Lean and Six-Sigma Applications in Higher Education Enterprise System - A Literature Review

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Abstract

Lean thinking not only changes the way of manufacturing, but also can be the way to improve any kind of organizations. Educational system is one of these organizations that consider using lean principles to improve the current system. The goal of this study is research models, which show how lean principles can be used to transform the university system into a lean organization.

Key words*:* Lean organization, lean model, educational system, and lean principles.

1. Background and Introduction

A book titled The Machine that Changed the World (Womack et al., 1990) detailed the progress of the Japanese automobile industry and compared their production model to the traditional mass production model common in the United States. The Japanese model was termed “Lean” and has since been associated with the practice of deciphering the value added activities from those that are waste (“muda” in Japanese) in an organization and its supply chain. Taichi Ohno, one of the co-developers of the lean system, suggested, “waste accounts for nearly 95 percent of all costs” (Kilpatrick, 2003). When broken into individual parts, the lean process was not new, but as a holistic program it was considered new. Womack and Jones (1996) explain that Lean “provides a

way to specify value, line up value-creating action in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more effectively. In short, lean thinking is 'lean' because it provides a way to do more with less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers with what they really want". Lean thinking is abolishing the way people think about departmental roles and responsibilities, and it is achieved by remaining focused on the customer and the core competencies that the customer values from an organization.

Lean Manufacturing reduces costs of manufacturing by improving labor utilization, decreasing inventories, reducing manufacturing cycle times, and increasing capacities without capital expenditures. Lean thinking not only changes the way of manufacturing in profit-oriented entities, but also can be the way to improve any kind of organization, such as public services and NGOs. The educational system is one of these organizations that is able to use lean principles to improve the educational enterprise system with its ultimate customer being the student.

In a global competition, customers are more demanding for quality. Therefore, the education system must react faster for delivering services to its customer at improved quality and lower costs. In this sense, lean thinking becomes a new trend that many leaders try to adapt the concepts to use in their organization (Howell, 1999).

2. A Note on Public versus Private Higher Education

Schools attempt to meet student needs by strategically determining what kind of students are desired on campus, how many of them to accept, and what and how faculty, staff, facilities, and other resources should be used to serve them. This is the sustainability question that every

institution of higher education faces. Public schools typically operate under much tighter financial constraints than private schools. They are more restricted, both in their sources of revenue and in their freedom to spend it, due to state and federal government intervention and often union law. Thus, they have historically tried to perpetuate themselves by becoming educational factories: obtaining additional funding by steadily increasing enrollment numbers and sponsored research efforts and by appealing to students via lower tuition prices. In general, public universities charge lower tuitions, have raised them at a lower rate, and have more scholarships, fellowships, and research dollars than their private counterparts. Enrollment in public institutions has been rising at a much faster rate, even though total expenditures for publics and privates are rising at approximately the same rate. Private schools, on the other hand, have much more freedom to raise and spend funds and are perceived to offer a more intimate and higher quality environment. They generally reach an economic balance point where enrollment numbers remain stable, allowing future spending to go towards improving the overall richness and prestige of the educational experience (teaching quality, facilities, and amenities).

Student to faculty and staff ratios have decreased over the last 25 years for both publics and privates, indicating a trend away from leanness, with private schools utilizing more staff per student than publics. America has chosen to support an accessible and diverse system of higher education. Institutions are constantly trying to teach new topics to more students more effectively, to perform more complicated and expensive research, and to increase the prestige of the school and its faculty (Johnstone, 1997). At the same time, applicant pools in the public system are rising just as states are cutting funding to them. As schools increase tuition to compensate for the loss of funding, they have to act like private schools in the marketplace (i.e. better financial aid packages, better facilities, more personalized instruction, better perceived quality and more amenities). Many

are forced to lay off faculty and staff and delay or cancel needed improvements. To make matters worse, top tier private schools in good financial shape can capitalize on financially weaker lower tier schools by stealing away faculty and students whom the weak schools cannot afford to retain any longer (Goral, 2002; Johnstone, 1991).

3. Literature Review

Extensive case-based primary research and secondary research has shown that while there are many examples of attempts to improve processes in universities (Rice and Taylor, 2003), there have been few examples of such as a holistic approach in the United States (Dew, 2007). The University of Wisconsin-Madison, for example, has a very well refined and defined continuous improvement process orchestrated by the Office of Quality Improvement. Their work to improve their admissions process cut admission costs by 38%, reduced the time required by 39% and eliminated the backlog of admissions work.

Early continuous improvement attempts have often been too technically bound, merely focused on the removal of 'muda' (or waste), rather than a more holistic approach drawing on the full muda, 'mura' (un-evenness), 'muri' (overburden) approach advocated by Toyota (Toyota Motor Corporation, 2006).

Some authors (for example Alp, 2001; Comm and Mathesiel, 2005 a and b) have explicitly discussed the implementation of Lean in universities but these works have largely been delivered from a theoretical, generalist perspective.

An exception to this is Emiliani (2004), who has shared his experiences of applying Lean in an academic environment with the authors. These experiences are very localized and specific, for

example, Emiliani uses Lean principles to improve business course content. Emiliani (Emiliani, 2006) presents methods to fix deficiencies in an entire MBA program keeping the student need in mind. Moore and Nash (2004) explicitly discussed how they plan to create a Lean university at the University of Central Oklahoma in unpublished work shared with the current authors. Interestingly, while Moore and Nash have instigated many bottom-up Lean projects, they have also included top-down Lean implementation activities. They held a strategy day with different stakeholders and key personnel in the university to work together to develop the 'vital few' key strategically-aligned actions which supported their vision and were able to be cascaded throughout the organization. While there have been notable successes as a result of their activities, they have not yet addressed fundamental, challenging aspects of a sustainable Lean value system—aspects that this research has addressed at the outset.

A need exists to provide a more concrete, holistic methodology to transformations in organizations. Improvements should be made with an awareness of the effect that these changes will have on other aspects of the organization. For real change to occur, major mental, transformational shifts need to take place at the upper levels of the institution. These shifts in thinking need to then be effectively communicated and cascaded through all levels of the organization.

It is helpful to think of the Lean process as an iceberg (Fig. 1). The technology, tools and techniques that affect processes are those visible above the water. However, the vast majority of the iceberg is beneath the surface and invisible. It is this enabling, anchoring mass which makes an iceberg a powerfully strong force. Addressing all of the enabling iceberg elements is essential in order to deliver a successful, sustainable transformation. However, this forms only part of the initiating mindset required by a Lean implementation team. There needs to be an appreciation of the right mix of 'above water' and 'below water' activities. It is also important to realize that the iceberg's components are all interdependent. For example, effective strategy and alignment can only be delivered through strong leadership which, in turn, will only be successfully realized in a positive organizational culture that is receptive to learning and improvement.

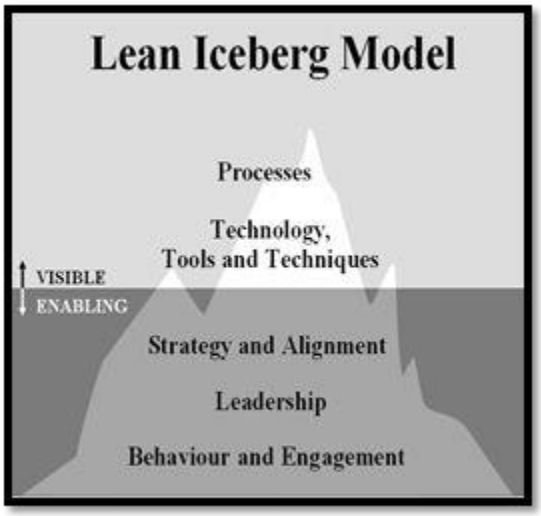

Figure 1. The Lean Iceberg Model (adapted from Hines et al., 2008)

Dennis (2006) has stressed the importance of getting the right balance of different implementation approaches. He categorizes Lean improvements in terms of top down and bottom up stating that bottom up approaches possess the power of the quick win, but they suffer from variable sustainability performance. Top-down Lean Thinking, he says, offers the opportunity for true culture change.

We believe that a combination of both approaches should initiate a Lean transformation program positively, while also providing long-term sustainability. Hence, starting with a muri

(removing overburden) approach of Lean, seen as making their job easier, is far more likely to be engaging and result in sustainable benefits.

4. Best Practices of Lean in Higher Education Institutes

Based on Comm and Mathaisel (2003) the best practices of Lean, published by Nightingale (1999), that are being applied by some High Education Institutes is as follow:

- Optimizing the flow of services and products, within or affecting the process, from concept design through point of use;
- Providing processes and technologies for seamless transfer of, and access to, pertinent data and information;
- Optimizing the capability and utilization of people;
- Implementing integrated product and process development teams;
- Developing relationships built on mutual trust and commitment;
- Continuously focusing on the customer;
- Promoting lean thinking at all levels;
- Continuously processing improvements;
- Maximizing stability in a changing environment.

For implementing better of the Lean on Higher Education Institutes, there are seven major components that must be followed. These are (Barroso 2010):

(1) Environment for change

(2) Leadership

(3) Culture

(4) Employee empowerment

(5) Training

(6) Communication

(7) Measurement

When the Lean concept once is implemented correctly, consequences of eliminating of the wastes, processes would be more productive and would provide value to the customer of the Higher Education Institutes better.

5. Wastes in Higher Education Institutes

Jens Jorn Dahlgaard (2000) stated that there are eight types of waste in the higher education context:

- Uncoordinated teaching, instructing and testing, with the result that students do not pass the exams;
- Graduate students, who are not be able to land a position and do not have lifelong learning abilities;
- planning courses for which the students have not yet got the suitable capabilities to pass;
- Courses that do not contribute to the customer value concepts;
- Bad planning and mistakes in teaching, instructing and examining so that students, instructors and staffs have to move from one class to another or from time to another with no purpose, or have to fix mistakes and damage that they are not responsible for;

- Bad planning so that materials and facilities needed for teaching, instructing and examining are not suitable in terms of time, cost and quality;
- Instructors and students in downstream are waiting because the supportive staff level have not been delivered at in time in upstream activities and vice versa;
- Planning of courses and related activities, which do not address the needs of the customers inside and outside the higher educational institution;

According to Lareau (2003) there are four general group of waste:

- Human waste – Refers to the group of waste that occurs when universities fail to capitalize fully on the knowledge skills and abilities of employers and workgroups;
- Process waste – Refers to the category of wastes that occur due to shortcomings in the design or implementation of university processes;
- Information waste – Refers to the group of waste that occurs when the information that is available is deficient for supporting university the processes;
- Resource waste – Refers to the category of waste that occurs when the university does not use its assets (people and facilities) in the best way.

6. Lean Processes in Higher Education Institutes

According to Harrington (1991), “There is no Product or Service without a process, the same way there is no process without a Product or Service”. Also, Davenport (1994) stated that a process is a structured sequence of activities, intended to produce a particular output based on a defined input. Because of the nature and complexity of Higher Education Institutes have a tremendous amount of processes that are came to existence based on the mission, vision and on the particular

goals of each university. As Cardoso (2005) expressed the major processes of a Higher Education Institutes are:

- Teaching process, related with the application of knowledge;
- Research process, associated with creation of new knowledge;
- Sharing process, related to the dynamic process between the teaching and research processes.

These major processes of a Higher Education Institutes can be expressed, according to Madeira (2007) as the following core areas:

- Students along their academic trajectory;
- Programs;
- Research.
- Technology transfer;
- Financial resources;
- Human resources;
- Physical resources.

7. Limitations and Tools of Lean Implementation in HEIs

Cullen et. al (2012) describes a number of limitations for lean implementation in HEIs. Their described issues include improve processes with tunnel vision rather than viewing processes from an entire system perspective, lack of support from higher authorities, viewing Lean as a swift solution, lack of process thinking and process ownership, lack of visionary leadership, lack of existing culture of openness, lack of understanding the voice of the customer, lack of

communication and prevalent functional silos, lack of resources such as time, and weak connections between kaizen projects and HEI objectives. A solution to the lack of visionary leadership may be to implement roles similar to the CE utilized by Toyota in order to have a leader champion Lean projects (Liker and Morgan 2006). And just as functional silos create rework in engineering processes, an analogous problem to reworks in HEIs may also be reduced by utilizing functional integration and improved communication (Liker and Morgan 2006).

Cullen et. al (2012) also lists pertinent LSS tools for HEIs. These tools include value stream mapping, cause and effect analysis, visual management, Pareto analysis, project charters, supplier-input-process-output-customer (SIPOC), and rapid improvement workshops (RIW). Value stream mapping enables a big picture view to understand how the HEI can produce value and where the aforementioned wastes occur in the system. Cause and effect analysis requires key players to target causes of issues which may include manpower, machines, methods, materials, mother nature, and measurements (Cullen et. al 2012). Pareto analysis can sift out major causes from insignificant causes.

8. Cases Studies of Lean Application in Higher Education Institutes

Cases Studies of Lean Application in seven universities in the USA described in Balzer (2010) and Moore et al. (2004) were presented in Table 1 in the core areas of a Higher Education Institute according to Madeira (2007).

It is apparent from the analysis that large portion of the Lean approaches done this far on Higher Education Institutes is concentrated on administrative processes, the ones that Higher Education

Institutes have in common with the other organizations, leaving apart the major challenging processes such as Programs, Research and Technology Transfer.

Table 1: Number of Lean processes/University in each key area of HEI (Barroso 2010)

Key Area \ University	University of Central Oklahoma	University of Iowa	University of New Orleans	Bowling Green State University	University of Scranton	Renssealer Polytechnic Institute	University of Wisconsin
Students	4	2	-	6	1	-	1
Programs	-	-	-	-	-	1	-
Research	-	2	-	-	-	-	-
Technology transfer	-	-	-	-	-	-	-
Financial Resources	1	1	-	-	-	-	-
Human Resources	2	1	1	-	-	-	-
Physical Resources	7	1	-	-	-	-	-

9. Lean Administrative Process in The University of Central Oklahoma (Moore, Nash Henderson 2004)

Problem: The University needed to find ways to considerably improve both efficiency and improve deteriorating employee morale. Limited financial resources with increases in staff costs and growth in student registration have made it challenging to keep existing programs, much less enhance and grow services.

Conventionally public university funding has been insufficient. Having experienced budget reductions of 15% in 2002 and insignificant increases since then, the University of Central Oklahoma students now contribute 50% of the total University Budget. The budget situation is not expected to improve; hence ways to use the University funds more efficiently is critical for keeping program and expansion of programs to reach the customer needs.

Design and implementation: A small team of management staff working directly with Executive Vice President of Administration, canvassed the campus listening to individuals and groups discuss their "problem" with the administrative processes at the University of Central Oklahoma. Annual meeting has followed the initial groups, but with smaller groups representing the university areas to analyze the improvement process.

As the team checked on the consequences of the initial survey, it was evident to Executive Vice President that the most of the problems presented were complaints based on non-value-added activities. Moreover, Executive Vice President noticed that majority of these issues were almost identical to those he had experienced in the private sector before his employment at UCO.

The model used to implement the Lean concept in University has been proven effective in other kinds of organizations. The four-step model is as follow:

Step 1: Identify the Opportunities - An organization-wide diagnostic search for problems and opportunities.

Step 2: Design Solution - Design a blueprint for success that involves all staffs: training, mapping, and planning.

Step 3: Implementation – Use kaizen events, core teams, and metrics to implement and demonstrate change.

Step 4: Continuous Improvement – Control performance after projects are finished.

The University outsourced the facilitator part to Argent for the initial few procedures. An office of Process Improvement with a director regulating the Lean processes has been included, which gives better oversight of past Lean processes and the planning for future Lean activities.

Significant improvement was accomplished in five days. Keeping in mind not all that matters could be measured at week's end, a thirty-days report further underlining the concept of continuous improvement was able to capture all data being followed. About six months later, repetitive effort concentrated

on the customers' major complaints about the process, the result was presented as follows:

Table 2: Results of lean implementation in administrative processes (Moore 2004)

Metric	Before	After	% Improvement
# pcs of paper generated	19	2.2(1)	88.4%
Annual paper cost	$15,597.46	$1,262.39	91.9%
Travel path of W/O	1265 ft.	253 ft.	80.0%
Average # of touches	28	5	82.1%
Average age of W/O waiting at assignment	24.1 days	2.6 days	89.2%
% of W/O submitted by email	26.8%	91.1%	240.0%

While Step Two and Step Three of the Lean model are keeping on developing and expand, Step Four is also up and running. As quickly as an initial project is completed, the results are reviewed and efforts are created to instill the concepts of continuous improvement into the affected process. Facilities Management is one of the best example of this on campus. The management team in Facilities Management continues to search ways to improve the work order procedure and eliminate waste. For 100% of all work orders the customer is contacted within two days of submittal. Over 90% of the work orders are done within three days and over 80% are fulfilled on the day of submission. A process that before lean implementation had over 3,000 backlogged work orders now has less than 300 at any given time.

Benefits: The following brief summary exhibits many of the advantages experienced:

Training: By providing the basic one-day introductory Lean course, all employees of Administrative Services have started to understand that they are a part of the bigger picture, that they have input into the processes they work within, and that beneficial things can and do happen at the end of continuous improvement.

Creating a common understanding and explaining to groups including of both management and staff positions that everyone is expected to take part, has opened the door for positive input and constructive criticism without fear of retribution. Many employees are not even waiting for events and workshops to occur. They are proactively making little quick changes with brilliant results.

Cost Efficiencies: Despite the fact that the emphasis of this effort is on enhancing customer service in university, there have been number of instances of cost savings through project work. The primary Facilities Management project could save more than $14,000.00 in annual paper cost with only one week's worth of work.

Productivities: In addition to the evident productivities that have been created in Facilities Management, several other areas have experienced enhanced efficiency. In the Purchasing Department the flow of processing purchase orders was altered from a batch and queue methodology to balanced flow. By working each purchase order as far into the process as possible and fulfilling the work and printing in a non-stop manner, one process agent has been able to reduce the average time to finish a work order by over 70%.

Personnel Performance Improvements: The overall morale and work ethic of employees in areas where changes have been made has improved considerably. By empowering employees to make positive process changes, actually have responsibility and be in charge of their work, Lean thinking has brought out the best in many employees. It has also on occasion motivated some

employees who have stagnated or are settled in their approaches to proceed onward. Removing these human roadblocks in many departments has only made it more convenient for the rest of the employees in these departments to embrace the culture of continuous improvement.

Student Satisfaction: Students have already begun to see the positive effect on services offered. The Facilities Management work order process improvements gained immediate support from students living on campus in student housing. Work order requests are considered to be part of the solution instead of a useless and prolonged step in the process.

Faculty Satisfaction: While the efforts of this initiative have basically centered around Administrative processes, the Lean core teams have addressed processes in Academic Affairs and Enrollment Management divisions. Faculty members are profiting from the enhanced processes. Faculty feedback has provided understanding into the wants and needs of faculty, and how they interact with Administrative staff. Faculty members whose responsibilities incorporate the role of building monitor have once again become engaged in the process. These building monitors funnel work order requests to Facilities Management and monitor progress on the work. Under the old process, faculty members endeavored to maintain this role. With the improved process, faculty members have become supportive team members.

10.Lean in the Admissions Process

A research paper by Jin and Kachroo (2010) detailed efforts to improve the admissions process at Texas A&M University in Kingsville, Texas. Their goals were to reduce the lead time of the application, correct workflows, improve consistency, eliminate waste (e.g. time, efforts, manpower), and improve work quality. The customer in their case is the student classified as

undergraduate and graduate. Each undergraduate and graduate student can be either domestic, international, or a transfer. Upon acquiring knowledge and data of the admission system defects were detected. Unclear application requirements written in the catalogue for domestic, international, and transfer students caused receipt of incomplete packets. The workflow distribution was poorly designed by the alphabet where a staff member would process last names A to G, the next would take H to P, and so forth. The clear issue is that these categories have a high variation causing some staff members to have higher workloads. The authors' solution was to provide two processors each for undergraduate and graduate level. Another defect discovered was many student query calls and emails where the authors' suggested a remedy by giving each student an estimated processing time and periodic updates. Issues were also found across functions with workloads and communication between the CIS which lagged in processing time. In the spirit of Kaizen, the authors recommended to issue surveys to students to acquire the customer needs and to consistently look for improvements on workflow.

11.Total Quality Management (TQM) Applied to HEIs

Total Quality Management focuses on the "…culture, attitude, and organization of a company that serves to provide customers with products and services that satisfy their needs" (Hashmi). According to Ho and Wearn 1996, TQM can be defined in detail as follows. Total means every person in the company is involved, which also includes customers and suppliers. Quality means the customer requirements are met exactly. Management means the senior executives are fully committed.

Ho and Wearn (1996) describe a TQM model for a HEI in the UK named the HETQMEX (Higher Education TQM Excellence) model as shown in Figure 2. The model's components will be briefly described in the application to HEIs.

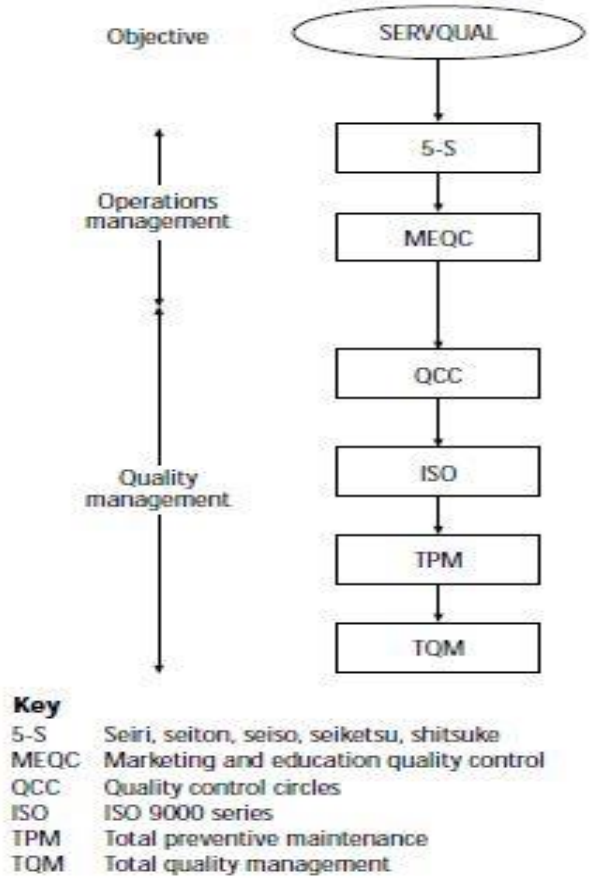

Figure 2: HETQMEX Model from Ho and Wearn (1996)

SERVQUAL stands for service quality which measures tangible and intangible service elements (Ho and Wearn 1996). SERVQUAL examines "gaps" to reveal areas where quality can be enhanced. According to Ho and Wearn 1996, there are five of these gaps as shown in Figure 3.

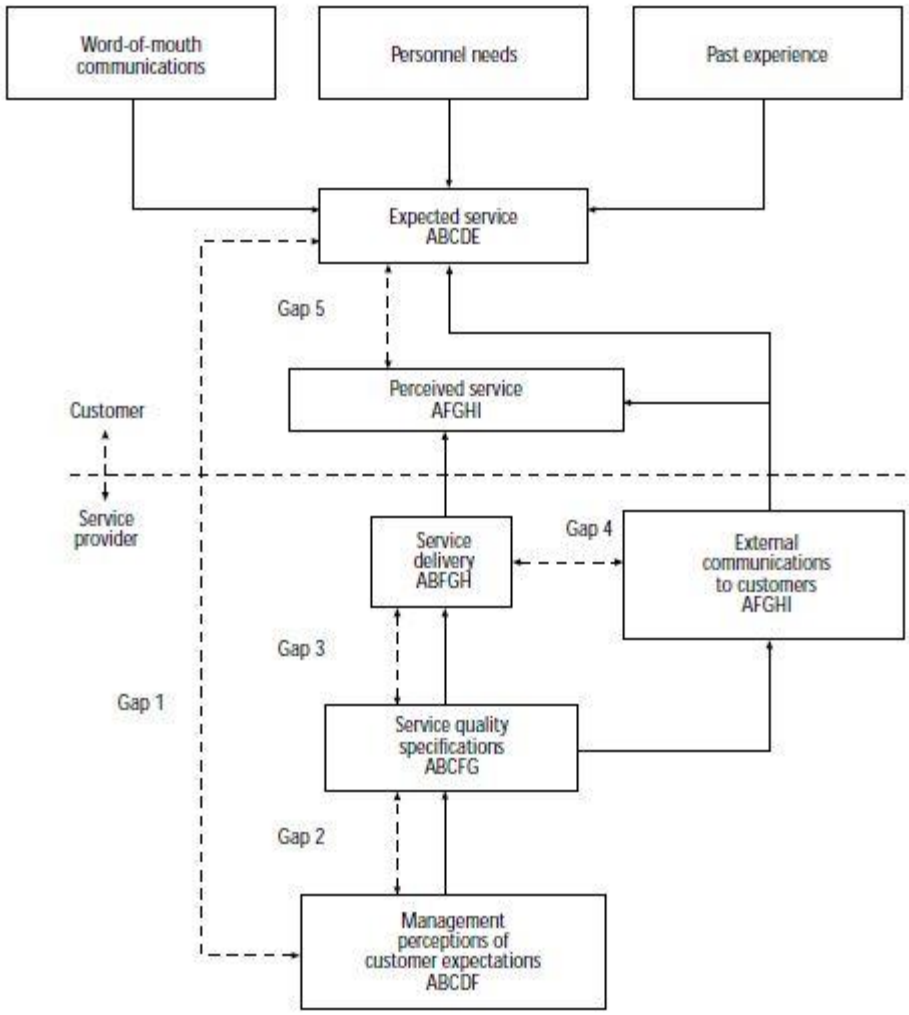

Figure 3: SERVQUAL Gaps (Ho and Wearn 1996)

The first gap is customers' expectations versus management's interpretations of customer expectations. The second gap is management's interpretation of customer expectations versus service quality specifications. The third gap is service quality specifications versus service delivery. The fourth gap is service delivery versus external communications to customers. The fifth gap is customer expectations and perceived service. An example of Gap 1 is when students may expect a hands-on course to heavily emphasize technical study with less emphasis on "academic rigour"(Ho and Wearn 1996). A course may also be designed by one academic scholar,

but taught by a different scholar who may give their own perceptions of the course which highlights Gap 3 (Ho and Wearn 1996).

5-S is briefly defined in transliterated Japanese in Figure 2. According to Ho and Wearn (1996), the meaning of these terms, respectively, are to organize, to be neat, to clean, to standardize, and to maintain discipline. These simple activities enable a total quality work environment (Ho and Wearn 1996). A simple example of 5-S at an HEI in a lecture room is to keep the classroom computer ready and organized so that each professor may easily utilize it.

Marketing and education quality control (MEQC) consists of having "the right product at the right place, right promotion and right price" (Ho and Wearn 1996). Universities must ask themselves if their student acceptance decisions are given promptly and if their university information brochures (whether university-wide or departmental-focused) are "user-friendly" and accurately reflect the service delivered (Ho and Wearn 1996).

Quality control circles (QCC) are "small groups which voluntarily performs quality control activities within a single workplace" (Ho and Wearn 1996). A QCC could be utilized to design and enhance courses and to share best teaching practices. We believe the issue with QCCs are that they are voluntary. As described in Liker and Morgan 2006, voluntary "technology clubs" were implemented within a North American car manufacturing group in order to increase communication among different functions. However, participation was not effective due to these clubs being voluntary.

ISO 9000 is a quality management system (Ho 1994). The British Standards Institute published guidance literature to aid educational and training entities in understanding ISO 9000-1 (Ho and

Wearn 1996). A number of education institutes have registered with ISO 9000-1 in the UK (Ho and Wearn 1996). This reveals that HEIs have taken steps to adopting systems to maintain quality.

Total Preventative Maintenance (TPM) in HEIs can be performed by ensuring that computing facilities, lab equipment, and demonstration units are regularly maintained (Ho and Wearn 1996). We have seen a particular room at a university requiring a significant time of class to set up for each meet which is a loss of valued time for the students and professor. TPM to prevent this type of class delay is needed in all areas of the university.

The components of Figure 2 enable a TQM model for HEIs. The HETQMEX model designed by Ho and Wearn 1996, is based on their extensive research with plans for future validation of the model.

TQM has also been implemented in Swedish HEIs. The National Agency for Higher Education, established in 1995 for issues in HEIs in Sweden, has one of its responsibilities in issues of quality and educational innovation (Edvardsson et. al 2003). According to the National Agency for Higher Education, a university "should be characterized by learning, long-term view, international perspective, clear leadership, co-operation, equality, student focus" (Edvardsson et. al 2003). A quick glance at the thirteen LPDS principles (Liker and Morgan 2006) below and there is some similarities with the aforementioned university characteristics.

- Establish customer-defined value to separate value-added from waste.
- Front-load the product development process to explore thoroughly alternative solutions while there is maximum design space.
- Create a level product development process flow.

- Utilize rigorous standardization to reduce variation, and create flexibility and predictable outcomes.
- Develop a chief engineer system to integrate development from start to finish.
- Organize to balance functional expertise and cross-functional integration.
- Develop towering competence in all engineers.
- Fully integrate suppliers into the product development system.
- Build in learning and continuous improvement.
- Build a culture to support excellence and relentless improvement.
- Adapt technologies to fit your people and process.
- Align your organization through simple visual communication.
- Use powerful tools for standardization and organizational learning.

Sweden uses different methods of quality assessments for their HEIs. One assessment focuses on continuous improvements with four key components: goals, activities to reach goals, results, and evaluation and action. Assessing these components is first done as a self-assessment by the university, then an assessment team chosen by the National Agency, a site visit from the National Agency, and a feedback report (Edvardsson et. al 2003). Edvardsson et. al state that the goal of the assessment is to cultivate reflection and self-regulation. These reflections are similar to the self-reflection (hansei) that Toyota performs.

12.Conclusion:

Lean implementation is indeed a growing area in HEIs across the world. We have noted several models in several areas of HEIs in this paper. The functions of the HEI that serve students can be bettered by avoiding functional silos and improving communication. From the classroom to the admissions process, HEIs are large, extensive enterprises with opportunity to apply concepts such as Kaizen. By integrating people, processes, and technologies a successful university will strive to emulate the LPDS model of Toyota as described by Liker and Morgan (2006).

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