Engaging Users through the Application of Value Stream Mapping to Streamline the Procurement Process for Office Equipment

A thesis presented to
the faculty of
the Russ College of Engineering and Technology of Ohio University
In partial fulfillment
of the requirements for the degree
Master of Science

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December 2016
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This thesis titled

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Procurement Process for Office Equipment

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ABSTRACT

HAYDEN, MARIE A., M.S., December 2016, Industrial and Systems Engineering

Engaging Users through the Application of Value Stream Mapping to Streamline the Procurement Process for Office Equipment

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This research used a value stream map to visualize the current procurement process for office equipment at a mid-western University. Employees who work at a computer workstation can spend 30-40 hours/week interacting with their equipment. Daily interaction can cause health risks, such as musculoskeletal disorders (MSD). Because MSDs can be linked to poor postures, providing office equipment that fits the user is important to reduce possible health risks. An efficient procurement process can ensure that employees get the appropriate equipment in a timely manner. This research consisted of two parts: 1) a survey to employees regarding office equipment, and 2) three focus groups with employees who are active in the procurement process. Current value stream maps were created from the survey data and focus groups. Each focus group provided suggestions to improve the current procurement process to create a future value stream map. Research indicated that adding the following items could improve the procurement process: 1) a decision tree for users that would aid in the determination of a product, 2) a pre-approved catalog for office equipment, and 3) better communication between individuals involved in the different stages in the process.
DEDICATION

This thesis is dedicated to my parents and sister for all their support.
ACKNOWLEDGMENTS

First, thank you to my advisor Dr. Diana Schwerha, and my committee members Dr. Dušan Šormaz, Dr. Gary Weckman, Dr. William Young for accepting and providing their knowledge on the proposed concept for this thesis. Thank you to the Russ College of Engineering & Technology for providing the appointment. I appreciated the help from Martin Dagostino, the ergonomist who recommended the participants. Thank you to Donald Perone for all the help editing my thesis. I would like to acknowledge all the help provided by the focus groups and survey participants who spent their time providing me the knowledge on the current procurement process.
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1 INTRODUCTION

A procurement process for office equipment can benefit the users by providing equipment to fit their needs in a timely manner. The quality of a procurement process can have a positive impact on revenue cost, total cost, and improved communication and relationship between suppliers and customers (Talib, Rahman, & Qureshi, 2010). The procurement process connects suppliers and customers. Suppliers provide raw materials to produce the product and the customers are the people who demand the product (Tan, K. C. 2001). Different stages link the suppliers to customers and individual stages can affect the finished product’s quality and customer’s satisfaction with the product. To understand the process a value stream map was applied to visualize the stages and assistance used in the process.

The procurement process affect the type of office equipment procured. Office equipment (that does not fit the user) can result in high risk of work-related musculoskeletal disorders (MSDs) among office workers (Mahmud, Bahari, & Zainudin, 2014; Robertson, Ciriello, & Garabet, 2013), and decrease the employee’s task performance (Halford, & Cohen, 2003). If the procurement process does not benefit the user, employees will not purchase office equipment to reduce their health risk. Far, Barbe, & Clark describe MSDs as injuries or disorders to the body’s muscles, tendons, joints, cartilage and spinal discs (2004). Prolonged sitting, awkward postures, repetitive movement, and the height location of a keyboard have been shown to contribute to the development of musculoskeletal disorders (MSDs) (Mahmud, Bahari, & Zainudin, 2014).
Office equipment used ranges from small items such as mouse controllers, and keyboards, to large items such as computer monitors, chairs, and computer desk.

The process affects the length of time an employee waits for the equipment, and the type of equipment procured to reduce MSDs. Assistance in the procurement process can affect the type of office equipment procured. Office equipment that fits the worker can improve their well-being and reduce MSDs (Bidassie, Goh, Feyen, & Barany, 2010). Procuring an employee's equipment that fits the user in a timely manner, and ensuring a neutral posture requires an efficient procurement process.

Procurement literature discusses different techniques to assess a current procurement process efficiency used in industries such as food supply programs, healthcare, and construction. One technique commonly used is a lean manufacturing tool called a value stream map (Abdulmalek, & Rajgopal, 2007; Teichgraber, & de Bucourt, 2011). Lean manufacturing is a concept focused on waste reduction, and quality performance. This concept is commonly used in manufacturing industries such as automotive and electronics. Lean principles have recently expanded to other industries such as healthcare, construction, food industries, and chemical companies. Few studies combine lean principles with management philosophy in the public sector for procurement processes. This is discussed further in the literature review (Schiele, & McCue, 2011; Waterman, & McCue, 2012).

The application of a value stream map gives a visual representation of the procurement process system. A value stream map can help increase the transparency of the stages in the system considered non-value added waste (Alexander, Aguinaldo, &
Adriana, 2012). The non-value added waste can be processing the item, the time spent waiting for the item to move to the next stage, overproduction compared to the demand for the item, the type of transportation, the amount of inventory for an item in a work-in-progress, unnecessary motion to create the item and defects found in an item (Teichgraber, & de Bucourt, 2011). Waste causes the procurement process to not meet the needs of the employees, and can results in procuring the wrong equipment for the employee.

The main objective of this research was to determine the current procurement process for office equipment at a mid-western university, and complete value stream maps. This research consisted of two parts: 1) a survey to employees on procurement and 2) three focus groups with employees who are active in the procurement process. The survey established the general knowledge of the procurement process and areas that affect length of time, quality, and functionality of the process. Focus groups established more detail on the value stream map created from the survey data. Value stream maps established a visual representation of the current process and knowledge of the process stages. Information a value stream map established was the different stages that had areas of non-value added that caused waste resulting in an inefficient process to employees.

Research Questions:

1. Using data from surveys and focus groups, what is the current procurement process as described by a value stream map?

2. Using additional data from focus groups, how much could the process be improved from the use of a value stream map?
3. What are the employee satisfaction levels with the process’s length of time, quality, and functionality participants experience using the current procurement process?

Specific aims:

1. Create a current value stream map and determine the types of value added, non-value added, and necessary but non-value added in the procurement process.

2. Evaluate if there is a difference between survey data and focus groups in the process.

3. Determine possible solutions to implement a future value stream map.
2 LITERATURE REVIEW

2.1 Procurement Process

Procurement is the action to obtain material or equipment, and the process can affect customer satisfaction. A procurement process contains a series of activities to acquire a finished good (Novack, 1991). In different case studies, the procured material ranges from food items to construction equipment. The case studies illustrated different procurement processes and methods used to demonstrate benefits of the current or improved procurement process. A method chosen to benefit this study on the procurement process for office equipment was the use of lean manufacturing value stream map. None of the case studies demonstrated procuring office equipment, but they do provide different methods that could assess an office equipment procurement process.

2.1.1 Procurement Assessment Methods

Jenny Thatcher and Liz Sharp documented a procurement process assessment method in the United Kingdom of a local food program called the Cornell Food Programme (2008). The assessment methods evaluated the cost benefit in using a short food supply chain process (Thatcher, & Sharp, 2008). Two methods used to calculate the benefits to use a short food supply chain were: 1) the Multiplier Effect, and 2) Nef’s Local Multiplier (LM3). The Multiplier Effect factors the direct effect and indirect effects of investment generated in the area. The LM3 focuses on the total income, total expenditure, and the estimated amount re-spent by suppliers and staff. Two disadvantages in using the LM3 method to evaluate the procurement process were the
required detailed on the process and the amount of time spent calculating the total process cost (Thatcher, & Sharp, 2008).

Chen and Sarker discussed a supply chain procuring milk products with a multi-vendor procurement employing an integrated Just-In-Time method to improve the delivery system (2010). The Just-In-Time method integrated is a strategic improvement to purchasing time, inventory control, and production management (Chen, & Sarker, 2010). The production process deals with three vendors sharing the same transportation system to reach the manufacturer. Integrated Just-In-Time procurement system implements a reduce cost with long-term collaboration, produced smaller batch sizes, synchronizing inter-firm operations, and joint inventory system between the three vendors (Chen, & Sarker, 2010).

Construction industries’ procurement processes have the potential to be inefficient and ineffective, which can contribute to a poor performance process for construction projects (Li, Love & Guna Sekaran, 1999). To understand and evaluate the current procurement process performance for the construction industries, Li, Love & Guna Sekaran, used two tools called a Petri-Net and a Colored Petri-Net (1999). Petri-Nets demonstrate the workflow for a process control and have been used since the early sixties (van der Aalst, & ter Hofstede, 2000). Both Petri-Nets present a visual and mathematical description of the current state of the procurement process. Factors contributing to the models are the individual stages and transition between the stages. The objective in using these tools is to illustrate the time taken to move items to the next stage in the process.
The two Petri methods are similar to the lean Just-In-Time in that they strive to minimize the holding or storing stocks in the process (Li, Love & Guna Sekaran, 1999).

A specific construction procurement for a public building in Germany used lean manufacturing methods. Factors emphasized were the need to incorporate flow and value principles. The value principles focused on reduction of cycle time and variability, while increasing the transparency and contained continuous improvement methods (Alexander, Aguinaldo dos, & Adriana de Paula Lacerda, 2012). The lean method applied was a current value stream map and a future value stream map. The current value stream map increases the transparency of areas with high waste, and provides information on the current cycle time starting with the request to build and ends with access to the completed building. There are three different value categories: 1) value added, 2) non-value added, and 3) necessary but non-value added (Alexander, Aguinaldo dos, & Adriana de Paula Lacerda, 2012). The non-value added is considered to be waste in the process. A future value stream map demonstrated possible solutions to implement waste reduction and reduce cycle time (Alexander, Aguinaldo dos, & Adriana de Paula Lacerda, 2012).

The procurement process for endovascular stents in healthcare used a lean manufacturing tool known as value stream map (Teichgraber, & de Bucourt, 2011). The current and future value stream map streamlines the procurement process beginning at the supplier and ending with implementing the stent into the patient. Similar to the construction case using value stream maps, healthcare categorized three types of values: value added, non-value added and necessary but non-value added elements. Teichgraber and DeBucourt refer to the Toyota Production System to discuss areas of what non-value
added waste could be considered as overproduction, waiting, transportation, inappropriate processing, unnecessary inventory, unnecessary motion, and defects (2011). The future value stream map provided possible solutions as a pull inventory control system referred to as Kanban to reduce inventory waste (Teichgraber, & de Bucourt, 2011).

2.2 History of Lean

Mass Production focused on decreasing the assembly time in automotive manufacturing which affected the quality and quantity of automobiles, and the employee’s interaction with the required task (Black, & Hunter, 2013). Eiji Toyota noticed these issues with quality and quantity and developed processes leading to a revolution known as Toyota Production System (Ross, Womack, & Jones, 2014). The purpose of Toyota Production was to decrease waste, and increase quality from the combined concepts of Just-In-Time and Total Quality Control (Koskela, 1992). Just-In-Time focused on the reduction of inventory stock, and total quality control resulting in a decrease in defects and increase in the quality of the production.

Lean methods have been used in manufacturing sectors such as the automotive and electronics. Recently lean methods have been used in the continuous process sector for procurement (Abdulmalek, & Rajgopal, 2007). The concept of lean thinking used in public sectors take the approach of a Toyota Production System. Lean thinking creates value in the system for the customer and eliminates waste processes (Schiele, & McCue, 2011; Waterman, & McCue, 2012; Wan, & Chen, 2008).
2.2.1 Purpose & Principles of Lean

Lean methods applied correctly result in waste reduction or elimination, and create a higher proficiency in manufacturing (Amin, & Karim, 2013). The focus for manufacturing is the quality, output, and cost (Black, & Hunter, 2013). The main non-value added elements to eliminate in manufacturing were waste from processing, waiting, overproduction, transportation, inventory, motion and defects (Teichgraber, & de Bucourt, 2011).

The five principles for lean production focus on the system. These principles focus on the customer’s definition of value, identifying required actions to produce the product, maintaining continuous flow, apply pull system to areas without continuous flow, and reduce the effort, time, space, cost, and mistakes to achieve the optimal product or service to the customers (Schiele, & McCue, 2011; Waterman, & McCue, 2012). Lean thinking uses those principles to increase the efficiency and effectiveness for the customer (Schiele, & McCue, 2011). Lean thinking is a combination of management philosophy and lean tools to reduce the non-value added activity waste, while increasing quality (Waterman, & McCue, 2012).

To implement lean production, there are ten main steps: 1) develop material flow, 2) reduce cell setup time, 3) quality control, 4) preventative maintenance, 5) synchronize sequence, 6) production control, 7) reduce work-in-process, 8) exchange technology with vendors, 9) automation mistake proof, and 10) modification to production system (Black, & Hunter, 2013). Other factors affecting an industry’s success of implementing lean include leadership from management, financial support, organizational culture, and the
skill and experience a person possesses applying lean (Achanga, Shehab, Roy, & Nelder, 2006).

Methods for industries will vary, but the purpose to decrease waste and cost remains the same. These methods can consist of 5S (sort, separate, shine, standardize, sustain (Black, & Hunter, 2013)), total productive maintenance, Just-In-Time, Kanban system, production smoothing, standard work process, visual management system, cellular manufacturing, single minute exchange of dies, safety-improvement programs, and information management system (Amin, & Karim, 2013). Depending on the company’s waste, there can be more than one method required to solve the problems (Amin, & Karim, 2013).

2.2.2 Different Industries Applying Lean

Lean methods previously used primarily in manufacturing are transitioning into newer industries. Recent case studies have shown lean methods applied to industries of healthcare, chemical companies, and construction. Applying lean methods to these areas have different advantages, disadvantages and limitations with the transition in techniques. These cases give a variety of application of lean methods. Knowing this information can increase our understanding why certain applications for this case study are not applicable, and why value stream mapping is the optimal lean method to streamline the procurement process.

Simons and Canarcari discussed the use of different lean methods and tools used to improve the healthcare management process on hip procedure (2013). A value stream map, and cause-and-effect diagram were used to visualize and depict the potential areas
of waste in the process. The value stream map starts with the procurement of surgical tools from suppliers, and ends with the patient’s completed hip operation. The main types of waste were the defects in medication or equipment, and the waiting time for patient care. The cause-and–effect diagram addressed the defect related to time delay with the possible causes being problems with lost instruments, improper cleaning, ineffective resources, sharp hazards, and malfunctioned equipment (Simon, & Canarcari, 2012). The benefits of using lean methods increases the transparency of the process to improve the value for customers and decrease cost of the process. The advantages with lean applied in this case resulted in improved sterilization, efficient equipment, and improved safety features (Simon, & Canarcari, 2012).

The Outpatient Oncology Department at Central Baptist Hospital, Lexington Kentucky implemented the 5S method (Speaks, Ross, Malone, & Jenkins, 2009). The 5S method eliminates waste by creating an organized system and in other cases applying safety to create the term 6S. The five steps to implement this method are 1) sort, 2) separate, 3) shine, 4) standardize, and 5) sustain. The benefits demonstrated in the case study are proper placement for medication, reduced cost and improved patient safety by eliminating expired medication (Speaks, Ross, Malone, & Jenkins, 2009). The disadvantage that can occur is the process returns to the original process when the new system is non-sustained.

Aqlan & Mustafa Ali discuss a study in the chemical industry adding risk management with the use of lean principles (2014). A fault tree and an event tree analysis were used. They are similar to value stream mapping by streamlining a visual
representation of factors that lead to a risk event. The fault tree analysis shows the risk factors, and the event tree analysis determined the impact of risk. The fuzzy bow-tie analysis was used to calculate the probability of the risk impact and event factors (Aqlan & Mustafa Ali., 2014). Once the probability and event factors were determined, the use of failure mode and effect analysis method was applied to determine a best strategy for mitigation. The advantage of these techniques is that they help to identify the risk hazard, and strategy best for mitigation. The disadvantage is the experience and knowledge the person needs to apply these tools (fault tree, event tree, fuzzy bow-tie, and failure mode and effect analysis) (Aqlan & Mustafa Ali., 2014).

2.2.3 Lean Methods Benefits & Disadvantages

There are different types of methods applied in lean, and each have advantages and disadvantages. The 5S mentioned earlier (Black, & Hunter, 2013), benefits the systems organization skills and efficiency. A disadvantage with implementing 5S is sustaining the new procedure. The total productive maintenance (Amin, & Karim, 2013), or total preventive maintenance (Achanga, Shehab, Roy, & Nelder, 2006) relates to maintaining equipment to prevent malfunction. The advantage is a decrease in possible defects caused by a broken machine. Just-In-Time benefits production, resulting in reduced work-in-progress, and inventory (Kioskela, 1992). This method uses a pull system referred to as Kanban. There are two types of Kanban known as a single card, and dual card system (Black, & Hunter, 2013). An advantage for a single card system is that it is simple and easy to implement. The dual card system can be harder to implement if there is not already a Kanban system in place. The advantage with a dual card system is
information on product orders and transportation is separated. This allows the employee to know the quantity of items in the work-in-progress and the quantity transported between stations. The single card system does not indicate the orders and transportation separately.

The visual management system includes quality control steps that are value stream maps, Histogram, Pareto chart, Scatter diagram, Fishbone diagram, Control chart, and Run chart (Black, & Hunter, 2013). Each visual management tool contains information related to a system’s process. A value stream map presents a visual streamline of the whole process. The histogram gives a graphical representation corresponding to frequency and is used in quality control to compare process speck limits, and indicate gaps in data. The Pareto chart is a type of histogram illustrating high contributors to waste. The Fishbone diagram or Cause-and-Effect diagram presents potential key process inputs possibly contributing to defects. The advantage for all visual management system tools is the transparency of the system to visually show potential areas of waste. Applying cellular manufacturing organizes the total process set up into groups to easily facilitate the operation (Abdulmalek, & Rajgopal, 2007).

2.3 Value Stream Map

The goal of a value stream map is to give a visual representation of a continuous value stream of a process taken from lean production and the concept of Lean Thinking (Wan, 2008). A main part of value stream map is to indicate the different types of activity values categorized into three sections of value added, non-value added, and necessary but non-value added. From those three types of activity, the non-value added
can create waste through overproduction, waiting, transportation, inappropriate processing, unnecessary inventory, unnecessary motion, and defects (Teichgraber, & de Bucourt, 2011). Data implemented into a value stream map can include cycle time, and lead time. The cycle time is the total time it takes for a process to be complete of an individual product or batch size of products. Total time factors include lead time for transportation, waiting time for work-in-progress products, processing and inspection. Lead time is considered the extra time added to assure the product can arrive as expected (Black, & Hunter 2003).

2.3.1 Application of Value Stream Map

There are different cases that used a value stream map as the primary method to identify waste produced in a process. The normal procedure is to create a current value stream map to first visualize the different control processes and then develop a future value stream map as a possible solution to implement. An advantage to creating a current value stream map is the increased transparency of the overall production process. This gives a visual representation starting from the order of raw material to the end where the customer receives the item. Documented studies evaluate the current value stream map areas of high non-value added waste to emphasize the significance of implementing potential future value stream map solutions.

Gracanin, Buchmeister, & Lalic present combined use of a value stream map method with cost-time profile (2013). This application illustrated total cycle process time with cost spent on the product. Costs consisted of manufacturing rate time, and material. The calculation for total cost and cost time investment were completed with a software
called Cost-time Profiler developed by Virginia Tech-Venter for High Performance Manufacturing in 2006 (Gracanin, 2013). Combining value stream map and cost-time profile creates more value for the customer by responding appropriately to improve the process by saving time and money (Gracanin, 2013).

A future value stream map can be evaluated through terms of cost and benefits improvement when compared to a current value stream map (Sihn & Pfeffer, 2013). To achieve this Sihn and Pfeffer used a five step process to evaluate the benefit of future value stream maps (2013). The steps were determining performance, expense and cost saving indicators, set up the functions and benefit values for the future value stream map, weight and prioritize indicators, calculate overall benefit for indicators, and selecting the process with the best value (Sihn & Pfeffer, 2013). This method evaluated the future value stream maps to the current value stream map to present which solution will give the highest benefit if implemented.

2.4 Office Equipment

The procurement process for office equipment affects equipment chosen to provide an environment in which employees should be able to effectively complete their job task, and collaborate with co-workers. Office equipment used daily should support employees’ needs and their well-being (Robertson, & O’Neill, 2003). The different stages and assistance in the procurement process affect the type of equipment procured for employees’ computer workstations.

Studies demonstrated assistance providing office equipment that better fits an employee can reduce health risks (Bidassie, Goh, Feyen, & Barany, 2010; Robertson,
O’Neill, 2003; Robertson, Ciriello, & Garabet, 2013), but they do not discuss the procurement process used to procure the equipment. Office equipment acquired were adjustable chairs and split keyboards that allowed an employee to have a neutral position. Employees assisted were satisfied by increased comfort with the use of a split keyboard (Bidassie, Goh, Feyen, & Barany, 2010). To provide employees with comfort using office equipment requires the use of a procurement process sensitive to ergonomic principles and products. A procurement process benefits employees by providing equipment to fit their needs in a timely manner.

2.4.1 Purpose to Procure Office Equipment

Hours spent at a computer workstation (with ill-fitting equipment) can increase the risk of work related musculoskeletal disorder (MSD) and visual discomfort (Robertson, Ciriello, & Garabet, 2013). Oha, Animägi, Pääsuke, Coggon, & Merisalu discussed a 12-month prevalence rate of MSDs that occurred between employees and computers (2014). The prevalence rates listed were 55-69% neck disorders, 31-54% back, and 15-52% upper extremities that demonstrated MSDs (Oha, Animägi, Pääsuke, Coggon, & Merisalu, 2014). In some cases, the factors that led to MSD were poor seating posture and poor workstation set up (Lui, n.d.). A sustained posture and repetition from the daily use of computer equipment such as a mouse controller and keyboard may also place an individual at risk for a MSD (Robertson, Ciriello, & Garabet, 2013). Other potential risk factors include awkward postures from sitting, bent wrists, awkward head and neck positions (Office Ergonomics Advisory Committee, 1997). If the interaction with equipment is not improved, or adjusted to fit the employee the work-related MSD
can become worse. MSDs can result in high medical cost and time loss at work (Office Ergonomics Advisory Committee, 1997).

Case studies incorporating uses of an ergonomic intervention mentioned equipment used to benefit employees (Bidassie, Goh, Feyen, & Barany, 2010; Robertson, Ciriello, & Garabat, 2013; Robertson, & O’Neill, 2003), but they do not discuss the procurement process used to procure the equipment. The chosen lean technique known as value stream map provided a visual representation to evaluate the procurement process for office equipment.
3 METHODOLOGY

The purpose of this research was to understand the procurement system for office equipment at a mid-western university. Research focused on acquiring information on the steps taken in a university procurement system and determining the value added, non-value added and necessary but non-value added elements in the current system. Decisions on the type of equipment procured, especially equipment designed to better fit employees, and the length of time needed to acquire the equipment were also concerns. Two methods, a survey and focus groups, were used to develop value stream maps of the current procurement system. The value stream maps provided a visual representation of the paths taken in the current procurement process. The survey data obtained general information about the participants’ familiarity and known paths taken to procure office equipment. Data from the survey provided satisfaction rates of the current process. Focus groups provided more detailed information about the process stages to elaborate on the satisfaction rate results, and generated recommendations to create a future value stream map.

3.1 Survey Development & Distribution

The survey went through a development phase before sent to participants. The survey consisted of four sections: 1) demographic, 2) current workstation equipment, 3) procurement processes knowledge and 4) satisfaction with purchased items. The demographics section included of five questions establishing participants’ history with the procurement process. Demographics questions also inquired about the time spent interacting with equipment and identifying discomfort or pain experienced from their
interactions. Six questions made up the second section concerning current computer workstation equipment and focused on the type and features of the office equipment participants interacted with daily. The third section focused on the procurement process and consisted of fifteen questions to determine participants’ awareness and involvement with equipment purchasing procedures. The fourth and last section consisted of six questions concerning requesters’ satisfaction related to the length of time to receive equipment, the quality of the equipment and function of their procured office equipment.

A survey was sent to faculty, administrators and staff of a mid-western university via email upon approval of Ohio University Institutional Review Board. Participants were provided an informal consent form and a survey link. The survey had an anonymous response setting and was sent out through a program called Qualtrics, a software used to create online surveys. The survey link was open for two weeks.

3.2 Focus Groups Participants & Process

Focus groups were conducted under the approval of the Ohio University Institutional Review Board. Three focus groups were assembled to characterize the procurement system at the university: representatives from an academic department, the Equal Opportunity and Accessibility department, and the university library with Project Management department. The academic focus group included five individuals familiar with the request and purchase stages. The accessibility group consisted of four participants possessing an understanding of the required stages to determine, request and purchase equipment. The combined university library and Project Management department handles large (15-20) orders of office equipment and its four staff were
familiar with the university’s determine, request and purchase stages of procurement. Recommendations for potential focus group participants were made by the campus ergonomist, as well as the participants themselves. Participants were contacted through email and received an informal consent form.

Focus groups took approximately an hour and participants did not receive compensation. Each session consisted of a group introduction, PowerPoint presentation and a discussion guided by interview questions. The PowerPoint presentation explained the concepts of a value stream map and flow process gathered from the survey data. The remainder of the sessions covered questions concerning the current procurement process. Appendix D covers the questions mentioned in the sessions allotted time.

3.3 Value Stream Map

Survey and focus group data provided information for development of current value stream maps. Survey data informed the general skeletal structure of a current value stream map, provided awareness on the knowledge participants had concerning the current procurement process, and the different pathways used by the university to procure office equipment. A current value stream map began with participants determining the need for equipment and finished with participant receiving equipment. A software used to create a digital value stream map was Visio. This software provided professional flow charts and diagram. Data obtained from focus groups contributed additional details on the current procurement process. These value stream maps were memory based compared to a normal application would be based on documentations. Recommendations made by the
focus groups can help the development of a future value stream map. Focus group participants were sent a copy of the finished value stream map to identify omissions.

3.3 Limitations Considered

Limitations to consider were number of survey responses, the allotted time to acquire knowledge from the focus groups, and the number of participants for the focus groups. The details based on participants’ knowledge and memory of the current procurement process limits the detail of the value stream maps.
4 RESULTS

The following sections describe results from the survey and focus groups. The survey assessed the current procurement process’s length of time, functionality and quality of the process. Survey responses provided the demographics of participants, descriptive statistics on their current work environment, pain or discomfort experienced by participant, and their knowledge of the different stages of the procurement process. Focus groups data provided more detail for the creation of current value stream maps and recommendations for amending the procurement process.

4.1 Survey Information

The survey was directed to participants who work at computer workstations. Of the nearly five thousand individuals receiving the survey, 11% responded (548 people started the survey out of 4,789). Respondents could skip questions and some responses were not completed in the allotted time. Answers given in a range had the higher value taken as the result. Data provided in a different unit from the assigned column unit were converted to the appropriate format (e.g., a question asked for hours but a participant provided a response marked as days).

4.2 Demographics

The mean age of a respondent was 44.7 years (SD=11.9 years). Distribution for gender responses were 62.7% female, 36.9 % male, and 0.37% listed as other. The average length of employment at the university was 9.9 years (SD=9.1 years). The average time spent working on a computer was 30 hours/week (SD=11.7 hours/week).
The survey solicited information about pain or discomfort for nine specific areas of the body. Figure 1 provides the number of participants experiencing pain in the identified body regions while working at a computer workstation. Each body region had four responses: 1) no experienced pain, 2) left section, 3) right section, and 4) entire section of that body region. Overall 49% of participants experienced no pain in their elbows, wrist/hands, hips/thighs/buttock, knees, and ankles/feet. By comparison, participants experienced pain in the area of the neck, shoulders, upper back, and lower back with 42% experiencing pain in the entire body section, 7% on the right side, and 2% on the left side. Results indicated slightly more than half of participants experienced pain working at a computer workstation.

Figure 1: Participants Who Experienced Pain in Various Parts of the Body
4.3 Current Office Equipment

Respondents were asked questions regarding features provided by their current office equipment. Table 1 demonstrated a variety of office equipment commonly used at most workstations. The most common pieces of equipment identified were wired mouse controllers (49%), wired standard-shaped keyboards (65%), and chairs with a height adjustable seat (28%), adjustable back support (19%), arm rest (26%) and casters (24%). Participants noted keyboards were largely placed on the desk with a few placed on a keyboard tray or on the lap (other). Only 13% of participants reported they could change the height of their desk to fit their height. Only 11% reported they had the capability to adjust their desk from a sit or to a stand position.

Table 1

<table>
<thead>
<tr>
<th>Features of the Current Office Equipment</th>
<th>Responses</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mouse Controller</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wired</td>
<td>303</td>
<td>49%</td>
</tr>
<tr>
<td>Wireless</td>
<td>206</td>
<td>33%</td>
</tr>
<tr>
<td>Combined with keyboard</td>
<td>75</td>
<td>12%</td>
</tr>
<tr>
<td>Other</td>
<td>38</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Keyboard</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wired Standard Shape</td>
<td>366</td>
<td>65%</td>
</tr>
<tr>
<td>Wireless Standard Shape</td>
<td>108</td>
<td>19%</td>
</tr>
<tr>
<td>Other</td>
<td>44</td>
<td>8%</td>
</tr>
<tr>
<td>Wired Non-Standard Shape</td>
<td>21</td>
<td>4%</td>
</tr>
<tr>
<td>Wireless Non-Standard Shape</td>
<td>21</td>
<td>4%</td>
</tr>
<tr>
<td>Location</td>
<td>Responses</td>
<td>Percent</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>Desk</td>
<td>398</td>
<td>74.2%</td>
</tr>
<tr>
<td>Keyboard Tray</td>
<td>120</td>
<td>22.4%</td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chair</th>
<th>Responses</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height Adjustable Seat</td>
<td>465</td>
<td>28%</td>
</tr>
<tr>
<td>Arm Rest</td>
<td>418</td>
<td>26%</td>
</tr>
<tr>
<td>Casters</td>
<td>398</td>
<td>24%</td>
</tr>
<tr>
<td>Adjustable Back Support</td>
<td>304</td>
<td>19%</td>
</tr>
<tr>
<td>Other</td>
<td>28</td>
<td>2%</td>
</tr>
<tr>
<td>Head Rest</td>
<td>22</td>
<td>1%</td>
</tr>
</tbody>
</table>

4.4 Procurement Process

Table 2 provides both responses on all the equipment procured over their years of employment and recently procured equipment. The survey allowed participants to choose more than one equipment in their response to equipment procured over their years since employment. Overall, only 14% (159 of 1121) reported not procuring any office equipment since their employment, with the number of participants who have not procured equipment at 32% (159 of 490). The equipment consisted of chairs, computer desks, mouse controllers, keyboards, keyboard trays, and “other.” Equipment listed as other included armrests for a mouse controller, Bluetooth, computers, arm monitors for dual screens, combined purchases of a chair with desk and mouse controller with keyboard, a trackpad, and laptop. A large percent (73.8 %) reported their most recently
procured equipment as chairs, mouse controllers, and keyboards. A small percent reported computer desk, keyboard trays and category “other.”

Table 2

<table>
<thead>
<tr>
<th>Items</th>
<th>Procured Over Time</th>
<th>Percent</th>
<th>Recently Procured</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse Controller</td>
<td>238</td>
<td>21.2%</td>
<td>75</td>
<td>22.7%</td>
</tr>
<tr>
<td>Keyboard</td>
<td>232</td>
<td>20.7%</td>
<td>73</td>
<td>22.1%</td>
</tr>
<tr>
<td>Keyboard Tray</td>
<td>82</td>
<td>7.3%</td>
<td>17</td>
<td>5.1%</td>
</tr>
<tr>
<td>Chair</td>
<td>249</td>
<td>22.2%</td>
<td>96</td>
<td>29.0%</td>
</tr>
<tr>
<td>Computer Desk</td>
<td>128</td>
<td>11.4%</td>
<td>44</td>
<td>13.3%</td>
</tr>
<tr>
<td>Other</td>
<td>33</td>
<td>2.9%</td>
<td>26</td>
<td>7.9%</td>
</tr>
<tr>
<td>None</td>
<td>159</td>
<td>14.2%</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

The survey identified four different stages for obtaining new equipment: 1) determine the need for the equipment, 2) request the equipment, 3) purchase the equipment, and 4) assemble the equipment. Figure 2 identifies the four stages in which participants were personally involved to procure their office equipment. Results indicated 36% were involved with determining the item need, 36% were involved with requesting the item, 18% were involved with purchasing the item and 10% were involved with assembling the item. Almost 75% of participants were actively involved with determining and requesting their item.
Respondents were asked at which stages they had assistances in procuring their office equipment. Figure 3 shows the assistance provided at each stage during procurement. Results indicate 26% assisted in determining the items needed, 25.4% assisted in requesting the item, 25.3% assisted in purchasing the item, and 23.3% assisted in assembling the item. Results noted 40% of participants marked acquired assistance as no assistance, which included if they did not require assistance, or unaware of assistance for that procurement stage. Reports indicated 21% assistance came from co-workers, 14% from others, 14% from supervisors and 11% from the university ergonomist. Participants reported other assistance came from administrators, or vendors. Assistance from the ergonomist was lower than expected when compared to other assistance listed.
The two commonly identified payment methods were a purchasing card and university purchasing system. Other payment methods reported were personal accounts, departmental budgets, or marked that the equipment was free. The overall percent of payments were 35% with university purchasing system, 34% with other methods, and 31% with a purchasing card. Figure 4 illustrates the payment used for each equipment procured. The university purchasing system was largely used for chairs (14%). “Other methods” of payment were largely used for mouse controllers (7%) and keyboards (7%), with purchasing cards largely used for mouse controllers (14%).

Figure 3: Assistance Acquired at Each Stage in the Procurement Process
Results demonstrated in figure 5 a high percent of 69% participants used sources other than the four commonly known vendors to procure office equipment. In comparison the known sources were 12% for LOTH Inc., 11% for Staples, 6% for Steelcase, and 2% for Grainger. Commonly used when assisted by the ergonomist were Steelcase, and LOTH Inc. in the procurement process.
4.5 Time Length for the Procurement Process

The average length of time since respondents last procured their most recent item was 407 days, (approximately 15 months, SD=464 days), indicating that even the most recent items procured were purchased a while ago. The overall time to receive office equipment was 17 days. Table 3 provides the average times for chairs and computer desks at the four different stages. For mouse controllers, keyboards, and keyboard trays used the median. The overall average time for each stage: 8 hours to determine the item need, 1 hour to request the item, 1 hours to purchase the item, and 1 hours to assemble the item. Results showed more time spent determining the item compared to requesting, purchasing and assembling the item.
Table 3

Average Process Time of Each Stage on Procured Equipment

<table>
<thead>
<tr>
<th>Items</th>
<th>Determine</th>
<th>Request</th>
<th>Purchase</th>
<th>Assemble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse Controller</td>
<td>1.0 hours</td>
<td>0.4 hours</td>
<td>0.5 hours</td>
<td>0.5 hours</td>
</tr>
<tr>
<td>Keyboard</td>
<td>1.0 hours</td>
<td>1.0 hours</td>
<td>1.0 hours</td>
<td>0.05 hours</td>
</tr>
<tr>
<td>Keyboard Tray</td>
<td>1.0 hour</td>
<td>1.0 hours</td>
<td>1.0 hours</td>
<td>0.5 hours</td>
</tr>
<tr>
<td>Chair</td>
<td>2.9 hours</td>
<td>1.5 hours</td>
<td>1.3 hours</td>
<td>0.8 hours</td>
</tr>
<tr>
<td>Computer Desk</td>
<td>4.1 hours</td>
<td>2.3 hours</td>
<td>1.4 hours</td>
<td>1.1 hours</td>
</tr>
<tr>
<td>Other</td>
<td>5.1 hours</td>
<td>0.5 hours</td>
<td>0.4 hours</td>
<td>1.1 hours</td>
</tr>
</tbody>
</table>

4.6 Satisfaction Rate

Respondents replaced their office equipment because of discomfort, or it was worn down, or broken. “Other” reasons to replace equipment included renovation, relocation of office, and ergonomic improvement to the workstation. Figure 6 identified the reasons for replacement were 31% other, 27% discomfort, 21% worn down, and 21% broken. The most cited reasons for replacing chairs was both discomfort and worn down; computer desks were listed as other; keyboards were broken; keyboard trays causing discomfort; non-operative mouse controllers; and “other” equipment procured listed the reason as “other”.

Figure 6: Reasons to Determine Replacement of Office Equipment

Respondents were asked about the features taken into consideration for the selection of office equipment for purchase. Figure 7 shows the selection of office equipment for purchase included an item's cost, durability, style, or other considerations such as reliability, availability, functionality, ergonomic design and comfort.
The total responses indicated 89.8% of respondents were satisfied with their replacement, while 10.1% were not. Equipment respondents reported dissatisfied with included 3.9% with chairs, 2.6% with computer desk, 1.3% with keyboards, 1% with mouse controllers, 1% with the other items, and 0.3% with keyboard trays.

The survey asked respondents about their overall satisfaction about the length of time required to procure equipment, and the quality and functionality of the procurement process. Satisfaction was rated using a five point Likert scale ranging from very dissatisfied to very satisfied. Table 4 indicates the percent of each satisfaction rate for the length of time, quality, and function of each office equipment’s procurement process.

Even though the responses for dissatisfaction were small the overall satisfaction for both somewhat and very satisfied rates for length of time, quality and functionality were in the range of 50-83%. Of the three areas, length of time had a lower satisfaction compared to
quality and function. Lower satisfactions were for the purchase of chairs, keyboard trays and computer desk compared to keyboards, mouse controllers and other equipment.

Table 4

Overall Satisfaction with the Procurement Process

<table>
<thead>
<tr>
<th>Time Length</th>
<th>Items</th>
<th>Responses</th>
<th>Very Dissatisfied</th>
<th>Somewhat Dissatisfied</th>
<th>Neutral</th>
<th>Somewhat Satisfied</th>
<th>Very Satisfied</th>
<th>*Total Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>90</td>
<td>4%</td>
<td>3%</td>
<td>39%</td>
<td>24%</td>
<td>29%</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>Computer</td>
<td>39</td>
<td>5%</td>
<td>10%</td>
<td>26%</td>
<td>28%</td>
<td>31%</td>
<td>59%</td>
<td></td>
</tr>
<tr>
<td>Desk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keyboard</td>
<td>63</td>
<td>2%</td>
<td>-</td>
<td>30%</td>
<td>11%</td>
<td>57%</td>
<td>68%</td>
<td></td>
</tr>
<tr>
<td>Keyboard</td>
<td>17</td>
<td>-</td>
<td>6%</td>
<td>41%</td>
<td>12%</td>
<td>41%</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>Tray</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>67</td>
<td>3%</td>
<td>-</td>
<td>21%</td>
<td>15%</td>
<td>61%</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Controller</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>-</td>
<td>-</td>
<td>22%</td>
<td>39%</td>
<td>39%</td>
<td>78%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality</th>
<th>Items</th>
<th>Responses</th>
<th>Very Dissatisfied</th>
<th>Somewhat Dissatisfied</th>
<th>Neutral</th>
<th>Somewhat Satisfied</th>
<th>Very Satisfied</th>
<th>*Total Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>92</td>
<td>3%</td>
<td>7%</td>
<td>18%</td>
<td>21%</td>
<td>51%</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>Computer</td>
<td>39</td>
<td>5%</td>
<td>-</td>
<td>15%</td>
<td>18%</td>
<td>62%</td>
<td>79%</td>
<td></td>
</tr>
<tr>
<td>Desk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keyboard</td>
<td>63</td>
<td>2%</td>
<td>2%</td>
<td>16%</td>
<td>22%</td>
<td>59%</td>
<td>81%</td>
<td></td>
</tr>
<tr>
<td>Keyboard</td>
<td>17</td>
<td>-</td>
<td>6%</td>
<td>18%</td>
<td>47%</td>
<td>29%</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Tray</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>67</td>
<td>3%</td>
<td>-</td>
<td>15%</td>
<td>15%</td>
<td>67%</td>
<td>82%</td>
<td></td>
</tr>
<tr>
<td>Controller</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>6%</td>
<td>6%</td>
<td>11%</td>
<td>-</td>
<td>78%</td>
<td>78%</td>
<td></td>
</tr>
</tbody>
</table>
Table 4: continued

<table>
<thead>
<tr>
<th>Functional Items</th>
<th>Responses</th>
<th>Very Dissatisfied</th>
<th>Somewhat Dissatisfied</th>
<th>Neutral</th>
<th>Somewhat Satisfied</th>
<th>Very Satisfied</th>
<th>*Total Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>92</td>
<td>2%</td>
<td>7%</td>
<td>13%</td>
<td>23%</td>
<td>55%</td>
<td>78%</td>
</tr>
<tr>
<td>Computer Desk</td>
<td>39</td>
<td>3%</td>
<td>8%</td>
<td>15%</td>
<td>23%</td>
<td>51%</td>
<td>74%</td>
</tr>
<tr>
<td>Keyboard</td>
<td>63</td>
<td>2%</td>
<td>2%</td>
<td>11%</td>
<td>25%</td>
<td>60%</td>
<td>86%</td>
</tr>
<tr>
<td>Keyboard Tray</td>
<td>17</td>
<td>-</td>
<td>6%</td>
<td>12%</td>
<td>35%</td>
<td>47%</td>
<td>82%</td>
</tr>
<tr>
<td>Mouse Controller</td>
<td>67</td>
<td>3%</td>
<td>-</td>
<td>15%</td>
<td>15%</td>
<td>66%</td>
<td>82%</td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>6%</td>
<td>-</td>
<td>11%</td>
<td>-</td>
<td>83%</td>
<td>83%</td>
</tr>
</tbody>
</table>

* This percent is the total of somewhat plus very satisfied.

Figure 8 compares the process satisfaction in length of time, quality and functionality at each stage with no assistance versus ergonomist assistance. Results indicated higher percent satisfaction with ergonomist assistance in quality (85-94%) and functionality (87-100%) compared to no assistance in quality (67-73%) and functionality (67-74%). Satisfaction in the determine, request and purchase stage on length of time demonstrated little difference between no assistance and ergonomist assistance. The assemble stage illustrated a higher percent satisfaction with ergonomist assistance (79%) compared to no assistance (49%).
4.7 Survey Value Stream Map

From the survey data provided an overview on the paths taken, and assistance acquired to procure equipment to create a value stream map. The process began with the participant requiring office equipment and finished with the possession of the equipment. There were four stages between initiating the process and receiving the equipment; 1) determine equipment, 2) request equipment, 3) purchase equipment, and 4) assemble equipment.

The decision to replace broken or worn down equipment, items causing discomfort, or the need for ergonomic support, led to the first stage of selecting an appropriate replacement. The assistance acquired in stage one came from co-workers, supervisors, ergonomists, and administrative staff. Stage two included assistance from those contributing to the selection of equipment in stage one as well as inventory specialists, project management, budget management and staff involved with the larger
university purchasing system. Focus group participants noted the university purchasing system can help place a request, in that its staff processes the paperwork and forwards the purchase request to the vendor, but does not assist in request. The third stage has two parts: 1) arrange the order with vendors to purchase and 2) determine the method of payment between which vendors receive order and deliver equipment. The purchase requests, packing slips and invoices list the vendors from which the equipment is ordered. All vendors including other sources were Steelcase, Grainger, LOTH Inc., King Furniture, Varidesk, Casto, Biz Chair, Staples, Amazon, Office Max, Dell, Apple, Project Management Department, University Surplus, GovConnection, and University technology supply. The payment methods reported were a purchasing cards, university purchasing system, personal funds, and department budgets. Focus group noted department funds are processed through either a purchasing card or university purchasing system for payment method. Stage four illustrated assistance from vendors, campus facilities, ergonomist, OIT, moving services and Project Management department.

Average times were based from participant’s memory of their experience. The average duration of time from the survey data for each stage varied; stage one 8 hours, stage two 1 hour, stage three 1 hours, and stage four 1 hours making the overall cycle time 11 hours (1.4 days). The pervious table 3 illustrated variability between equipment in the determine and request stage with large equipment take 1-2 hours longer than small equipment. By comparison participants were asked the overall time equipment took to receive equipment was an average of 17 days. The difference considered between 1.4 days and 17 days were shipment of products.
4.8 Summarized Survey

Survey data indicated 1) half of participants (figure 1) experienced pain at computer workstations, 2) a wide variety of pathways were used to procure office equipment, 3) a low 60% of participants used assistance, and 4) overall satisfaction for length of time, the quality and functionality of the process were low range between 50%-80%. A variety of pathways and low percent of assistance could possibly indicate purchasers’ unfamiliarity with the university’s procurement process. Average times were based on the action at each stage exclusive of the time required for shipment of product.
between stages three and four. Survey information developed the structure for the focus groups value stream maps.

4.8 Focus Groups

Each focus group had participants’ familiar with the procurement process for large equipment. The academic group just recently procured chairs and computer desks for faculty; the accessibility group of four had procured height adjustable desk and custom sit/stand desks to fit employee’s accommodations; and the library custom sit/stand computer desks, chair, keyboards, and roller mouse for employee’s. Both the library and Project Management department order large batches of equipment, in comparison to academic and accessibility office. Project management mentioned that their large orders of furniture follow the university guidelines for pre-approved furniture.

All current value stream maps began with the participant requiring office equipment and finished with the possession of the equipment. When considering the whole process, the system adds value to the employee. Focus groups discussed some non-value added areas that contribute to waste in the system. Waste in this system can be defects in equipment procured, and wait time spent at a stage in the process.

4.8.1 Academic Focus Group Current Value Stream Map

Similar to the survey value stream map, figure 10 shows the four stages between the academic process. The first stage to determine the equipment to be purchased involved assistance from classified staff. The three paths provided by the academic classified staff to determine equipment selection were; 1) check the University Surplus for equipment, 2) recommend help from the university ergonomist, if an ergonomic
problem, or 3) obtain the equipment from Project Management. Stage two required submitting a request from and obtaining approval of the request. Similarly, stage three included ordering the equipment to be purchased and determining the payment method. Again, the payments were a purchase card or the university purchasing system. Stage four includes receipt of ordered equipment and assembly if required. Assistance required in stage four came from vendors or department lab coordinators.

Time in the process was based on participant’s memory of the process. The cycle time varies depending on the equipment ordered and payment method selected. A maximum cycle time with a purchase card was 89 days. A maximum cycle time with the university purchasing system was 212 days. The longest process times were acquiring request form approval and the purchase process. Depending on the office equipment ordered it can take 2 to 6 months using university purchasing system. Further details on the university purchasing system were collected in the third focus group. The academic group interacts with one part of the university purchasing system. The main contributor of waste academic experienced in the university purchasing system was time used to find the catalogs from vendors. Once the order request and payment information is placed in the system, it goes to procurement services then the vendors.
Employee Requiring Equipment

Stage 1
Determine Equipment Assistance from Classified Staff

Stage 2a
Request equipment File request form; high amount is a bid waiver

Stage 2b
Request equipment Approval by Chair Board

Stage 3a
Purchase Order

Stage 3b
Purchase Payment, Purchasing Card

Stage 4
Received/Assemble Equipment

Academic Department Current Procurement Process

Stage 1
- Find equipment through Surplus if item was not already determined
- Assistance from Ergonomist if need ergonomic requirements
- Construction & Design Department

Stage 2
1-28 days Depending on Equipment

Stage 3a
1 hour

Stage 3b
1 hour

Stage 4
8 hours

Stage 1
8 hours

Figure 10: Current Value stream map from Academic

4.8.2 Accessibility Office Current Value Stream Map

Figure 11 shows the accessibility value stream map. The first stage to determine equipment involves assistance from Equal Opportunity and Accessibility department.

Reason to replace equipment included, employees’ experience of pain or discomfort, accommodating a doctor’s note recommending ergonomic equipment for posture support.

The ergonomist in these cases contributes to both determining and requesting the equipment. Stage three is the same process as in the academic process with selected payment methods as a purchase card and the University purchasing system. Stage four
represents uses assistance from the vendor or the ergonomist (instead of a department lab coordinator).

Time in the process was based on participant’s memory of the process. A maximum cycle time with a purchase card was 64 days. A maximum cycle time with the university purchasing system was 120 days. Similar to the Academic time the purchase stage and assembled stage takes the longest. The university purchasing system process is necessary but adds waste in the process through wait time. Communication issues occurred between department and procurement services on purchase order information.

Figure 11: Current Value Stream Map from EOA
4.8.3 University Library Current Value Stream Map

Figure 12 shows the library value stream map similar to both the academic and accessibility. Assistance from the library manager, or ergonomist is part of stage one. The process continues with the library manager or ergonomist requesting a quote, ordering and purchasing equipment with a purchasing card, or university purchasing system, receiving the equipment and either the vendor or ergonomist assembling the equipment. A decision to use a purchase card compared to university purchasing system depends on the equipment cost. Departments have different limitations on the spending amount for cards. The university purchasing system begins with an administrator placing the order into the system, and providing required account information, which is sent electronically to procurement services. Second step is approval from the procurement services, and then contact vendors. Customized equipment takes longer for vendors to ship to employee.

Time in the process was based on participant’s memory of the process. A maximum cycle time with a purchase card was 121 days. A maximum cycle time with the university purchasing system was 244 days. Requesting a quote is necessary to acquire cost information but sometime takes up to 2 months of wait time. Similar to the academic, and accessibility the time between the purchase stage and assembled stage took the longest. The university purchasing system process is necessary but can add waste in the process through wait time. Part of filling information, processing it and approving the order in university purchasing system can take up to six weeks while the rest of the time is waiting on the vendor to build and ship the equipment.
4.9 Overall Results

The value stream maps created a visual presentation of the process to illustrate the different values in the system. Table 5 details the comments, and actions of the four stages with the type of value it adds to the process. Value added responses were steps that progress to procure office equipment for employees’ accommodation. Necessary but non-value added responses were processes time, such as monitoring a department’s budget, important to the process but the wait time varies. Non-value responses were inconsistency of wait time or determined the wrong equipment.
Table 5

<table>
<thead>
<tr>
<th>Comments/Actions</th>
<th>Group</th>
<th>Value Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1 Determine Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Assistance from ergonomist using a health assessment tool.</td>
<td>1,2,3</td>
<td>Value added</td>
</tr>
<tr>
<td>• Searching through University Surplus inventory for equipment.</td>
<td>1</td>
<td>Value added</td>
</tr>
<tr>
<td>• Assistance from Project Management Department for equipment. (University has guidelines on pre-approved furniture).</td>
<td>1, 3</td>
<td>Value added</td>
</tr>
<tr>
<td><strong>Stage 2 Request Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Request form approval from chair board that ranges from 1-28 days. Range of time.</td>
<td>1</td>
<td>Necessary but non-value added</td>
</tr>
<tr>
<td>• Ergonomist provides request for equipment.</td>
<td>2</td>
<td>Value added</td>
</tr>
<tr>
<td>• Request a quote for equipment cost can take up to 2 months.</td>
<td>3</td>
<td>Necessary but non-value added</td>
</tr>
<tr>
<td><strong>Stage 3 Purchase Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Place an order using purchase card as payment. (quick payment)</td>
<td>1,2, 3</td>
<td>Value added</td>
</tr>
<tr>
<td>• Verification to buy equipment in the University purchasing system requires the person to have a bobcat form ID.</td>
<td>3</td>
<td>Necessary but non-value added</td>
</tr>
<tr>
<td>• Finding equipment in the University purchasing system through vendors’ catalog.</td>
<td>1</td>
<td>Non-Value added</td>
</tr>
</tbody>
</table>
Table 5: continued

- Filling account information to pay in University purchasing system to send to procurement services. 2 Value added

- Procurement services processing to approve information from University purchasing system can take 20 minutes to 6 weeks. 3 Approval-Necessary, but non-value added

- Procurement services sends purchase order to vendor through fax/electronic 3 Value added

- A technical problem when an order did not proceed to procurement services because it was in between the system. 2, 3 Non-value added

- The total purchase process can take 2-6 months. 1, 2, 3 Non-Value added

Stage 4 Received/Assemble Equipment

- With larger orders, 10% equipment has minor problems. Example with slight variation from the chosen fabric, or small scratch(s) on the tables from transportation. 3 Non-value added

- Some vendors install equipment such as LOTH, were others are self-install such as Office Max. 3 Value added

- Ergonomist assembles equipment. 1, 2, 3 Value added

Both the survey data and focus groups provided information on the satisfaction rates of the current process. The survey data demonstrated low satisfaction with the length of time, quality, and functionality of the procurement process. Low satisfaction
indicated the system could have problems. The focus groups provided low satisfaction from experience with communication on filling or receiving documents and the long length of time.

Three focus groups provided information on their department procurement process. The groups were similar with few differences on assistance acquired, and the procurement request stage. All the focus groups had four stages to determine, request, purchase, and assemble equipment. The groups were similar in stages three and four but the difference was detailed knowledge on those stages.

The difference between the groups were:

- Accessibility uses the ergonomist specifically in the determine and request stage.
  - Request completed by ergonomist.

- Academic had classified staff assist in determine and request stage.
  - Provide recommended steps before proceeding with a request.
  - Request form requires chair board approval.

- Library finance faculty and ergonomist assist to determine equipment.
  - Request a quote complete by either library finance or ergonomist.

The information from the survey data and focus groups showed a difference in the knowledge of the current procurement process. The main differences were assistance acquired at the stages, purchasing process, and time length. The survey data provided more variety of assistance to determine, and request equipment compared to the focus groups. Focus groups reported payment with either a purchasing card or university purchasing system were participants mentioned personal funds or department funds. A
focus group mentioned payment with department funds used a purchase card or university purchasing system for payment. The time length from survey data had an average of 17 days to receive equipment were the current process can take up to a maximum of 6 months. Depending on the product and vendor, the current process can take 30 days or less. The differences with 17 days to 6 months can indicate the whole procurement process is unfamiliar to participants who have procured equipment.

Each group was asked for suggestions to improve the current process. The Academic group suggested:

- Inventory of ergonomic equipment
- Catalog of available ergonomic equipment from vendors in university purchase system with prices within budget
- Advertise the ergonomic process to make staff aware there is ergonomics assistance at the university

The benefit with providing an inventory of ergonomic equipment already on campus can decrease the process to purchase the equipment. A catalog with available prices would decrease the time spent waiting on a request form.

The Accessibility group suggested:

- Consistency with process and documentation if requiring a bid waiver
- Increase communication on confirming processed order approval

Confirmation can provide proof the order was received and will begin the process approval stage. The Library group mentioned a similar problem with a submitted order that did not go through to the procurement services.
Suggestions provided from the Library group were;

- Provided ergonomic recommendation for posture between the wait time for equipment procured
- Provide the health assessment results used to choose ergonomic equipment
- Create communication between ergonomist and procurement services

The suggested information can help procurement services pre-approve ergonomic equipment from vendors that provide a lower cost. To implement the suggestions would take time but later would decrease the approval process.

4.9.1 Future Value Stream Map

The future value stream map standardized from the thee focus groups applied recommendations to the current process. Changes occur in the determine, request and purchase stage with the university purchasing system. Each application listed below is a reduction the university controls. Creating a catalog with specific information on health benefits equipment provides to a person’s well-being and low cost could reduce time in the determine, and request stage. The change in the purchase stage applies standardization with the process forms and pre-approved equipment. By providing equipment pre-approved, the wait time for approval will be reduced. To incorporate new equipment would require a maintained communication between the ergonomist and procurement services, and update the catalog in stage 2.
Table 6 provides a general comparison of the maximum process time for the current system, and the predicted future system. The time to determine the equipment would be reduced by half the time via assistance with a decision tree. This application would provide direction for employees to procure equipment fit for their needs. A catalog with a simple interface, and details on price and benefits could reduce approval in the request stage. Pre-approved resources in a catalog reduce the time spent for approval in procurement services. A request approval in the current procurement services process time can range from 20 minutes to 6 weeks were the future prediction could reduce down
to 7 days or less to approve equipment. Time estimated with shipment depends on how much customization is required for the designed and the distance of the vendor.

Table 6
Value Stream Map Comparison of Large Customized Equipment

<table>
<thead>
<tr>
<th>Steps</th>
<th>Current Value stream map</th>
<th>Future Value stream map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine</td>
<td>8 hours</td>
<td>4 hours</td>
</tr>
<tr>
<td>Request approval/quote</td>
<td>28-60 days</td>
<td>1-7 days</td>
</tr>
<tr>
<td>University purchase system</td>
<td>20 minutes-6 weeks</td>
<td>20 minutes-7 days</td>
</tr>
<tr>
<td>Vendors shipment</td>
<td>2-4.5 months</td>
<td>2 months-4.5 months</td>
</tr>
<tr>
<td>Assemble</td>
<td>1 hour</td>
<td>1 hour</td>
</tr>
<tr>
<td>Total Time</td>
<td>99 days-223 days</td>
<td>68 days- 144 days</td>
</tr>
</tbody>
</table>

Implementing a new catalog of ergonomic equipment from approved vendors would take time to place into the university purchasing system. Once the additions of a decision tree, catalog, pre-approved equipment controlled by the university are in the system estimates a reduction of 33% in cycle time. The future system would have consistency in documentations to reduce miscommunication in filling, and pre-approved ergonomic equipment would equipment better fit for employees.
This research studied the procurement process for office equipment at a university. Procured equipment directly affects employees’ performance and protects their physical health from injury caused by repetitive movement and poor posture. Application of a value stream map illustrated the university’s current procurement process. Survey data from the university office equipment purchasers informed the creation of a preliminary value stream map. Further refined by focus groups participants with extensive experience of the university’s procurement system. Discrete stages within the procurement process identified through collected data were illustrated in additional and more fully developed current value stream maps. Each value stream map is a visual representation on paths taken to procure office equipment.

5.1 Conclusions

This study successfully applied the lean manufacturing value stream map to the procurement process for office equipment. Benefits from applying value stream maps were; 1) visualizing the procurement process stages 2) understanding employees’ familiarity with the procurement process 3) determining value in the system and 4) developing solution for the future value stream map. A transparent procurement process of office equipment via current value stream map enabled a start to understanding the systems efficiency, and improve employee satisfaction with procurement process. The procurement process affects the equipment procured, and the length of time taken to possess the equipment to reduce health risk. Discomfort and pain reported from the survey data could result in higher health risks such as a musculoskeletal disorder.
Assistance provided a higher satisfaction in quality and functionality compared to no assistance. The data for days to procure office equipment in the current process versus the theoretical future process had an estimated 33% reduction. This reduction provided from future recommendations benefit employees and increase satisfaction with the procurement process. A standard expectation for process time enables employees to receive equipment in a timely manner. Unexpected length of time used in the process was request quote (up to 2 months), and university purchase systems approval (20 minutes - 6 weeks).

5.2 Limitations

The first limitation occurred by not obtaining survey respondents’ position. This limits knowledge if positions differ with familiarity and use of the procurement process. Limited number of focus groups, and time contribute to how much obtain details are provided within the value stream maps. A third limitation was generalized cycle time based on participants’ memory instead of receipts to provide exact time. The last limitation was knowledge on how the university guidelines, and polices affects purchased furniture.

5.3 Recommendations

A recommendation to enhance the procurement process is to apply an online decision tree to the first stage of the process. The decision tree would incorporate responses leading employees to equipment that will fit their accommodation, either pre-approved in the university purchasing system, or found in the University Surplus. The addition to pre-approved office equipment would reduce time spent waiting on the
approval request. General recommendations from the focus groups were an ergonomic catalog in the university purchasing system, and communication between the ergonomist and procurement services. These recommendations would affect the request and purchase stages. Communication between the ergonomist and procurement services would utilize the university purchasing system resources of vendors in the system. Procurement services would gain knowledge from the ergonomist to find equipment that benefits an employee’s physical health. Further research and time could conclude if recommendations are applicable from the future value stream map, and the cost benefits improved procurement process has on employee procuring equipment.
REFERENCES


Robertson, M. M., Ciriello, V. M., & Garabet, A. M. (2013). Office ergonomics training and a sit-stand workstation: Effects on musculoskeletal and visual symptoms and

http://doi.org/10.1016/j.apergo.2012.05.001


http://doi.org/10.1016/j.cirp.2013.03.042


techniques to eliminate non-value-added waste for the procurement of endovascular

Health Service procurement in the UK: an evaluation of the Cornwall Food
http://doi.org/10.1080/1354983070166905

http://doi.org/10.1016/S0306-4379(00)00008-9

quantifying impacts of lean initiatives. *International Journal of Production

Waterman, J., & McCue, C. (2012). Lean Thinking Within Public Sector Purchasing
Department: The Case of the U.K. Public Service. *Journal of Public
Procurement, 12*(4), 505–527.
APPENDIX A: SURVEY

I. Demographics (Part I)

Do you spend any time working on an office computer?

Yes
No

I. Demographics (Part II)

With what sex do you identify yourself?

Male
Female
Other

What is your age?

How many years have you been employed at Ohio University?

On average, how many hours do you spend at a computer work station per week?

II. Current Computer Workstation Equipment

What type of mouse controller is provided to you at work? Please check all that apply.

Wired
Wireless
Combined with keyboard
Other

What type of keyboard is provided to you at work? Please check all that apply.

Wired standard shape
Wired standard shape
Wired non-standard shape
Wireless non-standard shape
Other

Where is your keyboard placed?

Desk
Keyboard tray
Other

Is your Desk height adjustable?

Yes
No

Do you have a desk that is adjustable so that you can choose to sit or stand during
the day?
Yes
No

What type of chair is provided to you at work? Please check all that apply.
Casters
Adjustable seat height
Adjustable Back support
Head rest
Arm rest
Other

Have you experienced pain or discomfort in any particular areas after working at your desk throughout the day?
Neck
Shoulder(s)
Upper Back
Elbow
Lower Back
Wrist/hand(s)
Hips/thighs/buttock's
Knee(s)
Ankles/Feet

III. Procurement items

Have you personally had any of the following items replaced since you started working at Ohio University? Please check all that apply.
Mouse Controller
Keyboard
Keyboard tray
Chair
Computer desk

III. Procurement Items

Personally which of the following items did you most recently have replaced at your work?
Mouse Controller
Keyboard
Keyboard tray
Chair
Computer desk

III. Procurement Process

How many days ago was your $\{\text{Field/1}\}$ replaced?

To obtain your $\{\text{Field/1}\}$, what areas of the procurement process were you involved in? Check all that apply.

Determine item need
Request item
Purchase
Assembly

Who assisted or did any of the following areas for you to obtain your $\text{[Im://Field/1]}$? Check all that apply

<table>
<thead>
<tr>
<th></th>
<th>Co-Worker</th>
<th>Supervisor</th>
<th>OU's Ergonomist</th>
<th>Other</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine item need</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Request item</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Who assisted you to determine your $\text{[Im://Field/1]}$? (Please specify title, no personal name)

Who assisted you in your request for your $\text{[Im://Field/1]}$? (Please specify title, no personal name)

Who assisted you in your purchase for your $\text{[Im://Field/1]}$?

Who assisted you in the assembly of your $\text{[Im://Field/1]}$?
When purchasing your $[Im://Field/1], what payment method did you use?
Bobcat buy
Purchasing card
Other

What specific company did you purchase/receive your $[Im://Field/1]?
Steelcase
LOTTH Inc.
Grainger
Staples
Other

How many times have you received a new $[Im://Field/1]?

How many hours do you estimate was spent determining your $[Im://Field/1]?

How many hours do you estimate was spent requesting your $[Im://Field/1]?

How many hours do you estimate was spent purchasing your $[Im://Field/1]?
How many hours do you estimate was spent assembling your $[Im://Field/1]?

How many days did your $[Im://Field/1] take to receive?

IV. Satisfaction (Part I)

What was the reason for obtaining a new/replacement of your $[Im://Field/1]?
Please check all that apply.
Discomfort
Worn down
Broken

Other

Are you satisfied with your new/replacement $[Im://Field/1]?
Yes
No

Why are you not satisfied?

What features do you take into consideration when purchasing your $[Im://Field/1]?
Please check all that apply.
Price
IV. Satisfaction (Part II)

Please rate your overall satisfaction with the equipment procurement process.

<table>
<thead>
<tr>
<th></th>
<th>Very Satisfied</th>
<th>Somewhat Satisfied</th>
<th>Neutral</th>
<th>Somewhat Dissatisfied</th>
<th>Very Dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of time to procure your ${\text{im:Field/1}}$</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Quality of your ${\text{im:Field/1}}$</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Functionality of your ${\text{im:Field/1}}$</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

IV. Satisfaction (Part III)

If there are any additional comments or suggestions related to the current procurement process for computer workstation equipment please feel free to answer below.

[Blank space for comments]
Value Stream Maps

- Flow of Material & information
- Process Attribute - Cycle time
- Categories
  - Value added, Necessary but non-value added, & Non-Value added
- Type of waste
  - Processing, waiting, overproduction, transportation, motion & defects

Example of Value Stream Map
OU Procurement Process

References


APPENDIX C: FOCUS GROUP SCRIPT

Steps taken for the focus group
1. Answer any questions or concerns about the focus groups
2. Start script

Script
1. Introductions for the group:
   a. Name – (Note that names will not be included in hand written notes recoding responses)
   b. Job title
   c. Years employed at Ohio University
2. Explain the purpose of group:
   a. Understand the current procurement process, and the non-value added areas in the process. The time frame estimated is around 1-1.5 hours.
3. Explain a Value Stream Map and key components
   a. Use of PowerPoint
4. Engagement questions
   a. What type of office equipment is frequently procured?
      i. The current list for office equipment is mouse controller, keyboard, keyboard tray, chair, and computer desk.
   b. How much time do you expect is spent overall on procuring?
      i. Is there a difference between office equipment?
4. Exploration questions
   a. What is your current experience with the procurement process for the office equipment at Ohio University?
   b. What steps are taken to procure an office equipment?
      i. How much time do you estimate is spent on that step?
      ii. Do you consider differences in brands, or model in those steps?
         1. Difference such as ergonomic equipment
   c. What area or stage are you involved with for the current procurement process?
      i. Show the skeletal structure to elaborate.
      ii. What process do you take to procure the item?
      iii. Are there particular people or companies you used to procure item?
         1. Mention title of person to avoid names
      iv. What process is taken to determine item need, and request for the item?
      v. What payment method is taken to procure item?
      vi. If item needs assembled what steps are taken?
   d. Are there any areas you have difficulty with in the process to procure an item?
   e. Are there any areas that work well for you in the process to procure an item?
   f. Have you experienced any problems, or defects with the item procured?
i. How many times has this happened with this item?

6. Exiting questions
   a. Are there any particular areas you think need improvement or suggest a solution?
   b. Is there anything else you know that might have been left out on the current procurement process?

Steps taken for the focus group
3. Thank everyone for attending the focus groups. Ask if they would be willing to look at the finished diagrams for the current and future value stream map to validate the information, and flow of the procurement process. This would be emailed to them so we can avoid another group meeting.
APPENDIX D: INTERVIEW QUESTIONS FROM SCRIPT

Questions
1. What is your current experience with the procurement process for the office equipment at Ohio University?

2. What type of office equipment is frequently procured?

3. How much time do you expect is spent overall on procuring?

4. What process is taken to determine item need, and request for the item?

5. What payment method is taken to procure item?
6. If item needs assembled what steps are taken?

7. Are there any areas you have difficulty with in the process to procure an item?

8. Are there any areas that work well for you in the process to procure an item?

9. Have you experienced any problems, or defects with the item procured?
10. Are there any particular areas you think need improvement or suggest a solution?

11. Is there anything else you know that might have been left out on the current procurement process?