AC 2011-604: APPLICATION OF LEAN SIX SIGMA IN HEALTHCARE A GRADUATE LEVEL DIRECTED PROJECT EXPERIENCE

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Susan Scachitti is a Professor of Industrial Engineering Technology at Purdue University Calumet. Professor Scachitti consults and teaches in traditional areas of Industrial Engineering which include Total Quality techniques and organizational change, methods engineering (including Lean methods), facility layout, process improvement, simulation and ergonomics. Prior to working in education, she spent ten years in various engineering and supervisory roles in the telecommunications industry which focused on high volume electronics manufacturing. Her accomplishments include implementation of Total Quality principles including Lean Manufacturing concepts, Demand Flow Technology, self-directed work teams and various other techniques that improve overall process efficiencies within the organization. Also, she held key roles in successfully attaining ISO9001 certification, establishing a benchmark for a self-directed workforce, conducting economic analysis and cost justifications for new manufacturing technologies as well as utilizing various other industrial engineering concepts to reduce cycle times and increase production efficiencies. Since 2004 Professor Scachitti has focused her efforts towards applying Industrial Engineering concepts to improve Healthcare and other non-traditional service environments using Lean and Six Sigma methods.

Application of Lean Six Sigma in Healthcare – A Graduate Level Directed Project Experience

Abstract

Continuous change in complex healthcare environments is a challenge for nurse leaders, but it can also be an advantage. Change can leverage the introduction of innovations that improve the quality of care delivery. It all depends on how change is managed. Six Sigma and Lean are two performance improvement methodologies that could be utilized to improve the quality of healthcare. From the emergency room to the board room, Lean Six Sigma (LSS) can reduce variability and therefore waste, fewer errors, better processes, improved patient care, greater patient satisfaction rates and more productive employees that translate to bottom-line improvement. LSS builds on the knowledge, methods and tools derived from decades of operational improvement research and implementation. In this graduate level directed project the workload of Nursing Shift Directors (NSD) has been analyzed. NSD are responsible for the administrative direction of the healthcare facility including serving as a clinical resource person, interpreting and enforcing policies and procedures, intervening in difficult situations and medical crises, having overall responsibility for appropriate utilization of nursing personnel and for patient placement, and serving as a liaison to facilitate communication and problem solving within the healthcare facility. The purpose of this study is to (a) create a baseline metric of the existing process, (b) collect operational data and analyze ways to improve the work efficiency by eliminating the non-value added tasks from the daily workload, (c) automate some of the tasks performed by NSD and (d) monitor and provide control methodologies for sustainability.

Introduction

Purdue University Calumet School of Technology offers state-of-the-art curricula to meet the ever-changing demands of business and industry for highly-trained technical professionals. The School of Technology offers small class sizes, research opportunities, and the opportunity to profit from real-world laboratory experiences. The MS degree program in the School of Technology offers applied job-related skills and professional growth opportunities that make students very appealing to future employers[1]. This degree requires that all students conduct a directed project as a requirement for graduation. The directed project is an applied research project that is more extensive and sophisticated than a graduate-level independent study and less formal than a master's thesis. The overall objective of the requirement is to engage each graduate student in a study, typically industry or business focused, which is sufficiently involved as to require more than one semester to conceive, conduct, and report. The focus is to be placed on a topic with practical implications rather than original research.

Upon successful completion of a directed project a student should demonstrate:

- Ability to identify a business or industry relevant solution to a technology problem,
- Capability to define and/or validate a business or industry relevant problem,
- Competence to identify criteria for success/solution of the problem,
- Application of business research procedures to gather information,

- Ability to document the research and development activity in a manner that permits replication and assessment of key decisions and alternatives, and
- Proficiency to prepare and deliver a presentation in a form customary to business and industry [2].

Although there is much published literature available in healthcare, there is no readily available published research that discusses the NSD's workload efficiency[3-11]. The graduate level directed project discussed in this paper was undertaken in an effort to identify ways to increase the efficiency and effectiveness of the NSD through improved process steps and addressing the workload by which they can continue to evolve productively in spite of increasing volume and the continuously changing healthcare environment. Through execution of this directed project, experience learned in the academic arena of Industrial Engineering Technology has been successfully applied to a real world situation to solve existing problems.

The purpose of this project was to:

(a) Create a baseline metric of the existing process for NSD at a particular hospital.
(b) Identify process incompetency and recommend a closed-loop sustainable system by eliminating non-value added tasks to improve the work efficiency.
(c) Automate tasks to enable NSD to make use of their knowledge in strategic decision making so as to concentrate on performing value-added tasks.
(d) Monitor and provide control methodologies for sustainability of future NSD activities.

Procedure

This project was conducted at a hospital that embraces the Six Sigma methodology for process improvement. Therefore, the project was conducted by following the Six Sigma DMAIC methodology as shown in Figure 1.

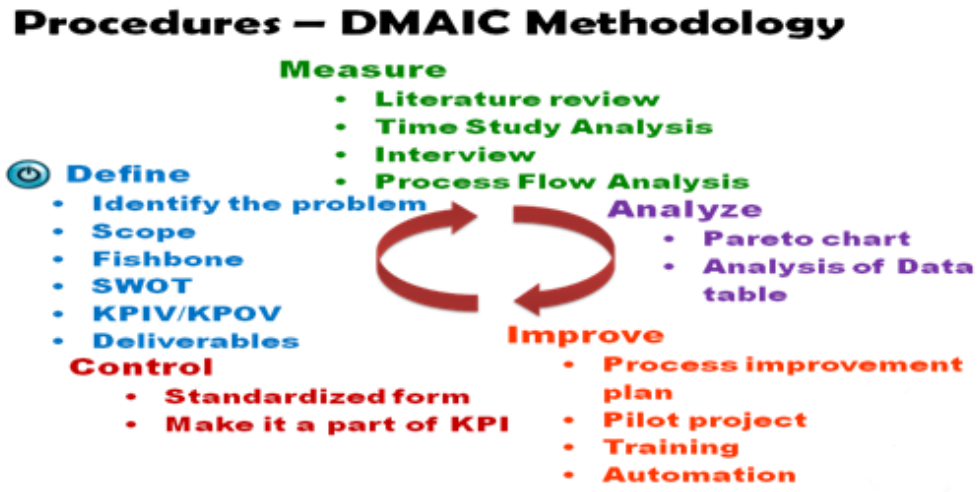

Figure 1: DMAIC Methodology

Define

During the Define phase, the team and its sponsors reached consensus agreement on what the project was and what it should accomplish. A project charter was developed by the project team that defined the business case, problem statement and goal statement. The decision was made to limit the scope of this project only to the workload of Nursing Shift Directors. A workshop was conducted to introduce key Lean and Six Sigma principles to the team members.

A Voice of the Customer (VoC) analysis was performed by interviewing the Six Sigma team and NSDs asking key questions[12]. From the VoC information a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was developed that provided information that was helpful in matching the organization's resources and capability to the competitive environment in which it operates. The SWOT analysis created from the VoC analysis conducted during this project is presented in table 1.

Table 1: SWOT Analysis

Strengths (S)	**Weaknesses (W)**
• Willingness of the NSD to make changes • The floor visit is an effective way of communicating with staff	• Unavailability of convenient technology to access and document patient information, bed placement and staffing • NSD are overloaded with routine duties where some activities are non value added to the overall process • Staff members cited lack of communication amongst care providers as a major component of delays in patient care
Opportunities (O)	**Threats (T)**
• Modifications and increase the user friendliness of the "Dash Board" • Make technology convenient to use to all the NSD • Automate some of the staffing forms	• Resource constraints • Reluctance in using the updated automated version of forms • Sustainability of the improvements.

Critical to Quality (CTQ) factors were then identified to establish baseline data. A CTQ is a product or service characteristic that must be met to satisfy a customer specification or requirement. The CTQs identified in this project were as follows:

- Workload of NSD
- Time spent on value added activities
- Improved communication among staff
- Convenience in using technology
- Staff satisfaction

Impacts on the CTQs were established by identifying the key process input variables (KPIV) and key process output variables (KPOV). The KPIVs and KPOVs were identified as follows:

Key Process Input Variables	**Key Process Output Variables**
Patient volume	Time taken for bed placement
Staffing volume	Time taken for documentation
Availability of beds	Time spent on floor
Communication method	Automation and standardization

A relationship between the input factors and the output factors was established by Cause and Effect analysis and is shown below in figure 2.

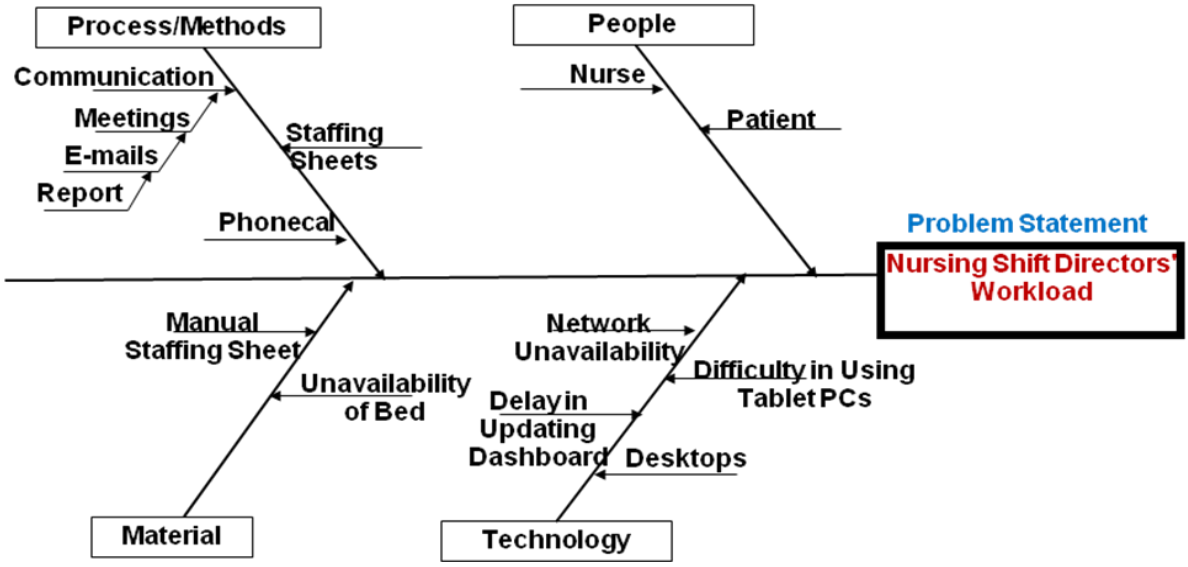

Figure 2: Cause & Effect Analysis

Measure

Shadowing of the NSDs as they worked was the primary tool used during this project for gathering the baseline data as the hospital did not have any existing data. Data was gathered for two weeks over three different shifts, morning, evening and midnight. It was found that the routine activities of the NSDs included documentation, communication (talking), floor visits (walking), phone calls, working on the computer and "Free time". Shadowing NSDs included following them and recording the time needed to complete each activity during a shift.

Analyze

In the analyze phase, a thorough data analyses was carried out to narrow down, from the trivial many reasons of a problem occurring, the critical few reasons. Summary of the analysis of data gathered is shown in table 2.

Table 2: Summary of activities of Nursing Shift Directors' in 2009

Symbol	Activities	% of time Consumed for 2009	Cumulative time distribution for 2009
	Documentation	39.0%	39.0%
	Phone calls	21.3%	60.3%
	Communication (Talk)	16.5%	76.8%
	Floor Visits (Walk)	9.5%	86.2%
	Computer	4.1%	90.3%
	Communication (Talk) & Floor visit	3.9%	94.2%
	Miscellaneous	2.9%	97.2%
	"Free" Time	2.8%	100.0%

It is evident that 76.8% of NSDs time is spent on documentation, phone calls and talking. The rest comprised of floor visits/walk, working on the computer, walking and floor visit, freetime and miscellaneous.

Further analysis of documentation and phoning (which are the two critical functions) shows staffing sheet update, report for next shift, file arrangement, bed placement, and patient update are the critical tasks which take up approximately 70% of documentation activity.

The next most time consuming activity, phone calls, are made regarding bed placement, staffing schedule, patient update, fax update, file retrival and meeting update issues. Among those, bed placement, staffing schedule and parient update take up 90% of the total time and the remaining activities constitute only 10% of the total time.

Improve

During the improve phase root-causes were identified and solutions were generated and tested by piloting. Data collected during this phase was reviewed against the baseline data as a measure of improvement.

The recommendations to improve the process were:

- Digitize the manual staffing form that that NSDs currently use for keeping the staffing log.
- Add a new menu to the hospital central database to show the patient length of stay and phone number.
- Upgrade the nurses' mobile phone units.
- Train and involve the employees to become familiar with the upgraded hospital central database.
- Install a digital staffing board on each floor indicating nurse availability.

After evaluation of the proposed solutions by the team and its sponsors, all solutions were implemented except for installing the digital staffing board due to budgetary constraints. The solutions that were implemented were focused on reducing the critical high time consuming tasks of the NSDs which were documentation, phone calls and communication (talk).

Documentation: Daily update meeting reports were eliminated and the need for fax updates was eliminated.

Phone Call Activity: The number of dropped calls between staff was minimized and the number of needed phone calls was reduced.

Improve Communication: Use of technology made the scheduled meeting for NSDs redundant, reducing the amount of non value-added conversation regarding nurse and patient updates.

Control

In the control phase, the improvements that were identified during the improve phase were documented and thoroughly captured. A roadmap of solving the problem was established. Implementation plans as well as change management procedures were suggested to ensure the successful transition of the solution to the team that was ultimately responsible for the process. In order to maintain the sustainability the gains made from the process improvements it was suggested that the use of new technology and the implemented solutions be monitored by the NSD and results tracked in NSD's performance appraisals.

Project Results

After one year of the solutions being implemented, post improvement data was again gathered by the same shadowing method of the NSD to compare current NSD activities to the baseline data. It was found that the critical few activities conducted by NSDs after the process improvement was complete had reduced documentation from 39% to 26% of their daily activities, reduced phonealls from 21% to 13% of their daily activities and while communication improved the actual amount of time spent talking was reduced from 16% to 14%. These improvements were a result of the implemeted solutions that increased computer use-time from 4% to 12% of their daily activities but as an overall improvement the free time of the NSD was increased from 2% to 19%. This time saved has been utilized to enhance patient care which includes strategic, administrative and other value-added tasks such as bed placement, additional floor visits and

improved employee satisfaction. A summary of pre and post improvements for NSD activity time data are given in table 3 and figure 3.

Table 3: Summary of Percentage change in activity time-pre and post improvements

Symbols	Activities	% of time Consumed for 2009	% of time Consumed for 2010	% Change from 2009 to 2010
	Documentation	**39.0%**	**26.20%**	**-12.84%**
	Phone calls	**21.3%**	**13.40%**	**-7.86%**
	Communication (Talk)	**16.5%**	**14.30%**	**-2.20%**
	Floor visits (Walk)	**9.5%**	**8.50%**	**-0.95%**
	Computer	**4.1%**	**12.90%**	**8.84%**
	Communication (Talk) & Floor visit	**3.9%**	**3.10%**	**-0.84%**
	Miscellaneous	**2.9%**	**2.00%**	**-0.94%**
	Free Time	**2.8%**	**19.60%**	**16.78%**

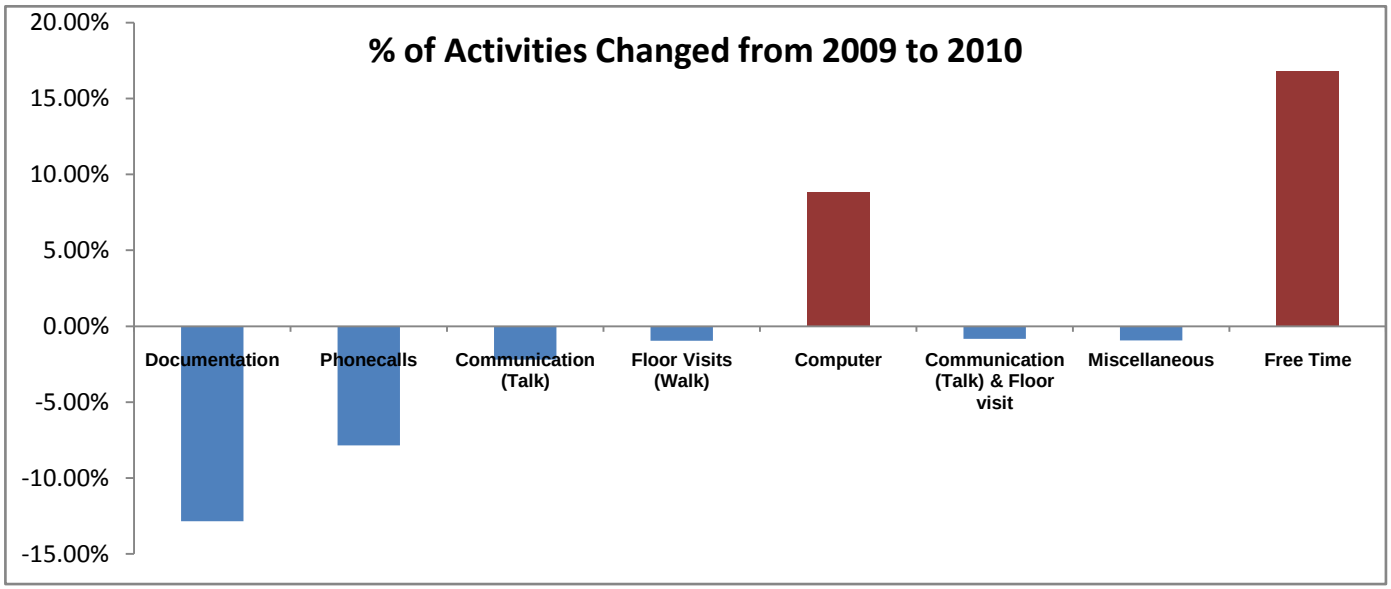

Figure 3 Percentage change in activity times from 2009 to 2010

Conclusion

This graduate level directed project allowed concepts and techniques from several courses in the MS Technology program at Purdue University Calumet to be applied in a business setting. This project focused in industrial engineering technology, therefore some of these concepts include:

- *The DMAIC methodology*, a consistent and standardized way of problem solving as used in *Six Sigma method* was applied throughout the organization.
- *Lean techniques* such as identifying non value-added tasks were utilized to reduce waste and increase better utilization of NSDs shift time.

- *Process observation charting* as was developed to identify the current state process.
- *Pareto analysis* which was applied to distinguish the critical few from the trivial many time consuming activities.
- *Training* which was initiated to create ownership of the project.To facilitate training, a workshop was developed and presented to the staff. This allows the staff to sustain the achieved benefits in the future as well as to undertake new Lean Six Sigma projects.
- *Performance appraisal* changes that were recommended to aid in the sustainability of this project and hold the gains in improved efficiency.

The project combined all the theory and concepts taught in the Purdue University Calumet MS Technology degree and enabled this author to tie these concepts to the real world. One of the additional benefits of this project that the author received was the successful attainment of certification as a Six Sigma Green Belt awarded by the American Society for Quality (ASQ) which can be directly attributed to real world experience attained by the author accomplishing this project.

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