Application of Lean Manufacturing Principles to the Healthcare Workforce Training System: Using lean principles to determine best practices in healthcare workforce planning for Linn, Benton, and Lincoln Counties (Oregon)

by
Christopher Allen Bame

A THESIS

submitted to
Oregon State University
Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Industrial Engineering
(Honors Scholar)

Presented October 25, 2016
Commencement June 2017
AN ABSTRACT OF THE THESIS OF

Christopher Allen Bame for the degree of Honors Baccalaureate of Science in Industrial Engineering presented on October 25, 2016. Title: Application of Lean Manufacturing Principles to the Healthcare Workforce Training System: Using lean principles to determine best practices in healthcare workforce planning for Linn, Benton, and Lincoln Counties (Oregon).

Abstract approved: ____________________________________________

Chinweike I. Eseonu

Increasing complexity and demand of healthcare has not been matched with policy changes and improvements in healthcare training. In Linn, Benton, and Lincoln Counties (LBL), a few challenges that prevent the efficient training of healthcare providers are (1) limited training capacity due to clinical placements and availability of qualified faculty and (2) the lack of feedback loops between employers and trainers. To address these and other healthcare workforce planning challenges, eight case studies are examined using lean manufacturing principles as the lens.

Best practices for healthcare workforce training are taken from each case study, some of which coincidentally align with the lean principles. Further analysis identified opportunities for applying lean principles to improve the training pipeline and address the LBL challenges. (1) The lean principles Specify Value and Respect of Humanity could be implemented to improve faculty retention and recruitment, using similar methods to those described in case studies. (2) Feedback loops are commonly used during curriculum development, but should continue to be used during the actual training process. This thesis provides the first explicit application of lean principles to the healthcare training pipeline and identifies several opportunities for further investigation into the merits of lean practices in this context.
Key Words: Healthcare workforce training, healthcare workforce planning, feedback loops, lean manufacturing principles, case studies

Corresponding e-mail address: bamec@oregonstate.edu, cbcb124@gmail.com
Application of Lean Manufacturing Principles to the Healthcare Workforce Training System: Using lean principles to determine best practices in healthcare workforce planning for Linn, Benton, and Lincoln Counties (Oregon)

by

Christopher Allen Bame

A THESIS

submitted to

Oregon State University
Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Industrial Engineering
(Honors Scholar)

Presented October 25, 2016
Commencement June 2017
Honors Baccalaureate of Science in Industrial Engineering project of Christopher Allen Bame presented on October 25, 2016.

APPROVED:

______________________________
Chinweike I. Eseonu, Mentor, representing School of Mechanical, Industrial, and Manufacturing Engineering

______________________________
Kenneth Maes, Committee Member, representing School of Language, Culture, and Society

______________________________
Barbara Croney, Committee Member, representing Samaritan Health Services

______________________________
Toni Doolen, Dean, Oregon State University Honors College

I understand that my project will become part of the permanent collection of Oregon State University, Honors College. My signature below authorizes release of my project to any reader upon request.

______________________________
Christopher Allen Bame, Author
# Table of Contents

Introduction ......................................................................................................................... 1  
  The Healthcare Training Pipeline .................................................................................... 2  
  Healthcare workforce planning..................................................................................... 3  
  Problem: Description of the Survey Conducted by Eseonu and Doolen (2013) ................. 4  
  Challenges in Workforce Planning .................................................................................. 5  

Use of Lean Principles to Identify Potential Improvements .............................................. 8  
  What is Lean Manufacturing? .......................................................................................... 8  
  Why Should Lean be used in this Scenario? .................................................................... 10  
  Lean Principles ............................................................................................................... 13  

Case Studies ..................................................................................................................... 29  
  1. Case Study: Development of UNC Public Health Program (Thompson, Harver, & Eure, 2009).................................................................................................................. 32  
  2. Case Study: Spanish Residency Program (Freire, Infante, de Aguiar, & Carbajo, 2015) .... 36  
  3. Case Study: Task Shifting in Uganda (Dambisya & Matinhure, 2012) ......................... 40  
  4. Case Study: Task Shifting in Maternal and Newborn Health Care (Deller et al., 2015) .... 44  
  5. Case Study: Rebuilding Human Resources for Health in Liberia (Varpilah et al., 2011) .... 48  
  6. Case Study: Creation of Residency Training Pathway at University of Pennsylvania Health System (Patel et al., 2015) ................................................................. 53  
  8. Case Study: Competency-based Medical Education in Sub-Saharan Africa (Malwadde et al., 2014) ............................................................................................ 59  
  Recommendations from Eseonu and Doolen (Eseonu & Doolen, 2013) ...................... 61  

Analysis ............................................................................................................................ 64  
  Limited Enrollment Due to Faculty and Clinical Placement Limitations ......................... 64  
  Lack of Feedback Loops between Employers and Trainers ............................................ 65  
  How Were the Lean Principles Addressed in the Case Studies ....................................... 66  

Limitations ......................................................................................................................... 74  

Recommendation for Future Work .................................................................................. 75  

Conclusion ....................................................................................................................... 77  

References ....................................................................................................................... 78  

Appendix ......................................................................................................................... 80
**Introduction**

Population demographics have significantly increased demand for the healthcare system. This trend is expected to continue. Amid these changes, the structure of the healthcare training system must be responsive, adaptive, and relevant. However, to date policy changes have primarily resulted in reactionary modifications to care delivery. This thesis examines how lean manufacturing concepts apply to healthcare workforce training. The goal is to suggest improvements for the training process to address workforce training problems that have resulted from changes in the healthcare industry.

Eseonu and Doolen (2013) conducted a survey of LBL employers and trainers to identify challenges and expected changes to the training pipeline. This survey revealed key findings related to challenges facing training institutions and the relationship between employers and training institutions. Training institutions were primarily challenged with finding qualified faculty and clinical placements for all of their students. Employers were found to be weakly connected with the training system, making the training process reminiscent of the “throw it over the wall” concept in design engineering. After completing this survey, Eseonu and Doolen (2013) stressed the importance of establishing a more cooperative relationship between industry and the training pipeline. A few of the recommendations made were forming industry advisory boards at training institutions and developing cooperative methods for qualified healthcare providers to be involved with training institutions as faculty and trainers.

In order to address challenges and substantiate recommendations from the study by Eseonu and Doolen (2013), case studies from other regions and countries are examined in this thesis. The goal of this thesis is to identify specific global healthcare workforce planning policies and practices that can be implemented in the LBL region. Case studies considering healthcare workforce training and management approaches are analyzed using lean manufacturing principles as the lens. The recommendations and approaches revealed in these case studies are specifically applied to the challenges in Linn, Benton, and Lincoln Counties in Oregon, noted by Eseonu and Doolen (2013). In addition to specifically addressing these challenges, best practices for healthcare training are identified and analyzed from a lean manufacturing perspective.
This thesis is arranged in four main sections. The focus of the first section is to establish an understanding of workforce planning and the inherent challenges. In the second section, lean manufacturing is introduced and the lean principles are defined. In the third section a variety of case studies are analyzed through the lens of lean manufacturing. Finally, in the fourth section, specific best practices are identified that should be considered in regions such as Linn, Benton, and Lincoln counties to address the previously identified challenges and more closely follow lean principles.

The Healthcare Training Pipeline

The healthcare system is extremely complex and contains a huge variety of processes including forecasting, training, delivery of care, costing, and politics. These components are individually complex and interconnected; however for the purposes of this thesis, a simpler system shown in Figure 1 is conceptualized to understand the system at a high level.

![Figure 1. Healthcare system from the perspective of a policy planner](image)

Lopes et al. (2015) identify the importance and value of completing an analysis of the entire training system in any analysis of healthcare workforce planning (also called health human resources planning). Lopes et al. (2015) describe a complete assessment as considering how training is conducted, the impact of regulatory requirements, and financial constraints. This thesis specifically focuses on how training is conducted by examining the training pipeline and how it fits in with the rest of the healthcare system. In order to understand the training process, it is important to also consider the processes that occur directly adjacent to the training process and how other elements of the healthcare system directly affect the training system. For this study, the training pipeline is defined as the training process and the adjacent processes (forecasting and hiring). Additionally, feedback from other parts of the healthcare system to the training pipeline is considered. This scope is shown diagrammatically in Figure 2 in red.
Figure 2. Training pipeline / Scope of thesis

While this description of the training pipeline applies to a variety of professional positions, this thesis will specifically focus on lower level professional positions. The Healthcare Needs Assessment Survey carried out by Eseonu and Doolen (2013) in Linn, Benton, and Lincoln Counties (LBL) focused on lower level positions due to the scope of the sponsoring organization, the Linn, Benton, and Lincoln Counties Workforce Investment Board (LBL-WIB). Since this thesis seeks to expand upon the recommendation and work completed in this study, the scope of this thesis will similarly focus on lower level professional positions such as RNs, CNAs, medical billing personnel, and technicians.

Healthcare Workforce Planning

Drake (2013) uses the Australian Health Workforce Advisory Committee (AHWAC) definition of workforce planning, “Workforce planning seeks to balance the supply and demand for nursing staff, to ensure that sufficient numbers of suitably skilled personnel are available, in the right place and at the right time, to meet the demands of the service,” (Drake, 2013, p. 95). Drake (2013) further defines the process of workforce planning as reconciling three factors: allotted budget, the necessary staff, and the number of staff employed. In this thesis, this definition of workforce planning is generalized (beyond nursing) to all healthcare professions. The definition of workforce planning by Drake (2013) gives a broad scope to workforce planning, including the reassignment of tasks, and changes to the delivery of care within its purview. However, as defined previously, this thesis specifically considers the process of moving new students through the training pipeline to employment as care deliverers.

Effective healthcare workforce planning is critical because a surplus or deficiency of healthcare workers can lead to large consequences (Lopes, Almeida, & Almada-Lobo, 2015). Lopes et al. (2015) identify literature that connects a myriad of problems to an
imbalance in the healthcare workforce. An oversupply of the healthcare workforce could result in economic inefficiencies, unemployment, and increased costs (Lopes et al., 2015). Shortages in the healthcare workforce can result in even worse consequences including lower availability or quality of care, shorter visit times, overburdening the existing professionals, and long waiting lists for access to care (Lopes et al., 2015). Curson (2010) also identifies workforce planning as essential in healthcare due to wage increases, long training times, the necessity of meeting demand for the healthcare system, and making sure taxpayer’s money isn’t wasted on inefficient training processes.

After reviewing the literature, workforce planning was observed to contain two primary tasks: (1) forecasting and (2) evaluation and regulation. Figure 3 shows the breakdown of workforce planning and specific examples of the outcome of each of the workforce planning tasks. The goal of forecasting is to determine the number of healthcare workers with specific skills necessary to meet the projected community need. Forecasting techniques should affect the number of spots in the training programs, the tasks within the scope of each profession, and the curriculum that is taught to students. The evaluation and regulation aspect of workforce planning involves setting requirements for students as they enter the workforce and determining how to assess the performance of employees. This aspect of workforce planning seeks to determine whether or not students are accomplishing the skills defined as necessary through forecasting.

Figure 3. Workforce planning breakdown

**Problem: Description of the Survey Conducted by Eseonu and Doolen (2013)**

Eseonu and Doolen (2013) conducted a broad survey of LBL employers to understand local employer’s current challenges and needs. This information was complimented by a survey and subsequent analysis of the training pipeline in Oregon
(Eseonu & Doolen, 2013). As a result of this study, several major limitations and challenges for the current system were identified. Employers anticipated needing increased numbers of employees, while training institutions were limited in expanding student enrollment by available qualified faculty and clinical placements for students (Eseonu & Doolen, 2013). Eseonu and Doolen (2013) made several recommendations primarily focused on increasing the communication and cooperation between employers and training institutions.

This thesis seeks to highlight additional recommendations to resolve some of the challenges identified by Eseonu and Doolen (2013). The recommendations identified by Eseonu and Doolen (2013) are compared with workforce planning best practices as defined in the literature.

Successful workforce planning should address the effective delivery of capable, qualified graduates to employers, resolving the potential problems employers expect to face. However, workforce planning in healthcare quickly becomes very complicated and difficult to analyze. The following sections explore healthcare workforce planning, how it has been conducted in the past, and the current research into best practices.

**Challenges in Workforce Planning**

Healthcare provision has become increasingly complex requiring a complex system of workers, who range from highly trained physicians to various levels of nurses and patient liaisons. Planning effectively for the future is complicated further by the high rate of change in the healthcare system and lengthy training times that range from a month for nursing assistants to over 10 years for some medical specialists. Employers and government agencies have attempted to address these complexities in a variety of manners, but it is difficult to determine the most effective methods for workforce planning.

In response to the many challenges of workforce planning, the Workforce Review Team (WRT) was created to support the English National Health Service (NHS) in workforce planning decisions. The WRT is a nationwide body that works with the NHS to influence the prioritization of planning and development, share best practices for service delivery, and provide decision makers with advice on adopting strategies (Curson, 2010). After criticism from the Select Committee Report in 2007, the WRT
commissioned a literature review to determine the current evidence for workforce planning and best practices (Curson, 2010). Curson (2010) describes the rapid review of the literature that was completed in response to the criticism from the Select Committee Report. Similar to the literature review completed by the WRT, Lopes et al. (2015) completed a review of workforce planning dating from 1951 to 2013. Both of these reviews provide a fundamental understanding of the current state and challenges of healthcare workforce planning.

After reviewing the current workforce planning literature, Lopes et al. (2015) and Curson (2010) found no standard or principle method for conducting workforce planning. Rather Lopes et al. (2015) observed a huge variety of methods, which have developed and evolved over time. Similarly, there is a huge variety of solutions available to address workforce shortages at different points in the training process ranging from accepting more students into training programs, to reducing the requirements for working as a healthcare professional, to raising the wages of healthcare professionals (Lopes et al., 2015). Amid the huge variety of possible solutions, Curson (2010) found that although the healthcare workforce planning process was well documented at a high level, practices were not described in detail or effectively compared with one another to determine best practices.

Curson (2010) primarily calls for a more empirical approach to workforce forecasting that is based on standardized metrics, in order to effectively compare and evaluate best practices. Lopes et al. (2015) call for an integrated approach to workforce planning and to develop practices that effectively close the gap between forecasted and actual results of planning.

While Curson (2010) and Lopes et al. (2015) call for these improvements, they also acknowledge the challenges that have made workforce planning extremely difficult to effectively complete. The two primary challenges to completing effective healthcare workforce planning are the difficulty of quantitatively measuring variables in the healthcare system and the challenge of simultaneously observing the entire healthcare system. These challenges stem from the complexity, size, and politics that are inherent to the healthcare system.
Curson (2010) specifically identified several challenges the NHS faces. The size and complexity of the NHS, the time taken to train healthcare staff, and the political environment in which workforce planning and healthcare delivery occur were all identified as challenges to workforce planning (Curson, 2010).

According to Lopes et al. (2015), the healthcare system cannot be analyzed like a traditional service market because (1) there is considerable supply and demand uncertainty, (2) “Asymmetric information between physicians and patients,” (3) “Restrictions on competition,” (4) “Strong government interference,” and (5) “Supply-induced demand,” (Lopes et al., 2015, p. 4). In relation to the variance from traditional market norms, Curson (2010) lists the complexity of healthcare workforce planning as arising from the difficulty of measuring demand on the healthcare system, the challenge of measuring productivity and quality, and the variability of the public’s perception and expectation of the healthcare system.

Uncertainty in the demand on the healthcare system occurs due to the difficulty of measuring and modeling the productivity of the healthcare system (Curson, 2010). Often times, the price a consumer is willing to pay for a service is used to indicate the demand on a system, however due to government involvement the individual is not necessarily responsible for the entire cost of care, making the actual cost of care a poor reflection of the amount a consumer is willing to pay. Curson (2010) also noticed this in the English healthcare system, where the price of care is compensated by government provision. To complicate matters even more, productivity in healthcare is extremely complicated to measure and must consider not only the delivery of care but also the quality of that care, for which there are many metrics (Curson, 2010). Without being able to quantitatively measure the demand for care, it is impossible to quantitatively forecast and complete workforce planning upon a quantitative foundation.

Another challenge in completing healthcare workforce planning is examining the entire system simultaneously. Lopes et al. (2015) comment that a number of studies solely focus on predicting the number of practitioners needed to maintain the current ratio of practitioner to population. While this is no simple feat, this methodology does not address the other factors that affect the ability of the healthcare system to meet demand, such as the changing efficiency and responsibility of healthcare workers (Lopes et al.,
In order to complete effective healthcare workforce planning, the entire healthcare system must be analyzed simultaneously to understand the true impacts of policy and changes. This is extremely difficult given the size and many moving parts to the system, as has been discussed.

This thesis includes case studies and best practices that offer possible solutions to the challenges defined by Eseonu and Doolen (2013) for the LBL region. This does not address the call made by Curson (2010) to effectively compare and empirically determine best practices. However, this thesis offers a starting point for future analysis and comparison.

Use of Lean Principles to Identify Potential Improvements

What is Lean Manufacturing?

As discussed in the previous section, without simultaneously studying the entire healthcare system with quantitative data, it is difficult to analytically determine the most effective methods and best practices for workforce planning. However, a theoretical model can be used to identify better practices and come closer to finding the best practices for healthcare workforce planning. This thesis uses the model of lean manufacturing to analyze workforce planning. The principles of lean manufacturing as categorized by Mirdad and Eseonu (2015) are used to analyze past examples of workforce planning and future solutions. In this thesis, workforce planning practices that more closely follow the lean principles are considered better practices.

The term “lean manufacturing” was first coined by Womack et al. (1991) to describe the unique manufacturing system Toyota implemented in the 1950’s. In 1950, Toyota was failing. After 13 years, the company had only successfully produced 2,685 vehicles (Womack, Jones, & Roos, 1991). From this context, Eiji Toyoda travelled to study the Ford Rogue plant, which was at this time the most efficient manufacturing plant in the world (Womack et al., 1991). Eiji Toyoda famously wrote he, “Thought there were some possibilities to improve the production system,” (Womack et al., 1991, p. 49). As Toyota began to implement and improve some of the practices from Rogue, they found that some of the mass manufacturing practices would simply not work in Japan, thus was
born the Toyota Production System (Womack et al., 1991), later broadly termed lean manufacturing. A succinct definition of lean is as follows: **Lean is a philosophy of continuous process improvement by eliminating waste and maximizing value for the customer.** Since the 1950’s, lean has been applied to a variety of contexts besides manufacturing including logistics, healthcare delivery, government, and management (Lean Enterprise Institute, n.d.).

Lean is a complex and growing field of study. As such, there is a varied and sometimes contradictory vernacular surrounding lean concepts. Mirdad and Eseonu (2015) completed a literature review and survey of experts, which demonstrated the confusion of lean terms. Mirdad and Eseonu (2015) identified six core tenants of lean, which they termed “principles”. A lean principle is defined as the foundational lean thinking that is implemented and acted upon through the use of lean practices (Mirdad & Eseonu, 2015). Lean practices are defined as the context specific methods for implementing a lean principle (Mirdad & Eseonu, 2015). Simply put, lean principles constitute the reasoning behind lean thinking, while practices put lean thinking into action in a specific instance. Since lean thinking has not been applied to healthcare workforce planning, a fundamental understanding of the lean principles will be used to identify best practices, which could henceforth be considered lean practices in healthcare workforce planning.

True lean implementation requires organizations to fundamentally change how processes are designed and managed. Additionally, the employer-employee relationship must be fundamentally altered. Womack et al. (1991) describes the many practice changes in the relationship between an assembler and its suppliers in the West, such as more frequent deliveries, higher quality expectations, and long term contracts. However Womack et al. (1991) clarify that the West has not moved any closer to lean supply. “Without a fundamental shift away from power-based bargaining relationship, it is almost impossible to move toward lean supply,” (Womack et al., 1991, p. 161). While, assemblers put some of the lean techniques into practice, their failure to enact the theory behind the practices prevented actual improvements in assembler-supplier relationships (Womack et al., 1991). The importance of fundamentally changing the way relationships or processes are approached is a common trend in applying lean.
The lean principles address this fundamental change in approach. Additionally, lean principles are free of context; they apply in all sectors although they correspond to context specific practices. In order to avoid confusion and misuse of terms, the definitions of the lean principles by Mirdad and Eseonu (2015) is used to guide the analysis in this thesis. Mirdad and Eseonu (2015) defined the following lean principles: Pull, Continuous improvement, Specify value, Flow, Zero Defects (referred to in this paper as Waste Elimination), and Respect of Humanity (Mirdad & Eseonu, 2015).

Pull is defined as completing processes only when the customer (either internal to the system or external) is ready to receive the output of the process. Specify Value is defined as identifying the components of a system a customer is willing to pay for. Waste Elimination is defined as the minimization of anything in a system that is not adding value as defined by the customer. Respect of Humanity is defined as the reflection of respect for workers by considering worker needs, creating valuable work, and viewing employees as customers. Continuous Improvement is defined as the process of generating, testing, and implementing process improvements in an ongoing journey towards perfection. Flow is defined as creating continuous, uninterrupted work along the identified value stream.

The lean principles are often interconnected, and there are a variety of categorizations and definitions of lean principles (Mirdad & Eseonu, 2015). In this essay, the lean principles have been discretely categorized for ease of understanding and simpler analysis. However, these principles are interconnected and may extend beyond the boundaries of a specific category. In practice, lean principles cannot and should not be applied singularly, but must be applied as an entire system (Mirdad & Eseonu, 2015), thus the recommendations generated in this paper should be considered in light of systems thinking.

**Why Should Lean be Used in this Scenario?**

The lean principles and associated mindset align well with the identified healthcare workforce planning challenges. Lopes et al. (2015) specifically refer to lean as a potential methodology to use for healthcare workforce planning; however Lopes et al. (2015) do not explore this application. Additionally, it is useful to ground changes and
analysis in theory. Due to the alignment of lean with healthcare workforce planning challenges, lean will be used as the theory from which best practices are compared.

Lean has been used extensively in improving manufacturing and healthcare delivery, however after completing a review of the literature, no application of lean thinking to healthcare workforce planning was found. Therefore, healthcare workforce planning represents a new field for lean application. It is expected that lean application will reveal system wide improvements in healthcare workforce planning, as lean has done in fields such as manufacturing and healthcare delivery.

Lean is a suitable theoretical model for this analysis for the following primary reasons: (1) Lean specifically addresses the challenges in the current situation, (2) lean corresponds with the challenges and recommendations that Eseonu and Doolen (2013) identified, (3) benefits of lean implementation would be valuable in the healthcare training system, and (4) reducing inventory is even more important in the healthcare training system.

(1) Lean specifically addresses the challenges in the current situation

Toyota developed the lean manufacturing system due to the inability to implement mass manufacturing practices and also the belief that Toyota could perform better under a different system (Womack et al., 1991). After traveling to Ford’s Rogue plant, Eiji Toyoda determined that mass production would not work in Japan for a variety of reasons (Womack et al., 1991). The domestic Japanese market required a very wide variety of vehicles, but lower quantities than the mass manufacturers were making (Womack et al., 1991). Similar to what Toyota faced in the 1950’s; the healthcare training system must be able to produce a wide variety of professionals including nursing assistants, therapists, and surgeons. Additionally, in Japan the workers and unions had become much more powerful after American occupation, and demanded an increased quality of work (Womack et al., 1991). Similar to the greater demands by workers, Eseonu and Doolen (2013) identify recruiting faculty as a limitation to training institutions. Adding to the difficulty in implementing mass manufacturing, Toyota did not have the capital to invest in huge, expensive machines that used advanced technology (Womack et al., 1991). The development of lean manufacturing to address similar
problems to what is currently seen in the healthcare training system indicates that lean could be a beneficial tool to apply in this new context.

(2) Recommendations by Eseonu and Doolen (2013) closely correspond to lean

The recommendations provided by Eseonu and Doolen (2013) closely correspond to the goals of lean. The common thread through the recommendations made by Eseonu and Doolen (2013) is the importance of integrating the healthcare training system with the rest of the supply chain and the customer, who is in this case local employers. One of the core aspects of the lean manufacturing system is the unique approach to supplier and customer relations that Toyota took under the lean manufacturing system. This approach specifically contrasted with the relationship between mass producing assemblers and suppliers, who often tried to maintain separation and did not share knowledge (Womack et al., 1991). Womack et al. (1991) specifically address both the relations with customers and the supply chain in individual chapters (for a total of 1/5 of their analysis). The focus of lean manufacturing on integrating the supply chain with the assembler and the assembler with the customer is a drastic shift from mass production. The similar focus on this integration by Eseonu and Doolen (2013) suggests an excellent pairing of the problems Eseonu and Doolen (2013) identify and lean manufacturing.

(3) Benefits of lean implementation would be valuable in the healthcare training system

Beyond the initial challenges that lean manufacturing was designed to alleviate, Toyota has seen other improvements that would be very beneficial to find in the healthcare training system. Workforce planning in healthcare is identified as a difficult task due to having to plan for the future amid changing policies and the need to examine the entire system. As mentioned in the previous point, lean places a great emphasis on system wide analysis and new product development in cooperation with suppliers. In healthcare, it is imperative to examine the whole system both in terms of the processes performed and how these processes are evaluated. Womack et al. (1991) describe lean as successfully improving on several dimensions at once including the reduction of defects (Quality), the reduction of inventories and manufacturing floor space (Cost), and the flexibility of quick product changes. Lean’s ability to improve a variety of process
parameters is promising for making improvements in healthcare, where the Iron Triangle concept in healthcare theorizes that Cost, Quality, and Access may only be improved at the expense of the other components. Womack et al. (1991) also found that lean manufacturers were able to develop new products and technologies much more effectively and quickly than mass manufacturers. The ability of lean manufacturers to quickly respond to changes in parts, identified defects, or emerging technology is an essential characteristic for the healthcare training system to share.

(4) Reducing inventory is even more important in the healthcare training system

Some of the problems in mass production that lean attempts to alleviate are even more problematic in the context of the healthcare training system. One of the biggest wastes that lean addresses is inventory in the system. In the manufacturing context, this could be a cart of parts waiting for the next operation, or a finished product waiting to be sold. When the healthcare system is examined however, inventory is the students who are moving through the system. Inventory could be a student waiting to get into a specific training program or a student waiting to get a job after graduating from school. The fact that the “inventory” in the system is a person instills a moral value in reducing inventory and allowing students to quickly move through their training program and find employment.

Lean is an effective theory for analyzing the healthcare training system, because at its core it already seeks to reduce waste, including inventory, from the system. While this is important in the manufacturing context, it is arguably even more important in the healthcare training system.

Lean Principles

Each lean principle is briefly described in Table 1 and elaborated upon in the following section. While this section does not provide a comprehensive review of each principle, it provides a basic understanding of each principle so the lean principles may be used to assess healthcare workforce planning practices.
Table 1. Summary of lean principles

<table>
<thead>
<tr>
<th>Lean Principle</th>
<th>Description</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| Pull           | System produces in response to customer demand | • Minimize work in process/inventory, thereby reducing risk of financial loss due to demand fluctuation  
                 |             | • Production can quickly respond to changes in customer demand |
| Specify Value  | Value is defined as anything the customer is willing to pay for and anything that does not result in value is defined as waste or “muda” | • Improve the system holistically and not just one segment  
                 |             | • Product meets customer needs, without exceeding them  
                 |             | • Defines waste |
| Waste Elimination | While acknowledging that some waste will always be present in a system, waste should be minimized | • Reduce cost, resource consumption, and labor use  
                   |             | • Reduce processing time |
| Respect of Humanity | Fully engage and utilize workers and their capabilities. According to Miller (2008) the language used at Toyota to describe Respect of Humanity is better translated to “holding precious what it is to be human” | • Increases the likelihood of employees significantly contributing to improvements and adding value to the company  
                    |             | • Improve retention and employee satisfaction |
| Continuous Improvement | Continually identify improvement opportunities and implement these improvements | • Continually draw closer to the other lean principles and a perfect system |
| Flow | Achieve a continuous and uninterrupted process across the value stream | • Faster throughput time  
                       |             | • Reduced work in process  
                       |             | • Steady production rates |

**Detailed Description of Lean Principles**

**Pull:**

*Description:*

The lean principle Pull seeks to develop systems that produce in response to customer demand.

*Practices:*

In manufacturing systems, pull is often demonstrated through the practice of setup time reduction, just-in-time, Kanban systems, and production levelling (Dennis, 2007). The practice of production levelling helps stabilize production by setting a general schedule. This general schedule is then modified through Kanban systems to make
precise changes that keep inventory to a minimum and the system at maximum flexibility (Dennis, 2007). While in a push system, production of a part is solely based upon the general schedule, in a pull system the production of a part is based upon the use of that part in the downstream processes (Koren, 2010). This demand is commonly tied to the production of new parts through Kanban cards, which are returned from the customer to the supplier when the minimum stock is reached. In pull systems, customer consumption triggers production to fill the gap created.

Instead of trying to predict the customer’s demand, a lean value stream should have short lead times and have production pulled by one process, if possible this can be achieved by differentiating products at the latest possible stage in production (Rother & Shook, 2009). This single process that pulls for the entire system is called the pacemaker process (Rother & Shook, 2009).

Benefits:

The pull principle seeks to reduce the amount of work in process, also referred to as inventory, to make the system more flexible and responsive to changes in demand. Besides increasing the flexibility of the system, the reduction of inventory reduces the risk of financial loss due to changes in customer demand. Balanced flow, which is discussed under the lean principle Flow, also significantly affects the flexibility of a system and can reduce the risk due to changes in customer demand. This is a good example of how the lean principles inherently overlap each other.

Belekoukias et al. (2014) found the lean practice of JIT (defined to include elements of Pull, Flow, and Waste Elimination) to have a significant effect on quality, due to organizations addressing problems exposed by low inventories. Poppendieck (2002) lists some of the hidden costs associated with in process inventory as: Handling damage, material handling costs, product obsolescence, inability to quickly detect errors, and long lead times which leads to the need for forecasting. Some of the problems from not following the Pull principle make it more difficult to follow other lean principles. For example, the inability to quickly detect errors makes it difficult to identify the root cause of defects as required by the Waste Elimination principle.
Main Takeaways:

1. Goods should be “pulled” through a system. This means the customer should define the rate at which goods are produced and goods should be produced to fill the gap caused by customer consumption.

2. The rate of production should be modifiable on multiple time scales to allow maximum flexibility.

3. Processes should be synchronized to minimize work in process inventory.

4. Before pull is implemented in a system, it is important to identify what components in the system should be pulled. The next lean principle, Specify Value, helps determine what system component should be used to create pull in a system.

Specify Value:

Description:

Value is defined as anything the customer is willing to pay for and anything that does not result in value is defined as waste or “muda” (Dennis, 2007).

Practices:

The Specify Value principle defines what value is and analyzes the system in terms of the value streams. Before the value stream can even be determined, value must first be defined by the customer. Toyota completed this aspect of Specify Value by considering interacting with the customer and sales team the first step in product development (Womack et al., 1991). In the Toyota dealership system, customer needs and perspectives are closely integrated with and relayed to the manufacturer (Womack et al., 1991). Value as defined by various stakeholders in the healthcare training process is diagrammed in Figure 6 in the Appendix.

After value is defined by the customer, the value stream must be defined and analyzed. A value stream is defined as all of the actions required to bring a product through the main flows of a process (Rother & Shook, 2009). Value streams are different from other ways of approaching a system, because they consider the overall process and focus on the concept of value as defined by the customer (Rother & Shook, 2009). In the case of Toyota, the value stream is considered to span from component suppliers, to the
One practice used to define the value stream and identify potential improvements is the use of value stream maps. Value stream maps are a visual tool for facilitating value stream thinking which entails examining how a combination of processes can bring value to a customer with a minimum of waste (Rother & Shook, 2009). Rother and Shook (2009) explain the process of creating VSMs in great detail.

Rother and Shook (2009) recommend collecting the data needed for VSMs through first hand observations in a process commonly known as “Going to Gemba”. “Going to Gemba” involves acquiring first hand observations by walking along the production line, in the context of manufacturing, and being involved with the process or involving operators in the creation of the value stream map. The practice of “Going to Gemba” is also used at Toyota to familiarize engineers with the production system, facilitating system level thinking (Womack et al., 1991). Toyota accomplishes this by having engineers start their careers by rotating among different positions in the company including working in assembly, marketing, and the various engineering departments for several months each (Womack et al., 1991).

Another practice employed in lean to facilitate value stream thinking is to assign someone to be in charge of the entire value stream (Rother & Shook, 2009). This is demonstrated at Toyota where a Chief Engineer is responsible for a product from design all the way through production (Ballé & Ballé, 2005). In lean manufacturing, this also takes the form of focusing on product teams (focus on all processes that happen to one product line), not departments (focus on one process as it applies to all product lines) (Rother & Shook, 2009).

Benefits:

Constructing feedback loops and defining value based on customer needs connects the customer and manufacturer. By knowing exactly what the customer wants and is willing to pay for, forecasting, which could lead to the production of unwanted products, can be decreased (Womack et al., 1991). Additionally, by knowing what customers define as valuable organizations can strategically place themselves and their product to attract customers.
By examining the entire value stream using methods such as VSM, production costs can be reduced and response to customer demand and quality can be improved (Lacerda et al., 2016). In the case described by Lacerda et al. (2016), VSM was effectively used to identify a variety of lean practices for implementation. The successful implementation of these practices reduced process time and inventory levels, and provided a significant decrease in process time at a bottleneck.

By “Going to Gemba” and involving operators in the improvement process, Lacerda et al. (2016) found workers to be more committed to their work and anticipated future improvements to go even better. “Going to Gemba” also addresses the Respect of Humanity principle, which is discussed later. (Lacerda et al., 2016; Womack et al., 1991)

**Main Takeaways:**

1. Value must be defined by the customer.
2. One person or team should be responsible for the entire value stream.
3. Data used to create value streams should be collected from first hand or as close to first hand as possible by “Going to Gemba”.

**Waste Elimination:**

**Description:**

In lean thinking waste is defined as anything the customer is not willing to pay for. While acknowledging that some waste will always be present in a system, the waste elimination principle seeks to minimize waste whenever possible (Dennis, 2007). The Waste Elimination principle is sometimes referred to as the Zero Defects principle, however when this terminology is used defects are defined as anything the customer is not willing to pay for, including machine down time. In this thesis, the term Waste Elimination is used to avoid confusion concerning the term “defects” and to be inclusive of all waste.
The broad term “waste” is further broken down into a number of categories in order to understand the variety of processes that can result in waste. Poppendieck (2004) identifies 8 different kinds of waste as follows:

1. **Overproduction:** producing more than needed or producing before a product is needed
2. **Delays:** People or machines waiting for materials, maintenance, or processing time
3. **Transportation:** Movement of products or materials
4. **Processes:** Unnecessary or inefficient processing defined as processing the customer is not willing to pay for
5. **Inventories:** Carrying work in process inventory
6. **Motions:** Any motion of machines or workers that does not add value
7. **Defective Products:** Product errors that result in scrap, rework, or dissatisfaction
8. **Defective Design:** Product exceeds or does not meet customer needs

The eighth form of waste Defective Design, is not identified consistently throughout the literature, for instance Waring and Bishop (2010) only defines the first 7 categories as being forms of waste. Some authors may consider Defective Design to be a specific subset of the category Defective Products. However it is classified, the category Defective Design is an interesting category and should be considered to understand the implications of producing an ineffective product due to not understanding the customer needs. Dennis identifies an eighth waste as Knowledge Disconnection (Dennis, 2007), which is defined as the knowledge gap between the supplier and assembler which may prevent waste reduction and the gap between the assembler and customer which may result in ineffective products. This description by Dennis (2007) is similar to the categories Defective Design and Processes Poppendieck (2004) identified.

For consistency and simplicity, this thesis will use the categories of waste defined by Poppendieck (2004). While there is overlap and different usage of terms in describing the categories of waste among the literature that was reviewed, this thesis seeks to use the core thinking behind the lean principle of Waste Elimination. Therefore, precisely defining each category of waste is beyond the scope of this thesis, and would in itself be a waste.
**Practices:**

The goal of lean manufacturing is to eliminate waste from the system. As such, many of the other lean principles also reduce waste in the system. For instance, the practices that achieve Pull in a system such as the use of Kanbans, also reduce the waste associated with Inventory. Additionally, many of the wastes are interconnected, so a reduction in one kind of waste will also result in another kind of waste. For example, a reduction in Inventory can reduce the necessary floor space allowing parts to be stored closer to their point of use, thus offering a reduction in Transportation and Motion wastes.

In this section, Defects will be focused on. The other categories of waste will be discussed more in terms of the other lean principles. Defects are defined as faulty parts that cannot be used in the final product. Defects have long been a problem in mass production, but have largely been accepted or ignored. In mass production, an assembler commonly defines a percentage of supplied parts that are expected to be defective (Womack et al., 1991). This acceptable level of defects is similar to the concept of statistical process control (SPC) which expects and takes into account defects (Dennis, 2007). On the other hand, lean manufacturing seeks to eliminate all defects from the process. An important clarification should be made that errors may occur, but the system should be designed to prevent errors from resulting in defects (Dennis, 2007).

As defined by Womack et al. (1991) detecting and tracing defects is one of two key organizational features of lean plants. A practice that is commonly used in lean manufacturing to identify defects is the use of poka-yokes. Poka-yokes are simple processes or tools that mistake-proof a process by checking for errors such as missing or disoriented parts (Dennis, 2007). Poka-yokes are used to inspect every part (Dennis, 2007). A key difference in the detection of defects in lean manufacturing compared to mass production is that once a defect is identified corrective action to resolve the defect is taken immediately. Toyota even installed a cable that could be pulled by workers to stop the line at each workstation, so if a worker cannot resolve a defect the problem can be addressed by the whole team (Womack et al., 1991).

After a defect is found, lean manufacturers focus on finding the root cause of the defect, so the actual problem can be resolved. When a defective part is found, Toyota
uses the practice of the “five why’s” to root out the underlying cause of a defect (Womack et al., 1991). Under this practice, it is initially asked why the defect occurred, and then the answer is re-questioned in five iterations to get to the root issue.

Benefits:

Process waste is often connected, so waste elimination in one area can result in waste elimination in another area. For example by reducing Inventory waste, a smaller manufacturing area can be used thus reducing Transportation and Motion waste.

The reduction of defects subsequently reduces scrap, rework and the amount of time required to produce a good part. Additionally, by finding and eliminating defects at the station level, rework areas can be eliminated, costs can be reduced and quality can be improved (Koren, 2010).

By immediately identifying problems and tracing defects back to the root cause, Toyota eliminated a lot of problems on the assembly line. Womack et al. (1991) comment that after workers got used to determining the root cause and solving problems, even though every worker could stop the line, the assembly line rarely stopped. This is compared to a mass manufacturing plant where production was constantly stopping (Womack et al., 1991). Identifying errors at the source reduces rework and the cost of scrap, and eliminates root causes from the system to prevent future errors.

Main takeaways:

1. Non-value adding processes (waste) should be eliminated or reduced.
2. Other lean principles seek to reduce the amount of waste in a process.
3. Defects can be minimized and waste reduced by identifying defects and finding the root problems within zones instead of at the end of the system.

Respect of Humanity:

Description:

The Respect of Humanity principle seeks to fully engage and utilize workers and their capabilities. Miller (2008) suggests that the language used at Toyota to describe Respect of Humanity is better translated to “holding precious what it is to be human”.

Practices:

Sugimori et al. (1977) identify just-in-time production and respect-for-human system as the major distinctions between Toyota’s lean manufacturing and mass
manufacturing. Fairly recently, Toyota made Respect of Humanity one of the core pillars that supports the Toyota Way (Miller, 2008). While Respect of Humanity is a critical aspect of lean manufacturing it has been often misinterpreted in the West as being nice to employees (Rother, 2010), giving employees free range in how to approach their work (Womack, 2007), or respecting the rights of an individual (Miller, 2008). While these may be good things, Respect of Humanity is defined by Sugimori et al. (1977) as being comprised of three main components: (1) elimination of waste made by workers, (2) considering worker safety, and (3) entrusting employees and utilizing their full capabilities.

The original lean thinkers perceived Toyota workers as extremely diligent and full of pride in their work. Sugimori et al. (1977) state, “Workers may realize their work worthy only if the labour of diligent workers is exclusively used to raise added value of products,” (p. 557). Sugimori et al. (1977) also refer to workers as, “diligent and enthusiastic about attaining production,” (p. 558). This perception resulted in the original lean thinkers emphasizing the importance of workers feeling like their work is adding value. Many of the practices that Sugimori et al. (1977) identify as related to this component of Respect of Humanity correspond to practices used in the Waste Elimination principle. Examples of practices used to reduce the waste created by employees are reducing idle time by assigning workers to be responsible for multiple machines and reducing the occurrence of defects (Sugimori, Kusunoki, Cho, & Uchikawa, 1977).

Another important component of the Respect of Humanity lean principle is the consideration of worker safety. Sugimori et al. (1977) consider standard work and reduced waiting time both practices that reduce the possibility of workers performing unusual tasks, which could result in defects or safety problems. Included in this component of safety is the quality of the work environment, which lean strives to improve.

The component of utilizing the full capabilities of employees is more consistently found in discussions of the Respect of Humanity principle (Miller, 2008; Rother, 2010; Sugimori et al., 1977; Womack, 2007). Utilizing the full capabilities of an employee also relates to the Waste Elimination principle’s Defective Design component. If employees
are not utilized to their full capacity, it could be equally stated that the employee was over trained for their job, thus representing a waste using the definition of Defective Design. Rother (2010) describes the Respect of Humanity principle as utilizing worker’s “human capability to learn and to grow”. The Respect of Humanity principle is therefore practiced by ensuring that during each day, employees participate in challenging work in which they are striving for a goal (Rother, 2010). After interviewing Toyota managers about how they respect their employees, Womack (2007) describes Respect of Humanity as being shown by challenging employees and collectively working to solve a problem. Womack (2007) finds this problem solving approach to be highly respectful, because it fully engages the employee in the process and the manager shows the employee that the employee and their intimate knowledge of the system is required to solve the problem. Womack (2007) emphasizes the respect for each individual’s contribution to the problem solving process, which occurs in the lean system. At Toyota, Respect of Humanity is deeply incorporated in corporate philosophy (Miller, 2008). Many of Toyota’s foundational principles are focused on the humanity of employees and working to improve the community and quality of life (Miller, 2008). The fifth guiding principle best describes the Respect of Humanity as “Foster[ing] a corporate culture that enhances individual creativity and teamwork value, while honoring mutual trust and respect between labor and management,” (Miller, 2008). Toyota practices this respect by developing employees through on-the-job training, emphasizing the importance of passing on wisdom and learning to successors, and understanding that managers and employees can both learn from each other (Miller, 2008).

**Benefits:**

For principles such as pull, waste elimination, and continuous improvement to succeed, workers must be fully engaged in their work. Therefore, the Respect of Humanity principle must be followed if lean is to succeed. Womack et al. (1991) describe the lean manufacturing system as fragile with no safety net, which requires every worker to try hard and do their best. The Respect of Humanity principle seeks to achieve this result in workers.

In order to achieve the Waste Elimination principle, workers must be comfortable admitting mistakes so they can be resolved at the root level (Poppendieck, 2004). As
noted by Womack (2007), managers are often not close enough to processes to know the intricacies of the process. In order for Continuous Improvement to be effective, employees must be engaged and given the opportunity to identify improvements in their area. This is most notably accomplished through the practice of Kaizen events.

Womack et al. (1991) comment that oftentimes workers in mass manufacturing companies they observed simply did not come to work. Mass manufacturers are able to accommodate these absences due to the robust system created by large inventories and extra workers (Womack et al., 1991). In comparison, Womack et al. (1991) describe the lean system as fragile, due to low inventories and the minimum number of employees. Such a system could not handle absent workers which could result in shutting down production. However, Womack et al. (1991) found that at Toyota workers just don’t miss work. This is a benefit of the Respect of Humanity principle which fosters a work environment where workers are expected to consistently show up for work.

The largest benefit of Respect of Humanity that Womack (2007) identifies is a much lower turnover rate. By not having to constantly hire and train personnel, productivity and quality are increased while rework and inventories are reduced (Womack, 2007). In his study Womack (2007) found low turnover to be directly connected to employees being challenged in their work and solving these challenges through mutual respect of each other’s contributions. The Respect of Humanity principle fosters this environment.

Another benefit to Ohno’s emphasis on giving assembly workers responsibility for housekeeping, some maintenance, quality control, and improvements was the reduction of non-value adding personnel who completed the previously identified tasks in mass-manufacturing plants (Womack et al., 1991). Additionally through the organization of employees as teams, the foreman was replaced with a team leader who completed assembly tasks and filled in for absent workers (Womack et al., 1991). Not only do these changes follow the Respect of Humanity principle by increasing the challenge and variety of work the assembly line workers perform, but they also reduce the waste of non-value adding personnel.
Main Takeaways:

1. Respect the humanity of employees by creating work that is not wasteful, safe, and fully engages the capabilities of workers.
2. Employee involvement and concern for the company is critical for the successful implementation of lean principles.
3. Involve all employees in improvements through the use of simple tools and engagement strategies such as Kaizen events.
4. Create an environment where employees are comfortable to admit mistakes and make suggestions or improvements.

Continuous Improvement:

Description:

An assumption in lean is that perfection can never be attained, but companies should constantly strive for perfection. The Continuous Improvement principle is followed when processes are continually examined for improvement opportunities, which are being implemented.

Practices:

As mentioned in the Respect of Humanity section, it is important to involve production workers in improvements, because often managers do not have the intimate process knowledge to implement improvements (Womack, 2007). In lean, gaining the involvement of employees from all levels of the organization is critical for successful implementation of continuous improvement. A variety of practices and tools are used in lean to ensure that everyone’s voice is heard. Employees can be involved in improvement activities by using tools such as Kaizen circles and suggestion programs (Dennis, 2007). Visual tools such as Value Stream Maps, Spaghetti Diagrams, and Fishbone Diagrams are also frequently used to make sure everyone understands the entire process (Poppendieck & Llc, 2002). Poppendieck (2002) describes the Fishbone Diagram’s purpose as to, “enable everyone to contribute their piece while seeing how it relates to those contributed by others,” (Poppendieck & Llc, 2002).

Lean organizations implement several policies and practice to encourage employees to participate in improvement activities. A standard policy in lean organizations is to not allow continuous improvement to cause any employee to lose their
job (Dennis, 2007). This is a very sensible but critical policy, as employees are unlikely to make suggestions for improvement if they believe the improvement may cost them their job. By creating a “No Blame” environment discussed by Poppendieck (2002), open communication and the proposal of new ideas is encouraged. Continuous Improvement relies on constantly trying new ideas and finding better ideas. For example, Toyota did not perfect rapid die changes on the largest sheet metal presses until the 1960’s (Womack, Jones, & Roos, 2007). Throughout this trial time, improvements were welcome and tested (Womack et al., 2007), which is a critical component of the Continuous Improvement principle.

Toyota uses a variety of practices and policies to not only force Continuous Improvement, but also encourage employees or suppliers to work to continuously improve processes. One example of forcing continuous improvement is the policy that suppliers must provide components at a continually declining cost as a model ages (Womack et al., 1991). This is also an example of how continuous improvement occurs across the value stream in lean manufacturing, involving both the assembler and the supplier. In mass manufacturing, suppliers are involved late in the design process preventing them from offering radical design changes to reduce cost and improve manufacturability (Womack et al., 1991). In following with value stream thinking, Toyota involves suppliers at the beginning of the design process (Womack et al., 1991). In order to encourage Continuous Improvement at this stage in the design cycle, Toyota encourages suppliers to seek improvements in their own processes by establishing policy to maintain the price of a part, even if a supplier can make it cheaper, thus allowing the supplier to increase their profit (Womack et al., 1991). Similarly, when improvements are realized through cooperation between the supplier and the assembler, the profit gain is shared between the two entities (Womack et al., 1991).

Benefits:

A critique against lean manufacturing is that the Continuous Improvement aspect of lean stresses workers by forcing them to constantly evaluate what they are doing (Womack et al., 1991). Womack et al. (1991) argue however, that the problems workers are asked to solve develop a “creative tension” and that workers are given the proper
tools and resources to effectively solve these problems. This “creative tension” is similar to the challenging work required by the Respect of Humanity principle.

Continuous Improvement can result in tremendous change, as Toyota saw in the die exchange process (Womack et al., 2007). Toyota’s focus on continuous improvement and integrating suppliers into the improvement process lowered the cost of parts and improved the assembly process (Womack et al., 1991). Continuous Improvement can be applied to many of the lean principles to move an organization closer to lean.

Main Takeaways:

1. Perfection can never be achieved, but should always be sought. There are always improvements to make.
2. Improvements should be suggested and made with the help of people involved in the processes.

Flow:

Description:
Flow seeks to achieve a continuous and uninterrupted process across the value stream (Mirdad & Eseonu, 2015). Flow is related to the lean principle Pull, because in order to achieve Flow in a system the product is *Pulled* to the bottleneck and then pushed from the bottleneck to the customer.

Practices:

In order to achieve a continuous and uninterrupted process, manufacturers should strive to produce items in batches of one (Dennis, 2007). It is important to note that achieving one piece flow may not be initially possible, but systems should seek this and minimize the amount of work in process inventory by reducing batch sizes. The use of Kanban systems can help manufacturers approach one piece flow. Kanban systems are simply a system that notifies the producer to make more of a part once the customer uses it. Kanban systems are not the goal however, minimizing the work in process by achieving balanced, one piece flow is the goal of the Flow principle (Reeb & Leavengood, 2010).

In order to approach one piece flow, another practice that must be focused on is the minimization of set-up times. Set up time is defined as, “The time taken from the last good piece on the previous run until good product is coming off the machine again.”
In order to allow Toyota to stamp car body parts without buying many expensive stamping presses, Taichi Ohno reduced the time it took to set-up the various dies so a few presses could stamp out all the parts they needed (Womack et al., 1991). After experimenting throughout the 1940’s and into the 1960’s Ohno greatly reduced set up times from a day to minutes (Womack et al., 2007). By reducing set-up times, Ohno enabled the use of small batches thus permitting Flow, since large batches did not have to be run to offset the long set-up time between parts.

In order to achieve Flow, work must be balanced across the process. Line balancing is the practice of reassigning tasks to have each process produce to takt time. Essentially, a part should move through a work station at the same rate the part moves through every other work station and therefore at the same rate products are finished.

**Benefits:**

Following the Flow principle results in many benefits for the manufacturer such as catching defects as soon as the occur, reducing in process inventories, and quickly responding to changes in customer needs. The first two benefits are closely tied to the lean principle Waste Elimination and the latter benefit is largely connected to the lean principle Specify Value.

In a traditional mass manufacturing environment where parts are run in large batches and then wait to be used in the next process, a machine can begin to produce defective parts unnoticed and end up producing an entire batch of defective parts. If the Flow principle is followed, even if the defect isn’t identified using a poka-yoke system as discussed earlier, the defect can be quickly found and corrected when the next process attempts to use the defective parts. By reducing in process inventories through the use of small batches or ideally one piece flow, the Waste Elimination principle is followed by catching and solving defects as soon as they occur.

Changes from suppliers or customers can be quickly incorporated into the production system if the Flow principle is followed. Since large inventories of half-finished, or finished products are not kept, customer changes result in much smaller amounts of scrap, thus relating to both Waste Elimination and Specify Value.

Womack et al. (1991) describe seeing large buffers of work in process and huge inventories of parts as two of the signs of old fashioned mass production. As discussed
previously, these inventories can hide defects, but they also represent company money that is tied up in materials. A lean manufacturer such as Toyota however is described as keeping less than an hour’s worth of inventory on the floor with no parts buffers between operations (Womack et al., 1991). Following the Flow principle large inventories of parts can be greatly reduced yielding more liquid assets for the company, less consumption of floor space, and easier identification of defects.

**Main Takeaways:**

1. Seek a continuous, uninterrupted flow across the value stream.
2. Minimize batch size, seeking one piece flow.
3. Standard work must be used in order to result in a standard rate and standard quality of work.

**Case Studies**

In order to understand how lean principles can be applied to the healthcare training system several case studies in workforce planning were analyzed, using the lean manufacturing principles just discussed as a lens. Best practices for workforce planning are taken from the case studies in order to develop recommendations for future practice.

The analyzed case studies considered a variety of positions, but primarily focused on upper level, professional positions. The scope of this thesis is focuses on lower level positions due to the initial aim of the survey conducted by Esconu and Doolen (2013), however the findings from these case studies still apply to lower level positions due to the similar structure of the training pipeline (value stream).

Case studies were identified by conducting a search on the PubMed, EBSCOhost, and other databases at the Oregon State University Library. Searches were conducted using keywords such as healthcare workforce planning case study, healthcare workforce planning, healthcare workforce training, and healthcare workforce policy. Additional case studies were identified based on citations in reviewed papers. 81 papers were reviewed in preparation for this study. The focus was on papers that described a specific workforce training program.

The recommendations made in each case study are summarized in Table 2.
Table 2. Summary of case study recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Lean Practice</th>
<th>Lean Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of roundtable discussions to engage stakeholders and define value</td>
<td>Customer defines value</td>
<td>Specify Value</td>
</tr>
<tr>
<td>Involve practitioners in the development of curriculum</td>
<td>Go to gemba</td>
<td>Specify Value</td>
</tr>
<tr>
<td>Match learning experiences with competencies</td>
<td>Define what the customer is willing to pay for &amp; Defective Design and Processes waste</td>
<td>Specify Value &amp; Waste Elimination</td>
</tr>
<tr>
<td>Use existing programs as a baseline for developing or assessing curriculum</td>
<td>Standard work</td>
<td>Continuous Improvement</td>
</tr>
<tr>
<td>Determine training spots to open based upon local authorities perception of employer need</td>
<td>Approaches following a kanban system</td>
<td>Approaches Pull</td>
</tr>
<tr>
<td>Use a common core trunk to differentiate professionals at the last possible time</td>
<td>Differentiate as late as possible &amp; Job rotation / flexibility</td>
<td>Pull &amp; Respect of Humanity</td>
</tr>
<tr>
<td>Use students to fulfill professional work</td>
<td>Utilize workers to their highest ability &amp; Simultaneously meet needs of all stakeholders &amp; Challenge workers</td>
<td>Waste Elimination &amp; Specify Value &amp; Respect of Humanity</td>
</tr>
<tr>
<td>Collect feedback from students on satisfaction with residency program</td>
<td>Collect feedback</td>
<td>Continuous Improvement</td>
</tr>
<tr>
<td>Consistent and standard process for student training</td>
<td>Standard work</td>
<td>Waste Elimination &amp; Flow</td>
</tr>
<tr>
<td>Insure proper communication and understanding of changes</td>
<td>Engage workers in the improvement process</td>
<td>Respect of Humanity &amp; Continuous Improvement</td>
</tr>
<tr>
<td>Develop standards for tasks to shift</td>
<td>Standard work</td>
<td>Flow &amp; Waste Elimination</td>
</tr>
<tr>
<td>Train workers for task shifting during pre-service or in-service training</td>
<td>Kanban system &amp; Zero defects / Defective Products</td>
<td>Pull &amp; Waste Elimination</td>
</tr>
<tr>
<td>Regulatory bodies and policy makers must be involved with change development</td>
<td>Stakeholder involvement</td>
<td>Specify Value</td>
</tr>
<tr>
<td>Complete task analysis to identify bottlenecks and determine roles within the system</td>
<td>One person is responsible for the value stream &amp; Going to Gemba &amp; Line balancing</td>
<td>Specify Value &amp; Flow</td>
</tr>
<tr>
<td>Provide employees with supportive supervision and mentorship</td>
<td>Mutual respect and support of workers</td>
<td>Respect of Humanity</td>
</tr>
<tr>
<td>Any permanent change in task shifting should affect the pre-service training curriculum</td>
<td>Kanban system</td>
<td>Pull</td>
</tr>
<tr>
<td>Use standard practices to regulate the implementation of task shifting</td>
<td>Zero Defects &amp; Defective Products Waste &amp; Address customer need and concerns</td>
<td>Waste Elimination &amp; Specify Value</td>
</tr>
<tr>
<td>Quantitatively measure the value students place on jobs and related benefits</td>
<td>Customer defines value</td>
<td>Specify Value</td>
</tr>
<tr>
<td>Use county level HR workers to collect local data and observations</td>
<td>Go to Gemba</td>
<td>Specify Value</td>
</tr>
<tr>
<td>Conduct initial studies to collect rough data on the situation and as the system improves recollect data</td>
<td>Establish a baseline</td>
<td>Continuous Improvement</td>
</tr>
<tr>
<td>Utilized a variety of “stop-gap” measures</td>
<td>Establish a baseline</td>
<td>Continuous Improvement</td>
</tr>
<tr>
<td>Use both pre-service and in-service training to include tasks that are being shifted</td>
<td>Kanban system &amp; Zero Defects</td>
<td>Pull &amp; Waste Elimination</td>
</tr>
<tr>
<td>Use standard practices to benchmark facilities and measure success</td>
<td>Standard work to provide a baseline</td>
<td>Continuous Improvement</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Lean Practice</td>
<td>Lean Principle</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Integrate healthcare training and delivery</strong></td>
<td>Examine the whole value stream &amp; Address customer need</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Address multiple stakeholder’s definition of value</strong></td>
<td>Customer defines value</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Develop training curriculum to address community need</strong></td>
<td>Customer defines value</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Adopt competency based medical education</strong></td>
<td>Customer specifies value &amp; Kanban system &amp; Processes</td>
<td>Specify Value &amp; Pull &amp; Waste Elimination</td>
</tr>
<tr>
<td><strong>Update curriculum to correspond to national needs</strong></td>
<td>Feedback from customer</td>
<td>Continuous Improvement</td>
</tr>
<tr>
<td><strong>Determine and ensure that students are prepared to delivery care</strong></td>
<td>Product must meet customer needs</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Training should be responsive to emerging diseases</strong></td>
<td>Responsive and easily adjustable system</td>
<td>Pull</td>
</tr>
<tr>
<td><strong>Include customers in survey of effectiveness of</strong></td>
<td>Customer defines value</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Have greater involvement of stakeholders in curriculum development</strong></td>
<td>Customer defines value</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Standardize curriculum</strong></td>
<td>Standard Work</td>
<td>Waste Elimination &amp; Flow</td>
</tr>
<tr>
<td><strong>Involve policy makers in curriculum development</strong></td>
<td>Examine the entire value stream</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Identify and remove bottlenecks to increase training capacity</strong></td>
<td>Identify and remove bottlenecks</td>
<td>Flow</td>
</tr>
<tr>
<td><strong>Gather all stakeholders to determine needs</strong></td>
<td>Stakeholders specify value</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Modify training program to address the stakeholder defined needs and not overtrain</strong></td>
<td>System is responsive to customer demand &amp; Processes Waste</td>
<td>Pull &amp; Waste Elimination</td>
</tr>
<tr>
<td><strong>Formation of information sharing networks</strong></td>
<td>Determine what employers need and deliver on need to avoid Processes or Defective Products or Defective Design Waste &amp; Change the training program according to customer demand &amp; Long lasting allowing improvement to occur over time</td>
<td>Waste Elimination &amp; Specify Value &amp; Pull &amp; Continuous Improvement</td>
</tr>
<tr>
<td><strong>Program partnerships between universities and community colleges</strong></td>
<td>Reduction in Processes Waste (in terms of students who later drop out) &amp; Examine the whole value stream &amp; More flexible system</td>
<td>Waste Elimination &amp; Specify Value &amp; Flow</td>
</tr>
<tr>
<td><strong>Addition of healthcare components to current educational programs</strong></td>
<td>Encourage value stream thinking in other disciplines</td>
<td>Specify Value</td>
</tr>
<tr>
<td><strong>Sharing of employees between training institutions and health care providers</strong></td>
<td>Give providers opportunity to do different things &amp; Determine number of faculty needed based upon student volume &amp; Reduce down time / idle professionals</td>
<td>Respect of Humanity &amp; Pull &amp; Waste Elimination</td>
</tr>
<tr>
<td><strong>Recommendations from LBL - WIB Report</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Creation of Residency Training**

**Curricula Development in Sub-Saharan Africa**

**Program partnerships between universities and community colleges**

**Addition of healthcare components to current educational programs**

**Sharing of employees between training institutions and health care providers**
1. Case Study: Development of UNC Public Health Program (Thompson, Harver, & Eure, 2009)

**Context:**

Recently the number of public health educational programs has greatly increased, due to a pressing need for knowledgeable health professionals. This need is driven by growing concern over the lack of formal training the public healthcare workforce currently has and an expected increase in the number of retirees from public health. Amid this growth, in 2002 the University of North Carolina (UNC) Charlotte decided to grow the College of Health and develop graduate and undergraduate programs in public health.

**Objective:**

This case study seeks to inform other institutions of the approach taken by the UNC to develop a new public health program, specifically focusing on the importance of using a top-down/bottom-up approach to planning.

**Case Summary:**

The iterative, top-down/bottom-up planning approach is commonly used by the UNC system and is shown diagrammatically in Figure 4 (Thompson et al., 2009). A few of the steps in the planning process are highlighted and described in greater detail below.
After defining the mission of the program and conducting a needs assessment of the area, a roundtable was held in 2003 to gather recommendations regarding the future of the developing programs. The roundtable was comprised of a broad variety of governmental and private healthcare professionals, academics, and community leaders. One of the key decisions made at the roundtable was the creation of an advisory board to connect the training program with industry. In conjunction with the recommendations made by stakeholders, planners used accreditation requirements and consulted other institutions to define the requirements the program had to meet.

The stakeholder recommendations combined with regulatory standards drove the top-down approach to planning. This approach was complimented by the bottom-up
approach, which defined the desired abilities of a graduate based on standard competencies and input from faculty and the advisory board. Through the bottom-up approach, curriculum was aligned with competencies in a systematic manner to avoid unintended duplication of any competency in the curriculum. Assessment methods were strategically linked to each curriculum component and competency to ensure that students were assessed for each objective in an appropriate manner.

After the process was completed and the curriculum was developed, the cycle is reiterated to make sure that the developed curriculum meets stakeholders’ expectations. The continual assessment of the program and collection and analysis of feedback allowed new opportunities and improvements to be identified. A few specific changes that were brought about were a different sequencing of classes and renewed focus to receive a specific accreditation.

The critical takeaway from this case study is the level of community involvement during curriculum development. Success, or in lean terms “value”, was, “defined by the community’s stated needs and expectations and by evolving professional standards,” (Thompson et al., 2009). Thompson et al. (2009) summarize the process for developing the program at UNC as a,

rigorous and cyclical process of determining what society needs, designing a curriculum specifically to prepare graduates to meet those needs, ensuring that those graduates meet those needs and reassessing society's needs that we can continue to advance the profession and ensure the public's health. (p. 7)

Results:

The programs at UNC Charlotte have been extremely successful and have rapidly taken off. Thompson et al. (2009) partially attribute the rapid progress to the support the program received from the stakeholders and community especially in areas such as internships. Thompson et al. (2009) identify a series of recommendations for other schools looking to build their program including: be connected to the training institution’s community, know the community and its needs, be responsive to the community, build coalitions by building consensus, and plan inclusively and effectively.
**Lean Principle Application:**

The case of the UNC Charlotte program expansion described by Thompson et al. (2009) provides an excellent example for how the Specify Value lean principle can be carried out in the healthcare training pipeline. In the Specify Value principle it is critical to define what Value means to the customer in order to reduce non-value adding processes in the system. When developing the curriculum for the course of study, value was defined as community need and expectation, which clearly establishes the community as the primary customer of the training system. The needs of other stakeholders (customers) such as employers, care providers, community leaders, and academics were included in roundtable discussions to make sure the curriculum addressed each of these stakeholders’ definition of value.

The UNC carefully approached the curriculum development by matching learning experiences with the list of competencies they developed. This practice is a good example of how the Specify Value principle ties in with Waste Elimination. By defining exactly what was valuable, the curriculum developers could eliminate anything that did not address the needs of the stakeholders. This results in Waste Elimination, specifically the Defective Design and Processes forms of waste. Defective Design can be considered to occur when students complete the curriculum, but are not prepared to deliver in the expected manners by employers. In this instance, the student does not meet the requirements of the customer and the resources spent on the training have proved to be wasted due to the failure to actually add value to the customer. Processes waste can be considered to occur when inefficient processing occurs such as would result from redundantly training students to meet a competency (without intending to), or completing courses that do not address any competency. Defining stakeholder needs and aligning a process with those needs is a good lean practice that can be applied in the healthcare training pipeline.

One of the benefits of following standard work is the ability to establish a baseline from which Continuous Improvement can occur. The UNC provides a good example of how a new program can be developed using the standard work of existing programs. The UNC initially used regulatory standards and existing programs to define competencies.
Subsequently, Continuous Improvement was used through the iterative cycle to align these standard competencies with customer need.

2. Case Study: Spanish Residency Program (Freire, Infante, de Aguiar, & Carbajo, 2015)

Context:

The Spanish medical residency training program is primarily completed by students wishing to become specialists after completing their medical degree; however other programs such as nursing have begun to follow a similar model using a residency based training system. In Spain, all professional qualifications and university degrees are regulated by the government, including the specialist training program (Freire et al., 2015). Due to the government’s strong presence as a healthcare employer, completion of the “residency” program became a requirement for working in a public hospital as a specialist (Freire et al., 2015). The goal of the residency system is described as seeking to develop, “the knowledge, skills, techniques, and responsibilities needed to become an independent specialist,” (Freire et al., 2015, p. 1).

Objective:

This case study aims to draw conclusions from the Spanish medical specialist residency system that could be helpful in developing or modifying other training systems.

Case Summary:

Freire et al. (2015) describe the Spanish medical specialist training system as having five pillars, since 1986. The Spanish residency training system is highly structured around the National Council of Medical Specialists (NCMS) and each specialty’s National Specialty Commission (NSC). The NSCs are comprised of 11 physicians (9 professionals and 2 student-residents). The NCMS is comprised of the NSCs’ presidents. These councils advise the Ministries of Health and Education and are actively involved with the residency system. The NSCs initially developed the official training programs (OTPs) for each of the specialties. The training programs are continuously reviewed. However, although the OTPs were published between 2005 and 2011, the latest update made was in 2013. The NCMS and NSCs are also responsible for accrediting hospitals and health units that wish to participate as a training unit.
At the core of the Spanish residency system is the selection process for placing students in training positions. The number of training spots available at each training unit is based on the approved capacity of the training institution, the national need for specialists as perceived by local health authorities, and the available budget. If necessary, the Ministry of Health may alter the local proposed numbers to meet national needs. Freire et al. (2015) comments that, “The annual approval of the national number of posts for medical specialty training is without doubt the main instrument of medical workforce planning in Spain,” (Freire et al., 2015, p. 3). Students are ranked by their performance in school and exam scores. Students then select a training position (both training institution and specialty) in rank order.

During the residency training period, the student-resident is personally evaluated by the staff of the unit they are working in. The student can improve and be re-evaluated after a waiting period if they are not competent in a skill. The student is also given an opportunity to review and provide feedback on the training program.

Besides describing the structure of the residency training system, Freire et al. (2015) comment on several other good practices that are followed. In the Spanish residency system, while specialists are in training they are considered professionals and undertake a large amount of work under the supervision of a qualified specialist (Freire et al., 2015). In the Spanish training system, a model of using a common core for specialties is believed to be effective for several reasons. The primary purpose of this approach was to reverse the narrowing of skills caused by specializing too early. Other benefits have included giving specialists opportunities to interact with other specialties, enhancing their ability to approach problems holistically and allowing specialists to re-specialize later in their career. Freire et al. (2015) comments that this approach will result in specialists, “Becoming more able for life-long learning and continuous professional development,” (Freire et al., 2015, p. 5). Continuous medical education (CME) is lawfully identified as a duty and institutions and communities are providing various opportunities for specialists to continue their education.

**Results:**

The Spanish residency training program has been identified as a major contributor to the development of the good healthcare system in Spain (Freire et al., 2015), so these
recommendations should be considered in other healthcare systems as well. Freire et al. (2015) identify the major challenges for the Spanish National Health Service as ensuring the continuity of education from medical school to retirement, enacting the common core trunk approach, and developing a mandatory system for re-certification.

**Application of Lean Principles:**

Although the Spanish residency training system appears to tie training spots to community demand, this is not an excellent example of implementing the lean principle Pull in the training pipeline. This is an improvement from just guessing how many training spots to open, but a true Pull system would define the number of training spots to open based upon customer’s demand, not on the perception of demand by local authorities. Ideally, training of workers wouldn’t start until a gap was created, however the long training times cause some forecasting methods to be necessary. Pull could be more closely followed in this example by defining the forecasts based upon customer specified demand, rather than the demand perceived by local authorities. By following the Pull principle, Inventories waste could be reduced, since if the student’s training spot is created by an employer need, the student will most likely be able to find a job with that employer after completing training.

Rother and Shook (2009) identify a technique to improve the Pull through a system as differentiating a product at the last possible stage in production. The recommendation to change the approach to the residency system to follow a common core trunk follows this lean practice. The common core trunk will increase the flexibility of the training system and allow specialists to re-specialize in a different area later in their career.

The Spanish residency system successfully achieved some facets of the Specify Value principle, while not achieving others. The Spanish residency system does not do a good job of engaging with the various stakeholders, which is a key part of the Specify Value principle. While the NSCs and the NCMS are used to develop the Official Training Programs, they are only comprised of professionals and several student representatives. Employers, the government, and the community are therefore given very little input into the development of the training program. Community need is slightly considered by using input from regional authorities to determine the number of training spots each year,
but this is not a good example of “Going to Gemba” which would allow the Specify Value principle to be more closely followed.

By considering student-residents in the Spanish residency system to be professional employees, students are given the opportunity to provide valuable care for patients in the training institution (hospital or health center) under qualified supervision. Therefore, this process adds value to the student by providing valuable field experience, which will result in improved delivery of care after the student becomes a professional. The process also adds value to the community and training institution by allowing the student to provide valuable care. By addressing several aspects of value, this process more adequately meets the needs of its stakeholders. Processes that can address many stakeholders’ definition of value more closely follow the lean principle Specify Value. Various stakeholder’s definition of value is shown in Figure 6 in the Appendix.

A key practice for addressing the Continuous Improvement principle is the collection of stakeholder feedback. In the Spanish residency system, feedback is collected annually from students to report resident’s satisfaction with the training program and subsequently make appropriate changes to the training program. These feedback systems however do not include other stakeholders such as employers who are hiring residents, which could improve the residency system’s application of the Continuous Improvement principle.

The Spanish residency system is extremely organized procedurally and is an excellent example of the completion of standard work which leads to addressing the Waste Elimination and Flow lean principles. Throughout the residency system process, very clear standards are used. For example, each profession has a standard training plan and each training institution must be accredited according to a standard set of requirements. These standards lead to consistency of results between students and the ability to more easily predict from year to year the outcomes of the residency system. This allows employers to easily forecast the number of students they need to hire and smoothly complete the hiring processing, resulting in the lean principle Flow. Additionally, if standardized curriculum is aligned with employer needs, students are more likely to meet employer needs upon hiring. A student who completes the training program, but doesn’t meet employer needs could be considered to be a defect. Therefore
an increase in the proportion of students meeting customer needs through the creation of Standard Work will also result in Waste Elimination, because variation is reduced. Typically, Continuous Improvement is most readily completed from a baseline, which Standard Work also creates.

Several of the components and practices of the Spanish residency system address the Respect of Humanity principle. As discussed previously, students are given a lot of responsibility during their residency, which creates more challenging work for the students. This increases the value of the residency for the student and follows the Respect of Humanity lean principle by giving the student challenging work. One of the benefits of the development of a core trunk for medical specialists is the greater ease with which providers can change their careers. This practice gives providers more opportunities in the future and the opportunity to explore new areas and challenge themselves with rewarding work, thus following the Respect of Humanity principle.

3. Case Study: Task Shifting in Uganda (Dambisya & Matinhure, 2012)

Context:

Task shifting has been practiced in Uganda since 1918, when a new profession originally called “licentiates” (later medical assistants, and then clinical officers) was formed (Dambisya & Matinhure, 2012). Task shifting is the redistribution of tasks from highly qualified health workers to healthcare workers with fewer qualifications in order to more efficiently use human resources for health. Currently the healthcare systems in East, Central and Southern Africa are in a human resources crisis due to low human resources for health density and high demand on the healthcare system. Dambisya and Matinhure (2012) identify task shifting as a potential solution to address the current shortages in the healthcare system and allow developing countries to build more effective healthcare systems. In 2008, the East, Central, and Southern Africa Health Community (ECSA HC) advocated for the adoption of task shifting (Dambisya & Matinhure, 2012). Shortly after this recommendation was made, the ECSA College of Nursing petitioned the government for the most effective ways to implement task shifting in order to reduce confusion (Dambisya & Matinhure, 2012).
Objective:

The study presented by Dambisya and Matinhure (2012) sought to understand the implications of task shifting for both health workers and community members and assess the attitudes of providers towards task shifting (Dambisya & Matinhure, 2012).

Case Summary:

The study was cross sectional and qualitative involving 34 interviews and 8 in depth focus groups (Dambisya & Matinhure, 2012). The interviews and focus groups were meant to address the following areas: (1) understanding task shifting, (2) providing examples of task shifting, (3) understanding the policies in place for task shifting, (4) determining the political interest in task shifting, (5) determining the barriers or facilitators for task shifting, (6) finding opportunities to use task shifting to increase human resource capacity, and (7) understanding personal perceptions of task shifting (Dambisya & Matinhure, 2012). The questions and topics were purposely kept broad in order to enable respondents to describe experiences including, but not limited to HIV/AIDS treatment which is prevalent in the region. Interview participants included front line workers, policy makers, HR managers, health worker managers, and student nurses.

Results:

Uganda has seen the benefits of successfully implemented task shifting. Dambisya and Matinhure (2012) identify the Company Medic position in the Uganda People Defense Force as a good example of how task shifting can be used to ease workforce shortages. Some of the critical steps that were taken included receiving the endorsement of the highest political level, the development of supporting policies and guidelines, and working with health education experts to develop the curriculum for the new professional. In another case, task shifting was used to increase the capacity of the mental health service. The program was so successful, that mental health services were offered in regional and district hospitals.

The results of the study will be organized in accordance to the seven categories previously mentioned.

(1) Policy planners and senior health professionals had a pretty good understanding of task shifting, but lower level professionals had several misconceptions (Dambisya &
Misconceptions included perspectives of task shifting as “dumping tasks to others”, “neglecting duties”, and “making unauthorized delegation of duty” (Dambisya & Matinhure, 2012, p. 3).

(2) Respondents identified a variety of cases of task shifting between health professionals, and also from health professionals to patients’ family (Dambisya & Matinhure, 2012). While some degree of task shifting was supported by most respondents, some “core” decisions such as the starting or changing of care routines were felt best left to a more highly trained health professional (Dambisya & Matinhure, 2012).

(3 & 4) When this case study was completed in 2012, there was no written policy for task shifting, however work was underway to develop a policy. The goal of the policy was described by the ministry as working to not compromise quality while still allowing some tasks to be shifted. The government seemed to be advocating for the use of task shifting and the Minister of Health was “very supportive of task shifting” (Dambisya & Matinhure, 2012, p.5). The Director of Health Services in Uganda identified task shifting as needing to, “Not be arbitrary or cast in stone,” (Dambisya & Matinhure, 2012, p. 5). While there have been policies to allow specific cases of task shifting, national policy would permit the use of task shifting across the entire healthcare system. Some respondents were concerned that development of national policy could result in opposition from professional associations and patients (Dambisya & Matinhure, 2012).

(5) A few of the identified factors that could facilitate task shifting are the creation of a policy on task shifting, the use of Standard Operating procedures, providing evidence of successful task shifting, institutional guidelines, and greater awareness of task shifting (Dambisya & Matinhure, 2012). A few identified barriers are the term “task shifting”, professional boundaries and regulations, and reluctance to change (Dambisya & Matinhure, 2012).

(6) Dambisya and Matinhure (2012) identify the actual or perceived presence of unemployed professionals as a barrier to the success of task shifting. The authors recommend a restructuring of the health system and prioritization of qualified professionals, in order to ease this barrier (Dambisya & Matinhure, 2012). If task
shifting is used to build the capacity of the healthcare system, Dambisya and Matinhure (2012) recommend training professionals in skills that are often shifted to their profession using either pre-service training or in-service training. Modifying the training system is difficult due to the challenge of retaining skilled professionals as trainers and the limited budget of training programs (Dambisya & Matinhure, 2012).

(7) Respondents had either strongly negative or positive perceptions of task shifting. The bad reputation the “task shifting” name carries suggests that the idea was not well explained to the lower level providers, who are key stakeholders (Dambisya & Matinhure, 2012).

Overall, Dambisya and Matinhure (2012) recommended implementation of standardized policies for task shifting, education of healthcare workers on task shifting developments, and publication task shifting successes. These last two recommendations will specifically help achieve buy in from healthcare workers and managers.

**Application to Lean:**

Task shifting is primarily focused on improving the efficiency of the delivery of care. While it is worthwhile to note that task shifting is a lean practice, since it can lead to the reduction of waste by allowing resources to be used to their full potential, this will not be focused on in this thesis. This thesis is focused on workforce planning, so the policies and approaches taken to implement task shifting will be focused on.

This case study provides an excellent example of the importance of following the Respect of Humanity lean principle when implementing policy changes. A fundamental challenge identified was lower level providers’ perception of task shifting as simply the “dumping of tasks to others” or “making unauthorized delegation of duty” (Dambisya & Matinhure, 2012, p. 3). These comments highlight the importance of creating standards for task shifting, but also lower level providers’ poor perception of task shifting. This poor perception is further seen by the consideration of the term “task shifting” and lack of awareness as barriers to task shifting. These problems indicate the importance of following the Respect of Humanity principle and ensuring proper communication and involvement of workers in change. If Respect of Humanity was followed, the misperceptions of task shifting could have been reduced. This case study demonstrates the Respect of Humanity principle by interviewing various levels of healthcare
professionals and policy makers. This expressly engages all workers in the improvement process, which is required by the Respect of Humanity principle.

In some specific programs, such as the management of HIV / AIDS, standard task shifting practices were already developed. However, there were no policies or guidelines developed to inform widespread task shifting across the healthcare system. Both frontline workers and regulatory bodies agreed that some sort of framework needed to be developed, either through the creation of policies and guidelines or legal expansion of professional’s scope respectively. Focusing on the creation of standard work is an example of following the lean principles Flow and Waste Elimination. Since standard work will reduce the variability in the knowledge graduates have and increase the likelihood of students meeting employer needs.

Survey respondents who had out of necessity taken on tasks outside the scope of their position recommended using in-service training to teach shifted tasks, instead of expecting healthcare workers to learn on the job. Similarly, formal task shifting has utilized pre-service (most likely during the regular training process, although this is not clarified) or in-service training to train healthcare workers in the skills that are shifted to them. To use an analogy from manufacturing, to complete regular training without teaching healthcare workers the tasks that will be shifted to them is similar to knowingly creating a part that will need rework. Lean manufacturing seeks to eliminate this waste through practices such as poka-yoke under the concept of Zero Defects (part of the Waste Elimination lean principle). Similarly in this case, rework or supplemental training once on the job, should be minimized by modifying pre-service training to include skills that are task shifted.

4. Case Study: Task Shifting in Maternal and Newborn Health Care (Deller et al., 2015)

Context:

Deller et al. (2015) identify difficult working conditions, poor distribution of healthcare workers, emigration, and HIV / AIDS as contributing to the inability of the healthcare system to meet demand, especially in Southeast Asia and Sub-Saharan Africa. Task shifting is one solution that could aid in meeting the demand on the healthcare
system, by either developing new professions or expanding the current scope of health professions.

**Objective:**

This study presents a number of experiences Jhpiego (a group associated with John Hopkins University) has had in using task shifting to improve maternal and newborn health (MNH) around the world. Task shifting should be part of a larger solution that seeks to meet the needs of mothers and newborns.

**Case Summary:**

Deller et al. (2015) list the five critical components for successful task shifting to be (1) policy and regulatory support, (2) clear definition of roles, (3) determination of required skills, (4) education and training, and (5) healthcare delivery support. Deller et al. (2015) identify a variety of lessons learned from Jhpiego’s experience with task shifting and identify several specific case studies that exemplify the effectiveness of task shifting and recommend best practices.

**Results:**

From the studies that were discussed, the following recommendations were made.

Typically, professions are clearly defined at a national level. Therefore, in order to make any significant changes regarding task shifting, regulatory bodies and policy makers must be engaged and involved with change development.

Task analysis should be carried out, to determine where bottlenecks occur in the process and understand current roles. Deller et al. (2015) recommend observing each profession’s responsibilities to ensure task shifting does not overburden a profession. During this analysis limitations and a referral structure should be developed to allow complicated cases to be passed to more highly trained professionals. Clear roles also harmonize the healthcare system and prevent it from becoming too fragmented (Deller et al., 2015).

As tasks are shifted, the expectations for professionals must also change to ensure that professionals can successfully complete the tasks that are shifted to them. Deller et al. (2015) identify the importance of shifting training practices to align with the shifted tasks. Deller et al. (2015) specifically describe in service training as a feasible starting point, but identify the importance of moving to pre-service training over time if possible.
It is important to involve professional associations and training institutions in the development of new curriculum. Clear coordination and consistent guidelines are critical as new tasks are shifted.

Another practice Deller et al. (2015) identify is having supportive supervision for workers. This supervision will help keep workers from getting frustrated, which is tied to improved staff retention.

**Application to Lean:**

Several of the best practices listed by Deller et al. (2015) closely correspond with the lean principle Specify Value. Deller et al. (2015) acknowledge that many of the health professions are defined at the national level and have stiff regulations surrounding them. Therefore any policy change with regards to implementing task shifting must engage both the healthcare policy makers and the responsible regulatory boards. This closely follows the lean principle Specify Value, specifically the practices of defining value from the customer perspective and engaging stakeholders. In lean manufacturing, it is critical to involve stakeholders such as suppliers and customers in the development of new products. In the same way, if any policy change is to be enacted those responsible for maintaining policy must be involved.

Deller et al. (2015) emphasize examining the entire healthcare system and clearly identifying the roles and bottlenecks within the system. This system level view follows the lean principle Specify Value, specifically the practice of one person being responsible for the entire value stream.

The task analysis that Deller et al. (2015) recommend, aims to keep the workload for various professions balanced. This is very reminiscent of line balancing, which is a common practice used in lean manufacturing to achieve the lean principle Flow. By balancing the line, bottlenecks are eliminated and the chance of workers burning out is reduced. Task analysis, including determining the roles professionals currently take on, closely mirrors the practice of “Going to Gemba” which is a practice related to the lean principle Specify Value.

Providing workers with supportive supervision is an excellent example of following the Respect of Humanity lean principle. This practice reduces attrition, as well as improving the training and assessment of employees.
Deller et al. (2015) identify the importance of altering the training system in order to accommodate the new skills professionals are expected to have. Training and education are identified as one of the five key components to successfully implement task shifting, demonstrating the importance of training and education in the implementation of task shifting. Deller et al. (2015) identify in-service training as a starting point and a valid method to train professionals who are already practicing. However, Deller et al. (2015) perceive sustained change in task shifting as necessitating revision of the pre-service training system. Identifying the importance of the education system on the delivery of care shows a good awareness of the entire healthcare training value stream. Working with healthcare training institutions to revise curriculum to address the skills professionals need is a good example of the lean principle Pull, because the curriculum is being directly affected by customer demand.

As with previous case studies examining task shifting, Deller et al. (2015) identify the importance of developing standard practices for the implementation and training of task shifting. This recommendation closely follows the lean practice of standard work, which in this case results in the lean principles Waste Elimination and Specify Value. In many instances of task shifting, concerns are raised about the safety and quality of a less qualified healthcare provider delivering care. In lean terms, this concern for safety is really a concern for the elimination of errors or defects, a central practice of the Waste Elimination principle. This criticism was specifically identified and faced in one of the case studies Deller et al (2015) refer to. Due to this concern, Jhpiego assisted the Federation of Obstetric and Gynecological Societies of India (FOGSI) in developing a Standards-Based Management and Recognition program to monitor quality and improvement. One change that this program brought about was forcing training sites to become certified. This is a good example of how standard work was used to meet customer requirements and how standard work can be used to reduce waste associated with errors.
5. Case Study: Rebuilding Human Resources for Health in Liberia (Varpilah et al., 2011)

Context:

A significant portion of the healthcare workforce has been driven out of Liberia in the last 40 years. Health professionals initially began to leave the country in the 1970’s to seek greater opportunity due to an economic downturn. In 1980, a coup and subsequent instability led to more professionals leaving the country. In 1989 civil war further fragmented the healthcare workforce. Besides driving away trained healthcare professionals, fighting hampered the training system due to the constant stopping and starting of training as fighting stopped and then resumed. The training system was additionally hampered by limited resources and few qualified instructors. By the end of the war, the upper level health workers were especially depleted, leaving only 20 physicians, 668 nurses, 297 midwives, and 1091 nurse aids. After the Sirleaf administration began, the MOHSW started work on three reforms: (1) build a leadership team separate from politics (2) increase partnership between and within sectors (3) develop and enact an evidenced based National Health Policy and Plan.

Objective:

This study is a description of the implementation of an emergency human resources plan to increase the number of qualified health workers in Liberia.

Case Summary:

After establishing a leadership team to address the first reform, the MOHSW immediately began to coordinate with stakeholders in the healthcare system to form two committees to address the second reform. Additionally, MOHSW established a Human Resources (HR) Unit, which was responsible for collecting HR data, developing and overseeing HR plans and policies, and coordinating all HR activities. In addition to this central Unit, HR officers for each county were hired to manage human resource issues at the county level. These workers also fed data back to the central unit.

Next the MOHSW conducted a gap analysis through a quick assessment of current health workers and community surveys to determine priorities and recommendations. The assessment revealed the healthcare system to be extremely weak, both in the quantity of qualified professionals and training institutions’ ability to function...
effectively. Community surveys revealed the community to be suffering from many curable diseases due to the inability of the healthcare system to meet their needs. Recruitment and training of nurses and midwives were prioritized to address some of the issues community members were experiencing.

Several alternatives were considered to address this gap. The MOHSW considered the creation of a new profession, which could be trained quicker than nurses called healthcare assistants, similar to an approach used in Ethiopia. In Liberia, this approach was modified to increase the use and responsibilities of community health volunteers, who were assigned a larger role in preventive care. Using best practices from Kenya and Malawi, the MOHSW used donor funds to fill priority positions and offer scholarships, stipends, and housing.

Four objectives were identified for the human resources plan to address. (1) Develop a coordinated approach to human resources planning. (2) Increase the number of workers and evenly distribute health workers around the country. (3) Enhance worker performance and retention. (4) Reach gender equity in the whole healthcare system, especially in management positions. These objectives were reached using various practices, which are described in the subsequent section.

Results:

It is important to note that the human resources plan described in this study was developed to address an emergency situation. Some of the practices used in Liberia are considered “stopgap measures” in that, they will be replaced with more permanent solutions as the economy of the country improves. One example is the use of donor funds to supply stipends to healthcare workers and authorities, which will eventually be replaced with government paid salaries.

Specific practices were used to address each of these objectives. The number of workers in healthcare (Objective 2) was addressed by raising and standardizing wages for providers, using donor money to increase the number of positions and support the healthcare system, offering free education, and developing specific policies to encourage students to work in hard to reach areas. Three interventions were found to increase the retention and recruitment of students to serve in rural areas (1) recruit students from rural
areas, (2) give cash bonuses for working in rural areas, and (3) provide nurses with transportation.

In 2009, staffing information was used to send nursing school graduates to specific clinics that did not have an Officer in Charge and the extra graduates were sent to specific clinics with shortages. At this time, another assessment of the current healthcare workforce was taken to improve the accuracy of the data collected during the quick 2006 assessment. This assessment revealed a significant increase in RNs, but a much lower production of CMs and PAs, which the authors attribute to lack of coordination among training institutions and imbalanced incentives.

Also in 2009, the HR Unit collaborated with the Clinton Health Access Initiative (CHAI) to complete a workforce optimization study and identify gaps in workforce needs. This study identified poor performance in the distribution of workers, and several professions as being understaffed. The findings from this study were used to complete evidence-based task shifting. Opportunities for implementing task shifting will be taken once appropriate incentives can be determined and areas of surplus and shortage are identified, in order to properly redistribute workers.

Using a discrete choice experiment, the MOHSW quantitatively measured the value system workers used to choose their job in order to determine cost-effective policy alternatives. Through this experiment, three policies were identified for increasing rural retention. (1) Recruit students from rural areas, because experience in rural areas increases the willingness for professionals to work in a rural setting. (2) Give nurses working in rural areas a $50 bonus, which was found to be the most cost effective policy. (3) Provide nurses with transportation. Other incentives considered were the availability of housing, conditions of equipment at the clinic, and workload.

Task shifting has been used in Liberia since 1958, when Physician Assistants were used to address the shortage of physicians. As the shortage for healthcare workers increased, informal task shifting was used to increase the productivity of the healthcare system. The MOHSW began to formalize task shifting in order to ensure a high quality of care, specifically shifting tasks to nurses, midwives, and nurse aids. To complete formalized task shifting, the MOHSW plans to use both pre-service and in-service training. Current healthcare workers can be quickly trained through supplemental courses
offered by the MOHSW or by certified hospitals. The MOHSW is collaborating with training institutions to broaden curriculum for future students, to include shifted tasks.

The authors mention that the MOHSW plans to combine the HR Division and Personnel Department, in 2011. This merger will result in improved coordination and streamline some processes. MOHSW is also working to develop a method to determine the quality of the services provided by healthcare workers, instead of just measuring whether or not a service was provided. The new HR plan will set specific goals and standards to measure performance against to monitor the quality of care delivery.

Many of the traditional international improvement methods such as continuing education, supervision, and incentives would not work in the context of Liberia. This led the MOHSW to develop specific strategies to address Liberian needs. The primary recommendations made in this report are focused on the distribution of the workforce, task shifting, the improvement of the healthcare training program, and the recruitment and retention of healthcare professionals.

Application of Lean Principles:

In the rebuilding of the healthcare system, the Liberian MOHSW has developed several policies and processes that specifically align with lean principles.

The process the MOHSW went through to understand the community need and student values exemplified aspects of the lean principle Specify Value. Specifically the use of an experiment to quantitatively measure the student’s definition of value, allowed the MOHSW to develop a cost effective policy that met their goals. Similarly, by understanding community needs, the MOHSW was able to focus the emergency human resources plan on training nurses and midwives to address the most pressing issues facing community members. Using a community survey was an effective method of determining specifically what components of the healthcare system the community valued.

Specify Value was also addressed through the employment of county level human resources officers. One of the practices in Specify Value is to “Go to Gemba”, meaning the practitioner should go to the system and see what is really going on. Completing this practice is difficult when dealing with a large system, due to the somewhat contrary practice of having one individual who is responsible for the entire value stream. The employment of county level HR officers allows the central HR unit to collect data and
observations from a local level, while still understanding the entire system and how the different counties compare and fit together.

The progression of the HR Unit exemplifies the lean principle Continuous Improvement. In 2006, when the HR Unit was initially formed, they completed a rapid assessment of the healthcare system to quickly get a rough understanding of the current situation. Later, in 2009, the MOHSW collaborated with Clinton Health Access Initiative (CHAI) to complete a workforce optimization study to reassess healthcare need. The study found that the need for some professions such as PAs and RNs was underestimated in the initial assessment. The study also emphasized the importance of distributing professionals in rural areas. The MOHSW created a feedback loop by completing a reassessment of the healthcare system, which revealed these improvements.

The MOHSW has also practiced Continuous Improvement in a variety of other manners. In 2011, the MOHSW reportedly planned to combine two departments and develop a method for assessing the quality of care being delivered. Both of these improvements represent better addressing the Specify Value lean principle. By combining the two departments, overhead can be reduced while simultaneously putting one organization in charge of the entire value stream instead of dividing responsibility between the two organizations. This plan follows the Specify Value practice of having one individual responsible for the entire value stream. Assessing the quality of the care delivered aligns the output of the training pipeline with the customer’s definition of value, allowing the process to more closely follow Specify Value. Additionally, several of the solutions the MOHSW employed, such as using donor money to subsidize healthcare professionals, were identified as “stop-gap” measures. This implies that the MOHSW will seek to improve workforce planning to eliminate these “stop-gap” measures and enact more sustainable solutions. The variety of initiatives the MOHSW has underway are strong examples of the Continuous Improvement principle.

As discussed in relation to the case study examining task shifting in Uganda, the MOHSW practice of collaborating with training institutions to modify curriculum in response to task shifting is a good example of the Waste Elimination lean principle. By training healthcare workers in the tasks that will be shifted to them, rework is reduced
following the concept of Zero Defects. Developing a training system that is responsive to changes in care delivery is also a good practice, which follows the Pull lean principle.

The MOHSW followed the lean practice Standard Work by creating the HR Policy & Plan, which will be used to benchmark facility performance and communicate expectations. This policy is expected to improve performance and gives facilities a baseline, from which Continuous Improvement can occur.

6. Case Study: Creation of Residency Training Pathway at University of Pennsylvania Health System (Patel et al., 2015)

Context:

The Healthcare Leadership in Quality track was developed in 2010 for residents at the University of Pennsylvania Health System (UPHS). This track is a two year program meant to align with the goals of the UPHS and increase the engagement of residents with the quality and safety mission of the UPHS. As of 2015, when the study was completed, the program had graduated 30 residents.

Objective:

The author’s seek to describe the UPHS Healthcare Leadership in Quality track and evaluate its effectiveness.

Case Summary:

The training program is broken into four major components: core curriculum, integration of the student into a QI team, completion of a capstone QI project, and a mentorship opportunity. The core curriculum for the track consists of about 120 hours of instruction, delivered in a multimodal fashion. The training program includes “local knowledge” which familiarizes students with the specific tools used at UPHS. The track also embraces experiential learning through the integration of students into the QI team and interaction with patients and staff. The project undertaken by residents extends over the two years the resident is in the program. The long term nature of the project allows the student to see the project completely through and make a significant improvement to patient care.

The Kirkpatrick framework as interpreted by Yardley and Dornan was used to evaluate the effectiveness of this program. The Kirkpatrick framework breaks the
program down into four tiers ranging from participation in the program, to behavioral change, to realized benefits for patients. Each of these tiers corresponded to a metric to ascertain the effectiveness of the program. Some of the metrics and assessment tools are still being developed.

**Results:**

According to the metrics established under the Kirk Patrick framework, Patel et al. (2015) found that the HLQ track met each of the tiers. This indicates the success of the program. Despite the success of the program, several barriers were identified, most notably the lack of faculty with appropriate training to teach classes and lead the program. In order to address this barrier Patel et al. (2015) plan to make better use of non-physician quality improvement (QI) experts and provide QI training opportunities for faculty.

**Lean Principles Application:**

This case study provides an excellent example of the integration between the healthcare delivery sector and training institutions, which produces students who can address issues relevant to the delivery of care. In this specific case study, a university health system was analyzed, which could be expected to already have strong ties between the training institution and delivery of care. However, these strong ties should be sought between other training institutions and employers as well. The integration of employers and training institutions is critical under the lean principle Specify Value, which emphasizes examining the entire value stream. As previously discussed, the healthcare training pipeline and the delivery of healthcare are in the same value stream, and should therefore be examined in relation to one another.

This case study provides an excellent example of how value as defined by patients, employers, training institutions, and students can be achieved through the completion of the capstone project. Value as defined by employers and patients is addressed through the improvement of care. For example, capstone projects addressed a variety of problems including outpatient medication adherence, determining factors that increase readmission, and improving safety. Value as defined by training institutions is addressed through the presentation of research and the publishing of journal articles, which is an outcome of the capstone project. Finally, value as defined by students is
addressed through the real world application practice they receive by completing the capstone project. The capstone project is a good example of how the Specify Value principle can be followed by simultaneously addressing the needs of several stakeholders.


Context:

The WHO lists Kenya as experiencing a healthcare workforce crisis (Mumbo & Kinaro, 2015). This crisis is compounded by mass poverty, political instability, and uneven economics (Mumbo & Kinaro, 2015). Additionally, training institutions are underfunded and are not being operated efficiently resulting in a lack of qualified professionals (Mumbo & Kinaro, 2015). From stakeholder meetings initiated by Makherere University in Uganda, responsive, competency based curricula was identified as the most critical recommendation. However, minimal research has investigated the implementation of competency based curricula in low resource environments such as Kenya. Currently the curriculum in many sub-Saharan schools has remained stagnant and does not necessarily correspond to need. The poor curriculum is identified as a factor resulting in a low quality of healthcare delivery. Mumbo and Kinaro (2015) assert that compared to issues such as getting a sufficient number of students trained, the curriculum is viewed as less important and hasn’t been focused on. In 2009, an assessment of the training system in Kenya revealed that quality of graduates was significantly tied to the quality of the curriculum. The study also revealed that many students were unsure that their education would prepare them to successfully deliver care. Mumbo and Kinaro (2015) nicely summarize the need for quality curriculum stating, “Quality of graduates is determined by responsive curricula that addresses emerging issues in the health sector,” (p. 3).

Objective:

This project seeks to improve the access to and quality of healthcare workforce training in four main ways: (1) Support new health workers, (2) support current worker’s training needs, (3) improve the capacity of training institutions and (4) strengthen
regulatory agencies to improve standardization. This paper specifically examined how curriculum was bottlenecking the training pipeline.

**Case Summary:**

Data was collected by conducting a cross-sectional descriptive survey of 533 respondents from 14 different institutions. The survey sought to address, “availability of curriculum guidelines, curriculum responsiveness to institutional mission and regularity of curriculum review as well as involvement of stakeholders in the review process,” (Mumbo & Kinaro, 2015, p. 4). The surveys were given to institution heads (3% of respondents), faculty (15%), students (75%), clinical managers (3%), and community / government leaders (4%). After the survey data was aggregated and analyzed, it was presented to stakeholders from each training institution to allow questions or disputes to be brought up. During this meeting, the stakeholders prioritized the bottlenecks and gaps and developed a plan to address these gaps.

**Results:**

The study completed by Mumbo and Kinaro (2015) revealed large gaps between what the curriculum was providing students and what students and other stakeholders believed was required to adequately prepare students. For example, respondents did not believe that students were prepared to be placed in hospitals for their clinical placement.

There was a perception that curricula responded to national needs, even though stakeholders were not involved in curriculum development. The survey found only about 1/3 of faculty and institution heads believed they used stakeholder involvement to develop curricula. The training curriculum was found to be unresponsive to emerging needs. For example, the Ministry of Health considers diabetes and cancer national needs, but the current training curriculum does not address these issues. One faculty from a training institution commented that short courses respond to emerging issues, but the regular pre-service training does not address these emerging issues.

Some of the recommendations made by respondents are shown in Figure 5 (Mumbo & Kinaro, 2015).
Overall, the survey suggested large dissatisfaction with the quality of education and identified the importance of involving government and stakeholders in curriculum review.

**Application to Lean:**

This case study highlights a number of gaps in the Kenyan healthcare training system that correspond directly with problems the lean principles seek to address. The primary value in reviewing this study lies in the gaps that are identified and the proposed solutions. The literature review completed by the authors emphasizes several other studies which exemplify Specify Value and Pull through recommendations for the involvement of stakeholders and the development of competency based curriculum.

A few of the main studies that Mumbo and Kinaro (2015) refer to in their literature review is the work completed by Makerere University and John Hopkins University in Uganda between 2008 and 2010, the needs assessment conducted by IntraHealth International Inc. in 2009 in Kenya, and the World Bank Working Paper No. 414 which examines the training system in Zambia. All three of these case studies recommend practices that directly relate to the lean principles.

The Makerere University and John Hopkins study held stakeholder meetings which is a good example of the Specify Value principle. Furthermore, the stakeholder’s primary recommendation was the adoption of competency based medical education, which if implemented appropriately can follow the Waste Elimination and Pull lean...
principles. The IntraHealth study found health worker’s abilities to not conform to standards, showing the importance of having Standard Work and aligning curriculum to successfully meet Standard Work. The IntraHealth study also stresses the importance of making sure the standards developed address national needs and priorities, thus following the lean principle Specify Value. The World Bank Working Paper No. 414 recommended conducting a thorough investigation to determine bottlenecks to increasing training capacity. The focus on eliminating bottlenecks and increasing capacity ties this recommendation to the lean principle Flow. Additionally, the World Bank Paper is concerned with producing graduates with adequate competency levels, which suggests a consideration of community need under the lean principle Specify Value.

The purpose of the study by Mumbo and Kinaro (2015) strongly relates to lean principles. Mumbo and Kinaro (2015) describe the survey as, “The study assessed aspects of curriculum revision, responsiveness of the curriculum to national health priorities, updating of curricula and involvement of stakeholders in curricula revisions,” (p. 7). These aims correspond to the lean principles Continuous Improvement, Pull, Continuous Improvement, and Specify Value respectively. Another goal of the survey was to determine if students were adequately prepared for delivering care. This goal relates to the lean principles Waste Elimination and Specify Value.

Mumbo and Kinaro (2015) identify a number of gaps in the current healthcare workforce planning system that relate to the lean principles. One of the gaps identified by Mumbo and Kinaro (2015) is that the curriculum does not respond to national needs because stakeholders are not involved in curriculum development. This gap could be closed by following the Specify Value principle, which requires identifying customer need and structuring the training program accordingly. Mumbo and Kinaro (2015) identify the problem of emerging diseases not being addressed in the training curriculum. If the Pull principle is followed, this gap should be closed since the training curriculum would be determined by customer demand.

Several of the practices Mumbo and Kinaro (2015) used provide decent examples of the Specify Value lean principle. The Specify Value principle was followed due to the inclusion of “other stakeholders” and “clinical site managers” in the survey process. Although the majority of respondents were students and faculty, it is critical to receive
the feedback of stakeholders such as government officials, and “clinical site managers” to ensure the training process is providing value to the customer. According to the Specify Value principle, the effectiveness of the training program must be determined by the customer, who is in this case government officials responsible for the health of the population and clinical site managers responsible for delivering care.

The stakeholders involved with the review of the current training system identified the need for greater stakeholder involvement in the development of curriculum and the standardization of curricula. As has been discussed the first of these recommendations specifically addresses the lean principle Specify Value. As has been discussed in reference to other case studies, the standardization of curricula follows the lean practice Standard Work, which results in more closely following the lean principles Waste Elimination and Flow.

This paper details the work specifically related to curriculum development, which is part of a larger project by IntraHealth to address gaps in the healthcare training system. The project has a variety of thematic areas including curricula, faculty, clinical practice and more. As part of the project, bottlenecks were identified with the involvement of managers of training institutions. This approach to identifying and then solving the bottlenecks of a process is a good example of the Flow lean principle.

While the healthcare training system in Kenya is currently not very lean, the recommendations provided in this study emphasize practices that would lead to closer alignment with the Specify Value, Pull, and Waste Elimination lean principles.

8. Case Study: Competency-based Medical Education in Sub-Saharan Africa (Malwadde et al., 2014)

Context:

Sub-Saharan Africa has a disproportionally large portion of the world’s disease burden while simultaneously having a disproportionally small portion of the world’s healthcare personnel, especially physicians. This has led to a need to strengthen the human resources for health in the region. Both an increase in the number of health professionals and the modification of professionals’ skills are identified as necessary changes. Competency-based medical education (CBME) has been identified as a
response to the calls for educational reform. CBME has been adopted in international training institutions, and has begun to be implemented in Sub-Saharan Africa.

**Objective:**

Gruppen et al. (2012) recommend the implementation of CBME to be contextual and not just transferred from developed nations. In accordance with this recommendation, this paper describes the process two Sub-Saharan universities followed to successfully implement CBME. This will provide beneficial recommendations for other low resource training systems.

**Case Summary:**

To begin implementation of CBME, Makerere University in Uganda partnered with John Hopkins University to carry out stakeholder meetings between 2008 and 2010. A variety of stakeholders including students, faculty, employers, community leaders, and government officials were included in the meetings. Through a needs assessment conducted by Makerere University and several stakeholder meetings, a set of competencies graduates must demonstrate was developed. After the competencies were determined, the curriculum was reformed accordingly. Course descriptions, objectives, outcomes, assessment methods, and level of competency were all determined by a multi-disciplinary team of experts. In addition to revising the curriculum, teaching and assessment methods were revised to correspond with the new competencies.

The College of Medicine at the University of Ibadan (CMUI) in Nigeria successfully implemented CBME through a series of phases. In phase one, CMUI built up the training capacity and increased awareness among stakeholders of the need to review the curriculum. Then in phase two, the current curriculum was reviewed by questioning stakeholders, faculty, and students. Subsequently, in phase three a revised curriculum was developed. During the fourth phase, the new curriculum was implemented.

Both universities used a similar process to implement CBME and later assess the change.
Results:

Both of the case studies examined were successful in implementing CBME, however the authors recommend each university to continue monitoring the curriculum for effectiveness.

Lean Application:

The implementation of CBME allows a training institution to more closely follow Specify Value, Pull, and waste Elimination. Makerere University was especially effective at creating a leaner training process through the implementation of CBME.

Makerere University and John Hopkins University effectively used stakeholder meetings which are a good example of the lean principle Specify Value. By gathering all of the stakeholders together, healthcare workforce planners can ensure that the variety of definitions of value is addressed. Next, the lean principle Pull was followed by restructuring the curriculum and courses to respond to the needs expressed by the stakeholders. The adoption of CBME encourages this feedback loop and fully engages the customer in determining how students should be trained. The involvement of the customer in determining curriculum content also prevents Process waste, which could result from training students to do a task employers do not find valuable. CBME can therefore also be seen to relate to Waste Elimination.

The College of Medicine at the University of Ibadan (CMUI) in Nigeria also successfully implemented CBME although in a less lean approach. Similar to Makerere University, CMUI involved stakeholders with the development of the new curriculum, but those involved with the survey were primarily students and faculty with a smaller emphasis on employers’ and the community’s need. This reflects following the lean principles Specify Value and Pull to a lesser degree, since the demand was not generated by the customer.

Recommendations from Eseonu and Doolen (Eseonu & Doolen, 2013)

Eseonu and Doolen (2013) made a number of recommendations to the LBL WIB, regarding the improvement of the relationship between employers and training institutions. Eseonu and Doolen (2013) specifically recommended the formation of information sharing networks, the use of program partnerships between universities and community colleges, the addition of healthcare components to other degree programs,
and the use of shared employees between healthcare delivery and training institutions. All of these recommendations create closer ties between employers and trainers. In the following section, each of the recommendations will be explained further through the lens of the lean principles.

Eseonu and Doolen (2013) call for the creation of information sharing networks between training institutions and employers. These information sharing networks (ISNs) (following a similar structure as industrial advisory boards) are proposed to increase the relevance of the training curriculum to industry needs, which specifically follows the lean principles of Specify Value and Waste Elimination and allows the customer to create Pull during training curriculum development. As discussed previously, by determining what employers value, training institutions can reduce the waste associated with Processes. By keeping the dialog open between employers and training institutions, the lean principle Continuous Improvement is also followed by collecting feedback on students’ preparation. These feedback loops will allow training institutions to modify programs to more closely meet the needs of employers. ISNs will also raise employer’s awareness of available training programs. This example of knowledge sharing reduces waste due to Delay by reducing the amount of time employers have to spend looking for training programs and the length of time an employee remains untrained.

Eseonu and Doolen (2013) call for the development of system wide partnerships to unclog the training pipeline. Eseonu and Doolen (2013) specifically identify partnerships between community colleges and universities and between industry and training institutions. Partnerships between universities and community colleges are already in place, for example Oregon State has Degree Partnership Programs (DPPs) with a number of community colleges that allow students to be enrolled at both institutions. Citing Carlone and Johnson (2007), Eseonu and Doolen (2013) argue that this multistage process, will allow students to be affirmed by the accomplishment of the initial Associates degree and therefore increase the retention rate in their field of practice. This process also reduces the amount of waste that comes from students not completing their education and dropping out (Defects), since there is a defined exit point before university enrollment. DPPs minimize the waste associated with Processes, by allowing students to take fundamental courses at local community colleges where tuition is lower before
moving on to universities to complete higher level training. Shorter training segments might increase the flexibility of the training pipeline and reduce the time forecasts have to be made over. Additionally, the segmented training program could facilitate interspersed internships or continuing education after entry into the workforce. This should improve Flow in the training pipeline. As more separate institutions and processes are added to the training pipeline, the Specify Value principle increases in importance, since all of the processes must be considered simultaneously to ensure waste reduction and lean processing, instead of just examining an individual training institution.

While partnerships between training institutions have already been enacted in the form of DPPs and other programs, partnerships between industry and training institutions are still lacking. These partnerships will benefit training institutions by increasing the number of clinical placements available and enlarging the pool of instructors. Eseonu and Doolen (2013) recommend sharing employees between industry and training institutions to address the challenge of finding sufficient qualified faculty. This recommendation would result in Waste Elimination by reducing the non-value add time between classes (might be scheduled only once a year) a trainer has to wait through. This improvement also addresses Respect of Humanity by giving professional providers an opportunity to significantly contribute to the education of students by teaching from time to time. By increasing the pool of available faculty, training institutions could only pay for the faculty they need at a given time to respond to demand, instead of having to predict the future demand and hire enough faculty to handle it. This would more closely follow the Pull principle. By improving partnerships between local employers and training institutions, the probability of graduates staying in the local area may be increased even as the demand for professionals increases. This could be especially important in areas such as Lincoln county, where wages are lower than the state average (Eseonu & Doolen, 2013). By collaborating with geographically large organizations such as the LBL-WIB, Eseonu and Doolen (2013) suggest students waiting for clinical placement or trained students could be pooled across the region to fulfill demand if it exceeds local supply.
Analysis

The survey conducted of LBL employers and training institutions by Eseonu and Doolen (2013) revealed two main challenges. (1) Training institutions were limited in the number of students they could accept due to the difficulty of finding qualified faculty and clinical placements for students. (2) There is a gap in the relationship between employers and training institutions, which was manifested by employers being unaware of local training opportunities and a shortage of clinical placements for students.

This section focuses on identifying practices from the case studies that address these challenges. A full summary of practice recommendations from the case studies is included in Table 2 in the previous section.

Limited Enrollment Due to Faculty and Clinical Placement Limitations

Eseonu and Doolen (2013) identified a central problem in the healthcare training pipeline as training institution’s limited capacity due to lack of qualified faculty and clinical placements. Eseonu and Doolen (2013) chiefly recommend improving the relationship between training institutions and healthcare providers, essentially linking the two together. This concept was put into action by the UPHS through the creation of a residency training system (Case Study 6) (Patel et al., 2015), however no other case study directly addresses this problem. The larger IntraHealth program, which the study by Mumbo and Kinaro (2015) is a part of, identifies faculty issues including retention as a thematic area for investigation; however Mumbo and Kinaro (2015) focus on curriculum development (Case Study 7). Humphrey (2014) also identifies limited faculty as a severe limitation for the training system in Tanzania in an IntraHealth blog post, however he does not develop any best practices or paths forward to address this limitation (Humphrey, 2014).

Only a few of the examined case studies identified quality faculty as a limitation and none of the examined case studies identified clinical placements as bottlenecks, even though Eseonu and Doolen (2013) highlighted these constraints as particularly problematic. The reason for this lack of identification should be further researched and healthcare policy makers should carefully examine the training system to make sure they are not overlooking these bottlenecks.
Although faculty retention was not specifically addressed in the case studies, some of the described practices could be employed to improve retention. The MOHSW effectively completed a quantitative experiment to determine graduating student’s definition of value (Case Study 5) (Varpilah et al., 2011). This understanding allowed the MOHSW to develop an effective reward system to encourage an even geographical distribution of healthcare professionals. A similar technique could be used to determine how faculty and other professionals define value, in order to encourage professionals to pursue teaching with the most cost effective policies.

**Lack of Feedback Loops between Employers and Trainers**

In lean thinking it is important to observe the entire value stream for a process and not limit analysis to one part of the value stream. In the context of healthcare training this is reflected by considering the entire training pipeline from the beginning of training to employment. Similar to the analysis of the entire value stream, feedback loops should be established between elements of the value stream to ensure that overall value is being achieved with minimal waste. This concept was found repeatedly when examining case studies from other regions, and should also be applied to the LBL region.

A number of case studies highlighted the feedback loop between employers and trainers, especially with regards to the development of training curriculum. Several case studies identify successful practices that involved employers, community members, and other stakeholders when developing curriculum. At the UNC, a roundtable with stakeholders was utilized to aid in the development of a new curriculum (Case Study 1) (Thompson et al., 2009). In Liberia, the MOHSW conducted a survey to identify the pressing community needs which resulted in an emergency human resources plan focused on training nurses and midwives (Case Study 5) (Varpilah et al., 2011). In Spain, the NCMS and NSCs provide advice to the Ministries of Health and Education (Case Study 2) (Freire et al., 2015). Additionally, the NSCs aided in the development and improvement of the official training programs for each specialty (Freire et al., 2015). In Kenya, community members, trainers, and other stakeholders were surveyed to determine how effectively the training program met stakeholder needs (Case Study 7) (Mumbo & Kinaro, 2015).
The feedback loops discussed in the examined case studies primarily focus on the development of training curriculum. The use of feedback loops should extend beyond this practice and also include defining the number of students to train and the number of faculty to employ. The Spanish residency system is the only example from the case studies of using feedback to define the number of students to train (Case Study 2). In Spain, the number of training spots for each specialty is determined based on forecasts made by the national governing body and local authorities (Freire et al., 2015). Although this practice comes the closest to using feedback loops to Pull students through the healthcare system, it is not a true example of Pull, since it does not directly rely on customer demand. Rather, it relies on local authorities’ perception of customer demand.

The examined case studies further support the importance of improving feedback loops between healthcare providers and trainers. Especially with regards to transitioning to task shifting or competency based medical education, several of the case studies highlight the importance of working with training institutions, providers, and government bodies to implement change or improvements. Quick and efficient new product development is a key benefit of lean. Toyota was able to quickly roll out a huge variety of new products due to lean practices such as closely working with suppliers and manufacturing personnel and establishing feedback loops between them. If new policies and practices such as task shifting or competency based medical education are to be quickly and successfully implemented in the healthcare training pipeline, feedback loops must be created.

The development of feedback loops in the training pipeline was identified as an important improvement by Eseonu and Doolen (2013). Many of the case studies examined address the use of feedback loops to a degree, which addresses the lean principles Specify Value, Pull, and Waste Elimination. However, in many of these case studies feedback loops could be extended to further improve the training pipeline.

**How Were the Lean Principles Addressed in the Case Studies**

A full list of the lean practices demonstrated in each case study is shown in Table 3. It is important to note that this is not a comprehensive list of lean practices; lean practices that were not implemented in the case studies are discussed in the subsequent section.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kanban systems</td>
<td>Customer use triggers production</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiate products at the last possible stage</td>
<td>Maintain a standard process for products as long as possible</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit of Pull: Responsive to variable demand</td>
<td>Can easily respond to changes in customer demand</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer defines value</td>
<td>The customer decides what is considered valuable</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer defines value</td>
<td>Realize there are many stakeholders and seek to meet all definitions of value</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The entire value stream is analyzed / Value stream mapping</td>
<td>Think about the whole system, not a subsection</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Go to Gemba</td>
<td>Observe the process first hand</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One person is in charge of the entire value stream</td>
<td>The process is not divided into separate groups without some unifying charge</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processes</td>
<td>Do not complete processes that are unneeded as defined by the customer. Utilize resource to highest capability</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventory</td>
<td>Minimize the stuff in system waiting for customer demand</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defective Product</td>
<td>Product errors that result in scrap, rework, or dissatisfaction</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defective Design</td>
<td>Product does not meet or exceeds customer needs</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delays</td>
<td>People or machines waiting for materials, maintenance, or processing time</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overproduction</td>
<td>Producing more than needed or producing before a product is needed</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero Defects</td>
<td>The final product is ready for the customer every time</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard work</td>
<td>Complete the same work for each repetitive process</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root cause analysis</td>
<td>Find the fundamental cause of waste or mistakes</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poka yoke</td>
<td>Make mistakes impossible to make</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>---------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------</td>
<td>-----------------------------</td>
<td>---------------------------------------------</td>
<td>---------------------------------</td>
<td>----------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Respect of Humanity</td>
<td>Utilize the full capabilities of workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Challenge workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engage workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Get feedback from workers and care about how they</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>feel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Create a physically and emotionally comfortable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Make workers feel comfortable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Job rotation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Give workers a variety of job possibilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Involve workers in improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Involve those who complete the processes with</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>changes and improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reward for improvement ideas, do not punish for</td>
<td>Make sure the reward system encourages the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>improvements by loss of job</td>
<td>flow of information and ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collect feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collect feedback from process participants and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>stakeholders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard Work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use milestones and benchmarks to assess improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OR create standard processes from which improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>can be made</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continually examine and improve processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After an improvement is made, continue to look for</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>other waste in the process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>One piece flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduce batch size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determine bottlenecks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Find the process that is limiting flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard Work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Keep things consistent and predictable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Line balancing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Each part of the system has the same amount of work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Workload leveling (heijunka)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Keep the production level constant from day to day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>JIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Produce only when the end product is required</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lean Principles Currently Being Followed

As shown in Table 3, the lean principles Pull, Specify Value, and Waste Elimination were frequently addressed in the examined case studies. Some of the most common practices discussed in the case studies are described in greater detail.

The Specify Value principle was followed through practices such as achieving value as defined by stakeholders, quantitatively determining stakeholder values, making sure students meet customer expectations, and developing feedback loops (discussed previously). In several cases, by strengthening the relationship between providers and trainers, students added value for employers while still completing their studies. This is a good example of addressing both the care provider’s and the student’s definition of value, since the student actually provides care in a learning environment. Through the creation of the Healthcare Leadership in Quality track at the UPHS, students were required to complete a capstone project for the unit they worked in (Case Study 6) (Patel et al., 2015). These projects produced tangible benefits for the participating delivery units (Patel et al., 2015). In Spain, residents are significantly involved in the delivery of care under the supervision of qualified professionals, and have the same status as professionals (Case Study 2) (Freire et al., 2015). In both of these examples, students add value to employers and learn at the same time, thus achieving the goals of the lean principle Specify Value for multiple stakeholders.

The MOHSW provided an excellent example of how the values of stakeholders (in this case students) can be quantitatively determined and then utilized to create policy (Case Study 5) (Varpilah et al., 2011). In this specific case, the MOHSW conducted a small experiment to determine what students valued and how they could be convinced to take a rural healthcare position. This information allowed the MOHSW to develop the most effective policy to achieve a better geographical distribution of healthcare professionals.

Many of the case studies identified the importance of making sure students could meet customer needs at the time of graduation, which demonstrates a commitment to the customer’s definition of value. With reference to the Kenyan healthcare system, Mumbo and Kinaro (2015) specifically identify the adoption of competency based medical
education as a practice that could improve graduates’ ability to meet customer expectations (Case Study 7).

The Waste Elimination lean principle was successfully followed through practices such as developing training curriculum to specifically address community needs, modifying the training curriculum to eliminate the need to retrain students after graduation, and using Standard Work to reduce errors and variation. At the UNC, the curriculum was matched with desired competencies in a bottom-up approach (Case Study 1) (Thompson et al., 2009). Processing waste is reduced by ensuring that each aspect of the curriculum is non-redundant and adds value to the student, since any training that does not get students closer to addressing community needs is left out.

The Pull lean principle was successfully followed in the practice of developing training curriculum based upon the demand from the community and employers. As mentioned during the discussion on feedback loops, many case studies effectively engage stakeholders during curriculum development (Case Studies 7 & 8) (Malwadde et al., 2014; Mumbo & Kinaro, 2015). An excellent example is the development of a training curriculum at UNC (Case Study 1) (Thompson et al., 2009).

The Continuous Improvement lean principle was best practiced in the creation of the UNC training program (Case Study 1) (Thompson et al., 2009) and the assessment of the Liberian healthcare delivery and training systems (Case Study 5) (Varpilah et al., 2011). While many of the case studies practiced working with customers to develop training curriculum, the UNC case study was the only one that used an iterative approach to make sure the customer needs were successfully met. By following an iterative process, the training curriculum was given the opportunity to improve after its creation, demonstrating Continuous Improvement. Similarly, in the Liberian case study, the MOHSW improved their data collection methods and results as the MOHSW matured and the healthcare system started to stabilize (Varpilah et al., 2011).

Additional Application of Lean Principles to Healthcare Workforce Planning

Lean principles have not been specifically applied to healthcare workforce planning, although a number of case studies have inadvertently followed lean practices very successfully. However, for the maximum benefits to be achieved through lean implementation, the lean principles must be followed holistically (Mirdad & Eseonu,
There are a number of practices that could be introduced or extended to more completely follow the lean principles. The lean practices described in this section should be further investigated in the context of the training pipeline to determine how they can be successfully implemented in healthcare training.

One of the primary problems that Eseonu and Doolen (2013) identified was the bottleneck caused by a lack of qualified faculty. Several case studies identify lack of qualified faculty as a limitation, however none of these case studies focus on developing best practices to recruit and retain good faculty (Case Studies 6 & 7) (Mumbo & Kinaro, 2015; Patel et al., 2015). This directly relates to the Respect of Humanity lean principle and if some of the practices were followed from this principle, improvements could be seen in faculty retention. Lean manufacturers have seen improvements in employee retention and engagement by completing practices such as involving employees in improvement opportunities, engaging the full skill set of employees, and showing employees how their work is adding value. By engaging in practices that achieve these same goals, faculty retention could be improved.

A number of the case studies examined did not successfully follow the lean principle Continuous Improvement after implementing changes. A central component of lean thinking is to implement change and then follow an improvement plan that allows for continual revision and adjustment. In many of the case studies examined, a change was implemented and then the policy makers seemed to move on to the next issue. It is possible that these Continuous Improvement efforts were simply not documented in the case studies, but did occur after the change implementation. The feedback loops that Eseonu and Doolen (2013) proposed could encourage Continuous Improvement by opening up the communication channel between healthcare providers and trainers allowing constant feedback on graduate performance. Other methods that were implemented in a few case studies, but should be implemented on a broader scale include: (1) Surveying students, faculty, and employers regarding student and program performance and (2) following an iterative process in developing new programs and curriculum. Many of the case studies involved stakeholders in the initial development of programs, however if the Continuous Improvement principle is being followed,
stakeholders should be continuously engaged with bringing improvements to existing training programs.

As briefly discussed with relation to Eseonu and Doolen’s (2013) suggestion of improving feedback loops, the lean principle Pull could be more comprehensively implemented in many of the case studies. Many case studies followed the Pull principle in the development of curriculum content; however the Pull principle should also be applied to other decisions such as the number of students to accept into a training program or the number of faculty to retain. The Spanish Residency System approached following the lean principle Pull by defining the number of students accepted into the residency program, but fell short (Case Study 2) (Freire et al., 2015). In the Spanish system, local policy makers determine the expected need in their region, which is then used to determine how many training spots should be opened. While this is an improvement from just guessing how many spots to open, in order to follow the lean principle Pull, employers (customers) should expressly define the number of new hires they need.

The lean principle Flow was not addressed very well by any of the case studies. A central practice related to the Flow principle is moving towards one piece flow. Currently the healthcare training pipeline functions under a batching system. The batching system currently occurs at two levels, the batching of students into cohorts at individual training institutions and the batching of cohorts to all start and end at the same time at different training institutions. It is unlikely that the training system will move away from batching students into cohorts, due to limitations in teaching resources which make teaching the same material to groups of students the most efficient method. However, one piece flow could be approached by staggering starting times for cohorts to allow a more continuous stream of graduates, as opposed to many students from different institutions graduating and looking for work at the same time.

In lean manufacturing, two of the key practices related to the lean principle Waste Elimination are error proofing and finding the root cause of problems. Neither of these practices were effectively followed in the examined case studies. Poka-yoke and Visual Management System are two practices commonly used in lean manufacturing to make errors impossible or at least easily caught. In the healthcare training pipeline, an example
of an error is a student not being trained appropriately and lacking specific skills. Standard Work is a practice that can improve the likelihood of students receiving the appropriate training through defining curriculum, but Standard Work should also be applied to defining the assessment of skills. Standard assessment of students could provide some of the same benefits as poka-yoke and Visual Management System, by easily identifying students that are not meeting requirements.

Most commonly Processes, Defective Products, and Defective Design waste were addressed in the case studies, but the other forms of waste were not expressly considered. A few areas of waste that could specifically be improved using lean practices in the healthcare workforce training pipeline are Overproduction, Delays, and Inventories. Overproduction could be reduced by following the Pull lean principle in determining the number of spots to open in training programs, a recommendation that has been discussed previously. Delays could be reduced by improving the Flow of the training pipeline, which as discussed should lead to one piece flow instead of remaining as a batch system. The continuous graduation of students should reduce the time employers have to wait between needing a new hire and hiring. Inventories should be considered in the training pipeline, although they are extremely difficult to reduce. In the healthcare training system, students who are waiting to begin training, are being trained, or are trained and waiting for a job could all be considered to be inventory. While reducing training time is an extremely complex and policy oriented change, the cost of having all of these students in the training system should be noticed and considered.

Task shifting and the required modification of the training system were discussed in three of the case studies presented. Two of the three case studies recommended modifying the pre-service training curriculum to include tasks that are shifted to a profession (Case Studies 4 & 5) (Deller et al., 2015; Varpilah et al., 2011), however Dambisya and Matinhure (2012) recommended either modifying pre-service or in-service training (Case Study 3). As mentioned in the discussion of these case studies, modifying the pre-service training curriculum can be a good example of following the Pull, Waste Elimination, and Specify Value lean principles. However, it is also important to not over train students in tasks that may not be shifted to them. If students are over trained in skills that exceed the needs of the customer, this would be an example of Processes or
Defective Design waste. A benefit of using in-service training is employers can readily define the specific set of skills their employees should have, preventing Processes waste. This conflict should be considered when determining how to implement task shifting in a lean manner. If pre-service training is used to train students in tasks that will be shifted to them, the training institutions must engage with employers, following the Pull and Specify Value principles, to reduce the Processes waste that could result.

**Limitations**

The two main limitations to this thesis are the small number of case studies examined and the variety of lean practices in the literature. However, the information presented is still extremely valuable and several good practices that should be implemented in the healthcare training pipeline are identified. This thesis presents a qualitative analysis, so the small sample size does not prevent the ideas discussed from being valuable to learn from and instigating further research.

This thesis examined eight (8) case studies. In the literature, many case studies examine the delivery of healthcare, however very few focus on the training process. The small sample size makes it difficult to ascertain the breadth of practices and policies that are being implemented to improve the training pipeline. On the other hand, it is possible that very little work is being done academically to determine best practices for workforce training and planning, resulting in the limited number of case studies. Regardless, the limited number of cases examined makes it difficult to produce a wealth of new ideas that can be compared against one another to define the “best” practice. Future work should investigate additional case studies to improve the accuracy and confidence of findings.

Another limitation of this thesis is that lean practices are constantly being developed and there is a huge variety of practices, that are not all agreed upon (Mirdad & Eseonu, 2015). Mirdad and Eseonu (2015) created a conceptual map of the various lean practices and principles, however other literature includes or excludes different practices from this conceptual map. The list of practices used in this thesis was determined based upon a summative research, which included but was not limited to the work done by Mirdad and Eseonu (2015). The lean practices defined in the lean principles section of the thesis strongly influenced how the case studies were analyzed and the details that
were taken from the case studies. It is a limitation of the thesis that a different definition of the lean practices could have resulted in different details and recommendations from the case studies being focused upon.

This thesis identifies several practices that can lead healthcare workforce planning towards becoming leaner. Several gaps that could be improved through the application of lean principles are also identified. Other lean practices, not mentioned in this thesis, may yield additional benefits for the healthcare training pipeline. However, this thesis provides an excellent starting point and introduction to lean thinking for healthcare training policy makers.

**Recommendation for Future Work**

While this thesis identified several cases where elements of lean principles were seen in healthcare workforce planning, there was no evidence that the policy makers intended to follow the lean principles. Various lean practices were identified that could be implemented in the healthcare training system, but there has not been any research to show the success or cost effectiveness of implementing these solutions. If lean principles are chosen as a guiding theory for analytic study of healthcare workforce planning, further quantitative analysis and experimentation should be conducted in order to determine the best policies.

A specific example of this could occur in the implementation of the Pull principle to determine how to effectively fulfill community needs. Potential points in the training pipeline to pull from include acceptance to an associate degree program, acceptance to university, or hiring. Pulling from each of these points in the pipeline has benefits and costs, which would need to be evaluated to determine the optimal pull point. Rother and Shook (2009) define a Pacemaker Process as the point after which there are no supermarkets or pulls. All of the downstream processes are continuous flow. If an early process in the system is chosen as the pacemaker, there could be considerable variability that is difficult to account for, reducing the benefit of following the Pull principle. However, if one of the last processes is selected to be the pacemaker process, a considerable number of processes have to be synchronized and understood to allow continuous flow and make sure that the flow can be easily adjusted to permit Pull. It is
unclear what pacemaker process would reduce waste due to Inventory and Delay, while still being able to meet customer demand in a timely manner.

This thesis identified several case studies that examined healthcare workforce planning; however the literature was sparse when it came to finding specific examples of workforce planning in action. Workforce planners around the world should begin to document methods and best practices in order to spread learning and successes. It is important to consider regional and cultural differences, however in this thesis, case studies from all over the world shared solutions for workforce planning problems. The similarities found in the examined case studies provide encouragement that these similarities will persist as workforce planning is more closely examined.

Of the reviewed literature, fairly extensive research was found on training for higher level providers such as physicians and registered nurses. Interest was found to improve the training pipeline for lower level providers such as CNAs, but this research is arguably not as advanced or common. Further work should be completed to gain a greater understanding of the training pipeline for lower level providers, to verify whether best practices for training higher level providers will transfer to training for lower level providers.

Some preliminary research was conducted into optimum forecasting methods, however this is not included in the lean focus (primary goal in lean is to reduce the production time in order to reduce the need for forecasting), and was therefore not included within the scope of this thesis. In the healthcare training pipeline, especially for highly trained professionals, the time for training is unlikely to be greatly reduced. Therefore, some forecasting will continue to be required to make sure there is an appropriate supply of healthcare workers to meet demand. While best practices for forecasting were not included in this paper, they should be researched further in order to determine appropriate forecasting methods for the healthcare training pipeline.
Conclusion

Lean principles have been applied extensively in manufacturing, healthcare delivery, and a variety of other contexts. However, according to a review of the literature, this thesis is the first to explicitly apply lean principles to healthcare workforce planning, specifically the training pipeline. While many examples were found that unknowingly applied lean principles to workforce planning, even more benefit could come by purposefully using the lean principles to shape policy, as has been done in other contexts. From this thesis, it is clear that the lean principles can be found in workforce planning currently, indicating that further implementation is possible in this context. In addition to using lean principles to develop new policies, lean principles can be used to develop a method to assess the quality and success of solutions. Similar to the approach used in this thesis, lean principles can serve as a qualitative measure to determine the value of a proposed solution.

In this thesis, a number of specific practices and recommendations were identified. Although these improvements may not result in the ideal training pipeline, by following the lean principle Continuous Improvement, policy makers can approach the optimum training pipeline overtime. The goal of this thesis was to specifically address the concerns of Eseonu and Doolen (2013) related to workforce planning in LBL. Some of the practices used in the examined case studies were found to address the identified challenges, such as involving stakeholders in the development of new curriculum. However, there is a large gap between the potential use of lean principles to address the challenges Eseonu and Doolen (2013) identified, and the actual use of lean principles. A number of additional practices were identified that should be further explored for potential implementation in the healthcare training pipeline.

The healthcare training pipeline is ripe with opportunity for the implementation of lean practices. Further research is needed to determine the best practices that can be implemented and how these practices should be approached. This thesis provides an excellent summary and introduction to the concept of lean and healthcare workforce planning. A review of existing research and gaps that could be reduced by lean is also provided. This thesis is an excellent starting point for healthcare workforce planning policy makers and future researchers.
References


Appendix

Figure 6. Definition of value according to healthcare training stakeholders