state?
- What is the next step?
- When can we do reflection on the lessons learned from taken this step?

We cannot introduce this change in operations without thinking about the effect the change will have on human capital. Every change will bring about a certain kind of resistance of some kind and specifically in service environments as people are the biggest assets in the service industry.

We can, however, expect that the bigger the change is, the bigger the resistance to this change will be, and although this is a moderating variable it cannot be ignored.

This variable is not tested in this study, but the success of this study is in the hands of the people involved in the change process. These are also the people who will be responsible for dealing with the resistance. We then must acknowledge the fact that change needs to be managed to secure the success of the project.

Vidal (2007:267) has also stated that people at all levels must be empowered to be part of the *Kaizen* process and to be part of the constant problem-solving and deci-

sion-making process. The success in all changing environments rests on the fact that people who will be affected by this change needs to be involved in the process, as their expertise is required to streamline the removal of *wastes*.

The subject of change management is not under investigation in this study but this contributing factor should not be ignored as it will definitely play a big role in the success of this entire exercise.

2.20 *LEAN* INITIATIVES AND MANAGERIAL RESPONSIBILITY

Rahman *et al.* (2010:1731) suggest that top management's continuous support and mutual understanding be obtained on the future state of operations after introduction of l*ean* principles in the organization. It is according to them crucial for management to play a leading role and they have to show employees that *Lean* is not only good for the current situation, but also necessary if the company wants to be sustainable and profitable for the future.

Managers and people in managerial roles are very often ignorant to the fact that *wastes* do exist and therefore resist the implementation of such practices. People tend to take this as personal and think people see this waste removal process as an attack and mistrust of their managerial abilities. The fact remains that managers are critical about the success of *lean* initiatives and need to seek for and help solve problems (Convis, 2001:2).

Neuropsychology was identified as another problem Liker and Rother (2013:2) where people have a habit to develop "well-worn" pathways or doing routine tasks. This sort of creates a sense of security which is a natural feeling needed by human beings. This can according to them be neutralized by creating an environment where the need for new solutions is instilled into the workers and environment.

2.21 LITERATURE CONCLUSION

Theory has given us some pointers about what *Lean* management is, how it is obtained, what tools we may use and what the potential results can be attained if it is implemented. *Lean* management aims at optimizing the value chain by means of

maximizing resource usage and increase *effectiveness*. This should result in maximum production which in the end will increase internal and external customer satisfaction.

Several aspects came to light but the main theme of this chapter remains that *wastes* need to be removed if productivity or performance increase is desired. This should, however, not contribute to the demise of quality. In actual fact can an increase in quality management at the input deliver better productivity and performance?

The golden thread is to use as few resources as possible and still meet client requirements or to use just enough resources to exceed client requirements. This will not only ensure optimal productivity as resources are not wasted inefficiently but could also mean that the service can be rendered more quickly or more cost effectively due to Efficiency + *effectiveness* = Productivity/performance

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3 CHAPTER 3: EMPIRICAL STUDY

3.1 INTRODUCTION

So far we have discussed the issue of *Lean* principles and the effect it may have on service and subsequently on performance. We have also seen that *Lean* principles are all about maximizing the output (which in this case is service) with the minimum required resources. The link between *efficiency*, *effectiveness* and performance has also been made and the study has established that there is a direct correlation between these variables. This implies that performance can be increased by either increasing *efficiency* and/or *effectiveness*.

This chapter will put the theory into practice and test the possibility of applying *Lean* management and *Lean* application principles to the service environment.

3.2 BACKGROUND OF THE EMPIRICAL ENVIRONMENT

To comply with the preceding of step 1 of Rother and Shook (2003:6) we have identified the "family" as the repair and maintenance section of a tertiary institution and this study was concluded in a closed environment of this tertiary institution. The department selected is that of a support service and in particular a maintenance setup. The services rendered alternate between service to the wide institution within the enclosed parameter and more secluded environments such as hostels and lecture rooms.

Faults are reported via several methods such as E-mail, a requisition system online, telephone calls and a one-stop call centre service which in turn reports via the previous methods mentioned before.

The parameter is divided into geographical sections and are these technicians assigned a specific area in which they operate. This is done to ensure even work distribution.

No formal measurement systems are in place to review and manage the performance of the technicians with regard to quality, speed, comebacks (redo), contractor

engagement and other performance measurements. There is also no performance management enrichment programme except for small incentives. No incentives are linked directly to performance and the achievement of set indicators.

3.3 LIMITATION TO EMPIRICAL STUDY AND RESULTS

This department is rendering this service at no cost and is run as a cost centre. This means that no or little money is asked or paid for any services. Small amounts are sometimes asked for services or departments excluded from the department's mandate. In this instance expected service quality and satisfaction levels may differ from those services rendered in a fully paid and corporate environment. It still does not mean that poor service is acceptable as the employees are still part of the bigger economy and have the same idea about service levels as any other citizen.

This study tested the opinions of the internal customers such as managers and employees in the specific department .They were interviewed in formal and informal groups or individually and their opinion of the issues and possible changes documented.

Some data of current operations (faults) was also collected and documented. This data was put into a Value Stream Map and *wastes* identified

Another limitation is the absence of current statistics. No relevant and current statistics are present to test or observe changes and to derive possible success of the effect of the suggestions. This deprives this study of statistical evidence of any results. We do, despite these limitations, still discuss the suggestions with the relevant personnel and publish their response with respect to the potential effect of the suggestions on their performance. The outcome is possibly subjective, but still valid because the results of all participants indicate common problems and common outcomes.

3.4 STEP 1: MAPPING CURRENT SYSTEM - MANAGERIAL VIEW

Literature has taught us that we need to involve management from the start and build a Value Stream Map that represents operations. The manager of this section

was contacted and after a few sessions the critical issues were identified. According to principle 1 in paragraph 2.8 p 23 we need to specify the Value by Service (*effectiveness*). According to the manager successful performance service in this environment is seen as quick response to the reported problem, repairing the fault as soon as possible with minimum defects (returning to same fault). He also mentioned that another big issue for him is the fact that his staff do not have enough time to do preventative maintenance. These have more faults as a result and have a negative effect on his budget.

The immediate manager was also asked to give any statistics and information about certain important or even critical services.

The value stream of these important services was laid out as the theory stipulates.

He raised concerns such as:

- Normal day to day micro-management
- Insufficient time for technicians to do quality management (TQM)
- Insufficient time for technicians to do preventative maintenance
- Faults that are in a pending status for quite a long time
- Employee moral that is affected by a typical understaffed maintenance department

Table 1: Wastes identified by the manager in the current system

	Access to information-Real time information	Not up to date with new technology	Availability and access	Available Spare parts	Keys	Traveling to same site more than once	Long lead time of contractors
Over production	-	-	-	-		-	-

Waiting	X	X	X	X	X		X
Transport/Travel	X	-	X	X	X	X	-
Inappropriate processing	X	-	-	-	-	-	-
Unnecessary inventory	-	-	-	-	-	-	-
Unnecessary motion	X	-	X	X	X	X	X
Defects	-	X	-	-	-	-	-

The above *wastes* are described as:

- **Transport/Travel** -Technicians travel back to the office just to return to the previous vicinity to repair a fault reported there in the meantime.
- **Waiting** - Long waiting times for contractors to repair outsourced faults. This leads to long lead times for pending faults.
- **Inappropriate processing** -This also leads to faults not given through to the technicians in real time and the technicians have to return to a fault in the same vicinity as earlier in the day and the fault could have been repaired while in the same proximity.
- **Unnecessary motion** -Technicians do not have critical spares at their immediate disposal and have to travel hence and forth to obtain spares. This also leads to transport/travel waste.
- **Defects** -This is seen as technical knowledge. Technicians do not keep updated with technology due to time constraints and repairs are sometimes not sorted out the first time or more time is then needed to spend on a fault.

3.5 TECHNICAL STAFF EVALUATION (STAFF, 2015)

The next step in this empirical study was to get information with regards to the *wastes* from the actual technicians. The department is currently understaffed due to resignations and is it an excellent time to investigate the operations.

The next few points were indicated by the technicians as concerns that restrain their day-to-day tasks. The information was gathered by means of an open focus group meeting with the technicians. No pre-selected questions were asked and the focus group was given the opportunity to state their concerns and personal views on the operational (not managerial) problems in the department as they perceived it. During this session the manager was not present to give them the opportunity to speak frankly.

- Installations are of good quality ,but without taking maintenance into consideration
    - Marking of equipment and the positioning of predecessor equipment.
    - Physical positioning of equipment makes maintaining it difficult.
- Client availability after reporting a fault makes completing the tasks in a respectable time difficult as client and premises availability impacts on service delivery and times. Technicians travel to repair faults just to discover that the premises or client is unavailable.
- Store facilities not adequate.
- Access to database and specific data insufficient.
- Faults at premises of big customers like hostels are being booked several times a day on the same premises due to high volume usage of different systems. Traveling hence and forth to the same customer per day is time-consuming and ineffective.
- Keys to unmanned premises are difficult to obtain - Time wasted on sourcing the keys.
- Lack of needed and crucial information *wastes* time.
- Lack of readily available spare parts

Table 2: Wastes identified by technical personnel

	Access to information	Store operations	Availability and access	Available Spare parts	Keys	Traveling to same site more than once	Installation information insufficient
Over production	-	-	-	-		-	-
Waiting	X	X	X	X	X		X
Transport /Travel	X	-	X	X	X	X	-
Inappropriate processing							X
Unnecessary inventory	-	-	-	-	-	-	-
Unnecessary motion	X	-	X	X	X	X	X
Defects	-	X	-	-	-	-	-

The above *wastes* are described as:

- **Waiting-** Unavailability of people, keys, information or premises. Inadequate store operations and slow response from sister departments.
- **Transport/travel –**Traveling hence and forth to the same location on the same day. Transport/travel back to stores to obtain equipment to repair faults. Traveling to obtain keys for unmanned premises and wasted travel due to un-available premises and people.
- **Unnecessary motion-** Data that is not available or inadequate and forces the technician to acquire this data all over again. This also leads to unnecessary travel time and information gathering.
- **Defects-**Faulty equipment issued by the store *wastes* time and leads to other *wastes* such as travel and more waiting

3.6 VALUE STREAM MAPPING

The Value Stream Map of a typical day in the life of a technician will show and indicate the problems experienced daily. Below are the faults done in that specific day with times reported and completed as well as the areas and repair actions taken? We have taken the data from 2 technicians to illustrate the daily issues presented to them. We name these 2 technicians number 44 and number 578 for the sake of privacy. The Value Stream Map will be done from the data and will the *wastes* be drawn from the values stream map and the daily logs.

Table 3: Technician 44: Date 12/005/2015

Event no:	Description	Event reported	Event resolved	Area	Repair action taken	Non value added activities
1	Cameras do not display on monitor	06:37	08:28	B11	Reboot PC	-
2	Cameras do not display on monitor	06:38	08:29	C 10	Reboot PC	-
3	Maintenance light flashing on system	07:47	08:29	C6	Replace battery	Unnecessary travel to store. Wait for battery to be issued
4	Access problem on	10:44	12:05 13/05/201	D1	Power problem, Faulty	Referred to the contractor for re-

	gate		5		equip-ment-*Contractor*	pairs.
5	Access problem on gate	11:58	12:06	D1	No fault found	Unneces-sary report
6	Dead lights on scanner	12:20	15:27	C1	Replace micro switch	Unneces-sary travel to store. Wait for micro switch to be issued
7	DVR not on network	12:37	14:51	B 11	Replace UPS	Unneces-sary travel to store. Wait for UPS to be issued
8	DVR not on network	12:38	14:52	F14	Reboot PC	Travel to site to reboot PC
9	TGB PC not on network	12:41	15:27	G15G	No fault found	No access /Key prob-lems
10	DVR not on network	12:42	14:52	T 8	Replace UPS	Unneces-sary travel to store. Wait for UPS to

						be issued
11	Access gates are open	12:48	14:52	T8	Replace UPS	Unneces-sary travel to store. Wait for UPS to be issued
12	Faulty alarm	13:29	15:05 13/05/2015	F10A	Repair alarm-	No access and too much activity to proceed immediately

Table 4: Technician 578: Date 13/05/2015

Event no:	**Description**	**Event reported**	**Event resolved**	**Area**	**Repair action taken**	**Non value added activi-ties**
1	T 1 over-view cam-era lane 3 out of order	07:21	07:46	T 1	Duplicate	Unnecessary action to at-tend
2	T 2 over-view cam-era lane 4 out of order	07:22	07:49	T 2	No fault found	Unnecessary action to at-tend
3	Glass door camera out	07:32	08:57	C1	Replaced	Order lens .Return to

	of order		23/03/2015		lens	site to re-place
4	CCTV camera faulty	07:44	12:10	C5	Remote reset did not work. Went to site and do hardware reset of PC	Travel
5	Overhead camera not working	07:47	12:10	E8	Power supply plug not inserted properly. Refit pow-er supply plug	Travel and no precau-tions
6	Room xxx intercom phone not working	07:56	12:09	E1	Refit wires in phone	None
7	Alarm inac-tive	08:41	08:59	C13	Duplicate request	Unnecessary action to at-tend

8	Red lights at turnstile	09:23	14:09	E7	Power problem due to contractor activity	Action of 3rd party caused problem
9	Red lights at turnstile	09:23	14:09	E7	Power problem due to contractor activity	Action of 3rd party caused problem
10	Emergency exit not se-cured	11:20	15:41 17/03/2015	F20	Replaced lock	Waiting for Key to lock
11	Recording equipment times stamp out of synch	11:21	12:30	C2C	Synched time with IT server	Travel
12	Microphone faulty	13:04	10:45 16/03/2015	J6	Replace battery-Not resolved Send in for repair-Not resolved Reset transmitter and re-ceiver-	Travel-Unnecessary motion on wrong fault allocation actions

					Resolved	

3.7 EXISTING VALUE STREAM MAPPING ANALYSIS

The value stream of the technician's daily task have pointed out several non-value added time spend on non-value added activities. One of the main required service outputs is time spend on a problem. Wasted time spend on one problem deprives the next issue of attention. The overall time spend on non-value added operations will have the following possible effect:

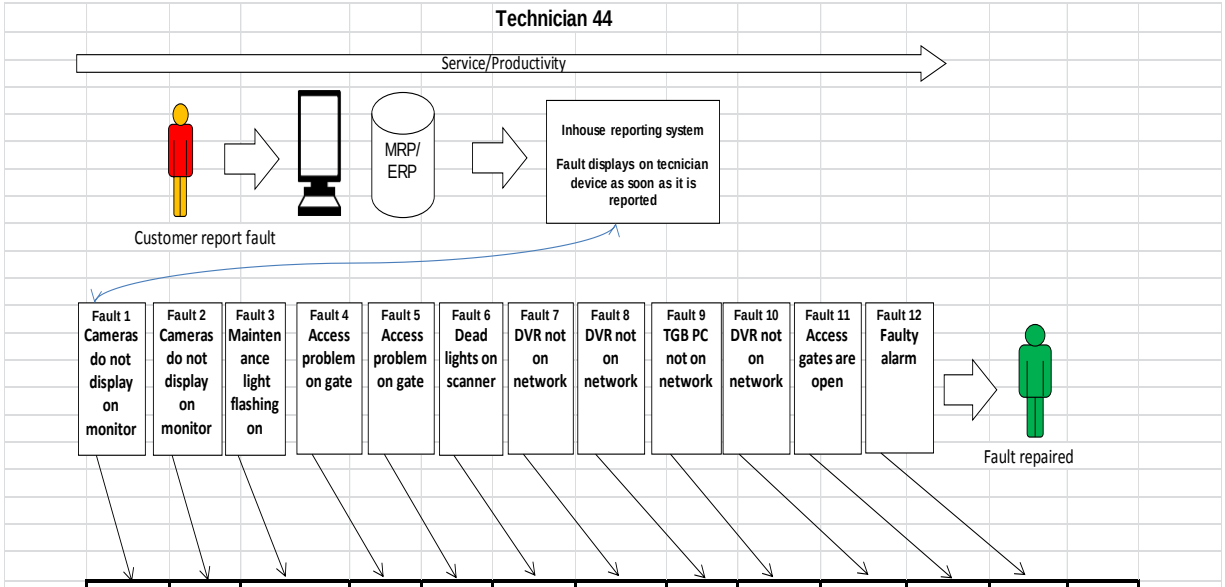
- Customer dissatisfaction
- Average overall time spend on a problem to high
- Response time to other problems higher than anticipated
- Less time for preventative maintenance
- Hasty actions and higher possibility of defects and redo.
- Decrease in moral of personnel

Which in turn implicates?

- Low *efficiency* rate
- Low *effectiveness*
- Low productivity and poor performance

3.8 VALUE STREAM MAPPING OF CURRENT SYSTEM

The value stream maps that was used and is displayed below differs from the traditional value stream maps that can be downloaded from the internet and of those present in some analysis tools. This method was adopted because of the service environment of this research and also because of the fact that the service is rendered within a closed environment. The value stream map was developed during the study and was simplicity the main issue because of the secluded environment.



	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Reboot PC	Reboot PC	Replace battery	Power problem	No fault found	Replace micro switch	Replace UPS	Reboot PC	No fault found	Replace UPS	Replace UPS	Repair alarm	
TT	58	59	42	501	8	127	88	88	114	85	64	516	1750
RT	20	20	15	120	0	35	20	20	0	20	20	45	335
D	1000	400	100	450	50	100	500	500	200	4000	0	150	7450
DT	1000	400	1500	450	50	1300	2000	500	200	6500	0	900	14800
DW	0	0	1400	0	0	1200	1500	0	0	2500	0	750	7350
STT	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97	97.77
ATT	13.12	5.25	19.69	5.91	0.66	17.06	26.25	6.56	2.62	62.00	0.00	11.81	194.23
WTT	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	9.84	73.15

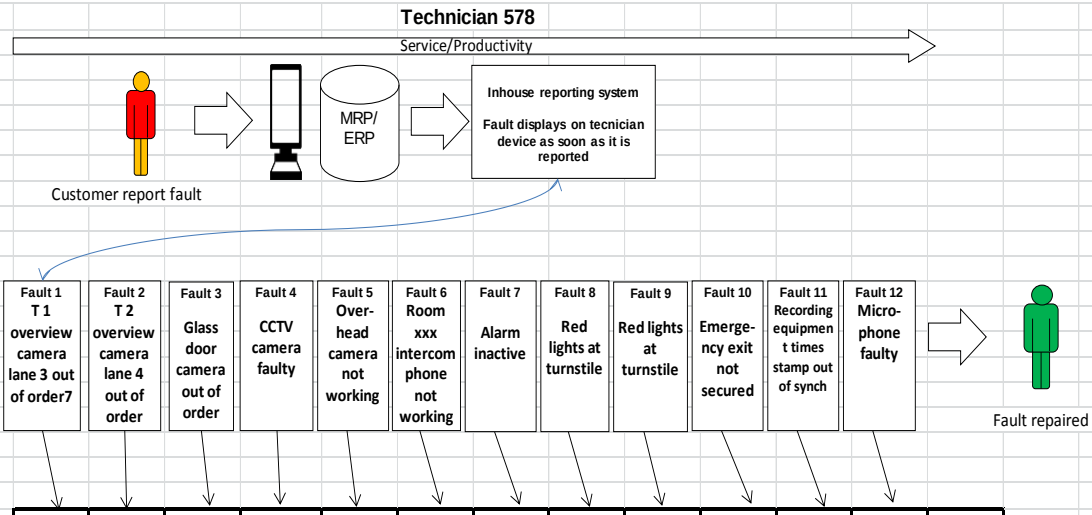
times in minutes and distances in meters

VA	20.00	20.00	15.00	120.00	0.00	35.00	20.00	20.00	0.00	20.00	20.00	45.00	335.00
NVABN	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97	97.77
NVA	24.88	33.75	25.69	375.09	7.34	90.69	61.44	61.44	111.38	12.51	44.00	469.03	1317.23
NVA-Wasted travel	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	9.84	73.15
NVA-Other	24.88	33.75	7.31	375.09	7.34	74.94	41.75	61.44	111.38	3.00	44.00	459.19	1244.08

TT-Total time fault was outstanding from reported to completed on system		VA	Value added activity=Real time spend on fault
RT-Repair time-Time it took to actually repair fault		NVABN	Non value added but necessary activity= Supposed time traveled
D-Distance between 2 destinations of consequative faults		NVA	Non value added activity=Time not spend on actual fault or supposed travel
DT-Actual distance traveled		NVA-Wasted travel	Access travelaccept actual distance between sites
DW-Travel distance wasted=Unproductivity		NVA-Other	Other than travel wastes
STT-Supposed Travel time			
ATT-Actual travel time		Technician average walking speed according to study =1.27 m/s or 4.572 km/h	
WTT-Wasted travel time			

Figure 7 Technician 44 current operations VSM[1]

[1] Larger version available as attachment 1



	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Duplicate	No fault found	Replaced lens	Hardware reset of PC	Refit power supply plug	Refit wires in phone	Duplicate request	Power problem due to contractor activity	Power problem due to contractor activity	Replaced lock	Synched time with IT server	Reset transmitter and receiver	
TT	25	27	2485	266	263	253	18	226	226	679	69	405	4942
RT	20	22	65	25	35	40	15	35	35	75	15	35	417
D	0	0	1200	250	800	100	0	450	450	400	1200	1500	6350
DT	0	0	4800	250	800	100	0	450	450	2400	2400	6000	17650
DW	0	0	3600	0	0	0	0	0	0	2000	1200	4500	11300
STT	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69	83.33
ATT	0.00	0.00	62.99	3.28	10.50	1.31	0.00	5.91	5.91	31.50	31.50	78.74	231.63
WTT	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06	148.29

nes in minutes and distances in meters

VA	20.00	22.00	65.00	25.00	35.00	40.00	15.00	35.00	35.00	75.00	15.00	35.00	417.00
NVABN	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69	83.33
NVA	5.00	5.00	2404.25	237.72	217.50	211.69	3.00	185.09	185.09	598.75	38.25	350.31	4441.67
NVA-Wasted travel	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06	148.29
NVA-Other	5.00	5.00	2357.01	**237.72**	217.50	211.69	3.00	185.09	185.09	572.50	22.50	**291.26**	4293.37

TT-Total time fault was outstanding from reported to completed on system	VA	Value added activity=Real time spend on fault
RT-Repair time-Time it took to actually repair fault	NVABN	Non value added but necessary activity= Supposed time traveled
D-Distance between 2 destinations of consequative faults	NVA	Non value added activity=Time not spend on actual fault or supposed travel
DT-Actual distance traveled	NVA-Wasted travel	Access travelaccept actual distance between sites
DW-Travel distance wasted=Unproductivity	NVA-Other	Other than travel wastes
STT-Supposed Travel time		
ATT-Actual travel time	Technician average walking speed according to study =1.27 m/s or 4.572 km/h	
WTT-Wasted travel time		

Figure 8 Technician 578 current operations VSM[2]

[2] Larger version available as attachment 2

3.9 HOW WAS THE VSM STUDY CONDUCTED?

The value stream maps of the 2 technician's daily activities are displayed in figure 7 Figure 8 above. These value stream maps depict the faults of technician 44 as per table 3 and table 4 respectively. The value stream map consist of the activities undertaken and the different types of activities such as Value Added (VA), Non Value Added But Necessary (NVABN) and Non Value Adding (NVA)

Travel times where allocated according to a study about average walking speeds by Bohannon and Andrews (2011:187).Fault times where categorized according to the actual time spend on the fault (Value added) and the shortest direct travel time to next fault without going to the office or stores (NVABN) .The sum of these times where subtracted from the actual time that the fault was outstanding and is seen as time wasted. These wasted times are seen as Non Value Adding (NVA) and depicts *wastes* within the current system.

The technical staff explained these *wastes* by means of actual problems experienced during this day of operations. These problems where tabled in table 5 and table 6 below and the different *wastes* where identified accordingly.

Table 5 : Wastes identified from the Value Stream Technician 44

Technician 44 faults	Over production	Waiting	Transport/Travel	Inappropriate processing	Unnecessary inventory	Unnecessary motion	Defects
1 ◎							
2							
3			◎			◎	

4		◎		◎		◎	
5						◎	
6		◎	◎			◎	
7		◎	◎			◎	
8			◎			◎	
9		◎	◎	◎		◎	
10		◎	◎			◎	
11		◎	◎			◎	
12		◎		◎		◎	

Table 6 : Wastes identified from the Value Stream Technician 578

Technician 578 faults	**Over production**	**Waiting**	**Transport/ Travel**	**Inappropriate processing**	**Unnecessary inventory**	**Unnecessary motion**	**Defects**
1				☆		☆	
2				☆		☆	

3		☆	☆			☆	
4			☆				
5			☆			☆	
6							
7				☆		☆	
8			☆			☆	
9			☆			☆	
10		☆	☆			☆	
11			☆				
12		☆	☆	☆		☆	

It is clear from the value chain mapping process that certain *wastes* are not present in this service environment and that several *wastes* are common in most of the issues handled.

3.10 WASTES NOT PRESENT OR IDENTIFIED IN THIS RESEARCH ARE:

- Overproduction

- Unnecessary inventory
- Defects

3.11 WASTES PRESENT IN THE CASE STUDY

Table 7 : Percentage wastes present in faults handled by technician

	Technician 44 faults	**Technician 578 faults**
Waiting	58.33 %	25 %
Transport/Travel	58.33 %	58.33 %
Inappropriate processing	25 %	33.33 %
Unnecessary motion	83.33 %	66.67 %

Table 8 : Wastes ranking per technician

	Technician 44	**Technician 578 faults**
Waiting	2	4

Transport/Travel	2	2
Inappropriate processing	4	3
Unnecessary motion	1	1

Table 9 : Common wastes present between 3 analysis methods

	Over produc-tion	**Waiting**	**Transport/Travel**	**Inappropriate processing**	**Unnecessary inventory**	**Unnecessary motion**	**Defects**
Manager	-	X	X	X	-	X	X
Techni-cians	-	X	X	X	-	X	X
Value Stream Mapping	-	X	X	X	-	X	-

The outcomes of the 2 practical methods that was used to determine *wastes* compares well with that of the theoretical method that was used by means of Value Stream Mapping (VSM)

The relevant *wastes* that were identified and the possible causes derived from the fault repair records and the interviews will be discussed before tools will be applied to suggest interventions.

3.11.1 Waiting

Waiting within this case study indicates the following:

- Waiting for equipment at the stores
    - Lead time for non-stock equipment to arrive at the store
    - Waiting time at the stores before equipment is issued
- Waiting on the response of contractors
- Waiting for information about the product , premises or other information not available (real time)
- Waiting for contractors to give support or to repair faults handed over to them
- Waiting for access to the premises
    - Keys or responsible persons not available

3.11.2 Transport/Travel

- Lack of access to correct information
- This waste is due to availability and accessibility (No keys and other delays)
- Insufficient emergency spare part on hand (not in the store)
- Repeated travel to the same site or adjacent premises for reported faults

3.11.3 Inappropriate processing

- Insufficient information supplied and displayed by installations dafter the project.
- Physical location of equipment does sometimes cause problems.
- Lack of access to information.

3.11.4 Unnecessary motion

- Lack of information
- Availability and access
- Available spares
- Availability of keys
- Contractors support

3.11.5 Defects

- Equipment issued by stores already defective when issued.

- Lack of knowledge on products causes defective repairs.

3.12 CORE ISSUES THAT CREATES THESE *WASTES*

- Contractor support and response.
- Store operations-Waiting for equipment to be issued, faulty equipment issued or long lead times for non-stock items to be sourced.
- Lack of knowledge about new technology.
- Lack of crucial information
- Keys
- Physical Access to premises
- As built information missing
- Not enough hands-on spares for common faults
- Repeated traveling to faults reported within the same vicinity

3.13 *LEAN* ELIMINATIONS TOOLS

Not all *lean* elimination tools taken from the production environment is applicable to the service environment and need the irrelevant tools be eliminated.

Table 10 : Tool appropriateness to identified wastes in current environment

	Cellular actions	**Just in Time (JIT)**	**Kanban's**	**Total preventative maintenance (TPM)**	**Setup time reduction**	**Total quality man-agement (TQM)**	**5S 's**
Waiting	X	X	N/A	X	N/A	X	X
Transport/travel	X	-	N/A	X	N/A	X	X

Inappropri-ate pro-cessing	-	-	N/A	-	N/A	X	X
Unneces-sary motion	X	-	N/A	X	N/A	X	X

Table 10 shows the typical *wastes* already identified and the appropriate tools that could be used to eliminate or reduce these *wastes*. The tools are marked against the different *wastes* and the solutions are discussed follow.

3.14 DESCRIPTION OF HOW THESE TOOLS CAN ELIMINATE THE *WASTES* IN THE CURRENT SYSTEM

3.14.1 Cellular action

In production terms cellular action means to organize all similar processes together in one cell. In the service environment it could mean to organize all faults in the same area together to reduce transport/travel waste and unnecessary motion such as transport/travel hence and forth. Waiting can also be eliminated as appointments at the same geographical area or same client can be grouped together and time wasted on unavailable clients can be reduced.

3.14.2 Just in time

This is supported by the pull function. Technicians can also perform the pull function by traveling to previously arranged appointments and arrive on time. This will give them time to perform other tasks instead of waiting on keys, clients or the availability of rooms and offices.

3.14.3 Total preventative maintenance

Preventative maintenance could prevent faults from occurring and so it could prevent *wastes* such as unnecessary travel, processing and the ever-present waiting. This

could only be achieved by loosening the hands of the technicians by reducing *wastes* that waste valuable time. This in turn will increase productiveness.

3.14.4 Total quality management

Quality management is seen as managing the prevention of failures. In other words if quality is assured failures are restricted and the same effect is obtained than with preventative maintenance.

3.14.5 5S

Although the 5S's are meant as organizing the working environment more effectively, it could also be applied to the service environment. By sorting the tasks in a logical order (cellular action) ensuring *Lean* stores, sorting or breaking down demographical areas in a logical way can ensure smooth operation within the total operating environment, standardizing could mean prioritizing and in this instance major classified issues get automatic preference. Although it could lead to *wastes* such as transport/travel etc. it will in the end satisfy the needs of the institution and create superior customer satisfaction.

The application of these tools is not generic to all cases, but a general idea of the *wastes* and the solution will advise the department of issues and steps needed to increase production.

3.15 SUGGESTED THEORETICAL TOOLS APPLIED TO *WASTES* IN PRACTICE

The core issues that cause these *wastes* have been identified and should these issues be addressed to reduce the ripple effect caused by them.

Theory suggests that Cellular actions, Just in Time (JIT), Total preventative maintenance (TPM),Total quality management (TQM) and 5S should be used to eliminate these *wastes*.

These tools can now be suggested by means of practical solutions. These solutions will later be given to the named department and section to discuss and give feedback on the potential effect it could have on their daily activities and in turn the potential effect on performance or productivity.

3.16 CORE ISSUES AND SUGGESTED SOLUTIONS

- **Contractor support and response**
  - In this instance we can start by suggesting total preventative maintenance and quality assurance .This would mean that statistics from the core and major faults/sites that are handed over to the electrical contractor should be generated. By generating preventative maintenance schedules and ensuring total quality management the faults that need the assistance of the electrical contractor can be minimised and waiting can in this instance be reduced and minimized.
  - The standardization S in the 5S method may also be used. This would mean standardizing repair response times into categories and drive these times as SLAs. This would mean a contractual binding agreement to enforce faster response times and reduce waiting for these contractors. Other 5S methods such as sorting may also be applicable. In this instance faults that could be foreseen the use of these contractors could be sorted and prioritised. This is only possible in cases where good estimated guesses are made from given data and of course only if the prioritising does not impact on other important issues at hand.
- **Store operations** - Waiting for equipment to be issued, faulty equipment issued or long lead times for non-stock items to be sourced/not enough hands-on spares for common faults
  - In this instance we feel the negative impact of the Just in Time (JIT) *Lean* elimination tool. Just in time reduces unnecessary inventory but impacts on service delivery. The inventory levels and dead capital in the shelves are reduced but to the dismay of the service technicians and the impact on service delivery. Remember that the manager has indicated that times needed to repair are seen as a good indication of good service delivery levels. The suggestion is to keep more critical and fast-moving inventory on hand and to maintain minimum stock levels of critical but expensive equipment on the shelves. If equipment needs cannot be identified the stores should source suppliers that are local or can deliver in a short period of time.

- Stores personnel should sort and ensure proper housekeeping for fast moving equipment. This will also reduce waiting times when equipment is needed from the stores.
- Total quality management programmes will ensure a better product on the shelves. This will decrease the breakdown of products and will also decrease time spent in the store.
- Cellular action will in this instance provide some relief. An automatically generated list of equipment needed from the stores can be sent from the technician's device directly to the stores and the store personnel can prepare the necessary equipment from a pick list. This will ensure quicker response at the store and less waiting time in total.
- Reorganise the process of obtaining equipment from the stores. This could also be seen as sorting (from the 5S tool) the current procurement process from the stores to prevent unnecessary *wastes* due to bureaucratic rules and regulation.

- **Lack of knowledge about new technology**
  - Training is a constant and ongoing process especially in the technology sector. Kaizen is the practice that involves continuous improvement (Alukal & Manos, 2006:25). Although this practice supports strategic processes it is a *Lean* tool that is aiming at the entire *Lean* management process. *Lean* is seen as a continuous and ongoing process. This is supported by the 5th principle introduced by Abdi *et al.* (2006:193)The practice of Kaizen is applicable in the training environment (Alukal and Manos (2006:25) and is continuous training of essence. Many *wastes* were identified referring to training and a training programme needs to be introduced and linked to performance agreements and performance appraisels.
  - The suggestion is made that a gap analysis be done on the training needs. Financial support must be obtained and a well-drafted long and short term training programme is to be introduced. In this case senior management should give support and drive this initiative.

- **Lack of critical information/ Installation information missing**
  - The 5S methodology could shed light on this waste. This tool includes Sort, Systematic arrangement, Spic and span, Standardized and Self-discipline. Although this methodology is aimed at workplace organization we can apply certain of these actions to service and especially to this waste.
  - Standardization implicates that data should be supplied and sorted into a logical and practical way to ensure easy access and the much needed data.
  - A systematic arrangement of the critical data will not only enable the team to perform better, but will also enable the installation team to supply the correct required data needed to perform the service of repairing faults.
  - Total quality management needs to be adopted to ensure not only required data but also valid and timeous information.
  - Again the 5S tool is needed to create a matter of urgency and self-discipline. This self-discipline is needed to ensure on time data updates.
- **Keys/access to premises**
  - Cellular actions could manage this problem. By organizing all similar processes and destinations together keys and access could be arranged beforehand and this waste could be minimized. This unnecessary travel and waiting can be minimized and other faults cleared in the time that is wasted looking for keys or waiting for access. This could also be covered by the S for systematic arrangement in the 5S tool .By arranging keys or access to premises systematically and logically this waste can also be minimized.
  - Arranging for spare keys and access to premises that are inaccessible and keeping them close can solve the problem. Although spare keys are present data should be kept about which premises are inaccessible and keys should be made for access to be managed. This could be achieved by quality management methods.
- **Repeated traveling to faults reported within the same vicinity**
  - Cellular action is again part of this solution. By arranging faults and issues together transport *wastes* could henceforth be limited. This means faults in the same vicinity could be grouped together to enable the technician to walk

once in that direction. Technicians could also delay some faults in instances where they have experience of this problem until there are a few faults reported and then attend at once to all faults.

- Do not keep the areas limited to people. Rather group the faults in close proximities and dispatch accordingly.
- Organize live dispatch via the dispatch programme to source the closest person to the fault and the faults closest to the person. In this way faults can be grouped together and dispatch could be made quicker and more effectively.

3.17 THEORY AND PRACTICE

We have seen that theory depicts certain fixed *wastes*, describes certain waste identification methods and suggests certain *lean* application tools. We need to determine the practical application of these methods and tools and the practicality in the service environment.

The theory will be tested by way of the practical application in this paper and the applicability in practice.

3.18 HAVE WE IDENTIFIED *WASTES* SUGGESTED BY THEORY?

The *wastes* identified where:

- Waiting
- Transport/Travel
- Inappropriate processing
- Unnecessary motion

3.19 COULD WE USE OPTIMIZATION TOOLS DO MAKE SUGGESTIONS?

The tools we used were:

- Cellular production
- Total preventative maintenance (TPM)
- Total quality management (TQM)

- 5S-Standard procedures and effective workplace organization

3.20 WHAT *LEAN* IDENTIFICATION TOOL WAS USED?

- Value Stream Mapping (Process activity mapping)

3.21 DID WE USE THE PROPOSED STEPS TO OPTIMIZE SYSTEMS AND TO ENABLE *LEAN* PRACTICES?

We have already done step 1 which stipulated the mapping of the current way things are being done. This step is crucial in *Value Stream Map (VSM)* as it helped us identify the *wastes* present in the current system. It also helped us to plot the times that these *wastes* are wasting. This brought us closer to the term called *efficiency* which makes up part of the entire productive or performance circle.

Because we will test the potential effect of this *Lean* elimination process on productiveness and performance we need to get the input from the relevant people. This input will help us move forward to step 2 where we will plot the suggested or future Value Stream Map (VSM).The inputs from the relevant people will not only provide us with the potential success of this waste elimination process but also with estimated times that can be saved with the process.

All this will be employed in the new Value Stream Map (VSM) and the new times and reduced *wastes* will be plotted. This process of total involvement will also add validity and credibility to the study as there is a lack of statistical evidence.

3.22 INVOLVEMENT

We have seen from a quality perspective that we need to involve all relevant people in the process of *Lean* management. We have also established that in this case study quality is not only seen as an end-product but as a total process. Quality management, quality service and quality products are of the utmost importance and need to be managed.

3.22.1 Manager

We included the manager and asked him what his clients perceived as good service. He pointed out that speedy response (*effectiveness*) with a quality service is important. We have also obtained the issues from a management perspective and plotted the *wastes* from the manager's inputs.

3.22.2 Technicians

We have also included the technicians and obtained their inputs with regards to the problems they experience. Wastes have been plotted from their point of view

3.22.3 Collective inputs

The inputs of these people will, as said, again be obtained to test the potential success of the *Lean* management process

3.23 CHAPTER CONCLUSION

Theory suggested a few fixed *wastes*, tools and methods that can be identified and used in the proses of production. This chapter applied these tools to the service industry. Proof is present that these tools can be used in a service environment and that similar *wastes* are present in the production as well as in the service environment. There is also proof that certain waste elimination tools can be taken from production and successfully (theoretically) be used to make certain suggestion towards waste elimination in the service environment.

The results from the validation process with the technicians and the manager are represented in chapter 4 and the new Value Stream Map indicates the potential success and effect on the performance of this service environment.

4 CHAPTER 4

4.1 INTRODUCTION

Chapter 4 ties the knot between the theory, empirical study and the applications in practice. So far theory has suggested certain tools that may be used to identify *wastes* within a service environment. The empirical study established what *wastes* are present in the case study and what tools may be used to eliminate these *wastes*. The Value Stream Map has been used to map the process and map the *wastes* present in the service environment presented in this case study.

The inputs of the manager and the technicians were also presented and common *wastes* between the data mining methods were identified. Chapter 4 will test the relevance and the potential effect on departmental performance.

Recommendations to the department will be made as well as recommendation on further studies. The success of the objectives reached and the success of this study will be discussed.

Table 11 : Core issues (wastes) vs solutions and feedback

Core issues and *wastes*	**Waste elimination tools applied to core issues**					**Feedback**
	Cellular actions	Just in Time (JIT)	Total preventative maintenance (TPM)	Total quality management (TQM)	5S 's	
Contractor support and response			X	X	X	Possible but not easy

Store operations	X	-	-	X	X	Positive
Lack of knowledge about new technology	-	-	-	X	-	Kaizen (continuous improvement) Finance needed
Lack of critical information/ Installation information missing	X	-	-	X	X	Positive
Keys/Access to premises	X	-	-	X	X	Positive
Repeated traveling to faults reported within the same vicinity	X	-	-	-	X	Positive

The above table has shown positive results with regard to the collective feedback of the manager and technicians meeting. The most prominent and appropriate tools seem to be:

- Cellular action
- 5S methodology and
- Total quality management

4.2 SUGGESTIONS THAT CAN BE IMPLEMENTED

4.2.1 Cellular action

This conclusion suggests that by grouping together actions such as areas and certain faults *wastes* can be eliminated.

The suggestion made from the feedback meeting is to divide the areas into close, close up and furthest from the office areas. By doing this 1 technician may respond faster to all faults in the nearby area and eliminate *wastes* such as travel. The technician servicing the furthest areas will make use of a vehicle with spare parts readily available. This will eliminate unnecessary and timewasting travelling by foot and wasting time traveling to the store for spare parts that can be kept in the vehicle.

4.2.2 5S Methodology

It also seems that the 5S methodology which is embracing housekeeping as a foundation is also a workable solution to eliminating *wastes* in a service environment.

The application of this method can be adopted in the case environment by standardizing fault categories within certain proximities. This will enable the gathering of statistics which is currently not present. These statistics will enable management to gather data on under-performance which can be due to *wastes* and can be managed through the process that has been followed in the empirical study in chapter 3.

Data sorting into categories and easy accessible to the technicians through servers and/or websites will reduce wasting time on gathering the data on site and enable quicker and more accurate responses.

A system where spare keys are kept in a *systematic* arrangement will reduce *wastes* such as waiting for access and will also provide more effective service delivery

4.2.3 Total quality management

Last but not least is the tool that is ever -present in all environments and industries. This tool is known as Total Quality Management. From the solutions suggested and the feedback it seems as if this solution is the most prominent tool to be used when it

comes to eliminating *wastes*. During the case study feedback session these were seen as the core principle to follow and to spend energy and were emphasis should put:

4.2.4 Quality service by training and sufficient product knowledge

This will lead to quality fault-finding methods and wasted time spent on irrelevant action will be reduced. Quality repairs will also reduce the repeated appearance of the same fault. This training should also be introduced to the planner and installation team as this will ensure quality planning and more accurate and effective installations.

4.2.5 Quality products installed and kept in store

This solution will be implemented by close collaboration with the planning office and store manager. A list of products that are inferior or do not meet quality standards should be circulated. The items will be phased out as soon as possible and research done on better products to replace these inferior products. This is a continuous process and will need the assistance of all parties involved. This will also be fed through to the installation department where the installation of products also needs to be of high quality. Quality is a continuous process and needs to become a way of doing daily business.

4.2.6 Quality management with respect to access to premises

This process will require more data at the reporting stage on the website. The suggestion was made that more fields with respect to access times and other relevant data such as responsible persons and contact info should be supplied when a fault is reported. These fields should be mandatory and the required data will be time-lined to assist the technician to visibly plan his actions more carefully and better planned. This will reduce time wasted in gathering this information and organizing action. More effective service will be delivered and efficient use of human resources will be obtained.

4.3 WHAT WILL BE GAINED?

The final phase of the waste elimination process is step 2 suggested by Abdulmalek and Rajgopal (2007:225).This step entails mapping the new process after *wastes* have been removed and documents the progress made and the gains obtained from the more *Lean* and less wasteful process.

Because no data or statistics are present estimated time that will be saved by implementing these actions was derived by consulting the technicians and manager and an average time was agreed on. The problem of subjectivity was minimized by applying waste removal techniques from the suggestions made in chapter 3 to the different faults per technician and the Non Value Added (NVA) times were removed. The new times after the Non Value Added (NVA) times were recorded and the savings in minutes were documented

This savings times were then mapped again and the value stream was revised.

4.4 WASTE REMOVAL APPLIED TO TECHNICIANS' FAULTS REPORTED.

Fault	Problem	Waste solution and eliminating the Non Value Adding activity times	Possible minute savings
Fault 1	Reboot PC	N/A	0
Fault 2	Reboot PC	N/A	0
Fault 3	Replace battery	Keep stock at hand and not travel to store	25.69
Fault 4	Power problem	Contractor SLA of 4 hours could reduce fault outstanding to Maks. 4 hours	135.09
Fault 5	No fault found	N/A	0
Fault 6	Replace micro switch	Keep stock at hand and not travel to store	90.69
Fault 7	Replace UPS	Keep stock at hand and not travel to store	61.44
Fault 8	Reboot PC	N/A	
Fault 9	No fault found	Key management could prevent long times and actual repair time could be only time spend on this fault	111.38
Fault 10	Replace UPS	Keep stock at hand and not travel to store	12.51
Fault 11	Replace UPS	Keep stock at hand and not travel to store	44
Fault 12	Repair alarm	Arrange access or indicate access time on report system could prevent unnecassary travel	9.84
		Total time saved	490.64

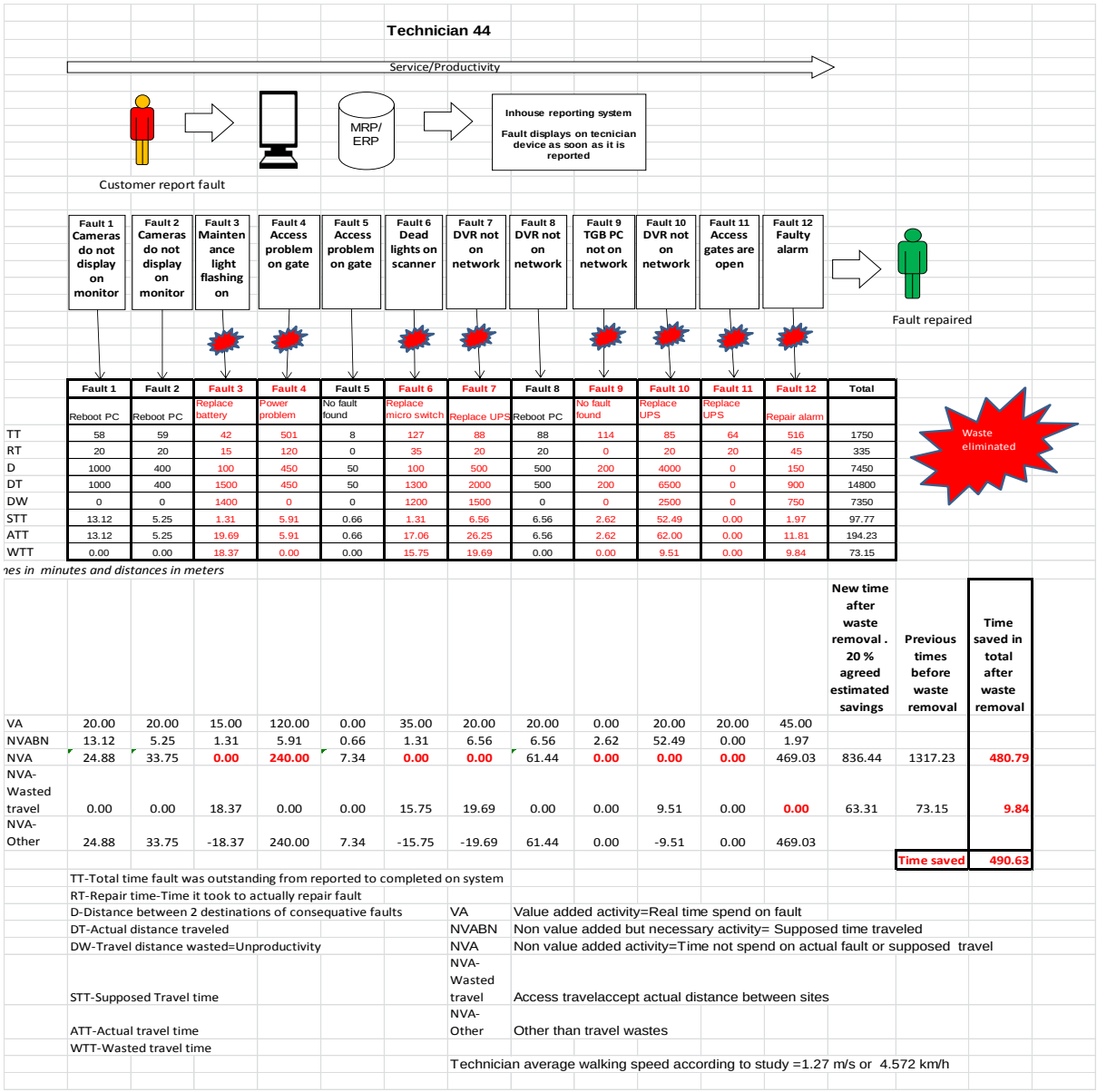
Figure 9: Technician 44 Waste removal applied to reported faults

Fault	Problem	Waste solution and eliminating the Non Value Adding activity times	Possible minute savings
Fault 1	Duplicate	N/A	0
Fault 2	No fault found	N/A	0
Fault 3	Replaced lens	3600 m wasted @ 1.27 m/s becauase no stock = 47.24 + 2357 minute due to out of stock	2404.24
Fault 4	Hardware reset of PC	N/A	0
Fault 5	Refit power supply plug	Preventative maintenance could prevent fault	217.5
Fault 6	Refit wires in phone	N/A	0
Fault 7	Duplicate request	Qaulity control on reporting system	3
Fault 8	Power problem due to contractor activity	N/A	0
Fault 9	Power problem due to contractor activity	N/A	0
Fault 10	Replaced lock	Key management could prevent long times and actual repair time could be only time spend on this fault	598.75
Fault 11	Synched time with IT server	N/A	0
Fault 12	Reset transmitter and receiver	Training could prevent unnecesarry actions and could fault be cleared 1 time	350.31
		Total time saved	3573.8

Figure 10: Technician 578 Waste removal applied to reported faults

4.5 NEW VALUE STREAMS AFTER WASTE REMOVAL

The next step after the process of waste removal is to draw the new value streams and to indicate anticipated savings.



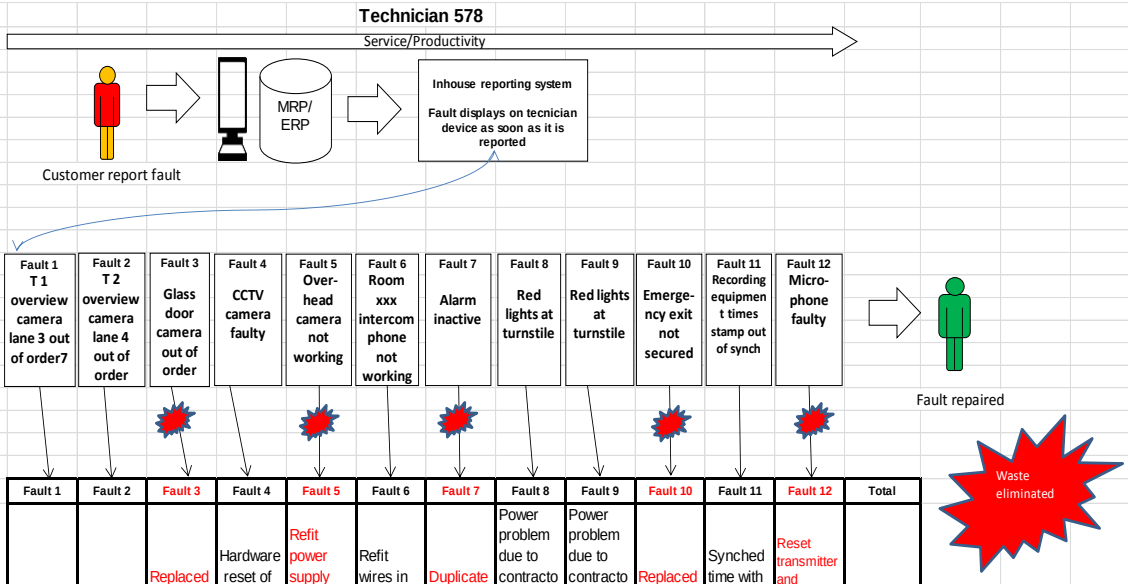
	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Reboot PC	Reboot PC	Replace battery	Power problem	No fault found	Replace micro switch	Replace UPS	Reboot PC	No fault found	Replace UPS	Replace UPS	Repair alarm	
TT	58	59	42	501	8	127	88	88	114	85	64	516	1750
RT	20	20	15	120	0	35	20	20	0	20	20	45	335
D	1000	400	100	450	50	100	500	500	200	4000	0	150	7450
DT	1000	400	1500	450	50	1300	2000	500	200	6500	0	900	14800
DW	0	0	1400	0	0	1200	1500	0	0	2500	0	750	7350
STT	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97	97.77
ATT	13.12	5.25	19.69	5.91	0.66	17.06	26.25	6.56	2.62	62.00	0.00	11.81	194.23
WTT	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	9.84	73.15

nes in minutes and distances in meters

													New time after waste removal . 20 % agreed estimated savings	Previous times before waste removal	Time saved in total after waste removal
VA	20.00	20.00	15.00	120.00	0.00	35.00	20.00	20.00	0.00	20.00	20.00	45.00			
NVABN	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97			
NVA	24.88	33.75	**0.00**	**240.00**	7.34	**0.00**	**0.00**	61.44	**0.00**	**0.00**	**0.00**	469.03	836.44	1317.23	**480.79**
NVA-Wasted travel	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	**0.00**	63.31	73.15	**9.84**
NVA-Other	24.88	33.75	-18.37	240.00	7.34	-15.75	-19.69	61.44	0.00	-9.51	0.00	469.03			
														Time saved	**490.63**

Figure 11: Technician 44 estimated times saved after waste elimination[3]

[3] Larger version available as attachment 3



	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Duplicate	No fault found	Replaced lens	Hardware reset of PC	Refit power supply plug	Refit wires in phone	Duplicate request	Power problem due to contractor activity	Power problem due to contractor activity	Replaced lock	Synched time with IT server	Reset transmitter and receiver	
TT	25	27	2485	266	263	253	18	226	226	679	69	405	4942
RT	20	22	65	25	35	40	15	35	35	75	15	35	417
D	0	0	1200	250	800	100	0	450	450	400	1200	1500	6350
DT	0	0	4800	250	800	100	0	450	450	2400	2400	6000	17650
DW	0	0	3600	0	0	0	0	0	0	2000	1200	4500	11300
STT	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69	83.33
ATT	0.00	0.00	62.99	3.28	10.50	1.31	0.00	5.91	5.91	31.50	31.50	78.74	231.63
WTT	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06	148.29

nes in minutes and distances in meters

													New time after waste removal . 20 % agreed estimated savings	Previous times before waste removal	Time saved in total after waste removal
VA	20.00	22.00	65.00	25.00	35.00	40.00	15.00	35.00	35.00	75.00	15.00	35.00			
NVABN	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69			
NVA	5.00	5.00	**0.00**	237.72	**0.00**	211.69	**0.00**	185.09	185.09	**0.00**	38.25	**0.00**	867.85	4441.67	**3573.82**
NVA-Wasted travel	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06			
NVA-Other	5.00	5.00	-47.24	237.72	0.00	211.69	0.00	185.09	185.09	-26.25	22.50	-59.06			
														Time saved	**3573.82**

TT-Total time fault was outstanding from reported to completed on system	VA	Value added activity=Real time spend on fault
RT-Repair time-Time it took to actually repair fault	NVABN	Non value added but necessary activity= Supposed time traveled
D-Distance between 2 destinations of consequative faults	NVA	Non value added activity=Time not spend on actual fault or supposed travel
DT-Actual distance traveled	NVA-Wasted travel	Access travelaccept actual distance between sites
DW-Travel distance wasted=Unproductivity	NVA-Other	Other than travel wastes
STT-Supposed Travel time		
ATT-Actual travel time	Technician average walking speed according to study =1.27 m/s or 4.572 km/h	
WTT-Wasted travel time		

Figure 12: Technician 578 estimated times saved after waste elimination[4]

[4]Larger version available as attachment 4

4.6 CONCLUSION OF STUDY

It can be seen from the revised Value Stream Maps (VSM) that relative progress should be made and the potential effect on productivity or performance can be significant. In total the completion time that could be reduced on the faults attended by the two technicians adds up to 4064.45 minutes. That adds up to more than 67 hours in which the faults could have been cleared earlier. These hours are not all spent on *wastes* as there are times that the fault was outstanding through the night and weekends. It does, however, underline the manager's point of view on successful performance of service in this environment that is seen as quick response to the reported problem, repairing the fault as soon as possible with minimum defects (returning to same fault).

He also mentioned another big issue for him is the fact that his staff does not have enough time to do preventative maintenance. The time spent on wasted efforts could be channelled through as preventative maintenance and reduce fault reporting and prevent a snowball effect of service vs faults vs preventing these faults.

The conclusion is thus made that the study has proved to be relevant to the specific service environment. The theoretical *wastes* taken from the production environment are applicable to the service environment. It is also concluded that waste identification tools such as Value Stream Mapping (VSM) and waste elimination tools such as cellular action and total quality management can potentially and successfully be applied to the service sector.

The outcome of this study could address the issues made by the manager such as quicker response and shorter delivery times which according to him are essential to the performance of his department. Reducing *wastes* will increase performance, shorten delivery times and in turn create opportunities for preventative maintenance which is in essence another tool to for *lean* management.

4.7 RECOMMENDATIONS

The next recommendation can be made to optimize the value chain of this service department. These should according to the study have a potentially positive effect on the service that is rendered by this department. This step completes the steps for optimization mentioned in paragraph 1.5 on p 4 of this study.

- **Obtain funds to establish a well-prepared training plan for all relevant parties**

  The study has indicated the importance of knowledge. The *wastes* generated by these knowledge limitations are visibly seen in the study and in some of the faults handled by the technicians. It is crucial to do a knowledge gap analysis and to identify the different needs within the current knowledge base. A well-developed training plan will ensure waste reduction and promote performance.

- **Obtain data from current records to gather data for statistical purposes**

  The lack of statistics in this section of the department obstructs effective management. Statistics is a useful management tool to observe performance and to do problem-solving. These statistics do not only supply figures, but it also provides assessment between performance of technical staff and year on year performance.

- **Immediately start a record log of inferior products and start phasing it out immediately**

  The effect of inferior products was already mentioned in this study. The department will definitely favour keeping and updating this log as it will prevent *wastes* such as travel and waiting. This is also part of the preventative maintenance plan which improves quality and in turn performance within the department.

- **Derive a strategic plan to ensure quality products by research and development**

  This forms part of the record log mentioned in the previous point. This suggestion does, however, not only identify products that add no value, but re-

search and development will provide clear and definite guidelines of good quality products and could also provide a list of preferred products and even service providers.

- **Do changes on the current reporting program to ensure more accurate and relevant data**

  This step will ensure accurate response and dispatch information. Wastes such as waiting can be reduced and tools such as cellular action (allocating fault in the same vicinity) can be employed more effectively.

- **Speed up housekeeping**

  This is a simple but effective method suggested by the 5S methodology mentioned along the study. Housekeeping in this instance suggests good record-keeping, key allocation and storage and even continuous improvement in areas such as logging of inferior products.

- **Create a continuous improvement environment where the process of quality and improvements are seen as a circle of quality**

  Quality is a non-negotiable variable in the service and production environment. This study has often referred to the influence of quality on service and productivity. Quality control is in fact a *lean* enhancement tool and used to reduce or eliminate *wastes*. The fact is, however, that quality is an ongoing effort and it does have to be part of any action undertaken in the service environment.

- **Manage change through change management initiatives and by focusing on why change is needed**

  Theory indicates change and resistance to change as a contributor to the failure of change due to lean activities. A well-developed change programme is vital to ensure not only *lean* implementation success but also to ensure continuous involvement and continuous improvement.

- **Continuous managerial contributions are vital**

  Managerial involvement creates alignment to *lean* practices. This is supported by Rahman *et al.* (2010: 1731) where they state that managerial support will

in fact ensure future state alignment and display seriousness about sustainability.

4.8 SUGGESTIONS FOR FURTHER STUDIES

This study has shown that *Lean* can be imposed on the service environment. The improvement on productivity or performance was, however, only seen as potential due to the limitations of the empirical study and the small sample of the department in the case study.

A further longitudinal study can not only support the findings of this study, but also create an opportunity to support the findings with real data such as waste removal influences observed after interventions.

This data will add validity to the field of *Lean* management in the service environment and could influence the way people think about their own industries and environment.

A study could also be done to investigate the re-engineering of the value chain. We have seen that service and the success of the service rendered are based upon the expectations of the client. These expectations should rather be inserted at the beginning of the value chain to ensure realignment of the rest of the value chain according to the client's individual expectations.

4.9 ACHIEVEMENT OF OBJECTIVES

4.9.1 General objectives

The general objective of this study was to determine whether *Lean* practices and management can be used in the service environment. It was determined that *wastes* are not restricted to the production environment and are just as present in the service environment. The objective to determine whether these production optimization principles called *Lean* or waste elimination can be applied to the service industry to identify *wastes* was reached as we have identified several *wastes* within this service department. These applications can be successfully applied because several recommendations were made by using the same waste elimination tools that are applied to the production environment

4.9.2 Specific objectives

- ***Lean* tools and practices are applicable to the service environment**

  The study has concluded that *lean* tools such as total quality management are applicable to the service environment. *Lean* identification such as Value Stream Mapping (VSM) was and can be used to identify *wastes* within the service environment

- **Several similar *wastes* present in the production environment were also identified a service environment**

  Wastes such as transport, waiting, inappropriate processing and unnecessary motion were identified within the service environment and the *wastes* that are prescribed for the production environment are also applicable to the service environment.

- **Value Stream Mapping (VSM) can identify these *wastes***

  Value Stream Mapping (VSM) was used apart from the interviews and did this analysis tool proof to be useful in this service environment. The relationship between the *wastes* identified by the technicians and the *wastes* identified by the *Value Stream Map (VSM)* was established and hence the successful application of the Value Stream Map (VSM) to identify *wastes* within the service environment.

- **Production *Lean* elimination tools can also provide solutions and positive recommendations to the service environment**

  The application of *lean* solution tools such as total quality management, cellular action and the 5S methodology was adopted from the production environment and gave positive and useful guidelines to the suggestions made prior in this study. Total quality management have been mentioned a few times as a solution in this study and have also been supported from the feedback sessions done with the manager and the technical staff.

4.10 CONCLUSION WITH REGARD TO THE TITLE OF THIS STUDY

The general conclusion is that *Lean* practices can have a potential effect on productivity and performance by optimising the value chain, managing resources more efficiently and by rendering service more effectively.

Selected *lean* tools and practices are applicable and can be applied to achieve this potential increase in performance.

Efficiency + effective = productivity/performance

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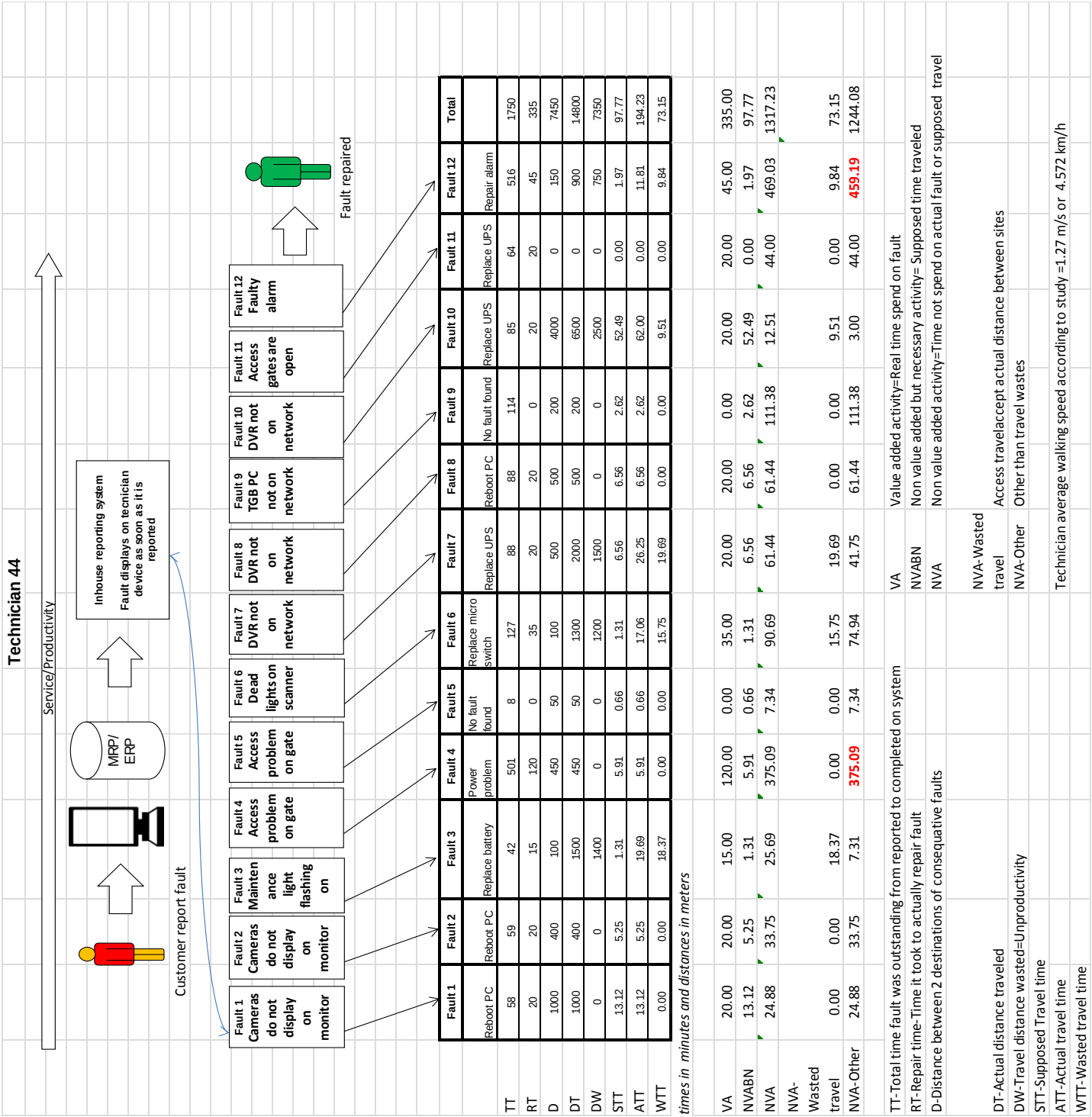
6 ATTACHMENTS

6.1 FIELD NOTES

- Field notes of focus groups in handwriting are available upon request.
- Original printouts of technician faults are available upon request.

6.2 ATTACHMENT 1: VSM OF TECHNICIAN 44 CURRENT OPERATIONS.



	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Reboot PC	Reboot PC	Replace battery	Power problem	No fault found	Replace micro switch	Replace UPS	Reboot PC	No fault found	Replace UPS	Replace UPS	Repair alarm	
TT	58	59	42	501	8	127	88	88	114	85	64	516	1750
RT	20	20	15	120	0	35	20	20	0	20	20	45	335
D	1000	400	100	450	50	100	500	500	200	4000	0	150	7450
DT	1000	400	1500	450	50	1300	2000	500	200	6500	0	900	14800
DW	0	0	1400	0	0	1200	1500	0	0	2500	0	750	7350
STT	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97	97.77
ATT	13.12	5.25	19.69	5.91	0.66	17.06	26.25	6.56	2.62	62.00	0.00	11.81	194.23
WTT	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	9.84	73.15

times in minutes and distances in meters

VA	20.00	20.00	15.00	120.00	0.00	35.00	20.00	20.00	0.00	20.00	20.00	45.00	335.00
NVABN	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97	97.77
NVA	24.88	33.75	25.69	375.09	7.34	90.69	61.44	61.44	111.38	12.51	44.00	469.03	1317.23
NVA-Wasted travel	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	9.84	73.15
NVA-Other	24.88	33.75	7.31	**375.09**	7.34	74.94	41.75	61.44	111.38	3.00	44.00	**459.19**	1244.08

TT-Total time fault was outstanding from reported to completed on system
RT-Repair time- Time it took to actually repair fault
D-Distance between 2 destinations of consequative faults

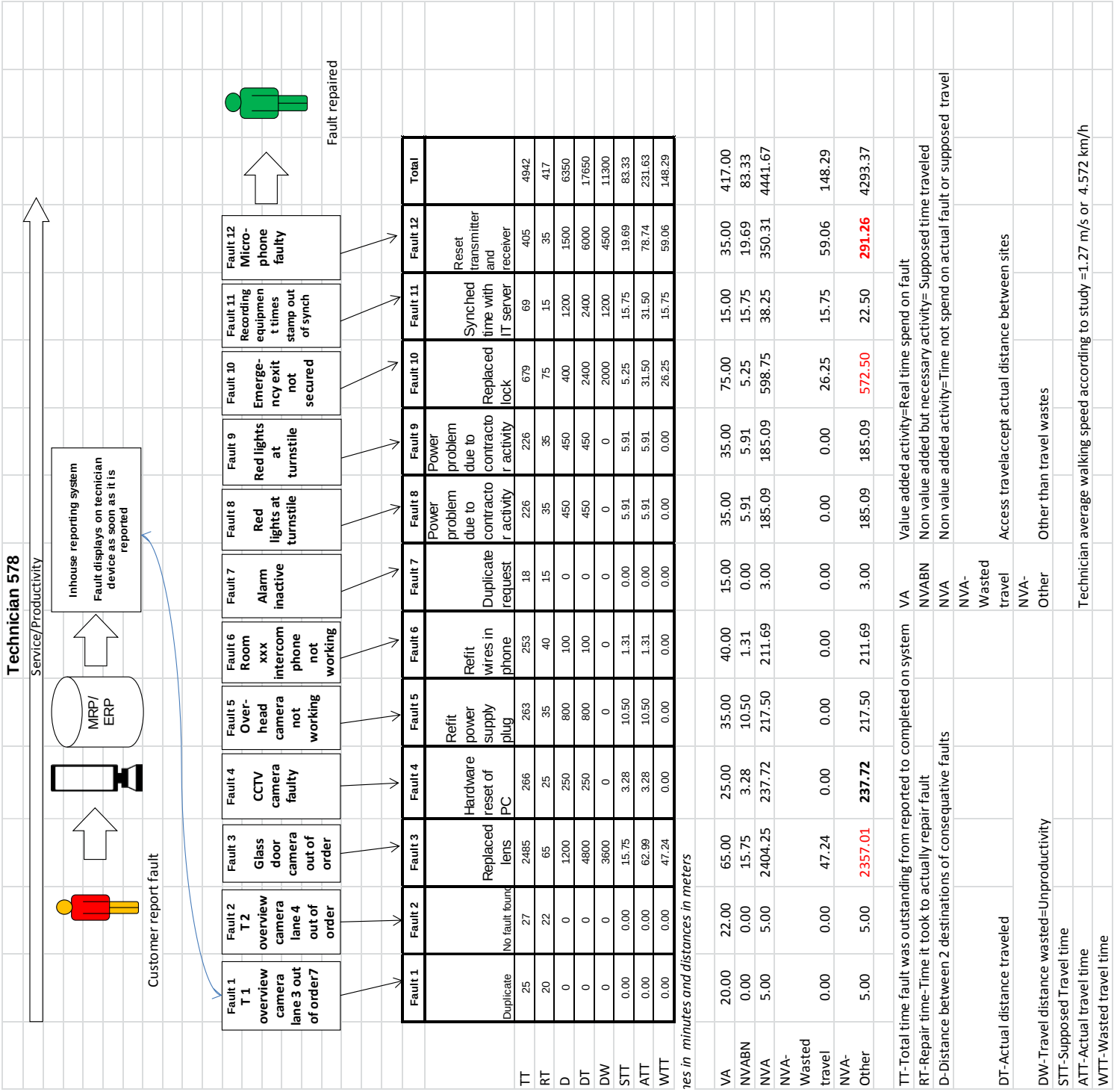
DT-Actual distance traveled
DW-Travel distance wasted=Unproductivity
STT-Supposed Travel time
ATT-Actual travel time
WTT-Wasted travel time

VA Value added activity=Real time spend on fault
NVABN Non value added but necessary activity= Supposed time traveled
NVA Non value added activity=Time not spend on actual fault or supposed travel

NVA-Wasted travel Access travelaccept actual distance between sites
NVA-Other Other than travel wastes

Technician average walking speed according to study =1.27 m/s or 4.572 km/h

6.3 ATTACHMENT 2: VSM OF TECHNICIAN 578 CURRENT OPERATIONS.



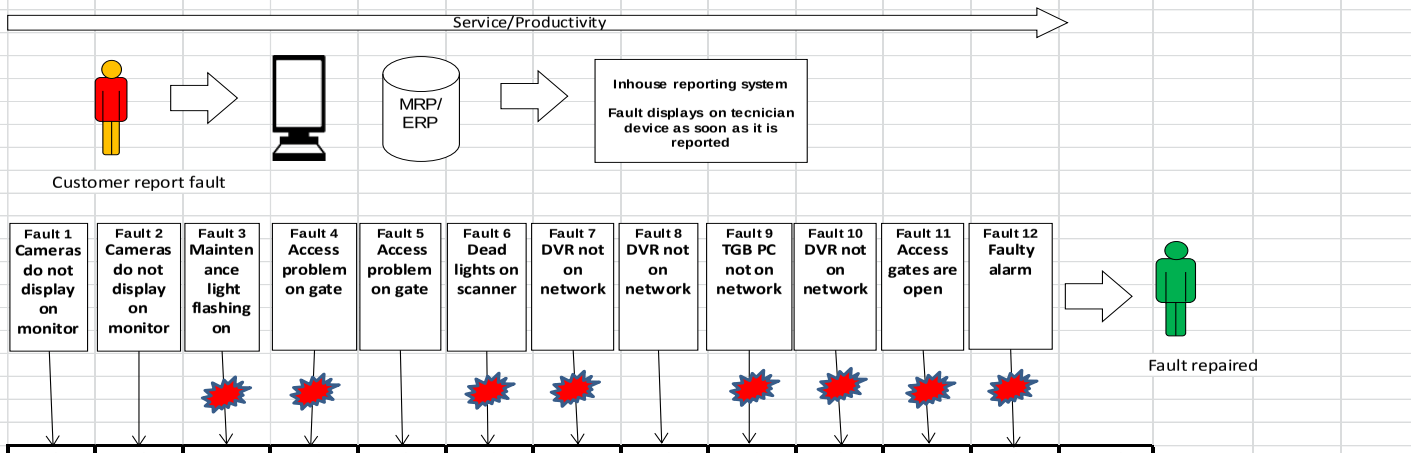
	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Duplicate	No fault found	Replaced lens	Hardware reset of PC	Refit power supply plug	Refit wires in phone	Duplicate request	Power problem due to contractor activity	Power problem due to contractor activity	Replaced lock	Synched time with IT server	Reset transmitter and receiver	
TT	25	27	2485	266	263	253	18	226	226	679	69	405	4942
RT	20	22	65	25	35	40	15	35	35	75	15	35	417
D	0	0	1200	250	800	100	0	450	450	400	1200	1500	6350
DT	0	0	4800	250	800	100	0	450	450	2400	2400	6000	17650
DW	0	0	3600	0	0	0	0	0	0	2000	1200	4500	11300
STT	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69	83.33
ATT	0.00	0.00	62.99	3.28	10.50	1.31	0.00	5.91	5.91	31.50	31.50	78.74	231.63
WTT	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06	148.29

nes in minutes and distances in meters

VA	20.00	22.00	65.00	25.00	35.00	40.00	15.00	35.00	35.00	75.00	15.00	35.00	417.00
NVABN	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69	83.33
NVA	5.00	5.00	2404.25	237.72	217.50	211.69	3.00	185.09	185.09	598.75	38.25	350.31	4441.67
NVA-Wasted travel	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06	148.29
NVA-Other	5.00	5.00	2357.01	**237.72**	217.50	211.69	3.00	185.09	185.09	572.50	22.50	**291.26**	4293.37

TT-Total time fault was outstanding from reported to completed on system	VA	Value added activity=Real time spend on fault
RT-Repair time-Time it took to actually repair fault	NVABN	Non value added but necessary activity= Supposed time traveled
D-Distance between 2 destinations of consequative faults	NVA	Non value added activity=Time not spend on actual fault or supposed travel
	NVA-Wasted travel	
DT-Actual distance traveled	Access travel	accept actual distance between sites
	NVA-Other	
DW-Travel distance wasted=Unproductivity	Other than travel wastes	
STT-Supposed Travel time		
ATT-Actual travel time	Technician average walking speed according to study =1.27 m/s or 4.572 km/h	
WTT-Wasted travel time		

6.4 ATTACHMENT 3: VSM OF TECHNICIAN 44 AFTER WASTE REMOVAL.



	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Reboot PC	Reboot PC	Replace battery	Power problem	No fault found	Replace micro switch	Replace UPS	Reboot PC	No fault found	Replace UPS	Replace UPS	Repair alarm	
TT	58	59	42	501	8	127	88	88	114	85	64	516	1750
RT	20	20	15	120	0	35	20	20	0	20	20	45	335
D	1000	400	100	450	50	100	500	500	200	4000	0	150	7450
DT	1000	400	1500	450	50	1300	2000	500	200	6500	0	900	14800
DW	0	0	1400	0	0	1200	1500	0	0	2500	0	750	7350
STT	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97	97.77
ATT	13.12	5.25	19.69	5.91	0.66	17.06	26.25	6.56	2.62	62.00	0.00	11.81	194.23
WTT	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	9.84	73.15

Waste eliminated

nes in minutes and distances in meters

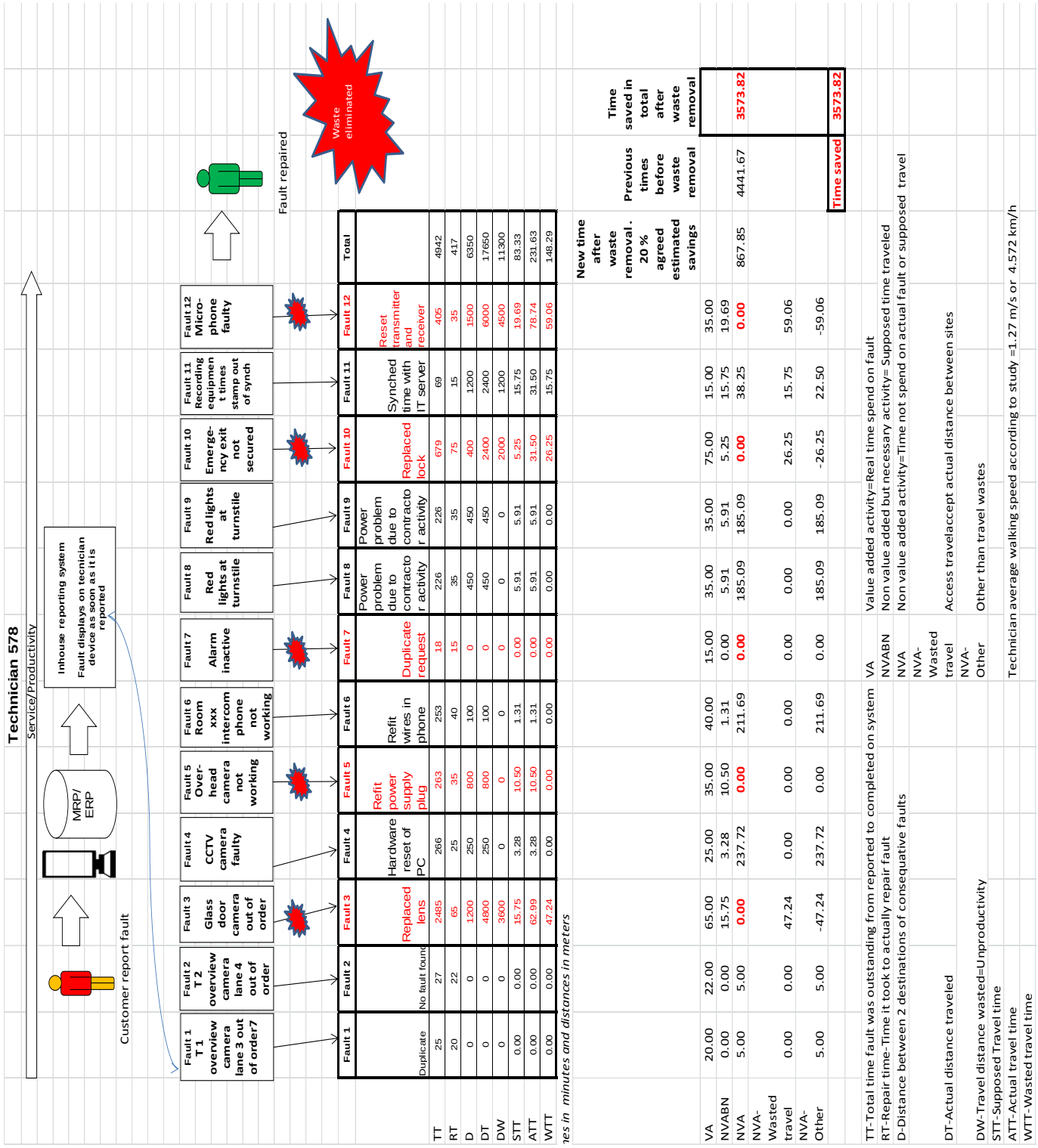
													New time after waste removal . 20 % agreed estimated savings	Previous times before waste removal	Time saved in total after waste removal
VA	20.00	20.00	15.00	120.00	0.00	35.00	20.00	20.00	0.00	20.00	20.00	45.00			
NVABN	13.12	5.25	1.31	5.91	0.66	1.31	6.56	6.56	2.62	52.49	0.00	1.97			
NVA	24.88	33.75	**0.00**	**240.00**	7.34	**0.00**	**0.00**	61.44	**0.00**	**0.00**	**0.00**	469.03	836.44	1317.23	**480.79**
NVA-Wasted travel	0.00	0.00	18.37	0.00	0.00	15.75	19.69	0.00	0.00	9.51	0.00	**0.00**	63.31	73.15	**9.84**
NVA-Other	24.88	33.75	-18.37	240.00	7.34	-15.75	-19.69	61.44	0.00	-9.51	0.00	469.03			
														Time saved	**490.63**

TT-Total time fault was outstanding from reported to completed on system
RT-Repair time-Time it took to actually repair fault
D-Distance between 2 destinations of consequative faults
DT-Actual distance traveled
DW-Travel distance wasted=Unproductivity
STT-Supposed Travel time
ATT-Actual travel time
WTT-Wasted travel time

VA — Value added activity=Real time spend on fault
NVABN — Non value added but necessary activity= Supposed time traveled
NVA — Non value added activity=Time not spend on actual fault or supposed travel
NVA-Wasted travel — Access travelaccept actual distance between sites
NVA-Other — Other than travel wastes

Technician average walking speed according to study =1.27 m/s or 4.572 km/h

6.5 ATTACHMENT 4: VSM OF TECHNICIAN 578 AFTER WASTE REMOVAL.



	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5	Fault 6	Fault 7	Fault 8	Fault 9	Fault 10	Fault 11	Fault 12	Total
	Duplicate	No fault found	Replaced lens	Hardware reset of PC	Refit power supply plug	Refit wires in phone	Duplicate request	Power problem due to contractor activity	Power problem due to contractor activity	Replaced lock	Synched time with IT server	Reset transmitter and receiver	
TT	25	27	2485	266	263	253	18	226	226	679	69	405	4942
RT	20	22	65	25	35	40	15	35	35	75	15	35	417
D	0	0	1200	250	800	100	0	450	450	400	1200	1500	6350
DT	0	0	4800	250	800	100	0	450	450	2400	2400	6000	17650
DW	0	0	3600	0	0	0	0	0	0	2000	1200	4500	11300
STT	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69	83.33
ATT	0.00	0.00	62.99	3.28	10.50	1.31	0.00	5.91	5.91	31.50	31.50	78.74	231.63
WTT	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06	148.29

nes in minutes and distances in meters

													New time after waste removal. 20 % agreed estimated savings	Previous times before waste removal	Time saved in total after waste removal
VA	20.00	22.00	65.00	25.00	35.00	40.00	15.00	35.00	35.00	75.00	15.00	35.00			
NVABN	0.00	0.00	15.75	3.28	10.50	1.31	0.00	5.91	5.91	5.25	15.75	19.69			
NVA	5.00	5.00	0.00	237.72	0.00	211.69	0.00	185.09	185.09	0.00	38.25	0.00	867.85	4441.67	3573.82
NVA-Wasted travel	0.00	0.00	47.24	0.00	0.00	0.00	0.00	0.00	0.00	26.25	15.75	59.06			
NVA-Other	5.00	5.00	-47.24	237.72	0.00	211.69	0.00	185.09	185.09	-26.25	22.50	-59.06			
														Time saved	3573.82

TT-Total time fault was outstanding from reported to completed on system	VA	Value added activity=Real time spend on fault
RT-Repair time-Time it took to actually repair fault	NVABN	Non value added but necessary activity= Supposed time traveled
D-Distance between 2 destinations of consequative faults	NVA	Non value added activity=Time not spend on actual fault or supposed travel
	NVA-Wasted travel	
DT-Actual distance traveled		Access travelaccept actual distance between sites
	NVA-Other	
DW-Travel distance wasted=Unproductivity		Other than travel wastes
STT-Supposed Travel time		
ATT-Actual travel time		Technician average walking speed according to study =1.27 m/s or 4.572 km/h
WTT-Wasted travel time		