Reducing waste in administrative services with lean principles

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Beckers, David, University of Twente, d.k.beckers@student.utwente.nl

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Supervisors: Fons Wijnhoven and Chintan Amrit

Abstract

Lean techniques have been applied for improving production systems in manufacturing processes over the last two decades and have had a profound impact on productivity. More recently, lean is used outside manufacturing; for example in hospitals, government agencies, and service organizations. This paper focuses on reducing waste in administrative processes in organizations. A lean approach for optimizing administrative processes is developed by adapting the conceptualization of waste and developing a set of lean principles for administrative processes. The method was field tested at a university. Waste in the current processes was identified and classified. Recommendations for reducing waste were then made according to lean principles. The study shows that the adapted conceptualizations of waste are applicable to administrative processes. Principles and techniques could also be transferred from manufacturing to administrative processes. Two additional principles were added to address recurrent problems found in administration: improving communication and designing information systems to support users in an optimal way.

Keywords: lean, process improvement, administration, design science

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List of abbreviations

EEA: European Economic Area
DAF: Digital Application Form
GIM: Faculty of Geo-Information Management
LEFI: Lean Evaluation and Future Improvement
MD: meta-design
MR: meta-requirement
M.Sc.: master of science
NFP: Netherlands Fellowship Programme
Nuffic: Netherlands organisation for international cooperation in higher education
SIS: Student Information System
USTS: the University of Social and Technical Sciences
VSM: Value Stream Map

1. Introduction

The emergence of lean, lean production, and lean thinking has been one of the major developments in management practice during the last two decades (Alsmadi, Almani, & Jerisat, 2012). The term "lean" was coined in 1990 by Womack & Jones who used it to describe the Toyota Production System, which was able to produce more output while using less resources. Lean manufacturing has the aims of reducing waste and ensuring that remaining steps flow (Womack & Jones, 1996). This approach, if executed well, also leads to significantly better quality. Even though lean was born and has evolved in manufacturing, it has recently been applied in services with some degree of success (Alsmadi et al., 2012; Bortolotti, Romano, & Nicoletti, 2010; Swank, 2003).

Although lean is said to target the whole value stream (Womack & Jones, 2003), existing literature on lean is primarily concerned with addressing the problems associated with batch-and-queue production systems by improving layout design as well as production and distribution timing. The administrative component of an organization coordinates the work of the operating core (Mintzberg, 1979), but insufficient attention is given to this in lean. Administration includes all the activities in order to plan, organize, and run an organization. Organizations have a crucial dependency on these administrative services: people and resources must be coordinated, quality and customer satisfaction must be monitored, orders must be processed, and deliveries need to be scheduled. Unfortunately, administrative services in many organizations are carried out in an inefficient manner, resulting in long waiting times and frequent errors (Bortolotti et al., 2010; Piercy & Rich, 2009).

Some previous studies have demonstrated that lean techniques can significantly improve the performance of services (Bortolotti et al., 2010; Middleton & Joyce, 2012; Piercy & Rich, 2009; Swank, 2003). However, these existing contributions have limitations in a number of areas. Lean is not a clearly defined concept, and the theoretical underpinnings of many studies are inconsistent. Some studies emphasize the philosophical foundations of lean thinking, e.g. Ohno (1988) while others only discuss lean tools and techniques, e.g. Shah & Ward (2003, 2007). Most studies are exploratory and lack generalization (Bortolotti et al., 2010; Middleton & Joyce, 2012; Piercy & Rich, 2009); they show that a lean-like approach (eliminating waste) is usable in pure services or the public sector, but they do not describe how they adapted or extended lean thinking to their needs, or how it could be used in other similar contexts.

Kotler (1988, p. 477) defines a service as "… any act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything." Services differ from manufacturing in a number of important ways, and the lean approach therefore needs to be adapted to bring about operational improvements in this context. This paper proposes a method for improving the efficiency of administrative services based on lean. The research question addressed is: "How can lean principles be adapted to administrative services?" A design science approach is used to develop a lean implementation method with an adapted conceptualization of waste and a modified set of lean principles. This design artifact is evaluated with a field test at a university. A number of processes related to the registration and admission process of a university are analyzed and recommendations in line with lean principles are made in order to streamline this process.

2. Theory

Lean, lean manufacturing, or lean production is one of the most prominent methods for continuous improvement of production systems. Toyota's journey to become the world's most profitable automobile manufacturer is often credited to the Toyota Production System (TPS) (Staats, Brunner, & Upton, 2011). Car manufacturers relied on large lot sizes due to long set-up times, but such methods would not work in Japan during the 1950s where demand was smaller (Ohno, 1988). Lean production developed gradually over many years as an accumulation of many small innovations (Fujimoto, 1999). The Toyota Production System resulted in an ability to produce a variety of automobiles in comparatively low volumes at a competitive cost, altering the conventional mass production logic (Holweg, 2007). Lean practices spread from Toyota to the wider automotive sector, and soon expanded into other manufacturing and service operations. Its link to superior performance is well-accepted among academics and practitioners (Shah & Ward, 2007). To further explain lean, the problem of waste is first discussed. This is followed by a review of principles and techniques that are used to reduce waste. The issues that need to be taken into account for applying lean in services are subsequently discussed. Lastly, existing applications of lean in service contexts are presented.

2.1 The problem of waste

According to Womack & Jones (2003), all activities to design, order, and make a product can be sorted into three categories: (1) activities which create value for the customer, (2) activities which do not create value but are required by the current product development, order filling, or production systems and therefore cannot be eliminated just yet, and (3) actions which do not create value for the customer and can be eliminated accordingly. These non-value-creating activities are waste, and it is commonly referred to as *muda*. Type I muda is waste that is necessary to make the current system function. Type II muda is non-value-added and should be eliminated first. In manufacturing, waste occurs in the form of mistakes which require rectification, the production of items no one wants, performing process steps which are not actually needed, movement of employees and goods from one place to another without any purpose, and people in a downstream activity waiting because an upstream activity has not delivered on time (Womack & Jones, 2003).

Even from the most casual observation of an average organization, it is hard to dispute that waste is everywhere. Traditional mass production in batches does not produce a steady flow of goods, resulting in waste in the form of inventory and waiting. Traditionally, a steady flow of products could not be produced since large lot sizes were needed due to long set-up times (Ohno, 1988). In addition, machines of the same kind (lathes, presses) were put together, resulting in unneeded *motion* of workers and materials. Mass production systems were also guided by capacity rather than demand, creating in a *push* system that generates a large amount of work-in-progress and finished goods inventory. Another disadvantage of traditional mass production systems is that because large batches are produced, faults cannot be addressed quickly, so when they occur, they occur on a large scale (Swank, 2003). A further important cause of waste is that defective products are passed on to the next production step. Inspection is typically only done at the end of the line and quality is the responsibility of a small group of specialists (Ishikawa, 1986). Ohno (1988) identified seven types of waste, which were reported later by Womack et al. (1990):

1. Overproduction – this occurs when operations continue after they should have ceased. Overproduction leads to increased inventory.
2. Waiting – this is sometimes referred to as queuing and occurs when an upstream activity has not delivered its output on time.
3. Transport – unnecessary motion or movement of materials, such as work-in-progress (WIP) being transported from one place to another. Transport should be minimized because it increases lead times and does not add value. Furthermore, damage can occur during transport.
4. Extra processing – extra operations such as rework, handling, or storage that occur because of defects, overproduction, or excess inventory.
5. Inventory – all inventory not needed directly to fulfill customer orders is waste. Inventory requires extra handling and space.

6. Motion – refers to the extra steps taken to accommodate inefficient layout, defects, reprocessing, overproduction, or excess inventory.
7. Defects – goods or services that do not conform to the specifications or customer expectations, thus causing dissatisfaction.

An important form of waste that is not represented in the original Seven Deadly Wastes is *unused human potential*. Not fully using people's mental, creative, and physical abilities leads to all sorts of lost opportunities such as lost motivation, less creativity, and lost ideas. Unused potential often results from management policies and management styles that diminish employee contributions (Lindner & Becker, 2010).

2.2 Lean principles and techniques

The lean literature contains principles and techniques that can be used to reduce waste in organizations. The principles and techniques that make up lean are listed below.

Reduce waste: eliminating waste from the value chain has the highest priority in lean. Waste is an expenditure of resources for a purpose other than creating value for the customers (Liker & Morgan, 2006; Womack et al., 1990). Waste can occur as excess inventory, unnecessary steps, backtracking, and scrap (Shah & Ward, 2007; Womack & Jones, 1996). Reducing waste reduces resource requirements while maintaining or increasing output levels. Reducing waste contributes to increasing operational performance by streamlining processes and increasing process consistency (Alsmadi et al., 2012).

Focus on customer value: focusing on the customers and their needs is an integral part of lean. Directing attention to the customer and striving to deliver good service is something most organizations claim to be concerned with (Radnor & Johnston, 2012). Customer focus means that the customer becomes part of the value creation of the firm, and that the organization tries to find opportunities for creating greater value for both the customer and the organization (Prahalad & Ramaswamy, 2006). A collaborative approach to customers allows the firm to better understand and deliver what the customer needs (Radnor & Johnston, 2012). The lean thinking concept (Womack et al., 1990; Womack & Jones, 1996) considers defining value from the customer's perspective as its first principle, with the other principles being (2) identify the entire value stream for each product or product family and eliminate waste, (3) make the remaining value-creating steps flow, (4) design and provide what the customer wants only when the customer wants it, (5) pursue perfection. Value was crystallized as the first principle of lean thinking, moving lean away from the shop-floor to an approach that contingently seeks to enhance value (or perceived value) to customers by adding product or service features and/or removing wasteful activities (Hines, Holweg, & Rich, 2004).

Standardize work: all activities at Toyota are highly specified as to content, sequence, timing, and outcome (Spear & Bowen, 1999). Standardization of work means to select the best possible way of performing an activity, applying this, and standardizing it (Lindner & Becker, 2010). A high degree of specification reduces variation, which improves quality, productivity, and costs. The use of a well-defined sequence of steps for a particular job makes it clear when there is a deviation from the specifications (Spear & Bowen, 1999).

Make steps flow: making steps flow means working continuously from beginning to end without waiting, downtime, or scrap within or between steps (Womack & Jones, 1996). One way of creating flow in the workplace is to position machines and people according to the flow of operations, which prevents workers from having to carry back and forth materials and tools between machines (Ohno, 1988). Flow also means that materials are only produced when they are needed so that inventory can be reduced to a minimum. A further important consequence of establishing flow is that throughput time is reduced by eliminating the frequent stop-and-go operations that are typical for batch-and-queue production systems (Shah & Ward, 2007). The ultimate goal in creating flow is to establish a batch size of one – a one-piece flow. At Toyota, goods and services do not flow to the next available person or machine, but to a *specific* person or machine. This links each operator who contributes to the product across the whole production line and supply chain. If this person or machine is not available, Toyota will see it as a problem that might require a redesign of the line (Spear & Bowen, 1999).

Reduce inventory: inventory consists of all components, work-in-progress, and finished goods that are not being processed (Gopinath & Freiheit, 2012). Inventory is held by firms to ameliorate the effects of variability in supply, processing time, and demand (Shah & Ward, 2007). Inventory is often the result of inefficient plant layout, unreliable suppliers, variable processing time, and customer demand that is poorly managed. Excess inventory is a form of waste because it does not add value for the customer. Inventory also takes up space and leads to higher costs; moreover, excess inventory reduces production flexibility and makes problems hard to detect on time. Inventory can be reduced by focusing on the production flow to ensure that material is only produced in the exact quantity when it is needed. Less inventory reduces costs, increases flexibility, and allows the source of defects to be identified quickly (Middleton & Joyce, 2012).

Increase employee involvement: Lean management emphasizes the role employees play in solving problems. Lean tries to involve employees in improving operations by allowing them to provide input in problem-solving, reengineering, quality improvement, and preventive maintenance (Shah & Ward, 2007). Some lean conceptualizations recommend that employees be cross-trained so that they are able to step in for absent employees without disrupting flow or compromising on the quality and quantity of the work delivered (Shah & Ward, 2007). Employee involvement is closely related to continuous improvement. Continuous improvement consists of taking small steps to improve every day, put forward by the employees actually working in the process (van Campen & Hertzberger, 2009). Especially the cultural change associated with employees themselves taking steps to increase the efficiency and effectiveness of their work is seen as a very powerful mechanism in bringing about operational improvements (Ohno, 1988; van Campen & Hertzberger, 2009).

Take a holistic perspective: lean should be applied to the whole organization. Lean techniques and principles need to be put together to form a coherent business logic, otherwise the effect of lean will remain limited (Womack & Jones, 1996). Lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services through entire the value streams that flows horizontally across technologies, assets, and departments. Eliminating waste along the entire value stream, instead of at isolated points, creates processes that need less effort and produce more output.

In addition to principles, a number of specific practices are associated with lean thinking. Researchers disagree on the exact practices and their number, but there is general consensus that there are four groups or bundles of related practices (Shah, Chandrasekaran, & Linderman, 2008).

Quality management: practices related to continuous improvement and sustainability of quality products and process were combined to form the Total Quality Management (TQM) bundle (Shah & Ward, 2003). Quality frameworks typically stress the importance of cross-functional product design and systematic process management. Furthermore, they emphasize the involvement of customers, suppliers, and employees to ensure quality(Cua, McKone, & Schroeder, 2001).

Pull production: a pull production system is oriented towards consumption (Lindner & Becker, 2010). Material replenishment is triggered on short notice when inventory falls below a predefined level. This gives suppliers an immediate overview of demand and this is connected to a supply order. The result of a pull system is a reduction of inventory and increased flexibility because the system can cope with constantly changing demand (Lindner & Becker, 2010). A well-known tool is Kanban, a system to control the logistical chain and inventory. Kanban facilitates pull production by using signal cards to trigger automatic replenishment of materials (Ohno, 1988). It establishes an upper limit to the amount of work-in-progress inventory, which prevents the manufacturing system from getting overloaded.

Preventive maintenance: this bundle includes practices mainly designed to maximize equipment effectiveness through planned predictive and preventive maintenance and using maintenance optimization techniques (Shah & Ward, 2003). Emphasis on maintenance may also be reflected by the emphasis given to new process equipment or technology acquisition.

Human resource management: Shah & Ward (2003) include two practices in the HRM bundle: creating a flexible, cross-functional workforce and the use of self-directed work teams. These two practices can be broken down into further tools and practices. The two practices mentioned here are practices to support the overall principle of increasing employee involvement.

Although firms are confronted with strong demands for efficiency, one must consider that some slack is necessary to stimulate innovation (Nohria & Gulati, 1996). Going too far with cost-cutting using methods such as lean production, downsizing, and business process re-engineering could jeopardize a firm's capacity for innovation and renewal (Hamel & Prahalad, 1994). Slack is defined as the pool of resources that is in excess of the minimum necessary to produce a given level of output. It includes excess inputs such as redundant employees, unused capacity, and excess capital expenditures, which is similar to the concept of waste in lean thinking. The presence of slack resources leads to a relaxation of controls and provides funds for projects with a high degree of uncertainty. It allows the pursuit of innovations which would normally not be approved, fostering a culture of experimentation. Such uncertain projects often fail, but they can be of great benefit to the firm in case they become successful. However, too much slack inhibits innovation as it leads to complacency and lack of discipline, making it likely that more bad than good projects are pursued. The results of an empirical study by Nohria and Gulati (1996) show that there is a curvilinear relationship between slack and innovation. The implication of this is that there is usually room for reducing the amount of slack in organizations to increase efficiency, but an appropriate amount of slack should be kept to maintain the firm's innovativeness.

2.3 Lean in services

Since this paper is about using lean in administrative services, it is useful to discuss the specific characteristics of administration. Administration includes the activities that are done to plan, organize, and run an organization. The input of an administrative process is information. Administration has decisions or rights as output. To illustrate, the IT department translates information needs into technological capabilities by making decisions on which IT resources to purchase or develop. Accounting collects billing information and produces reports and other performance measures. Finance receives capital requirements and planned investments from the rest of the organization which it turns into budgets and financial measures. A human resources department is provided with certain labor requirements. It then ensures that the necessary labor skills will be available at an acceptable cost by coordinating hiring, payments, and benefits.

A wide range of services exists. Johnston et al. (2012, p. 6), referring to Sampson & Froehle (2006) define "service" as the following: "While a product is a thing, a service is an activity – a process or a set of steps – which involves the treatment of a customer (or user) or something belonging to them, where the customer is also involved, and performs some role in the service process (also referred to as the service delivery process)." One of the key differences with manufacturing is that services generally do not have a tangible output. Instead, services provide benefits to the customers. An important outcome of services is the "functional" output, which can be an actual "product" such as the food and drink served by a restaurant, or something intangible such as the knowledge gained from a training course (Johnston et al., 2012). The second key difference with manufacturing is that the customer is able to see much of the service process and in many cases plays a key role in rendering the service (Grönroos, 2007; Johnston et al., 2012; Murdick, 1990). For example, you are required to carry your own meal to your table at a fast food restaurant and a doctor cannot treat you if you do not physically visit him. In contrast, most customers do not get to see a manufacturing process and generally do not get involved in it. The part played by customers in the service process is referred to as co-production or co-creation (Johnston et al., 2012).

Comparing manufacturing to services with the purpose of transferring lean principles is complex due to the great variety in service processes. A few implications can nonetheless be derived from a comparison to manufacturing. The intangibility of many service outcomes can make some issues related to the flow of physical goods less relevant. However, although many services do not have a physical component, movement of workers, customers, and information still takes place, creating opportunities for waste reduction in this area. Another important implication of the difference between services and manufacturing is that customers play a very important role in rendering a service, which means that processes need to be adapted to their needs. Considering the customer as a co-producer of value is one of the foundational premises of the service-centered view on marketing (Vargo & Lusch, 2004).

A number of authors argue that lean principles can be applied to nearly any environment where a process can be defined (Arlbjørn, Freytag, & de Haas, 2011; Bhatia & Drew, 2006; Radnor, Walley, Stephens, & Bucci, 2006). Womack & Jones (1996) proposed a major role for lean in the service sector. Lean is especially effective in situations where demand is predictable, the need for variety is low and the volumes are high, which are the conditions in which Toyota developed the lean philosophy (Christopher, 2000). These conditions are present for many service processes, including administrative processes, which is the type of service this paper focuses on. A lot of administrative processes are repetitive, with low variety. Administrative processes can occur in high volumes – a process has a high volume when each operator has to process a large number of similar documents and requests. Demand for administrative processes is stable in some cases, but not always. Problems arise when the lean approach is implemented in situations where demand is less predictable (Christopher, 2000). Instead, “agile” approaches are more suitable for situations with higher demand variability and product variety. Over the years, lean has moved from the production floor to other functional areas such as supply chain management and logistics. Lean has moved to sectors other than manufacturing more recently, with applications of lean thinking at hospitals, administrations, and pure service organizations (Arlbjørn et al., 2011). It is suggested that lean can contribute to increasing productivity by more structured problem solving in teams, a more flexible allocation of resources, and smoothing out the workload (Bhatia & Drew, 2006). Although lean approaches have been widely applied in manufacturing, there is a lack of width and depth of understanding in the service sector (Hines, Martins, & Beale, 2008; Radnor et al., 2006). Still, there is support that lean can be successfully adapted for use in services. According to Piercy & Rich (2009, p. 72), “… the lean approach can be relatively easily applied, with minimal investment in training, very rapidly generating major improvement gains for adoptive companies.”

Techniques originating from lean production are applied increasingly to services. The empirical results of the study by Alsmadi et al. (2012) comparing lean practices in UK production and service firms confirmed that service firms are interested in lean practices. Most of the 10 lean practices were applied both in manufacturing and service firms. Only total productive maintenance, set-up time reduction, and supplier feedback differed due to the nature of service operations (Alsmadi et al., 2012). Not all lean practices and principles can be translated to services, for example, total productive maintenance and set-up time reduction are not directly replicable in service operations since there is no machinery that needs to be maintained or set up (Alsmadi et al., 2012). A number of case studies and surveys indicate that lean practices contribute substantially to the performance of firms, also when they do not manufacture physical products. Swank (2003) showed how a lean initiative was able to push the performance of an insurance company to new heights. By creating a small batch flow to reduce work-in-progress, standardizing procedures, and placing linked processes near one another, the lead times and quality were improved dramatically. At a publishing company, cycle time and output quality were improved significantly by installing an operational management process based on the Lean Six Sigma methodology (van Campen & Hertzberger, 2009). Reviewing the division of work and monitoring performance was very important for increasing efficiency and quality. The cultural change associated with the lean management approach was perhaps the most beneficial aspect: continuous improvement by taking into account staff suggestions was very well-received and effective. The “Lean First, Then Automate” framework was developed in the banking sector and dramatically improved operational efficiency and customer satisfaction (Bortolotti & Romano, 2012). By removing waste from processes in accordance with lean thinking and automating where possible, waiting times and quality problems were reduced drastically.

In software development, lean further expands agile development methods by introducing a number of thinking tools to translate lean principles into agile practices (Kupiainen, Mäntylä, & Itkonen, 2015). A case study carried out by Joyce & Middleton (2012) showed how a lean software development process creates more customer value and better efficiency. Short work cycles make it easy to identify and solve problems. Lean reduces the size, complexity, and volume of work input. Lean in software development was shown to have a number of advantages compared to agile approaches, for instance, lean avoids arbitrary deadlines, which prevents game playing and poor quality to finish work in less time. In lean, data is used to empower the team rather than using it as a management control tool. Lean makes continuous process improvement explicitly part of the routine. Finally, work-in-process limits and Kanban boards make problems visible to everyone so staff cannot “cherry pick” what they would like to work on (Middleton & Joyce, 2012).

The public sector has also come under pressure to reduce costs and improve the quality of service they offer. Some administrations were induced to utilize best practices from manufacturing, with many public sector organizations introducing lean practices and tools to achieve costs savings and quality improvements (Di Pietro, Mugion, & Renzi, 2013; Radnor & Walley, 2008). The public sector differs in a number of ways from the private sector. First of all, the “customer” is not as well-defined. According to Arlbjørn et al. (2011), “customers” of a public service are stakeholders with potentially conflicting interests and political ideals. A study involving several UK government agencies showed that especially front-line staff found the idea of the “customer” difficult to grasp because they do not have a choice of service provider. Likewise, they found the idea of “internal customers” difficult to understand (Radnor & Johnston, 2012). There may be a challenge in establishing a link between internal operations, service delivery, and customer value. The starting point for improvement in the public sector does not have to be the customer; it could also be the process (Radnor & Johnston, 2012). The implementation of lean thinking in the public sector is also affected by administrative law and other legal constraints. The public sector possesses limited resources and must address the key issues of equity, transparency, and fairness in a political context (Di Pietro et al., 2013). However, when the legal constraints are taken into account, lean thinking can be used to reduce cycle time and rework in public sector services (Scorsone, 2008). In a case study of the legal public sector in Wales and Portugal, making changes to the process was very effective in reducing waiting and extra processing. Shorter lead times improved customer satisfaction and the much smaller backlog was good for staff morale (Hines et al., 2008). Similar productivity, staff morale, and customer satisfaction improvements were reported by Radnor & Johnston (2012) who studied the use of lean techniques in various branches of the UK government. One important reason for the effectiveness of a lean approach is that it breaks with the trade-off between quality of public services and the cost of providing them (Bhatia & Drew, 2006). Other positive aspects of using a lean approach are that it brings different stakeholders together to work on solutions with a strong sense of team spirit and increased learning and information sharing across departments. Moreover, processes and workflows are mapped through direct observation and it gives employees a greater sense of control over their environment (Bushell & Shelest, 2002).

3. Designing a method for applying lean to administrative services

This section describes how a method for implementing lean in administrative processes is designed following a design science methodology. The outcome of design science is an artifact (Cleven, Gubler, & Hüner, 2009); in this case, the "Lean Evaluation and Future Improvement" (LEFI) two-step method. The design theory concept articulated by Walls, Widmeyer, and El-Sawy (1992, 2004) is followed by developing meta-requirements, a meta-design, and a kernel theory. Gregor & Jones' (2007) formulation of the structural components of design theories is also taken into account to overcome some of the limitations of Walls et al. (1992, 2004). Kernel theories are "micro theories" (Simon, 1996) or "justificatory knowledge" (Gregor & Jones, 2007) that determine the requirements of the design artifact. Lean makes a statement about what is desirable (e.g. value creation, smooth flow of materials) and what is undesirable (waste). Lean is also an instrument for problem-solving and action. In this paper, lean is therefore viewed as a normative and pragmatic theory of operations management. According to Gregor & Jones (2007), "justificatory knowledge" (kernel theories) provide an explanation of why an artifact is constructed as it is and why it works. This can be accomplished even though the theory originated outside the social or natural sciences, as is the case with practitioner-in-use theories like lean.

The Lean Evaluation and Future Improvement (LEFI) method has a number of meta-requirements (MR). It is important that the method is able to function within the resource constraints and decision-making processes of the organization (MR1), the method needs to be suitable for identifying waste (MR2), and the method has to propose adequate solutions (MR3). The *meta-design* is the method itself and intends to fulfill the meta-requirements. The meta-design emerged from comparing and evaluating existing lean implementation methods. According to Pearce & Pons (2013), a typical lean implementation involves an initial value stream mapping (VSM) that describes the current state of processes and defines the path of improvement by defining a desirable future state. This is followed by "organizing of the house" which involves implementing flexible work systems and 5S (a methodology for organizing the workplace in a clean, efficient, and safe manner). After that, other tools are implemented where relevant, such as standardization of work, setup time reduction, and total productive maintenance (TPM). Further advancements might involve managing supply and demand with just-in-time (JIT) pull systems and level scheduling (Heijunka) (Pearce & Pons, 2013). A weakness in typical lean implementation approaches is the emphasis on tools, which promote isolated improvement instead of optimizing the entire production system (Pearce & Pons, 2013). An alternative method for lean implementation is organizing a "Kaizen event" which is a rapid improvement activity lasting three to five days during which a team improves a process toward a particular goal. The use of Kaizen events has been reported in several case studies in the service industry (Di Pietro et al., 2013; Hines et al., 2008; Radnor & Johnston, 2012). Kaizen events generally consist of preparation including team selection, gathering background information, and goal setting, followed by training the team in relevant lean basics. The current state is then documented. Team members brainstorm and develop a future state, which is subsequently implemented. It is recommended that a follow-up plan is created and that results are presented. A limitation of Kaizen events is that it cannot solve all problems. For example, process improvements that require experimentation and statistical methods are best carried out over a period of time. Radnor & Walley (2008) also conclude that establishment of a more sustainable lean capability is achievable with a fuller implementation that takes a more longitudinal, developmental approach.

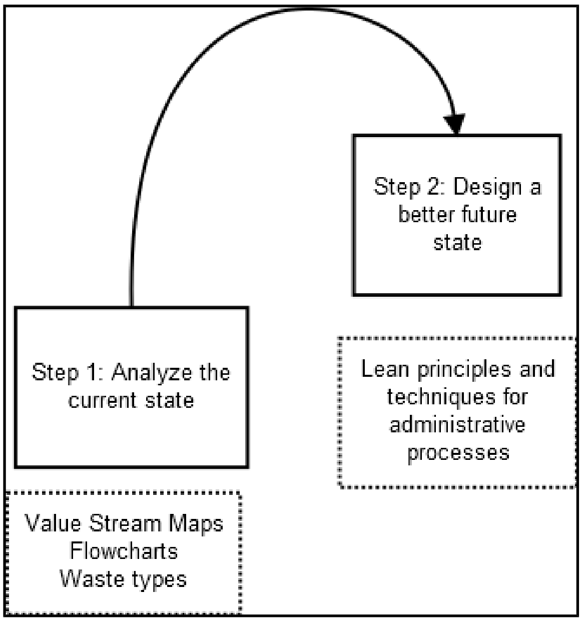

Figure 1: the Lean Evaluation and Future Improvement (LEFI) method

LEFI follows the two first phases of the Value Stream Design method described by Lindner & Becker (2010). Advantages of the Value Stream Design method are that it takes a holistic approach and does not emphasize tools. In addition, the method distinguishes between an ideal future state and a feasible future state. The outcome of using LEFI is an overview of the current process and a set of recommendations for improving it. The LEFI two-step method is outlined in Figure 1 and forms the *meta-design* (MD1). The first step is to analyze the current state of the process. This is done with Value Stream Maps (VSMs) and flowcharts (MD2). Value stream maps (VSMs) show the steps in the process, the information systems that are used, and the time it takes to complete each step. In addition, VSMs allow people to fill in the number of units processed in a given period, the number of employees performing each step, as well as inventories. This information is collected by going through the process ("line walk"), measuring processing times, and inquiring with personnel. After this has been done, waste in the existing process is identified. This means finding activities that do not add value, detecting where waiting times occur, and where mistakes are frequently made. These problem areas are indicated with "Kaizen bursts" and numbered. The second step involves designing a better future state by making suggestions to improve the current-state process. Addressing the "Kaizen bursts" identified in the value stream maps is sometimes enough to create significant operational improvements. In general, solving the Kaizen bursts one by one is suitable for short and simple processes. More extensive redesign of the process may be needed for more complex and long processes (Lindner & Becker, 2010). The lean literature provides a lot of guidance on how processes should be designed for high value creation and short throughput times.

The first two steps of analyzing the current state and designing an ideal future state require theory application to administrative services. An adapted description of the different waste categories is provided below. A set of lean principles and techniques for reducing waste in administrative processes is also provided. In addition to literature on lean in services, the ideas of Hicks (2007) on lean information management are used since administrative services are information-intensive as most of the time is spent on dealing with information. Higher information intensity allows greater use of IT (Mithas & Whitaker, 2007); administrative services generally use information systems for most activities. Waste categories specific to administrative processes are provided below (MD3). An overall definition of waste has been added to the list of waste categories since not all waste can be classified into a specific category. "Transport" has been left out since the movement of physical materials plays a minor role in administration. Still, "motion" can occur in administrative processes. The "lack of standardization" category was added because this is a type of waste that was reported several times in the literature (Bortolotti et al., 2010; Swank, 2003; van Campen & Hertzberger, 2009). Moreover, under-utilization of human potential, the "eighth category of waste," should be emphasized in a service context since services are people-intensive, depending highly on human input and interaction. In addition to human potential, information technologies could be under-utilized when users underestimate the performance-enhancing potential of information systems. These two forms of under-utilization are represented as one waste category.

1. Expenditure of resources that does not add value for the customer: Waste is any expenditure of resources which does add value from the perspective of the customer (Gopinath & Freiheit, 2012; Liker & Morgan, 2006; Womack et al., 1990). Unneeded expenditure of resources could be the additional steps or inactivity due to poorly executed tasks. For example, at a publisher, sorting was done multiple times and could actually be done in a single sorting phase (van Campen & Hertzberger, 2009). In a software development case, many additional actions had to be taken because developers had difficulty in obtaining passwords and data from customers (Middleton & Joyce, 2012). Correspondingly, in the context of information management, Hicks (2007) considers waste to include the additional actions and inactivity as a result of not providing the information customer with an adequate amount of appropriate, accurate, and up-to-date information.

2. Information overflow: Overproduction does not occur in the same way in administrative processes. This type of waste is therefore named "information overflow" since the only type of "overproduction" that can occur in administration is when too much information is generated. Overproduction is much less visible in services since there is no material flow. Generating more information than needed is a waste of effort and can lead to other forms of waste, for example, excess inventory and extra processing. Examples of information overflow are sending and receiving too many emails, copies of documents for different repositories and people, reports about everything, and creating fully developed solutions where a basic concept is sufficient.

3. Waiting: Waiting occurs when an upstream activity does not deliver on time. Waiting is a common occurrence in services and strongly reduces customer satisfaction (Bortolotti et al., 2010). Waiting is the result of other problems such as wrong office layouts, data entry errors, lack of standardization, or poorly designed IT systems (Di Pietro et al., 2013; Hines et al., 2008; Lodge & Bamford, 2008). Other departments may take a long time to correct errors, poorly designed IT systems can have long loading times, and waiting occurs before a decision is made or a document is signed.

4. Extra processing: In administration, extra processing has to be performed as a result of mistakes or missing information. Correcting and verifying information is time-consuming and can be prevented. Hicks (2007) named this "failure demand" which he describes as the resources and activities that are necessary to overcome a lack of information. This may include generating new information and/or acquiring additional information. For example, failure demand occurs when lacking functionality of information systems leads to an inability to perform certain functions. Additional resources that may be needed in case of failure demand can be manual systems and end-user developed applications (Hicks, 2007).

5. Excess inventory: Inventory is less visible in services, yet it has an impact. Inventory in services occurs as unfinished work or customers waiting for service. Alternatively, excessive inventory could mean storing too much information. Hicks (2007) termed this "flow excess" which he specified as storing excessive amounts of information partly due to a poor understanding of its current and potential value. Excess inventory in administrative processes includes keeping multiple copies of documents in different repositories, unfinished tasks, and unused data in databases.

6. Motion: In services, the layout of buildings can cause unnecessary movement by employees to reach certain equipment (Bortolotti et al., 2010; Bushell & Shelest, 2002). Customers may need to move around unnecessarily due to the layout of facilities (Di Pietro et al., 2013). Attending meetings could also be an important source of motion waste, especially when these meetings are not essential. In information management, Hicks (2007) describes "motion" as the time and resources spent trying to identify the information elements that need to flow, naming it "flow demand." An example of flow demand waste is the inability to automatically exchange information, which requires the operator to go back and forth between different software applications. The effort needed to arbitrate between multiple instances due to duplication is also a form of flow demand or motion.

7. Defective information: Defects in administrative processes are wrong or missing information. Defective information can be data entry errors, inadequate processing of information, or poor-quality inputs from customers (Bortolotti et al., 2010; Middleton & Joyce, 2012). Hicks (2007) termed this "flawed flow" and describes it as the resources and activities that are necessary to correct or verify information to ensure information completeness and accuracy.

8. Lack of standardization: Although services are characterized by a higher degree of variability in customer demand (Murdick, 1990), many processes in services are routine and can be carried out more efficiently through standardization. A lack of standardization in routine processes creates variability in lead times and waiting times, which is inconvenient for customers (Bhatia & Drew, 2006; Bortolotti et al., 2010; Hines et al., 2008).

9. Under-utilization of people's talents and systems' capabilities: Unused human potential leads to lost motivation and creativity in employees. What could be added is that this applies to IT systems as well. Some information systems are not fully used due to poor training or communication. This also results in lost opportunities for carrying out activities more efficiently and the systems cost money and effort to install and maintain. Althuizen, Reichel, & Wierenga (2012) studied the relationship between user evaluations of decision support systems (DSSs) and actual performance. They found that users often fail to recognize the performance-enhancing potential of DSSs. "Harmful neglect" is a situation where the effect of a DSS is positive, but user evaluations are negative (or neutral), and are unlikely to adopt and use the DSS (Althuizen et al., 2012).

The *second step* of LEFI is to design a better future state, which can be done by using lean principles and practices. Table 1 gives an overview of the different principles and practices that can be used to reduce certain types of waste. As can be seen, some principles can be applied broadly to solve waste in general, while other techniques address only a small range of waste categories. As for waste, not all techniques are applicable for services in the same way as in manufacturing. Existing literature about lean in service contexts was therefore reviewed to find ways in which various lean principles and techniques were applied. Examples of practically all lean practices were found in services and nearly all were adapted to fit each service process. However, the four "bundles of practices" (Shah et al., 2008) mentioned in section 2.2 were not represented in services. Instead, three commonly applied techniques in services will be described. Many tools and techniques have been created over the years, and this is only a small selection of the tools that were described in multiple studies.

		Lean principles and practices								
		Reduce waste	Focus on customer value	Take a holistic perspect-ive	Standard-ize work	Make steps flow	Reduce inventory	Increase employee involve-ment	Level the workload	Metrics, visual control boards
Waste categories	Expenditure of resources that do not add value	x	x	x						
	Information overflow	x		x	x		x		x	
	Waiting	x	x	x	x	x			x	x
	Extra pro-cessing	x	x	x	x	x	x			x
	Excess invent-ory	x		x	x	x	x		x	x
	Motion	x		x	x	x				x
	Defective in-formation	x	x	x	x			x		x
	Lack of stand-ardization	x		x	x					
	Under-utiliza-tion of human potential and IT functional-ity	x						x		

Table 1: Forms of waste and their possible solutions

1. Reduce waste: Eliminating waste from the value chain is the overarching value of the lean approach. Reducing waste reduces the need for resources while maintaining or even increasing output levels. Reducing waste contributes to improving operational performance by streamlining processes and increasing process consistency (Alsmadi et al., 2012). Reducing waste was mentioned by most publications on lean in software development, services, and the public sector. While waste in manufacturing can be directly seen as excess inventory and motion, in services it tends to occur as long waiting lists, rescheduling, and preparing unnecessary reports (Hines et al., 2008; Radnor & Walley, 2008).

2. Focus on customer value: Focusing on the customers and their needs is an integral part of lean. The focus on customer value is also strongly supported in the literature on lean in services. Customer focus issues such as service quality, customer satisfaction, and the customer experience are crucial for the success of service organizations.

3. Take a holistic perspective: Waste needs to be eliminated along the entire value stream for the best results. In software development, “seeing the whole” means that the whole software development process needs to be considered to prevent local sub-optimizations (Pernstål, Feldt, & Gorschek, 2013). In a case study at an insurance firm, locating people in linked processes closely together not only cut down the time it took to transfer files, but also gave operators a better awareness that they were part of a whole with the purpose of satisfying advisors and policyholders (Swank, 2003). Lean management has a propensity towards process improvement as a whole instead of optimizing sub-parts. This is especially relevant to services because their vertical and functional structures may inhibit communication between offices so that optimization may be done in isolation (Bortolotti et al., 2010).

4. Standardize work: Standardization of work is directly applicable to services. A standardized error code system for a software development project saved time that was normally wasted on classifying programming errors (Staats et al., 2011). Similarly, the standardization (and automation) of some activities in the service sector reduced queues and data entry errors (Bortolotti et al., 2010). In addition, standardization of tasks in the service sector allows others to carry out tasks in case of absence or high workloads (Swank, 2003). Standardization of operations was also found to bring advantages in the public sector, mainly reducing variation, but it also improved safety in a hospital (Bushell & Shelest, 2002; Radnor et al., 2006).

5. Make steps flow: Flow means that service flows seamlessly from start to finish in the value stream (Piercy & Rich, 2009). Shorter work cycles are a key enabler of flow in software development projects (Middleton & Joyce, 2012; Staats et al., 2011). One case study in software development showed that work-in-progress in the form of requirements, designs, and unfinished code was kept to a minimum in order to create a flow and bring problems to the surface (Middleton & Joyce, 2012). At another software project, changing to a single-piece flow resulted in simpler process architectures (Staats et al., 2011). At the insurance company studied by Swank (2003), flow was improved by placing people working on linked processes near one another. This reduced the amount of movement of people and documents between departments. At an Italian bank, tools such as one-piece flow and cell layout were introduced to reduce motion, work-in-progress, and batch production, which significantly improved the flow of private credit processes (Bortolotti et al., 2010). Improving the flow allowed a great reduction of waiting time and significantly increased the operational efficiency of the bank. The use of software to streamline information flows was also emphasized. Interfaces should be designed to connect automated and manual activities and, where applicable, front-office activities and customers. For instance, an optical scanner speeds up the interface between paper documents and automated activities. An automated teller machine (ATM), which was not used previously at the bank allows some routine tasks to be carried out automatically, i.e. cash withdrawals and deposits (Bortolotti & Romano, 2012). Improving the physical layout of offices can also improve flow as work activities will not be interrupted by reaching for documents and equipment (Di Pietro et al., 2013; Malmbrandt & Åhlström, 2013).

6. Reduce inventory: Inventory is also monitored in lean software development. Work-in-progress (e.g. requirements, designs, and code) was kept as low as possible, which meant that design, implementation, and testing could start earlier so that problems in requirements could get caught earlier (Kupiainen et al., 2015; Middleton & Joyce, 2012). Limiting work-in-progress as much as possible creates a more continuous flow of deliveries. Identifying work-progress was also used to find blocked work items and the development phase where the blockage occurred (Kupiainen et al., 2015). It is also possible to reduce the buildup of work-in-progress in services by shortening work cycles and creating a small batch flow (Swank, 2003). Reducing inventory in terms of work-in-progress can also be done in the public sector and leads to similar improvements in flexibility and lead times (Di Pietro et al., 2013).

7. Increase employee involvement: A significant number of publications on lean in non-manufacturing contexts mentions employee involvement. According to Alsmadi et al. (2012), service firms score higher on employee involvement. Their explanation is that service firms realize that human resources have the main role in determining the competitive advantage of the firms and the quality of service. Empirical results in the service sector affirm that service firms are interested in employee involvement, making use of their ideas, stimulating them to confront problems, and keeping them open to change and flexibility (Alsmadi et al., 2012). Similar findings were reported in the public sector where employees were also empowered to solve problems, more emphasis was given to working in teams for problem-solving, as well as supporting multi-functional skills and flexibility (Bhatia & Drew, 2006; Bushell & Shelest, 2002; Di Pietro et al., 2013).

8. Metrics for throughput time and quality: Throughput time is one of the main metrics in lean and measures the time it takes to perform an activity from start to end. In addition, Statistical Process Control (SPC) is a standard methodology for measuring and controlling quality. These metrics are used in services, for instance the number of defects per 1,000 lines of code and the number of maintenance requests from customers (Kupiainen et al., 2015; Staats et al., 2011)

9. Visual control boards: Visual control boards quickly communicate information to people, indicating whether a condition is acceptable or not and provide some direction of action from people. Visual controls can be charts, graphs, signs, colors, and more. Visual control methods aim to increase the efficiency and effectiveness of a process by making the steps in that process more visible. Visual controls are used in manufacturing plants, but can also be applied in service environments. They are especially relevant in services because the processes are far less visible. Visualizing performance results allowed more objective evaluation and allowed problems to be solved more quickly at an insurance firm (Swank, 2003). In software development, visual control boards were used to reduce polling by the project manager (Staats et al., 2011). Middleton & Joyce (2012) also documented extensive use of visual controls at a lean software development project. Everyone checks that their work status is correctly displayed during the daily standup meeting. Clusters of cards on the visual control board indicate bottlenecks, and people are then organized to resolve this.

10. Leveling the workload: Production leveling, also called “Heijunka,” means producing output at a steady rate that is sufficient to keep up with customer demand. Heijunka was applied in software development to eliminate haste and slack time. Tasks such as testing were spread over the entire development period instead of being performed at the end of the project. Additional time could be used to perform more work for the client (Staats et al., 2011). Working with users upstream in the process to smooth future demand was done at another software development case (Middleton & Joyce, 2012). At an insurance company, the workload was evened out by clustering tasks into different levels of complexity. This reduced the variation in time spent on processing different requests so that a customer with a long transaction would not cause customers with simpler transactions to wait. Furthermore, incoming tasks were distributed equally to different teams so that no teams were idle at any time. For the public sector, it was mentioned that proactive planning should be used to smooth demand and create a more level and balanced workflow (Malmbrandt & Åhlström, 2013).

The following *testable design product hypotheses* will be used to test whether the proposed method satisfies the *meta-requirements:* the Lean Evaluation and Future Improvement (LEFI) method is able to cope with resource constrains and decision-making processes in the organization (PH1), it allows the identification of waste (PH2), and the method proposes adequate solutions (PH3). The meta-requirements, corresponding meta-designs, and the testable design product hypotheses are summarized in table 2.

Meta-requirements	Corresponding meta-designs	Design product hypotheses
MR1: The method must function within the constraints of the organization.	MD1: The Two-Step Method for Lean Administration.	PH1: LEFI functions within the constraints of the organization.
MR2: The method needs to be suitable for identifying waste.	MD2: Value stream maps and flowcharts. MD3: Waste conceptualization for administrative processes.	PH2: LEFI allows the identification of waste.
MR3: The method needs to propose adequate solutions.	MD4: Lean principles and techniques adapted for administrative processes.	PH3: LEFI proposes adequate solutions.

Table 2: Summary of meta-requirements, meta-designs, and design product hypotheses

4. Testing the meta-design

The Lean Evaluation and Future Improvement (LEFI) method was tested with a field study. A field study is one of the naturalistic evaluation methods which explore the performance of a “solution technology” (artifact) in its real environment, the organization (Venable, Pries-Heje, & Baskerville, 2012). Naturalistic evaluation embraces all of the complexities of human practice in organizations. The field test of the LEFI two-step method (MD1) was conducted as part of a process integration project between a university and an institute that merged with the university in 2010. In addition to integrating the admission process at the two organizations, the objective was to increase the operational efficiency and the quality of educational support services to students. A previous project which was initiated as a response to complaints from students concluded that the current admission process is complex, takes too long, and lacks transparency[1]. This presented an opportunity for applying lean techniques in an administrative context since using the method would result in a set of recommendations that could be used to improve processes, which was relevant to the objectives of the project. The research goal of applying LEFI in this context is to demonstrate the utility, quality, and efficacy of the design artifact.

4.1 Background

An institute providing education and performing research in the field of earth observation and geographical information systems (GIS) became a faculty of a Dutch research university in 2010. Because the institute became a faculty, it was renamed and will be referred to as the "Faculty of Geo-Information Management" (GIM) in this paper for reasons of anonymity. Since the university offers research and education in technical and social sciences, it will be referred to as the "University of Social and Technical Sciences," (USTS). Integrating educational support services had been a discussion point from the beginning, but there are still steps to be made. The Faculty of Geo-Information Management still largely uses its own procedures for registrations and admissions and also utilizes separate information systems. The research was tied to a project for integrating GIM with the rest of USTS and improving educational support for international Master of Science (M.Sc.) students from outside the European Economic Area (EEA).

The admissions procedures for non-EEA M.Sc. students at USTS and GIM have the following general phases. The process starts when a student applies on the website and submits an application for a study program. The application is then reviewed according to formal, minimum criteria at the admission office; this stage is called the "formal admission." The minimal criteria are that the applicant has sufficient prior education, a sufficient English test score, and sufficient grades in his or her previous education. The minimum criteria differ slightly depending on the study program the candidate applied for. When the applicant does not meet the minimum criteria, the student is rejected. In case the applicant meets the formal criteria, the application enters the "academic admission" stage. During this stage, a decision to admit or reject a student is made based on academic criteria such as the relevance of previous education, study results, and motivation. The academic criteria are generally less concrete than in the formal admission stage. At USTS, academic admission is done by the study programs, at GIM this is done by individual course directors. When a candidate at GIM meets the minimum criteria, the admission office send his/her application to a course director via an email link. The course director then reviews the application and gives a score from 0 to 10. A score of 0 indicates that the candidate is not eligible according to academic criteria. The scores are also used for ranking students for the Netherlands Fellowship Programme (NFP) scholarship.

4.2 Application of the LEFI two-step method for Lean Administration

In *step one* of the Lean Evaluation and Future Improvement method (Meta-Design 1, table 2), the current state of processes at USTS and GIM was analyzed with flowcharts and value stream maps (MD2). The first area to be researched was the admissions process from the perspective of a student. Information was gathered by signing up for a study program at USTS and GIM. All actions needed to complete an application were captured using screen recording software. The screen recordings were then examined to identify all steps, the information required, and the time it took to complete each

1 Final report of the Acceleration Admission Procedure Commission, 2012

step. The recordings also showed where non-value-adding activities were carried out. The information was then displayed in value stream maps (VSMs) to provide a visual representation of the process (MD2). The time line on the bottom of the VSM indicates the time spent on value-adding activities and the time spent on non-value-adding activities such as correcting errors, looking for missing information, and dealing with error messages. Problem areas are indicated with so-called "Kaizen bursts" and are numbered. A description of each problem area accompanies each VSM.

After having analyzed the registration and admission process from the view of a student, flowcharts and value stream maps were made to get an overview of the current state of the back-office processes (MD2). Initial flowcharts were made first by using existing process descriptions, parts of existing flowcharts, and manuals. Interviews were conducted with employees at USTS' and GIM's admission offices to verify and correct the flowcharts. The interviews were also used to correct and complete process descriptions that had been written before. Two iterations were needed at both USTS and GIM to produce flowcharts that represent the back-office processes correctly. The final flowcharts and process descriptions were approved by the department manager. This was followed by inquiring staff about the time it takes to complete each process step and whether any activities contain waste. An employee at GIM gave a demonstration of how registrations and admissions were processed, which gave additional information about all the steps and any waste occurring. At the USTS, additional information was obtained by attending several meetings that were part of a project aiming to improve communication with international students during the admission process, which was relevant since a large part of the discussion was about reducing the throughput time of the academic admission process. Course directors and several department coordinators attended these meetings, which also provided opportunities for asking additional questions about the current state of the process. Flowcharts and VSMs, as well as descriptions and explanations of problem areas in the back-office were produced from this information (MD2). The flowcharts and VSMs were used during meetings of the integration project to highlight differences between the university and the GIM faculty as well as pointing out areas that needed to be improved. The meetings served as a further verification of the flowcharts, VSMs, and problem descriptions as the participants commented on them.

Step two, designing a better future state (MD1), was done by examining all areas where waste occurred and proposing suggestions for improvement in line with lean principles and techniques. Most suggestions for improvement were made by resolving individual "Kaizen bursts." Process redesigns were proposed in several areas where more was needed than resolving Kaizen bursts. These suggestions were proposed and discussed at meetings. The suggestions were supplemented by suggestions from members of the working groups. Not all the suggestions made by the working groups correspond to a lean approach – they were general organizational changes to solve problems. The feasibility of the changes was also discussed during the meetings. For the IT system, further investigation of information needs and available functionality is performed by the IT department.

5. Results

5.1 Overall current state

The registration and admission processes at USTS and GIM suffer from some overall problems that affect multiple steps along the value stream. The first overall problem was that GIM still uses separate procedures and IT systems. GIM uses an ERP package with various customizations. Digital Application Form (DAF) is one of the custom-developed applications that is relevant for the registration and admission of students at GIM. DAF consists of an online registration form for candidates and an approval component that is used by the admission office and course directors. DAF also serves as a communication tool between the admission office and candidates with message box functionality. Student Information System (SIS) is also a custom-developed application that ties in with the ERP package used at GIM and is used for curriculum information (including financial information) and for managing student records. GIM uses some systems from USTS such as bookkeeping (Oracle Financials) and Financial Student Administration (FSA, custom-developed application for Oracle Financials). A link has been established between SIS and the USTS system OSIRIS to provide GIM students with student numbers, email addresses, and access to the Blackboard e-learning system. OSIRIS is also connected to other systems used by USTS including the national application system Studielink and the Blackboard e-learning system. USTS uses OSIRIS, which is a packaged software solution used by several other Dutch higher education institutions as well. OSIRIS is the student information system used by USTS and contains information about registrations and admissions, student records, and tuition payments. OSIRIS is modular with different modules that can be purchased and customized. USTS currently uses the modules for student registration and admission, managing student records, and tracking the study progress of students. The different sets of IT systems used by the organizations are redundant and lead to higher maintenance and management costs (waste categories 1 and 4). In addition, only limited functionality of OSIRIS is used, which is waste in the form of under-utilization of a system's capabilities (waste category 9).

The second problem is that the throughput times for registration and admission of non-EAA students at USTS are too long and variable (waste category 2). The academic admission phase is the step that takes the longest at USTS and generally exceeds the internal norm of processing applications within two weeks. Some faculties process applications in less than two weeks, while other faculties can take up to eight weeks[2 3]. This was seen as a problem since students may perceive this as "unwelcoming" and this poses a risk to the image of USTS, which could be perceived as a "slow organization" by new applicants[3]. The long throughput time for registrations and admissions could be a contributing factor to the low conversion rate of the university, which is only two percent for non-EEA M.Sc. students. The conversion rate is the ratio between the number of students who interacted with the university in some way (by visiting the website, inquiring about courses, registering) and the number of students who eventually attend courses at the university. There are many other reasons for the low conversion rate, such as the large number of students that are not eligible, the "tone of voice" in messaging, and the availability of scholarships. Nevertheless, members of the project teams deemed throughput time an important aspect of the registration and admission process, and reducing it was an important goal for USTS.

Now the two overall problems with the registration and admission process have been explained, the focus will be on the individual parts of the process, starting with the initial registration process that is performed by the applicant by using an online form. This process has potential for improvement: it can be made shorter and more could be done to prevent confusion and errors.

5.1.1 Analysis of the registration process from the perspective of an applicant

The first part of the registration and admission process consists of entering personal information and details about previous education into an online registration form. To perform step 1 of LEFI (MD1, table 2), I signed up as an international non-EEA student at both USTS and GIM and recorded all actions using screen capturing software. This allowed the identification of all steps, the information required, and the time it took to complete each step in the application. This information was then used to create value stream maps (VSMs) which give an overview of the process, the information systems used, and any waste in the processes (MD2) and are shown in Figures 2 (USTS) and 3 (GIM). The time line on the bottom of the VSM indicates the time spent on value-adding activities and the time spent on non-value-adding activities such as correcting errors, looking for missing information, and

2 Final report of the Acceleration Admission Procedure commission, 2012

3 Summary report of "stumbling points" of first working group session on the 2020 admission process, 3rd of September 2015

dealing with error messages. Problem areas are indicated with so-called “Kaizen bursts” and are numbered (tables 3 and 4). The description of each problem area accompanies each VSM (MD3).

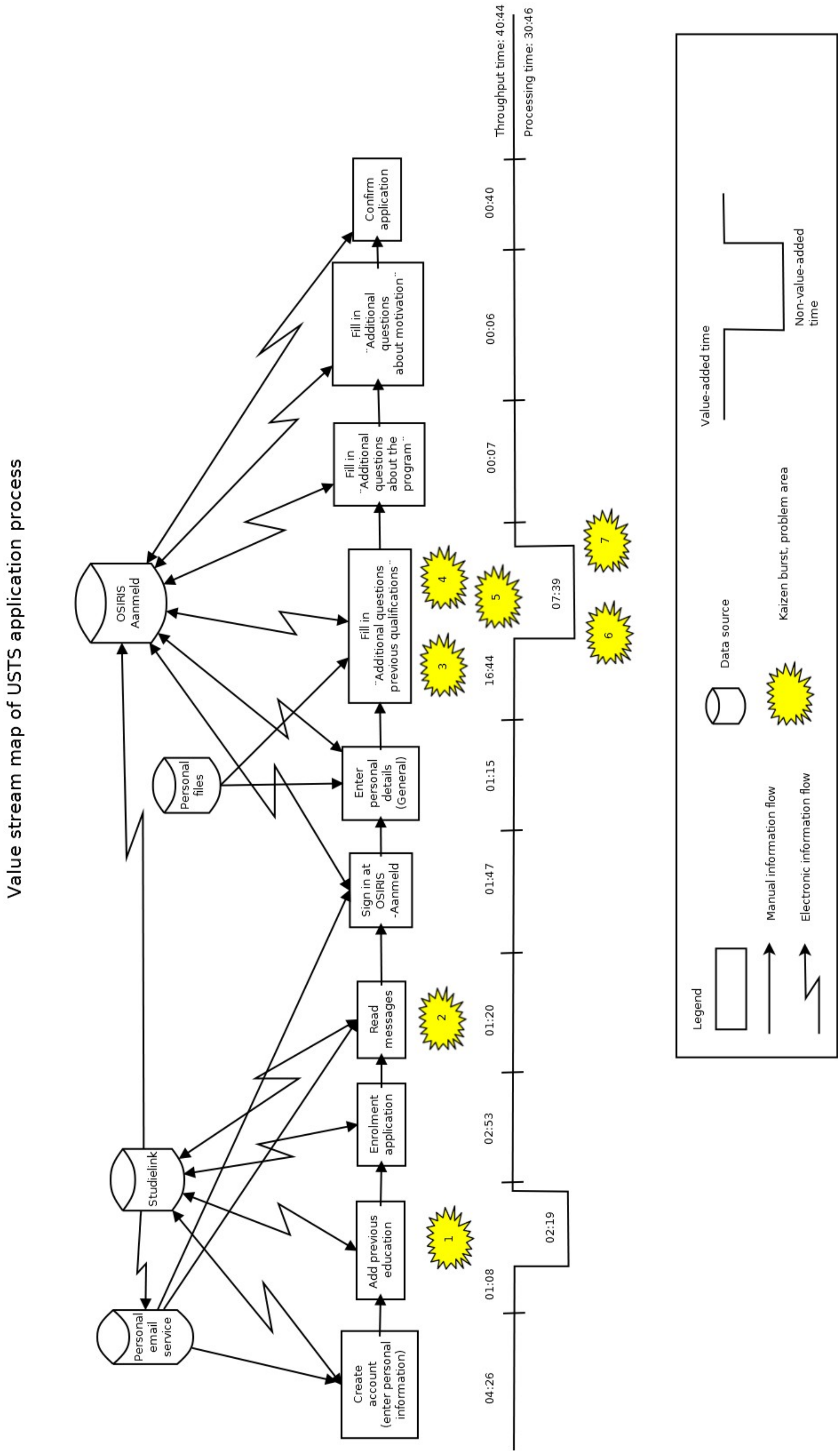

Figure 2: Value Stream Map of the USTS registration process (student perspective)

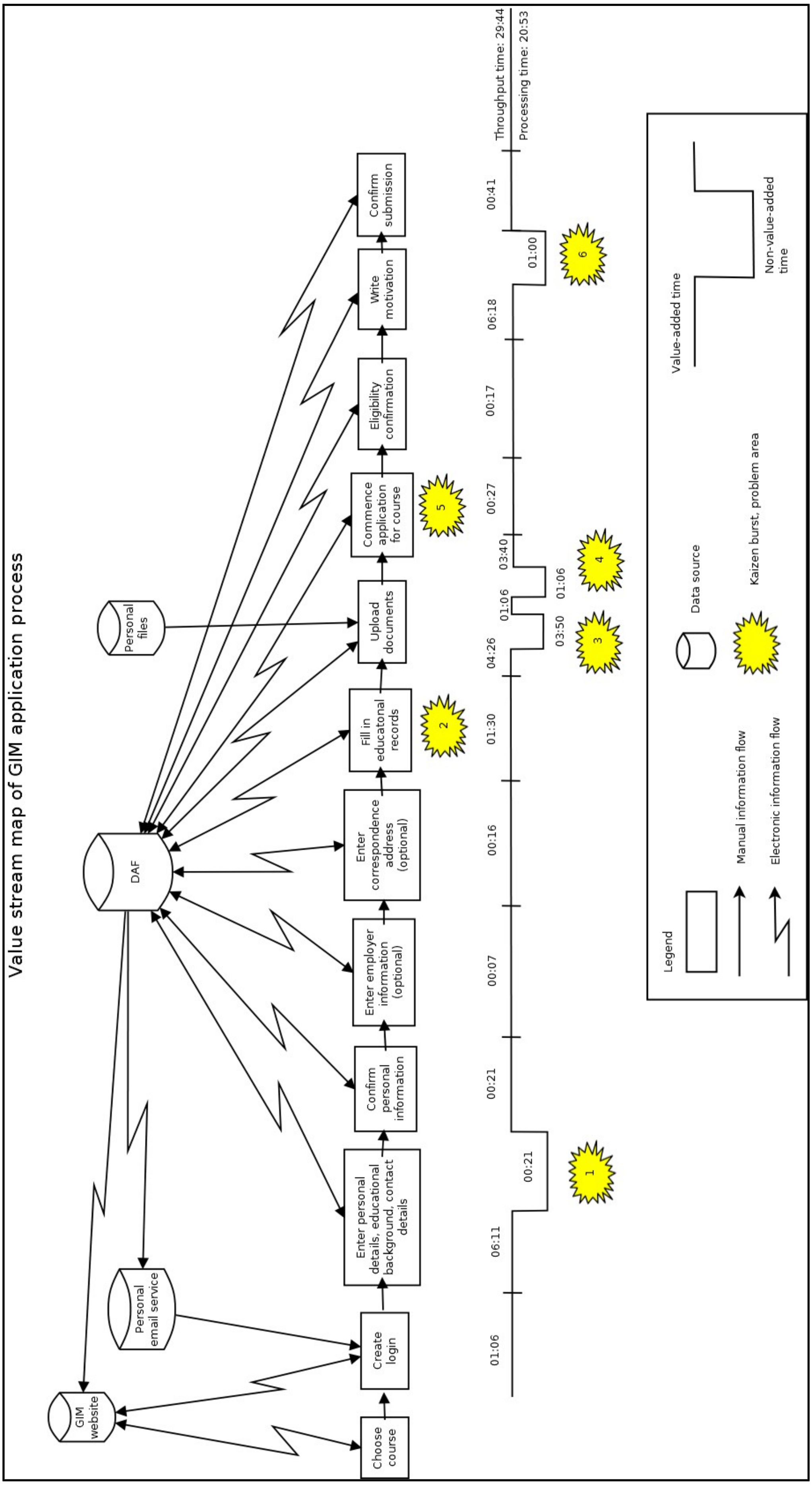

Figure 3: Value Stream Map of the application process at GIM (student perspective)

When going through the online application, it was found that roughly ten minutes of each application at USTS and GIM was spent on non-value-adding activities. It is also notable that the application procedure at USTS took about ten minutes longer than at GIM. The time indications and some of the problems are not representative for all applicants, but documenting them this way does provide useful information as a starting point for lean improvement. The problem areas indicated with numbered Kaizen bursts are described in Table 3 (USTS) and Table 4 (GIM) and are classified according to the waste categories developed in chapter three (MD3).

Kaizen burst number	**Description**	**Cause**	**Type of waste**
1	Studielink asked to enter "previous education." Only high school education could be entered, even though filling in information about the bachelor's degree would have been relevant.	Page was not designed correctly and descriptions were ambiguous.	Defective information.
2	The Studielink message window is very small, requiring a lot of extra clicking and scrolling.	Poor page design.	Motion.
3	The academic transcript exceeds the file size limit. It needed to be modified before uploading.	5 MB file size limit.	Extra processing.
4	The UT asks for course description of my previous education program. This would be a description of every course attended during the bachelor's as well as the books used. It would take very long to compile this document because I do not have a complete study guide. There was no possibility to send this afterwards, which was possible most other documents.	It is a potentially useful piece of information to determine a student's eligibility, but it is impractical for the student. It is also doubtful whether administrators are able to read through the entire documents.	Information overflow.
5	"Statement of financial resources" is a static document that must be printed, filled in with a pen, and then scanned and uploaded.	Poorly designed document.	Extra processing.
6	Registration could not proceed due to missing or wrong information. It did not say where the mistake was. Had to go back and forth on the page.	Poor design.	Defective information. Motion.
7	Successful uploads are indicated with a bold red cross and "in progress" written next to it. This is very confusing.	Poor design.	Defective information.

Table 3: Waste at USTS registration process (student perspective)

Kaizen burst number	**Description**	**Cause**	**Type of waste**
1	Uncertainty about English test type. Filled in wrongly at the first attempt.	Explanation for my situation was missing.	Information defect. Extra processing.
2	Unable to upload academic transcript because the file was too large. It could only be uploaded by lowering the resolution and leaving out some pages.	Maximum file size is 1 MB.	Extra processing.
3	The system asks for official proof of	The earlier option of	Information defect.

	my English level, even though this was not necessary for me. The application could not proceed.	"university fully in English" is not acted upon.	
4	Finance information is empty. Tuition fee, additional costs, living allowance, and insurance are all 0 Euros.	Supporting information had not yet been filled in, even though the course was available already.	Information defect.
5	Warning message to upload a copy of my English certificate appears at the course overview page and does not go away, even after the correct document had been uploaded. Spent time on trying to solve this error.	Earlier options not acted upon.	Information defect. Motion.

Table 4: Waste in the GIM registration process (student perspective)

5.1.2 Analysis of the back-office processes at USTS and GIM

After having analyzed the admissions procedure from the view of the student, attention was directed towards the back-office processes at the admission offices of USTS and GIM. Processes were analyzed by creating and checking flowcharts. Value stream maps (MD 2) were also created since they allow for easier visualization of throughput times and waste. The situation at USTS is discussed first, followed by a description of the situation at GIM.

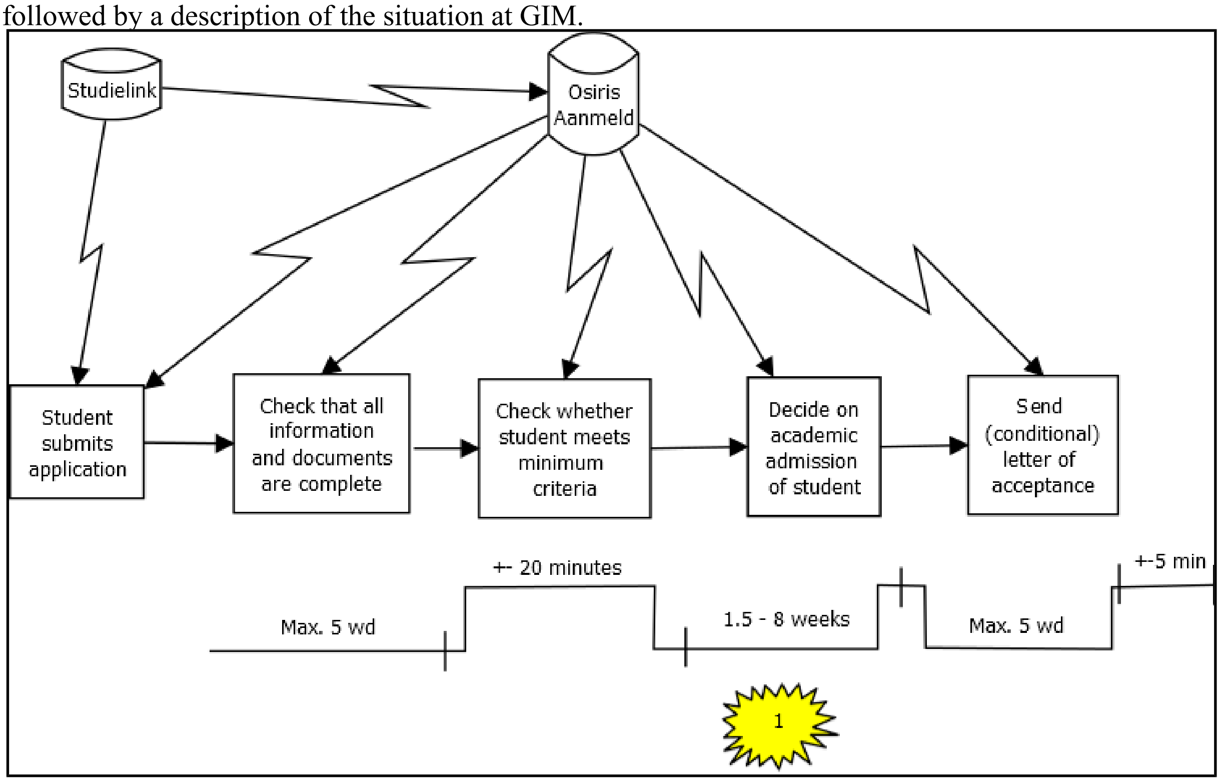

Figure 4: VSM of the USTS office process

The lead times of the process steps at USTS are shown in Figure 4. Checking the completeness of a registration and verifying that the applicant meets the minimum criteria takes roughly 20 minutes per application. It usually takes several days before each application is processed and sent to the respective study program for the academic admission stage. This means that there is usually some accumulation of applications waiting to be processed by the admissions office. This corresponds to the "excess inventory" waste category (waste #5, chapter 3). The number of applications varies across the year, which also leads to variable levels of inventory. The maximum lead time for the formal admission is set to five days, and there are generally no deviations from this requirement at this stage of the admission In contrast, the *academic admission* stage at USTS usually takes longer than the specified two-week maximum. The academic admission in which applications are reviewed according to academic rather than formal, minimum criteria, is carried out by the study programs. Some study programs take more than eight weeks to make a decision. The reasons for this long throughput time are various. First of all, there is very little standardization across study programs (waste #8). Each study program has a different process, different criteria, and different policies. This makes monitoring the operational performance difficult, and potentially leads to quality problems too since not all decisions can be explained accurately. Furthermore, lead times vary among study programs since some have made agreements that allow the admission office to perform a part of the academic admission process. A lot of applications can be rejected administratively since they do not meet certain academic criteria that are practically standard, and having this review performed directly by the admission office saves work at the faculties. However, this has not been standardized and communication about this among programs has been poor (waste #8). Responsibilities for admissions differ per study program: course directors, study advisors, course coordinators, and Faculty Internationalization Coordinators (FAINCOs) can be responsible depending on the study program. Commissions are used in some cases to make decisions, but this has not been standardized (waste #8). Capacity constraints exist at some programs because admissions are often something that someone needs to do “as an extra.” This may result in a low priority for admissions and leads to delayed decisions. It also occurred that key personnel took vacation during peak times. Delays are also caused because some admission commissions only meet every four weeks. The resulting waste corresponds to the “waiting” waste category (waste #3).

A few examples of systems and people being under-utilized were also found in the academic admission phase at USTS (waste #9). Many applicants can be admitted directly because their educational background corresponds to all the requirements and there have been many applicants with similar data. It is a waste to let these be evaluated by the same people and in the same process as some of the more complex cases that require more personal judgment. Letting the admission office perform a part of the admission process for the candidates that can be admitted or rejected with high certainty is one way of preventing this type of waste. A database had been created a few years ago to help with admission decisions. The database is managed by the admission office and contains data of students that had been admitted before, which allows an easier comparison to earlier decisions and acts as a guide. In addition, the database would track how students with a certain educational background perform. This can guide changes in admission requirements, for instance, the system could indicate that a requirement of 70 percent should be increased to 75 percent because students with 70 percent underperform. Storing this information also provides additional information about foreign higher education institutions. It may be possible that good students come from institutions that do not score high enough according to the Netherlands organization for international cooperation in higher education (Nuffic). Unfortunately, the database is barely used and communication with the study programs has been very limited. It is evident that this is an under-utilization of a system (waste #9).

After the academic admission phase, the study program sends the application file back to the admission office. The admission office then informs the applicant. There are three options: rejected, conditionally accepted, and accepted. A candidate is conditionally accepted when he/she is academically admitted, but has not yet handed in his/her diploma. This step takes about five minutes per applicant and a maximum processing lead time of five days has also been set for this. The forms of waste (MD3) at USTS are summarized in table 5. Each problem area has not been labeled with an individual Kaizen burst since nearly all problems at USTS occurred in the academic admission phase.

Problem	Type of waste
New applications are stored several days before being processed by the Admissions Office.	Excess inventory.
Each faculty has their own way of processing applications. Criteria and processes differ widely and no real overview of this exists.	Lack of standardization.
Faculties take long to process applications.	Waiting.
A database to help support decisions is barely used.	Under-utilization of systems.
“Easy” applications are processed by higher-level staff, even though decisions could be made administratively.	Under-utilization of people’s capabilities.

Table 5: Summary of waste at the USTS office process

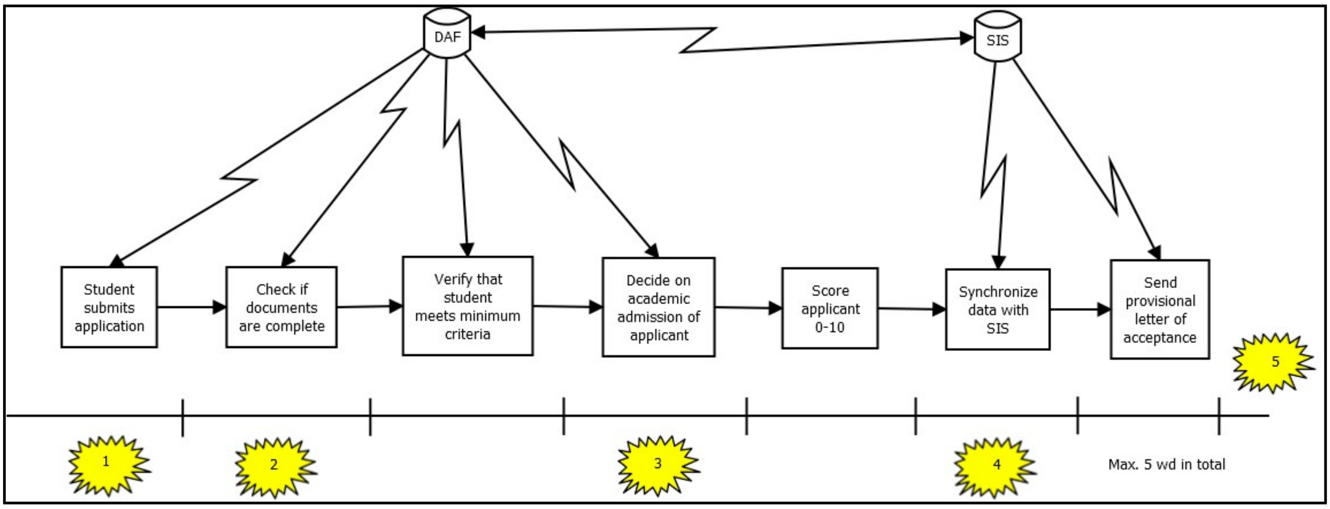

Figure 5: Summary of waste at the GIM office process

The registration and admission process at the Faculty of Geo-Information Management usually takes around five days in total. Problem areas were also found at GIM. The first issue in this process (Kaizen burst #1) is that hardly a single application is complete (waste #7). Asking to upload additional documents and supply additional information takes extra time at GIM's admission office and delays the registration and admission process (waste #4). Candidates also supply unneeded information and documents in some cases; for instance they submit a CV and research topic even though this is only needed for PhD positions, not regular M.Sc. courses (waste #2 and #7). Moreover, quite a few candidates try to apply for a Netherlands Fellowship Programmes (NFP) scholarship, even when their countries are not supported, which means that candidates often fail to read important information on the website (waste #7). Kaizen burst number two in Figure 5 indicates some waiting (waste #3) because the Digital Application Form (DAF) application responds slowly. Loading a list of applications can take several minutes. It was also mentioned that some scans of documents have such low resolutions that they cannot be read. This is due to the 1 MB file size limit in the online registration application (Kaizen burst #2 in Figure 5). Moreover, the Decos document management system can only store PDF files, but applicants can submit files in various formats when using the online registration application. This leads to extra processing at the GIM admission office because they have to ask for new documents or convert existing ones (waste #4).

For the *academic admission* stage, the application file is sent directly to a course director after the formal admission has been completed. The course director receives an email with a link to the application documents and he/she is able to approve applications regardless of location or time. The course director decides whether a candidate is academically admissible and assigns a score from zero to ten. The course director has five working days to complete this step of the process. This requirement is usually met. A minor issue at this stage is that some course directors provide detailed descriptions of how they scored each candidate while others do not (Kaizen burst #3). This extra information is useful in case a further inquiry is made at a later point in time – the course director then does not need to go through the whole file again. It also creates more transparency. This could be standardized (waste #8).

After the course director has made a decision to admit a candidate, the candidate's data contained in Digital Application Form (DAF) has to be synchronized with Student Information System (SIS). Synchronization with SIS does not take place when the student is rejected. Rejected students are informed via the message box function in DAF. Information from DAF is synchronized with SIS by first checking the name as mentioned in the passport of the applicant. Many candidates are already registered in SIS because they had been admitted to GIM before, even when they never attended courses. Searching existing persons in SIS is cumbersome because SIS does not generate a list of results, but instead requires the user to click through all the pages of people who had been registered in the system before. This is "motion" waste (waste #6). Some names are nearly impossible to find in SIS because they are common in some countries and can be spelled in different ways. It is a common occurrence that someone spells his/her name differently in the DAF application system than listed in the passport, and some people use different names altogether. A workaround is used in case a name is hard to find. A different form which is normally used for entering student information manually is opened and allows a search with additional variables such as country of birth. From this, a student number can be found, which gives certainty that the person had or had not been registered at GIM before. This workaround is waste because it involves extra processing and motion (waste #4 and #6). When it is determined that someone had been registered in SIS before or not, the new information coming from DAF is copied into SIS using an automatic function. It is possible to overwrite DAF information with existing information in SIS, which has to be done when inconsistencies arise. Complete manual data entry is needed in some situations. The problem areas in this step of the admission process at GIM are indicated by Kaizen burst #4.

GIM targets mid-career professionals, and information about a candidate's employer is usually needed. Employer information has to be entered manually in SIS because the potential for inconsistencies and double entry is large, which is indicated by Kaizen burst #4. As for names, information about employers could have been filled in slightly differently than the existing entries. This operation involves extra processing (waste #4). A connection with the OSIRIS information system used by USTS was made to give basic compatibility and access to some USTS applications. Only a small fraction of OSIRIS' functionality is used, which is waste in the form of underutilization of an information system (Kaizen burst #5, waste #9). Despite the connection, a lot of incompatibilities between the USTS and GIM continue to exist. Systems are also redundant and there is a lot of motion between the different systems (waste #1 and #4). In terms of post-merger IT integration, this is a *synchronization* type of merger since the original IT systems at both organizations are preserved with some software and hardware bridges to consolidate data or synchronize the different systems (Wijnhoven, Spil, Stegwee, & Fa, 2006).

Kaizen burst number	**Description**	**Type of waste**
1	Hardly any application is complete at the first time.	Extra processing.
1	Students submit unneeded documents.	Information overflow.
1	Students from the wrong countries try to apply for the NFP scholarship.	Information defect.
2	DAF loads slowly.	Waiting.
2	Some scans cannot be read and need to be re-submitted. This is caused by the 1MB file size limit.	Extra processing.
2	Decos only stores PDF documents but students can submit documents in various different formats.	Extra processing.

	Documents need to be converted.	
3	Only some course directors provide extra information about how score candidates. This is not compulsory, but quite useful.	Lack of standardization.
4	SIS does not have an adequate search function. Navigation in SIS is cumbersome.	Motion.
4	A workaround has to be used when some names are hard to find in SIS.	Motion. Extra processing.
4	Employer information has to be entered manually due to possible inconsistencies.	Extra processing.
5	OSIRIS is only used for basic compatibility with some USTS software applications. This is only a fraction of the available functionality.	Under-utilization of systems.
5	Redundant systems continue to be used and various incompatibilities exist.	Motion. Extra processing.

Table 6: Summary of waste at the GIM office process

5.2 Designing a better future state

The current state has been described in the previous section with the use of value stream maps (MD2) and the waste has been classified according to the different waste categories (MD3). Step 2 of the Lean Evaluation and Future Improvement method is to design a better future state by tackling the problem areas with the use of lean principles (MD4).

The first problem area from a student's perspective at USTS is the "previous education" section in Studielink (table 3, Kaizen burst #1). This could be solved by making descriptions clearer and allowing applicants to also fill in information about their bachelor's education. Message windows on the main page in Studielink should also be enlarged for better usability (Kaizen burst #2). The next problem, Kaizen burst #3 in table 3, could be solved by increasing the file size limit. A more user-friendly user interface of the online application form would be in line with lean principle #2, focus on customer value. Supporting the user in entering the correct information at first creates a better flow through the process, which corresponds to the "make steps flow" principle (#5).

One time-consuming element of the USTS registration procedure is that the applicant needs to provide detailed course descriptions of his or her previous education program (Kaizen burst #4). It should be questioned whether all the information is useful for making a decision. Kaizen burst #5 could be solved by creating a PDF document that can be filled in digitally or making an additional menu in OSIRIS that is able to fulfill the same function. Successful document uploads have to be indicated with a less ambiguous symbol (Kaizen burst #7). The problems at USTS and their possible solutions are shown in table 7.

Kaizen burst number	Problem	Type of waste	Solution
1	"Previous education" is ambiguous in Studielink.	Defective information.	Improve labels.
2	Small message windows in Studielink.	Motion.	Redesign page.
3	Academic transcript exceeds file size limit.	Extra processing.	Increase the limit.
4	Course descriptions are too detailed and potentially not needed.	Information overflow.	Reduce the amount of information demanded. Only ask for course descriptions when strictly needed.
5	"Statement of financial resources" has to be printed and scanned.	Extra processing.	Use a different PDF file with more functionality or design an additional form.

6	Inaccurate error messages.	Motion. Extra processing.	Improve page design.
7	Successful uploads are indicated with a bold red cross.	Defective information.	Change to a better symbol.

Table 7: Recommendations for reducing waste at the USTS application process (student perspective)

As for USTS, the problems at GIM's online application forms could also be solved by applying lean principles. Uncertainty about the English test type (table 4, Kaizen burst #1) could be eliminated by providing more complete information on the website. The 1 MB file size limit of the Digital Application Form (DAF) should be increased to at least 5 MB. The earlier choice of English test should be acted upon (Kaizen burst #3); the appropriate document upload option should be available. Confusion due to missing finance information in DAF (Kaizen burst #4) could be avoided either by entering the information or displaying a message that the information will be available at a later date. The final problem encountered at GIM was that a warning message to upload an English certificate would not disappear even though the document had been uploaded (Kaizen burst #5). This can be solved by making small changes to the system. Table 8 mentions the Kaizen bursts from figure 3 together with their possible solutions.

Kaizen burst number	Problem	Type of waste	Solution
1	Uncertainty about English test type.	Information defect. Extra processing.	Provide more detailed information on the GIM website.
2	1 MB file size limit.	Extra processing.	Increase file size limit to 5 MB or more.
3	Earlier option not acted upon, official English proof was demanded although it was not needed.	Extra processing.	Adjust the software configuration.
4	Finance information is missing.	Information defect.	Fill in the information or display a message informing the applicant that the information has not yet been generated.
5	Warning message to upload an English certificate does not go away.	Information defect.	Adjust the system.

Table 8: Recommendations for reducing waste in the GIM application process (student perspective)

Recommendations for improving the back-office processes are also made in a similar fashion. The proposed changes at USTS focus chiefly on the academic admission stage as this is the principal source of delays in the overall process. The recommendation that could be made for the first and last stages of the admission that are handled by the admission office are that the inventory of unprocessed documents be reduced (principle #6). The academic admission stage could be improved significantly by standardizing procedures (principle #4). The standard of processing applications within two weeks has to be enforced. All faculties should work with clear academic admission criteria that are more standardized. Agreements with the admission office for "pre-advice," performing part of the academic admission can be standardized to be used as a more thorough filter for all faculties.

With regard to personnel management at the study programs, it should be clear who processes applications and how this is done. People who are tasked with processing applications need to have this as a part of their job descriptions and sufficient time and responsibility for decisions has to be provided. At one of the meetings, a course director mentioned that when he handles admissions frequently, a routine develops which allowed him to work more efficiently and make more consistent decisions. The person who performs the task needs to have the right skills and scheduling should be done in a way that ensures availability during peak times. Another suggestion made by one of the course directors is that applications be sorted according to their level of complexity. The “simple” cases could be decided on quickly in a standardized process. The more complex cases that require more personal judgment should be handled by people who are more knowledgeable and experienced with such applications. Segregating complexity spreads the workload more evenly and reduces variability in lead times.

The database at USTS which had been created a few years ago with the purpose of helping with admission decisions needs to be populated and used by the faculties. This would reduce waste in the form of under-utilization of an IT system (waste #9). A performance management system is currently missing and deadlines are frequently exceeded because nobody tracks them. The lead time should be the key metric for managing this process (principle #8). Visual control boards are commonly used in lean production, and could also be used at USTS to visualize processes, monitor performance, and track problems (principle #9). Some quality measures could be used to further support performance management, for instance tracking the number of inquiries or complaints. The solutions and the lean principles applied are summarized in table 9.

Problem	**Type of waste**	**Solution**
New applications are stored several days before being processed.	Excess inventory.	Do not let applications pile up.
Each program has their own way of processing applications. Criteria and processes differ widely and no real overview of this exists.	Lack of standardization.	Create standards for processes, academic criteria, and additional checks that could be performed by the admission office.
Some faculties work slowly.	Waiting.	Allocate sufficient time and responsibility for processing applications. Communicate when delays occur.
A database to help support decisions is barely used.	Under-utilization of systems.	Populate the database with data and allow faculties to access it easily.
“Easy” applications are processed by higher-level staff, even though decisions could be made administratively.	Under-utilization of people’s capabilities.	Segregate complex applications from the easier ones. Divide the work according to the skill and experience of employees.

Table 9: Recommendations for reducing waste in the back-office processes at the USTS

Now recommendations for the back-office process at USTS have been made, the same is done for GIM. In contrast with USTS, the admission process at GIM does not have a single source of delays and problem areas can therefore be referred to with the different Kaizen bursts of figure 5 and table 6. The first Kaizen burst in table 6 (section 5.1.2) refers to the fact that hardly any application at GIM is complete and correct from the beginning. The waste resulting from this could be reduced by providing more information on the website as well as “guiding”- the applicant more during the registration in DAF.

The overall process was analyzed was investigated in more detail because there was not a single source of delays. The first problem at GIM was that hardly any submission was complete and correct when it arrives at the admission office. Students also submit unneeded documents and apply for the NFP even though their countries are not supported. This waste could be prevented by providing more information on the GIM website as well as “guiding” the applicant with more information during the registration process in DAF. Selecting certain fields should also eliminate others and automatic controls should be in place to make it less likely that false information gets entered. The slow loading speeds in DAF could be solved by optimizing code and upgrading hardware to increase access speeds. Waste due to low-resolution scans should be solved by increasing the file size limit. Furthermore, DAF could be adapted so that only PDF files can be uploaded, which is the only file format that can be managed with the Decos document management system.

The work performed by the course directors at GIM could be standardized further (lean principle #4). Course directors should provide explanatory information on how they calculated scores. Kaizen burst #4 at the back-office process of GIM refers to the cumbersome activities that are needed to synchronize DAF and SIS. Solutions to this are a better search function in SIS with multiple variables and results that are displayed in a list. Moreover, inconsistencies in employer information should be eliminated as much as possible so that synchronization can be done with minimal manual intervention. GIM continues to use its own information systems (Kaizen burst #5). A migration to the information systems of USTS had been proposed. This requires adaptation to the processes and requirements of GIM. Integrating similar IT functions is a *standardization* IT integration method (Wijnhoven et al., 2006). This also called a common systems approach, which selects one system even though it is not objectively the best system. Standardization is often done using a "best-of-breed" selection procedure which results in a mixture of IT based on a combination of the best practices of the two previous systems (Wijnhoven et al., 2006). The solutions to reach an ideal state at GIM are outlined in Table 10.

Kaizen burst numbe r	**Problem**	**Type of waste**	**Solution**
1	Hardly any application is complete at the first time.	Extra processing.	Provide more information on the website and build in more automatic checks in DAF to ensure that applications are submitted correctly.
2	Students submit unneeded documents.	Information overflow.	Inform the candidates better and design DAF so that unneeded documents cannot be uploaded.
2	Students from the wrong countries try to apply for the NFP scholarship.	Information defect.	Inform candidates better and design DAF so that candidates with certain information cannot apply for scholarships they are not entitled to apply for.
2	DAF loads slowly.	Waiting.	Optimize code and upgrade the infrastructure.
2	Some scans cannot be read due to the 1 MB file size limit.	Extra processing.	Increase the file size limit to 5 MB or more.
2	Decos only stores PDF documents although students can submit documents in various different formats.	Extra processing.	Only allow PDF documents to be uploaded.
3	Only some course directors provide extra information about how score candidates.	Lack of standardization.	Require all course directors to provide additional information about the scoring.
4	SIS does not have an adequate search function.	Motion.	Create a search function with multiple search fields. Display results as a list.
4	A workaround has to be used when some names are hard to find in SIS.	Motion. Extra processing.	Improve the search function (same point as above).
4	Employer information has to be entered manually due to possible inconsistencies.	Extra processing.	Automate this where possible, implement a suitable search function to identify existing entries effectively.
5	Osiris is only used for basic compatibility with some UT software applications.	Under-utilization of systems.	Migrate to USTS's systems.
5	Redundant systems continue to be used and various incompatibilities exist.	Motion. Extra processing.	Migrate to the USTS's systems.

Table 10: Recommendations for reducing waste in the back-office processes at GIM

6. Discussion and conclusion

The Lean Evaluation and Future Improvement (LEFI) method developed in this paper attempts to make lean thinking applicable to administrative processes. LEFI was tested with a field test at two higher education institutions. The method was usable within the constraints of the organization; design product hypothesis 1 (PH1) is therefore supported. LEFI was successful in identifying waste in the registration and admission processes of GIM and USTS (PH2). Some directions for solutions could also be made in the second step of LEFI (PH3). Although the suggestions for improvement were not yet implemented, it could be said that there was design acceptance. Many people involved with the admission process knew the basics of lean thinking, which meant that many of the techniques were understood without formal training. The visual representation of processes and waste was useful when working in groups because of the overview and structure it provided. The results of analyzing the registration and admission process from the perspective of the student were presented at one of the meetings and recommendations are considered for planning proposed changes. LEFI created transparency, which prevented disagreements and allowed people to set goals.

Based on the types of problems found in the registration and admissions process at USTS and GIM, two additional principles could be added. A lot of waste was caused by poor communication with applicants and among study programs. One additional principle that would therefore be useful for administrative processes is to *improve communication*. Better communication prevents errors and missing information. Better communication between different departments allows processes to be coordinated better, which reduces waste. This resembles the second rule of the Toyota Production System (Spear & Bowen, 1999, p. 98): "Every customer-supplier connection must be direct, and there must be unambiguous yes-or-no way to send requests and receive responses." At Toyota, this way of connecting people to each other eliminates gray zones in deciding who provides what to whom and when. There is no confusion about the supplier, the number of units, or the time of delivery. Similarly, when a person needs assistance, there will be no confusion about who will provide it, how the help will be triggered, and what help will be provided (Spear & Bowen, 1999). In addition to poor communication, substantial waste in several process steps was caused by the design of the IT systems. Poorly designed user interfaces and gaps between the functionality and user requirements (misfits) lead to extra work (Soh, Kien, & Tay-Yap, 2000). Accordingly the second principle that should be added to lean for administrative processes it that, *IT systems should be designed to support the users in an optimal way*. Administrative processes rely heavily on information technology nowadays. Nearly every step and sub-process at USTS and GIM were guided and supported by an IT system of some sort. As a result, the design of IT systems has a significant impact on operational performance.

Future research is needed to demonstrate the effects of using lean in administrative services. Two additional steps could be added to LEFI for implementing the solutions. The third step would be do derive a *feasible future state*. It is important that stakeholders evaluate which changes are possible and which ones are more important. A holistic perspective must be taken to prevent local sub-optimization. With regard to the feasibility of the solutions, one information systems analyst said that making changes to Studielink and OSIRIS is not feasible because these systems are used nationally. Customization possibilities are limited. There is more possibility for making changes to the systems used by GIM since important components were custom-developed and are not used by other institutions. However, it is likely that GIM will move to USTS' systems in the future, which would make the changes to DAF and SIS irrelevant. Introducing more standardization in the academic admission process at USTS is generally feasible. Changing personnel policies for increased availability and efficiency will require significant organizational change. The fourth step that could be performed in future research would be to *implement the feasible changes*. For this, it is useful to establish a plan with fixed start and end for all measures. The organizational change process should start when management approves the plans.

The findings from this research are encouraging, but are not without limitations. The main limitation of this study is that the proposed changes to reduce waste could not yet be implemented. Accurate performance data was only partially available; estimates and findings from previous process improvement projects therefore had to be used. However, objective data about admission processing times became available near the end of the research. The field test also confirmed some of the challenges in when implementing lean in administrative services. Most administrative processes are not visible, which means that waste cannot be observed as directly as in manufacturing. Demonstrations, meetings, and other tools were needed to make waste visible. Another challenge in administrative services is that processes consist of many sub-processes that stretch across departments. Sub-processes can be mapped relatively easily, but one should strive to map the whole process. Breaking a process down into sub-processes is contradictory to the lean principles of flow (principle #5) since buffering takes place at each sub-process.

Future research could consist of longer-term studies or more intensive lean implementations that can be carried out over a short period of time, Kaizen events for instance. Future research will allow the waste categories and lean principles to be refined further with observations at different organizations. Despite the limitations, this research makes a contribution to lean in administrative services.. There is significant potential for improving the operational efficiency of administrative processes, and lean is a valuable way to achieve improvements. Principles and techniques are conceptually applicable to service businesses, but implementation has to be done differently.

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