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Applying lean thinking in an educational institute – an action research

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Abstract

Purpose – Lean thinking (LT) has been implemented in various manufacturing and service sectors. But, only a few published research articles have developed a framework describing the procedure for implementing LT in an educational institute. The purpose of this paper is to develop and demonstrate a framework that can provide a structured procedure for the implementation of LT in an educational institute.

Design/methodology/approach – Various LT tools and techniques applicable in educational institute were identified by reviewing the relevant literature. By adopting an action research methodology (ARM) for a time period of 28 months, the processes in a case institute were studied; wastes in the process were identified and various solutions were proposed and implemented.

Findings – A comparison of the performance measures before (Batch 1) and after (Batch 2) implementation of solutions provided interesting insights into the effectiveness of LT. In both the batches, absenteeism in the class was found to increase across the terms. But the magnitude of increase was lesser in Batch 2. Results also showed that the number of unfilled seats (poor utilization) in an elective course in the second year of the program drastically reduced in Batch 2. Finally, a framework that can guide LT implementation in educational institutes was proposed.

Research limitations/implications – The current study describes only the initial stages of implementation in an educational institute. Hence, some of the benefits discussed are expected in the long run which can be assessed by carrying out a longitudinal study. Future study can attempt to empirically validate the proposed framework in multiple educational institutes and theoretically explain the reasons behind the results obtained.

Practical implications – ARM can be used as a tool by practitioners to study the behavioral aspects of employees of educational institutes toward LT implementation. The proposed framework and its demonstration can assist employees in educational institutes to implement LT. Positive results obtained in this study can further motivate the educational institutes to consider LT as a potential tool for improving the processes.

Originality/value – This is the first study to develop and validate a framework for structured implementation of LT in the processes of an educational institute. The study is also unique in empirically capturing the impact of LT implementation of an educational institute by analyzing the archived data.

Keywords Framework, Lean thinking, Higher education, Implementation, Process improvement, Action research

Paper type Research paper

1. Introduction

Excellence in quality and efficiency in processes have gained significant importance in educational institutes (Sunder, 2016; Handy, 2002; Doria *et al.*, 2003; Ghoshal, 2003; Grey, 2004). Research studies have documented how educational institutes have catered to this need by adopting different process improvement philosophies such as total quality management (TQM) (Mergen *et al.*, 2000; Mizikaci, 2003; Sahney *et al.*, 2003; Bayraktar *et al.*, 2008; Sharabi, 2013, etc.), six sigma (Sunder, 2014), lean six sigma (Furterer, 2009; Antony *et al.*, 2012; Antony, 2014; Sunder, 2016), and lean thinking (LT) (Comm and Mathaisel, 2005a, b; Maguad, 2007). TQM and six sigma philosophies have got a structured framework and guidelines to assist in their adoption and implementation to address a certain objective in a particular context. For instance, Bayraktar *et al.* (2008) conducted a thorough review of TQM literature to identify 11 critical areas of TQM in higher education institutes (HEI) (e.g. leadership, vision,

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student focus, etc.) and constructed an instrument to measure and evaluate the TQM practices in HEI. Similarly, Sunder (2014) has proposed a Six Sigma implementation model for higher education providers. But even though many educational institutes have seen value in implementing LT (refer to the literature review, Section 2.2), none of them have developed and validated a framework that can guide the structured implementation of LT in the processes of an educational institute. This study addresses this gap by developing a step-by-step framework with associated lean practices and performance measures. The framework developed is validated by studying the lean implementation experience of an educational institute in India using the action research methodology (ARM).

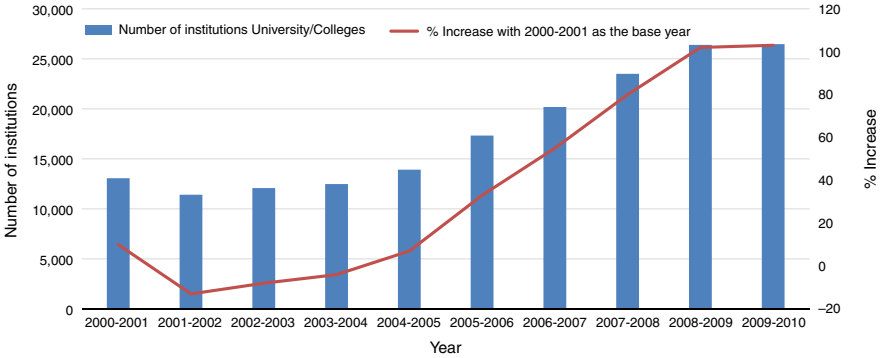
Lean implementation in the manufacturing sector has been widely studied (Narayanamurthy and Gurumurthy, 2016). Over the past four decades, researchers have come up with various frameworks and procedures for implementing lean in the manufacturing sector (Stone, 2012; Shah and Ward, 2007). In recent years, the concept of lean has been implemented in diverse service domains such as software development (Staats *et al.*, 2011; Widman *et al.*, 2010; Narayanamurthy, Gurumurthy and Balagangatharan, 2017, etc.) and healthcare services (Atkinson and Mukaetova-Ladinska, 2012; Martin *et al.*, 2012; LaGanga, 2011; Kollberg *et al.*, 2006; Narayanamurthy, Gurumurthy and Lankayil, 2017, etc.) under the nomenclature of LT. However, studies discussing LT in the service domain from an Indian context are very few in number. Further narrowing down, no study in the literature has so far applied LT to Indian education services. In this study, the experience of implementing various solutions to achieve process improvement in an educational institute (i.e. a business school in South India) is documented using the lens of LT. Change in performance measures such as absenteeism, utilization, and learning before and after LT implementation are also documented.

1.1 Challenges for Indian management education

In the decade 2000-2010, the number of universities and colleges in India has grown by more than 100 percent (see Figure 1).

Agarwal (2009) noted that a number of universities and colleges in the formal system of higher education in India is four times that of HEI in both USA and Europe. Enrollment of students to these institutes also doubled from 2002 to 2007[1]. Despite such positive signs, the education sector is facing the following challenges:

(1) Although the number of institutes increased rapidly, the number of good quality institutes was less, thereby creating high competition among students for good



Notes: Graph constructed using data on Educational Institutions, Scholars and Expenditure (All India). Data available at http://data.gov.in/catalog/educational-institutions-scholars-and-expenditure-all-india#web_catalog _tabs_block_10 (accessed August 9, 2014)

Figure 1.
The growing number of educational institutions (university/colleges) in India

quality education (Agarwal, 2009). This was commonly observed across different education streams including management. Very few good quality management institutes such as the Indian Institute of Management (IIMs) were highly preferred by aspiring managers.

(2) According to the All India Council for Technical Education, more than 160 Indian management schools in cities such as the Delhi – National Capital Region, Mumbai, Bangalore, Ahmedabad, Kolkata, Lucknow, and Dehradun were shut down during 2012 and 2013, due to poor quality and inability to run it at full utilization (Murray, 2014).

(3) A recent article in *The Economist* (2016) commented that despite India being the world's largest provider of management education, the intake for a quarter of business schools is fewer than 60 candidates in each annual cohort. The All India Management Association, a national body commented that this class size of 60 to be "abysmally low."

(4) Another important challenge is that the Government of India has recently directed all the premier HEI such as IIMs, Indian Institutes of Technology, National Institutes of Technology, and central universities to increase the intake to accommodate more students and also to offer diverse degree programs and specialization. At the same time, these HEI are required to pay more attention to the quality of teaching and research (Smeby, 2003; Bhattacharya, 2010).

Specifically, the last challenge mentioned above is analogous to the scenario in the manufacturing industry, where quality and variety along with cost efficiency (i.e. utilization) act as order qualifiers. It is difficult for the manufacturing firms to sustain in the market by targeting only one of the order qualifiers, i.e. high quality with less variety (standardized product family) or high variety with less quality (craft manufacturing without efficiency). Hence, many manufacturing organizations have relied on LT to address it. Taking a cue from this phenomenon, it is proposed that the educational institutes too can address these challenges by implementing LT.

1.2 Motivation

Implementing LT provides an opportunity for educational institutes to improve their academic and administrative processes and in turn their market competitiveness. Comm and Mathaisel (2003) supported this claim by stating that the application of LT and other cost-reduction strategies have huge potential in the educational sector. They noted that implementation of lean initiatives will be considered very critical and important for quality improvement and for institute's sustainability in future. Flumerfelt (2008) mentioned that "it would be a mistake for educators to dismiss lean without understanding it as LT provides excellent opportunities to solve the problems such as inadequate funding, ineffective remediation, and lack of developmental learning opportunities." Flumerfelt and Green (2013) stated that LT can be used by schools to improve processes ranging from the core technology for delivery of instruction to administrative support. Significant potential of LT in the education sector has attracted consulting firms such as Lean Education Enterprise Inc. to get involved with K-12 schools to implement process improvements. Some of the projects undertaken by the consulting firm includes instructional time recovery to meet the curriculum goals (resulted in the recovery of 120 hours of instructional time per teacher over a nine-month period), improving math scores in title-1 school (yielded an average improvement of 116 percent in the scores), improve the supply chain procurement process to meet district strategic and funding goals (the district reduced the supply budget by 39.6 percent, thereby saving taxpayers money of $174,941 over a period of three years which was used to purchase

200 computers and also make other investments), and meeting standards to achieve 100 percent accreditation (the accreditation rate improved from 82 to 88 percent within ten weeks of implementing the improvement program). Both research and practice have only anecdotally indicated the effectiveness of LT in improving the processes of an educational institute. This was also one of the motivations for the authors to carry out a study that documents the implementation of LT from the Indian context.

The rest of the paper is structured as shown in Figure 2.

2. Literature review

The review is broadly classified into three categories: the existing frameworks for LT implementation in an educational institute, case examples of educational institute implementing LT, and LT for education/teaching process. The review of the existing frameworks helps us to understand how these frameworks provide the necessary guidelines for implementing LT, while a review of case studies on LT implementation in educational institutes and in the teaching processes helped us to understand the steps involved, the more frequently and least frequently used elements, performance metrics monitored, etc.

2.1 Existing frameworks for LT implementation in educational institutes

Alp (2001) developed a model showing how the lean principles can be used to transform the College of Engineering at University of Tennessee at Chattanooga to a lean organization. The objective of the model was to identify the ultimate customer, use the value stream mapping (VSM) to remove waste from the system, create flows for the value, pull each element when needed, and finally to pursue perfection. Comm and Mathaisel (2003) listed the following nine practices to help colleges and universities in attaining lean sustainability: optimizing the flow of products and services, provide processes and technologies for seamless and timely transfer of and access to pertinent data and information, optimize the capability and utilization of people, implement integrated product and process development teams, develop relationships based on mutual trust and commitment, continuously focus on the customer, promote LT at all levels, continuous process improvement, and maximize stability in a changing environment. Moore *et al.* (2007) documented the experience of the University of Central Oklahoma

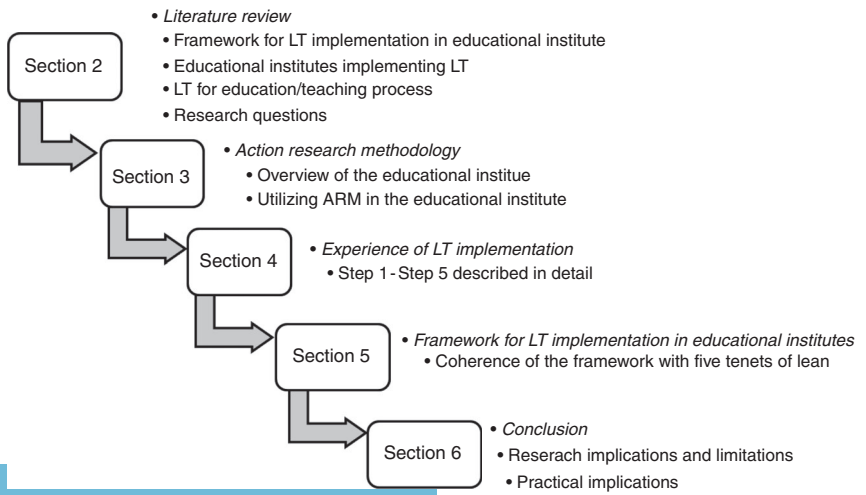


Figure 2.
Structure of the paper

which has embraced the concept of LT on facing significant financial issues. LT was introduced in the administration area of the institute through a comprehensive employee training program, creating more efficient job processes, and generating greater job satisfaction through job improvements. They proposed a four-step lean enterprise model: identify the opportunities, solution design, implementation, and continuous improvement. Hines and Lethbridge (2008) explained the advantages of applying LT to universities and proposed a lean iceberg model to develop an effective lean enterprise in a university environment. They applied LT in a client university whose objective was to become a top 50 university. A lean core team was formed to translate the lean value system to an academic environment.

Some of the gaps identified in the above studies proposing the frameworks are listed below:

(1) Alp (2001) only documented the process flowchart after applying LT and compared the education procedures followed before and after implementing LT.

(2) In the case of Comm and Mathaisel (2003), the practices listed were not structured to provide a roadmap and thereby guide the university throughout the process of implementing LT. Performance measures for assessing the extent of leanness attained was also not discussed for the various LT practices that were mentioned.

(3) Moore *et al.* (2007) did not document the construction of VSM mentioned in the solution design step. It left the readers with difficulty to understand the application of lean tools for identifying wastes and solutions. In addition, this study did not appear in a peer-reviewed journal.

(4) Hines and Lethbridge (2008) have only reported the experience of a case organization without discussing much on the lean tools and techniques deployed. They only proposed a model (the Lean Iceberg Model), but failed to validate it in detail using the experience of the case organization discussed. In this study, Hines and Lethbridge (2008) also observed that the studies by Alp (2001) and Comm and Mathaisel (2005a, b) have been largely delivered from a theoretical, generalist perspective, without empirically contextualizing to the context of educational institutes.

(5) In addition to the above shortcomings, the existing literature has not addressed the following:

- Contextualizing the classic list of seven wastes (wastes due to transportation, inventory, motion, waiting, overproduction, overprocessing, and defects) proposed by Taiichi Ohno within the education sector.
- Selection of lean elements and usage of performance metrics to assess the improvements attained.

The current study also attempts to fill these gaps.

2.2 Educational institutes implementing LT

Educational institutes such as the University of Central Oklahoma, University of Wisconsin – Madison, University of Virginia, University of Michigan, Miami University, St. Andrews University, and University of Washington have pursued implementation of LT. Kallam (2013) described the implementation of LT in these institutes (summary of the description is provided in Table AI). In addition, a few researchers have also demonstrated the implementation of LT in educational institutes without specifying the name of the institutes (listed in Table I). Although the potential for implementing LT in educational institutes is well recognized in both literature and practice, none of the existing studies have shown a step-by-step roadmap with procedures to be followed by an educational institute in implementing LT.

Authors	Remarks	Drivers, lean principles, practices, and performance measures
Comm and Mathaisel (2005a)	Studied the application of the concepts of lean and sustainability to higher education by collecting data using a questionnaire from 18 public and private universities	Factors: budget allocation, compensation package, competitive trends, vision communication, customer feedback, employee empowerment, institutional culture, leadership philosophy, organizational structure, supplier relationships, and technology. Data were also collected on the adoption of nine overarching practices discussed in Comm and Mathaisel (2003)
Comm and Mathaisel (2005b)	Surveyed 18 public and private universities representatives by administering an open-ended qualitative questionnaire and identified best lean practices at the institutional level, which were felt to contribute to the sustainability of their universities	Drivers: state funding cuts, increasing enrollment numbers, union contracts, overall state of the economy, increasing demands of applicants for continuously improving campus amenities and perceived quality beyond the classroom Initiatives: outsourcing, collaborative efforts, use of technology, use of excess capabilities (physical plant space, services, network bandwidth, and professional expertise), reduction and elimination of duplicate effort, staff reductions, closing non-core operations, feedback through survey and benchmarking, open communication and dialogue, centralized purchasing and vendor management, streamlined online human resources systems, encouraging customer involvement in lean initiatives, etc. Metrics: schools pointed to the importance of ratios such as endowment per student, annual cost per student, square footage space per student, and technology usage per student. It was also noticed that there were no global standards in metrics to follow
Maguad (2007)	Used LT for eliminating wastes in the educational sector to cut costs and ultimately improve teaching and learning activities in schools	Various LT practices were discussed including 5S (can be implemented in supply rooms or storage rooms), mistake proofing (preventing a student from going forward if the prerequisites are not satisfied such as stopping from registering for a course when not eligible, device to shut off office or classroom lights), VSM (no quantification of process metrics, only captures the process flow), quick changeover, self-inspection, total productive maintenance, kaizen, and teamwork environment. The paper gives a general description of these practices and explains the need for LT in educational institutes. The experience of implementing these practices in the context of educational institute context was not discussed
Furterer (2009)	Improved the "discipline" process in the school by adapting and implementing Lean Six Sigma (LSS). Discipline process comprises several subprocesses that	Used both lean and six sigma tools such as Define, Measure, Analyze, Improve, and Control (DMAIC), Supplier-Input-Process-Output-Customer

(*continued*)

Table I.
Review of the articles discussing lean in educational institute

Table I.

Authors	Remarks	Drivers, lean principles, practices, and performance measures
	work together to achieve an environment conducive to quality learning. Some of the practices considered were minimizing classroom disruptions, minimize school discipline referrals, level of knowledge of the student code of conduct, and consistency of offenses and actions	(SIPOC), Pareto charts, process mapping, voice of customer surveys, voice of process matrix, Quality Function Deployment (QFD), etc.
Jin and Kachroo (2010)	Focused on the implementation of LT to improve the efficiency of admissions office which handles the admission of domestic, international, graduate, undergraduate, freshman, and transfer students. The reason for implementing LT is that the efficiency of this department's work affects the enrollment and student retention at the university	Some of the lean principles implemented are the standard operation procedure (recommended the modification of graduate and undergraduate catalogues), load balancing (Heijunka) (new way of work distribution among the employees was proposed), flow (implement lean principles in other departments on which admissions office relies for processing), continuous improvement (suggestions were made to conduct surveys on student satisfaction with the admissions office)
Langer (2011)	Analyzed how principles of LT can be adapted to a higher education context by studying three UK universities. Qualitative methods, namely semi-structured interviews and document analysis, were used and it was inferred that LT can be applied with less spectacular results than in manufacturing	Enablers/barriers: were identified organizational culture and structures, awareness, and change capacity. Using these enablers and barriers, the level of organization readiness was evaluated. The impact of LT was assessed through performance measures such as efficiency improvement (staff time savings), cost savings, lead time reduction, WIP reduction (queue length in services), quality/fewer defects, customer satisfaction, employee satisfaction, and cultural change
Antony *et al.* (2012)	Critically evaluated whether LSS can be a powerful business improvement methodology for improving the efficiency and effectiveness of HEIs by using secondary data from the literature	Issues/barriers: problem with the lean terminologies, lack of systems perspective, lean viewed as quick-fix, lack of cultural readiness, lack of communication, lack of resources (time, budget, etc.), and a weak link between the continuous improvement projects and the strategic objectives Critical success factors: top management support, effective communication, strategic and visionary leadership, developing organizational readiness, resources and skills to facilitate implementation, project selection and prioritization, and knowledge on tools and techniques (VSM, cause and effect analysis, visual management, Pareto analysis, project charter, SIPOC, Rapid Improvement Workshop (RIW)). Although a comprehensive list of success factors for implementing LSS was identified, the contextual adaptation of LSS for the educational institute was not provided

(*continued*)

Authors	Remarks	Drivers, lean principles, practices, and performance measures
Antony (2014)	Identified the prerequisites (i.e. readiness factors) for successful implementation of an LSS initiative in higher education sector based on the existing literature and authors' experiences	Readiness factors: leadership and vision, management commitment and resources, linking LSS to university's strategy, customer focus, and selecting the right people
Sunder (2016)	Applied LSS in a university library process and discussed the value that LSS can bring to the higher education system	Factors differentiating education institutes from manufacturing units: market perspectives, customer definition, defect detection, unevenness, measurement system, inseparability, and people perspectives Principles, tools, and practices: failure mode and effects analysis, kaizen, refined workflow, improved employee and customer satisfaction, breeding excitement for future improvements, training, student-centric approach, student engagement, student flagging, root cause analysis, DMAIC, plan-do-check-act (PDCA), etc. Performance indicators: university ranking, number of research papers published per department, quality of research, pass percentage of students in a class, turnaround time of different processes, overall student satisfaction score, laboratory equipment availability, college maintenance and infrastructure metrics, food wastage in University cafeteria, computer systems downtime at colleges, number of students placed at corporate jobs, salary range of graduated students from the University, faculty members' standard of teaching, student's absenteeism, accuracy of medical prescriptions at University clinics, paper consumption in the photocopying department, facilities at college gymnasium and sports center, residential facilities at hostel rooms, effectiveness of accreditation process, etc.

Table I.

2.3 LT for education/teaching process

Table II reviews the literature on LT implementation in the teaching process with an objective to improve specific degree programs than the institute's processes as a whole.

Authors	Remarks	Drivers, lean principles, practices, and performance measures
Cookson (2003)	Discussed five core values of LT that may be applied to the improvement and evaluation of network-based distance education systems	Five core principles: identifying aspects of the educational service learners regarded as value, mapping the value stream to understand the different educational services provided by the institution; steady flow of educational services without the periodic strain of responding to peak periods and relatively low periods, increased speed with which the educational services flow from the institution to the learners (pull), and perfection in terms of high quality of educational services
Emiliani (2004)	Studied the design and delivery of a graduate business course on leadership for the part-time working professional students apart from describing the application of lean principles and practices to improve course consistency	Lean principle/practices implemented were continuous improvement, 5S, just-in-time, load smoothing, standard work, visual controls, and respect for people
Emiliani (2005)	Used kaizen to improve the processes for ten courses contained in a part-time executive master's degree program in management	Helped in improving the purpose and course objectives, attributes of content, organization and sequence, and classroom experience
Emiliani (2006)	Suggested 11 practical improvement areas for correcting deficiencies in courses and degree programs and also proposed an improved Master of Business Administration (MBA) curriculum	LT practices and tools implemented were problem recognition, root cause analysis and countermeasures, results-only focus versus focus on the process to achieve results as well as results, value added and waste, performance metrics, and respect for people
Stratton *et al.* (2007)	Utilized lean production from industry to improve the medical education process by introducing hybrid curricular quality-assurance governance structure at the University of Kentucky College of Medicine	Practices implemented: systematic quality control; consistency of evaluation; systems to establish ongoing student and faculty input, responsibilities, and budgeting; unrestricted and timely flow of data to key decision-makers at both the institutional and individual levels; and robust, accurate, and comprehensive means of monitoring system performance
Doman (2011)	Used lean principles and practices to improve university's grade change processes	Identified four wastes: over processing or incorrect processing, correction, and knowledge disconnection Practices: process mapping, VSM, and A3 methodology (consisted of theme, background, current condition, cause analysis, target condition, implementation plan, and follow-up) Performance measures: number of grade changes, cycle time, and number of disapprovals from college/school and the instructor
Flumerfelt and Green (2013)	Described the use of continuous improvement to achieve instructional and instructional technology improvement with the help of an example of a high school	The performance measures considered were the ratio of time allocated to task/relational activities and to passive/active learning, and the amount of time allocated to a new learning opportunity, individualization, and differentiation

Table II.
Review of the articles describing lean in teaching process

2.4 Research questions (RQs)

Based on the detailed review carried out, the following RQs were identified:

RQ1. How should an educational institute implement LT? Can a framework (structured procedure) be developed to assist educational institutes in implementing LT?

RQ2. What are the wastes prevailing in the processes of an educational institute and how they can be addressed using the tools and techniques of LT?

To answer these RQs, the experience of implementing process improvement in an educational institute is documented using the lens of LT by adopting ARM.

3. ARM

ARM was defined by French and Bell (1973) as a "research technique that relies on the application of the scientific method of fact finding and experimentation to practical problems requiring action solutions and involving the collaboration of scientists, practitioners, and laymen." According to Benbasat *et al.* (1987), an action researcher is a participant and not an independent observer in a system's implementation who simultaneously evaluates a certain intervention technique. Intervention technique in this study is the implementation of process improvements using the lens of LT in an educational institute. Wood-Harper (1985) state that action research is one among the most effective approaches for technique development. Similarly, the underlying objective of this study is to propose and demonstrate a framework for deploying LT for an educational institute. Westbrook (1995) explains action research as a variant of case research, where a case researcher is an independent observer and an action researcher is a participant observer. In this study, the process improvements were studied by the author(s), who participated in the implementation. One of the authors was a part of the deployment team responsible for carrying out process improvements, while the other author experienced the changes during the implementation by being a student in the batch. Authors did not interact or influence each other during the implementation period to achieve unbiased interpretations. This acts as the primary source of data for answering the RQs listed earlier.

Pasmore and Friedlander (1982) stress the value of ARM as a means of generating and assessing involvement and collaboration of employees on new initiatives. It is a known fact that implementing LT completely depends on the involvement and collaboration of employees. Moreover, the objective of this study was to document the implementation of LT and its impact; ARM was felt to be appropriate for this research. The biggest advantage of action research is that it emphasizes the importance of understanding the total situation rather than abstracting it with a few measurable variables. By trading off with objectivity and rigorous relationship establishment among different variables, it helps in developing a broad conceptual basis leading to theory building. Pasmore and Friedlander (1982) also mention that the value of adopting ARM gets enhanced while implementing the Japanese management techniques (or LT) as it involves group problem-solving than few members from the top management solving the problem (Gilmore and Smith, 1996). ARM had much to offer for this study as the researcher's role was that of a facilitator than an instigator (Gilmore and Smith, 1996). Therefore, ARM is chosen as an appropriate method to document the process and outcome of the implementation of process improvements using LT in an education institute.

3.1 Overview of the educational institute

Choice of the educational institute for the present study is primarily driven by the RQs raised. Educational institute selected for ARM is a business school located in South India with an administrative staff strength of 66 people and student strength of about 750 spread

across various programs. The institute comprises 64 full-time and 26 adjunct faculty members distributed across eight academic areas. The institute is 19 years old and has undergone significant changes over the period of its existence. The institute started with its first batch of 42 students in 1997 and increased the intake to 120 in 2003, 180 in 2005, 261 in 2008, 356 in 2012, and finally to 390 in 2016. The administration of the educational institute chosen had implemented several process changes in the academic program to improve the effectiveness of the processes delivering value to students. Motivation to implement process changes, in both core and non-core processes, were to reduce the non-value adding tasks and lean wastes. This enhances the relevance of applicability of ARM, which is usually guaranteed by working with management on an issue that the enterprise (educational institute in our study) is self-motivated to address (Westbrook, 1995).

The major functional areas in the institute are admission, alumni management, institute administration, academic administration, student affairs (scheduling and student body election coordination), placement, and research. The institute offers various programs such as the postgraduate program (PGP) in management, management development program (MDP), faculty development program (FDP), executive postgraduate program (EPGP), and fellow program in management (FPM). PGP is considered as the flagship course offered for two years on-campus. It comprises of six terms distributed equally across both the years. PGP is offered as a general management program, but students can customize their choice of electives to specialize in marketing, operations, finance, accounting, strategy, information systems, human resource (HR), etc. EPGP is predominantly an off-campus version of PGP offered as a two-year course for employed candidates who can take a major portion of the course through the Interactive Distance Learning platform. EPGP participants can attend the classes from the designated classroom centers at various locations and participate in the proceedings through two-way audio/video synchronous telecommunication channel. MDP is offered on a more focused topic for a shorter period of time – ranging from three days to three months – to people employed in organizations. FDP is offered for faculty members of other institutes for a shorter period of time – one week to a month – on a more specific area of relevance. EPGP also includes various one-year certificate programs for specializations such as marketing, strategy, etc., while MDP and FDP offer programs of diverse nature. FPM is a doctoral course designed for a normal period of four years where the student completes course work for first two years and works on a dissertation for the next two years.

3.2 Utilizing ARM in the educational institute

Table III presents the timeline of this research study and Table IV details the steps followed in applying ARM to answer the RQs raised.

The incoming batch size of 356 students during the year 2012 is considered as a reference as the study was planned during this year. The process improvements were continued in subsequent years and the corresponding changes were documented with necessary data to analyze "before" and "after" scenarios.

4. Experience of LT implementation

The experience of implementing process improvement in an educational institute using the lens of LT is documented below. A step-by-step description of the implementation experience helps in easy understanding and it is expected to ease the implementation of LT in other educational institutions in future.

Step 1 – understanding the various processes and stakeholders in an educational institute

This was accomplished by utilizing tools such as the supplier-input-process-output-customer (SIPOC) model and the process flow diagram.

Time period	Event	Remarks
June 2012	New academic year begins	Participant observation began from this stage. Processes in the institute were experienced just like any other stakeholders in the system
July 2012-October 2012	Term 1 of year 1	In all these three terms of the program, observer(s) got introduced to the system and its functioning. Repetition of terms provided with multiple similar experiences
October 2012-January 2013	Term 2 of year 1	
January 2013-March 2013	Term 3 of year 1	
April 2013-May 2013	Summer break	–
June 2013	New incoming batch enrollment	PGP academic program administration decided to implement process improvements in the system to improve its efficiency. These changes were experienced by the new incoming batch
July 2013-October 2013	Term 1 of year 2	In all these three terms of the program, observer(s) experienced the process changes implemented to improve its efficiency. Repetition of terms provided with multiple similar experiences and thereby helped in replicating and triangulating the patterns observed
October 2013-January 2014	Term 2 of year 2	
January 2014-March 2014	Term 3 of year 2	
April 2013-May 2013	Summer break	–
June 2014-October 2014	Data collection	Informal documentation which was carried out by the participant observer(s) during the study period was organized into patterns and related contents were grouped together for easy inference. Data such as attendance, feedback, etc. of the first year of the two batches were obtained from the program office. Data obtained were cleaned and subjected to analysis to answer the research questions raised

Table III.
Timeline of research study

S. no.	Step	Summary
1	Decide broad area of investigation	Investigate the experience and procedure of implementing LT in an educational institute
2	Design research around key method(s)	ARM was chosen based on research questions and convenience. The study was carried out for nearly two–and-a-half years
3	Focus: focus area of investigation, refine research method	An academic program within the educational institute was focused due to time and resource limitations of the institute as well as that of the participant observer(s). Comparison of certain metrics before and after LT implementation was studied
4	Develop: repeat method, develop theory	Due to multiple terms within a year, repetition of processes being studied was possible. It supported in replicating the study to confirm the outcomes and hence develop a concrete LT implementation model for educational institutes
5	Apply: express theory as applicable technique	The proposed framework for implementing LT was developed and demonstrated for an educational institute. This framework can be used for future applications in other institutes
6	Evaluate approach	Data were gathered both through participant observation during the study period and from the administration of the institute post the study period to evaluate the benefits, attained through LT implementation
7	Disseminate results	Learnings from this experience can be generalized for applying LT in other processes or other educational institutes

Source: Based on steps proposed by Westbrook (1995)

Table IV.
Details on action research methodology adopted

The SIPOC model. Table V shows the SIPOC model for the case organization. SIPOC has been borrowed from the tools of Six Sigma to understand the list of processes and stakeholders involved in the institute at a much broader level. Educational institutes are creating managers (output) by performing knowledge work (process) to add intellectual

Table V.
SIPOC for the case organization studied

Core Supplier	Input	Process	Output	Customer
• Undergraduate Colleges • Postgraduate Colleges • Experienced Employees from Industries • Faculty members from other institutes for upgrading their subject knowledge **Other Non-Core Suppliers** • Organizers of Entrance examination • Education content providers • Financing institutions such as Banks • Parents • Government	• Students • Qualified faculty members • Education content • Library • Invited expert talks • Infrastructure	• Admission • Registration • Inauguration • Orientation • **Learning: 6 terms** • Summer Placements • Internship • Foreign Exchange • Final Placements • Graduation • Alumni, etc.	• Successful graduates placed in an industry • Successful graduates not placed in an industry • Students who failed to graduate by not satisfying the minimum program qualification criteria • Competitions participated and won • Live projects completed for industries • Research papers authored with faculty members	• Industries • Educational institutes • Government • Non-governmental organizations

value to students (input). The definition of a customer is not explicit in the case of educational institutions (Kay *et al.*, 1997). Studies have discussed students, future employers, society (i.e. taxpayers) and other beneficiaries of the educational operations of the institution as customers. In this study, recruiters are being considered as customers for the institute, as students of flagship program from the management institute are delivered to industries to satisfy their requirements.

Understanding the processes at the macro level using the process flow diagram. Efforts were made to understand the various key processes of the entire educational institute at a macro level. Hence, a simple process flowchart was constructed as it helps in understanding the linkages between the processes. Some of the processes comprised various subprocesses/functions such as admissions, summer internship, learning, etc. Various stages present in the broad process flowchart of the entire educational institute are linked as shown in Figure 3.

Students interested in pursuing the flagship program (the equivalent of MBA) make an application and write Common Aptitude Test (CAT). On the basis of the score obtained in CAT, students are shortlisted for group discussion (GD) and interview. Finally, students are admitted based on their performance in GD and interview. After the orientation program, students begin their learning process by attending classes. At the end of the second year, after successfully completing the flagship program course, students receive their graduation certificate and become alumni of the institute. Interactions between all these processes and suppliers (both core and non-core), institute management, industries, etc., are shown in Figure 3.

Process selection at the overall organization level. Various stakeholders from different stages of the model can be involved in the construction of the process flow diagram. Potential stakeholders could include a representative from top management such as the director, deans, students, institute employees (both academic (faculty) and administrative (staff) employees), industry representatives, and government representatives (in board of governors). Similar to a product family (comprising a variety of products with slight changes in the features, components, etc.) in a manufacturing company, an educational institute offers various types of degree programs such as PGP, EPGP, FPM, etc. Each of these degree programs is different in their structure and processes as they cater to different needs of the market. Generally, a process associated with a product family that adds maximum value to the organization is chosen for lean implementation. In this study, the processes associated with the flagship PGP program are studied. This program utilizes the maximum amount of physical resources of the institute and hence contains the huge potential for the application of LT to establish flow, eliminate waste, save the resource, and add value. Process selection framework proposed by Narayanamurthy and Anand (2014) has also revealed that flagship program is the best candidate for LT implementation. Students, office staff, members of the faculty, etc., were identified as stakeholders for the program chosen. Figure 4 captures all the processes that a student undergoes after joining the flagship PGP program. This program involves three terms per year with summer

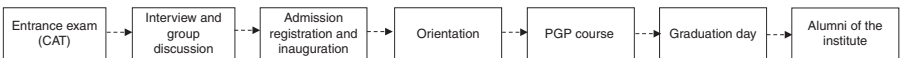


Figure 3.
Process flow diagram of the entire educational institute

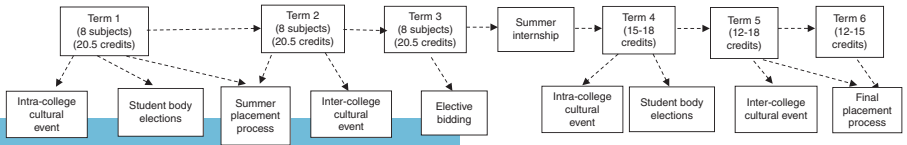


Figure 4.
Detailed process flow chart of the flagship program

internship program for two months between the first and second year. Activities associated with each process are listed in Figure 4. For instance, elective bidding for all three terms in the second year is performed in term 3 of the first year. Processes in the institute are cyclic in nature and repeat on term/yearly basis.

Step 2 – VSM of a specific process

To reduce the complexity, only those processes involved in a single term were chosen from Figure 4. An attempt was made to develop a VSM for the set of processes prevailing at a single-term level. There was difficulty in providing quantitative data for each process on lead time, throughput, delay, etc., as there was no clear-cut boundary between the different processes. Hence, the conventional way of developing VSM as prescribed by Rother and Shook (2003) based on the flow and discontinuity in the assembly process was suitably modified to address this issue. A rough-cut VSM for a single term is shown in Figure 5 and the details of each process in the single term are listed in Table VI. Table VI documents the prerequisite, process lead time, process time, and the number of people involved in individual subprocesses.

Every term comprises of a specific number of hours of teaching sessions for each of the courses, mostly distributed over three months. Usually, on a given day, three sessions before lunch and two sessions after lunch of 75 minutes each were scheduled. Quizzes (if any) were scheduled post-lunch, before the start of the afternoon sessions. Second-year sessions were usually scheduled for two hours with a ten-minute break in between and on average three sessions were scheduled per day. Each credit requires a process time of ten hours. For example, a course of three credits will have up to 30 hours of sessions and course of two credits will have up to 20 hours of the session. The scheduling process takes care of providing a gap to students for course preparation before attending the session. The stakeholders would include PGP students, PGP office staff, faculties handling courses, teaching assistants, student bodies and interest groups, library, etc.

Step 3 – identify the different types of wastes

As a result of the thorough study carried out, wastes in terms of non-value adding tasks were listed for each of the subprocesses identified at the single-term level. Table VII lists the different types of wastes identified at each of the subprocesses activities. As mentioned earlier, the seven wastes proposed by Taiichi Ohno has been contextualized within the domain of the educational institute.

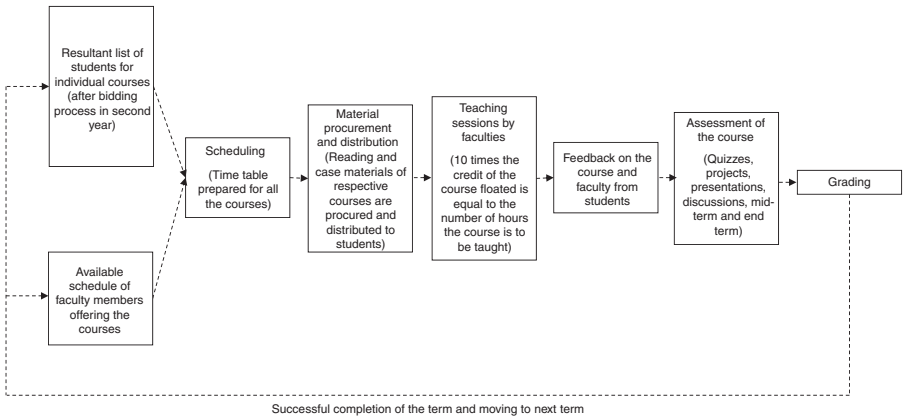


Figure 5.
Rough-cut VSM for single-term process of the flagship program

Note: It should be read in tandem with Table VI depicting rough cut VSM

Table VI.
Details of rough-cut VSM of single term

S. no.	Process	Prerequisite	Process lead time	Process time	No. of people involved
1	Scheduling	Outputs of bidding process (for last three terms) and availability of faculty members, timings, and venue for the course are decided	Nearly a month before the beginning of the term, schedule for the first month of the given term is shared with students through an online link. Schedule for subsequent months within a term is shared with students at least before a week of the beginning of the next month	Schedules are subjected to changes which force the extension of process time on scheduling through multiple reworks	Minimum is 2. But dynamically varies based on the task demand
2	Procurement and distribution	List of textbooks, case packs, reading materials, simulation software, etc., to be purchased. Decided by the faculty members of the course	Procured (nearly 1 month) and distributed (1 day) before the first day of every term	Books are purchased by placing orders to publishing or distribution houses by PGP office	Minimum is 2. But dynamically varies based on the task demand
3	Teaching	Scheduling, procurement, and distribution	Sessions of one hour fifteen minutes and on average five sessions per day	Each credit has a process time of ten hours	Average of 24 instructors with support from PGP office employees
4	Feedback	Last teaching session/after completion of the course to evaluate the content of the course, pedagogy adopted by faculty members, and their skills	Hardcopy of feedback forms are administered and the resulting feedback metric is used as an assessment component for evaluating the capability of faculty members. Varies from 15 to 45 days	Involve data entry, analysis, and summary documentation. It requires on an average about 120 minutes	Minimum is 6 as six sections of teaching happen simultaneously. But dynamically varies based on the task demand
5	Assessment	Distributed over the entire term to ensure continuous learning of students	Decision on assessment components is made by the faculty member of the course. Total time can be considered to be 1 term (3 months) as the assessment components such as quizzes, project presentations, mid-term, and end-term are distributed over the term	Total evaluation time is highly dependent on the assessment components employed by the faculty member and varies widely within the subjects	Quizzes, mid-term, and end-term are scheduled by program office employees whereas project presentation and discussions are scheduled by the concerned instructor themselves
6	Grading	Scores in different assessment components and corresponding weights/points allotted	Relative grading is adopted by faculty members and is mostly completed within a month after end term. Program office ensures that students are distributed across all the grades by fitting the final scores into a predetermined template	Usually, grading is performed before the mid-term of next term and within two weeks after end term of term 6. With the availability of scores, the entire grading process takes less than two days. In the case of discrepancies, the program office asks the instructors to rework their grading	Individual faculty member teaching the course perform grading and submit the individual component marks/grades of all their students to the program office, which will be released to students

Table VII.
Different wastes identified in the subprocesses of a single-term process flow chart

S. no.	Process	Problems identified	Wastes 1	2	3	4	5	6
1	Scheduling	(1) The schedule was released only on a monthly basis and was released before a week for next month to start	✓		✓			✓
		(2) Multiple reworks over scheduling	✓					
		(3) No or low involvement of faculty members in the process leading to multiple rescheduling	✓			✓		✓
		(4) Separate e-mails sent to students by the program office alerting the change in schedule and informing the schedule of quizzes, mid-term, and end-term examinations	✓	✓		✓		✓
		(5) Choice of venue for classes did not consider the movement of students from one session to another		✓				
		(6) Most of the quiz slots in between morning and afternoon sessions remain unutilized by the program office			✓			
		(7) The schedule was found to be distributed nonuniformly, i.e. it was varying from six to two sessions per day		✓	✓			
2	Procurement and distribution	(1) Printing of registration form from the program office portal at the start of every term before receiving the materials		✓	✓	✓		
		(2) Sometimes case books and materials were distributed after the start of the term	✓	✓	✓			
		(3) Availability of books and materials are notified individually through e-mails		✓	✓	✓		
3	Teaching sessions	(1) Delay of nearly 75 minutes between morning and afternoon sessions due to quiz slots		✓	✓			
		(2) Manual attendance is taken for every session in an attendance sheet by a faculty member or teaching assistant	✓		✓	✓		✓
		(3) Details from the attendance sheet are transferred to a template that captures the list of absentees by teaching assistant. Details of absentees are then transferred again to the online portal of attendance by the program office				✓		✓
		(4) Deviation in the course curriculum	✓		✓	✓		
		(5) High absenteeism of students in the classes that were scheduled on the days of quizzes	✓					✓
		(6) Overlapping of course contents of different but related courses	✓			✓	✓	
4	Feedback	(1) Use of hardcopy feedback forms				✓	✓	✓
		(2) Manual distribution and collection of feedback form during the final session of the course by the program office. This also led to missing of feedback (equivalent to defects) if a student was absent in the last session		✓	✓			✓
		(3) Data entry from the feedback forms into the data analysis software to evaluate the feedback metrics which brings in more chances of manual error	✓					✓
5	Assessment	(1) Hardcopy quiz papers (mostly multiple choice questions and one-word answers), manual correction, and manual data entry of the scores for grading	✓	✓	✓	✓	✓	✓
		(2) Descriptive exams (usually mid-term and end-term) conducted using hardcopy question papers and answer sheets		✓	✓			
		(3) Rework in evaluation process because of human errors	✓	✓	✓			✓
		(4) Different assessment pattern, assessment components, and marks allocation for the same course by different faculty members	✓			✓		
6	Grading	(1) Correction of mistakes (if any) in individual assessment components was not possible immediately, as the grades for these components were released only at the end of the term after completing all assessment components	✓		✓	✓		✓
		(2) Due to errors in few assessment components, reworking demands correction of the entire grading process	✓	✓	✓	✓		✓
		(3) Students' inability to regularly view individual component grades thereby not enabling them to understand current grade status and expected final grade			✓			✓
		(4) Evaluation and grading sheets are mailed by faculty members to the program office to upload the same in the online portal	✓	✓	✓	✓		✓

Notes: 1 – reworks; 2 – motion; 3 – waiting; 4 – overprocessing; 5 – overproduction; 6 – defects

Step 4 – identify lean solutions to eliminate the wastes

The solutions proposed to remove the wastes and non-value adding activities in different subprocesses at the single-term level are mentioned in Table VIII.

Table VIII also maps the solution proposed to the existing tools and practices of LT. Some of the solutions listed in Table VIII are detailed below.

Scheduling:

- Faculty members should be involved in the process of scheduling their classes. They can make use of the information on available slots to schedule the classes. This will also make them aware of open slots that can be used for rescheduling in future. This reduces the rescheduling lead time and also the number of reworks in future.

S.no.	Process	Solutions proposed	Lean tools and practices adopted
1	Scheduling	(1) Involvement of faculty members in the process of scheduling (2) Automatic notification of final schedule or change in schedule to the program office and students (3) Online timetable with different color codes for actual sessions, revised sessions, buffer sessions, etc. (4) Classroom allotment to ensure minimum movement and gap between sessions (5) Distribute class sessions uniformly throughout the term	(1) Cycle time and lead time reduction (2) Information sharing (3) Use of Electronic Data Interchange (EDI) (4) Stakeholder involvement in design (5) Workload smoothing (Heijunka) (6) Visual control
2	Procurement and distribution	(1) Adopt materials from Indian publishing houses wherever possible (2) Biometric system such as a finger print sensor or face recognition as sole authorization for several processes (3) Online portal notification for availability of course materials	(1) Process simplification (2) Poka-yoke (3) Information sharing (4) Cycle time and lead time reduction (5) Process standardization
3	Teaching Sessions	(1) Online attendance portal (2) Single-day scheduling of quizzes (3) Online portal for sharing course outlines	(1) Heijunka (helped in removing unused quiz slots in weekdays) (2) Information sharing (3) Communication between faculty members, students, and program office (4) Stakeholder involvement
4	Feedback	(1) Online feedback portal ensuring 100% feedback system	(1) Cycle time and lead time reduction (2) Use of EDI
5	Assessment	(1) Online examination portals (2) Online display of grades of components as and when evaluated (3) Standardization of assessment components and weights	(1) Cycle time, setup time, and lead time reduction (2) Information sharing (3) Heijunka (4) Process standardization (5) Poka-yoke
6	Grading	(1) Avoid reworking by displaying assessment component grades in the online portal as and when evaluated (2) Direct accessibility to online portals for faculty members to enter the evaluations and final grades	(1) Identifying problem at source (2) Information sharing

Table VIII. Details of the solutions proposed for problems and wastes identified

The proposed solution can be implemented through online timetable sheet accessible to instructors, teaching assistants, program office, and students. Same online timetable can also be used to display the schedules of quizzes, mid-term, and end-term examinations.

- Changes made by faculty members to the schedule will be automatically notified to the program office and students. This makes the scheduling process live and interfaced with all involved. This solution also replaces the present system of sending e-mails for alerting students about rescheduling of classes, and schedules of quizzes, mid-term, and end-term examinations.
- The entire term timetable for three months can be released. Changes incorporated in the online timetable can be tracked using different color codes.
- The schedule should also consider common students between different courses while allotting venues to ensure minimum movement between venues and gaps between sessions.
- The schedule can distribute classes uniformly throughout the term by attempting to schedule only three classes before lunch on every weekday. These solutions are expected to provide additional time for academic preparation and participation in other co-curricular and extra-curricular activities for students.

Learning management systems such as Moodle, Blackboard, Piazza, etc., can be used for sharing information such as the course outline, pedagogy, session plan, etc., to students to help them in making an informed decision in their elective choices. In addition, this portal also updates faculty members on courses offered by their colleagues. This could assist them in designing new courses without content overlap. This would also help the faculty members to integrate concepts from other related courses in their teaching sessions, thereby assisting students to connect the learnings from different courses.

Feedback:

- Online feedback system would remove the wastes of current hardcopy system, such as usage of paper resources and manual data inputting. Flexibility to provide feedback from other places, in addition to classrooms can increase the feedback percentage.

Implementation of this solution helps in reducing the cycle time and lead time, resources utilized (both paper and HRs), defects, and reworks by directly collecting the data in softcopy for the analysis.

Assessment:

- Online examination portals to conduct time-bound quizzes are proposed. They can automatically evaluate the responses submitted by students and display the results immediately. At the end, a database with all the scores will be created automatically for grading. Time-bound descriptive examinations can also be conducted using online portals.
- Reworks can be reduced by displaying the grades obtained in each component in the online portal immediately after their evaluation. This solution reduces the waiting for identifying the defects as the information is shared as and when generated. In the previous system, both cumulative and individual component grades were published in the online portal only after the end-term examinations.
- Standardization of assessment components and weights are proposed for similar courses even if handled by different faculty members.

Implementation of the proposed solutions helps in reducing the cycle time, resources used, etc., by implementing information sharing, poka-yoke, and process standardization. There is

no transfer of hardcopy answer scripts between the program office and the concerned course instructor for evaluation. Online examination portal directly delivers the softcopy answer scripts to the instructor for evaluation after the completion of the examinations. Grades attained after evaluation can be directly uploaded online for students' information. Online display of grades helps in workload smoothing. Corrections will be incorporated instantaneously after receiving the feedback from the student.

Grading:

- The solution proposed in the assessment process to display the component grades in online portal enables immediate correction in defects and thereby avoids complete reworking and delay in the grading process at later stages.
- Faculty members can be made to access directly the online portals to enter the evaluations and final grades with the help of teaching assistants. Changes (if any) after releasing the grades can also be incorporated by faculty members themselves as this might reduce the possibility of occurrence of defects. The program office and students can have access to view the changes that have been incorporated.

As explained under the assessment process above, implementation of the solutions proposed would lead to the adoption of lean practices such as information sharing, fast feedback, the involvement of student and instructors, workload smoothing, etc.

Other solutions. Some of the solutions proposed above require the adoption of software packages such as Learning Management Solution, Enterprise Resource Planning, etc., customized to an education institute. They are costly and require significant time before it can be put into action. Hence, some of the low hanging solutions were implemented in the institute with the help of the available resources. A list of the same is presented below:

- Websites demanding multiple logins were combined together under a single page with a single login.
- A fixed timetable was created with various logics such as a three-credit course having 30 hours of sessions would be scheduled on Monday, Wednesday, and Friday, while a two-credit course would be scheduled on Tuesday and Thursday every week. Thus, sessions were uniformly distributed, as much as possible, throughout the term with three sessions per day for five days in a week.
- All the quizzes were scheduled on Saturdays to ensure smooth flow of sessions in weekdays.
- Minimum movement of students and professors was achieved by scheduling subsequent sessions in the same or nearby classroom.
- All the course outlines of the approved elective courses were gathered and uploaded in the online portal.
- Course assessment components and weights of similar courses handled by different faculty members were standardized. This enabled faculty members to review course outlines of other related courses and design their course outline with minimum overlap. This helped students to plan their choices of electives by understanding why certain course needs to be taken and how it connects with courses already taken and to be taken in future.
- Additional hours were scheduled for each course in the beginning of the scheduling process to provide for unexpected class cancellations. This was informed to students while communicating the entire schedule. This helped in removing the last minute difficulties in finding a slot for canceled sessions.

- Additional sessions, canceled sessions, and conducted sessions were color coded in the online sheet by the program office. This ensured that students were aware of the entire schedule in the beginning including the additional sessions.
- Paperless online feedback system was pilot tested for a term (term 3 of Batch 2). It significantly reduced the man-hours required for collecting the feedback, loading the feedback scores into an excel sheet, etc. It also decreased the missing feedbacks and maximized the number of students providing their feedbacks.

Step 5 – identify and compare the change in performance measures for the process studied

Data were collected from the administration of the case institute for two batches of students (named as Batch 1 and Batch 2). Batch 1 represents "before LT implementation" and Batch 2 represents "post-LT implementation." Data were collected from the administrative office on the student attendance (for identifying absenteeism), elective choice, feedback, and grades for both the batches. The comparison was carried out between the batches to understand the impact of process improvement solutions implemented.

Table IX documents the increase in absenteeism across terms between Batch 1 and 2. Absenteeism here indicates the sum of the number of sessions (each 75 minutes) missed by students across all the courses in a particular term. For instance, 4,535 sessions were missed by students of Batch 1 in all the courses of term 1. In both the batches, the number of absenteeism was found to increase across the terms. However, it was found that the amount of increase has reduced in Batch 2.

The next interesting inference that was noticed across the terms between the batches was that the number of unfilled seats in an elective course in the second year of the program drastically reduced in Batch 2 (as shown in Table X). Availability of all the elective course outlines with the students provided them with an opportunity to make an informed decision by discussing with other students and focusing their bidding points on certain specific courses. Thus, it can be found that the courses which finally got subscribed had minimum unfilled seats in Batch 2 in comparison to Batch 1, thereby increasing the utilization of individual courses.

Table XI compares the missed feedback responses across the terms between the two batches. Feedback responses were obtained for the faculty members of a course in a term. For instance, if the same course in a classroom is shared between two instructors', students of that section have to fill two feedback forms, one for each faculty member. The feedback scores of multiple faculty members handling the same course was averaged to obtain a single score for the course. The total number of feedback responses was

Table IX.
Difference in the number of sessions absent by students across the terms

	Term 2-Term 1	Term 3-Term 2	Term 3-Term 1
Batch 1	646	563	1,209
Batch 2	748	270	1,018
Decrease in absenteeism (Batch 1-Batch 2)	−102	293	191

Table X.
Comparison of number of unfilled seats for electives offered in each term across two batches

	No. of electives floated	Batch 1	Batch 2	Difference (Batch 1-Batch 2)	Difference per elective
Term 4	19	216	156	60	3
Term 5	16	418	84	334	21
Term 6	15	126	79	47	3
Total	50	760	319	441	9

calculated by multiplying the number of courses in a term with the number of students. Missed feedback responses were comparatively lesser in Batch 2 due to the effect of some of the lean solutions implemented.

The current study describes only the initial stages of implementation in the educational institute and some of the benefits discussed are expected in future by implementing the rest of the proposed solutions. Table XII lists the performance measures specific to the process chosen as well as those measures that are common in all the process (in the last row). Due to the inability to track the data on these measures, analysis of these measures is not reported in this study. It is recommended that educational institutes implementing LT in teaching process can consider these proposed metrics and record relevant data from the beginning of the project.

5. Framework for LT implementation in educational institutes

As shown in Figure 6, the framework proposed to adopt LT in the process of an educational institute comprises of five steps. These steps are to be followed in sequence to implement LT:

- Step 1 – construction of process flow diagram of the entire organization.

Identify the stakeholders of the entire organization. This helps in understanding the holistic picture of the entire organization. This step also exposes various functional areas, associated processes, interdependency between processes and functional areas in a bigger picture at the organization level thereby would assist in attaining systemic improvement than local improvement. Include as much as quantitative and qualitative data at each process in the diagram that would help in the analysis to be performed in Step 2:

- Step 2 – construct the process flow diagram of a specific process to be studied.

Term	Batch 1 Responded	Batch 1 Total	Batch 2 Responded	Batch 2 Total	Missed responses (total responded) Batch 1	Batch 2
1	2,384	3,389	2,092	2,944	1,005	852
2	2,345	2,914	2,102	2,945	569	843
3	1,885	2,887	2,232	3,054	1,002	822

Table XI. Comparison of missed feedback responses in each term across two batches

S. no.	Process	Process metric
1	Scheduling	Absenteeism per course per term Maximum number classes scheduled per day Standard deviation of the number of sessions in a day per term Average number of absenteeism for classes on quiz days
2	Procurement and distribution	Cost of materials purchased to total program cost per term Number of days before which course materials are distributed
3	Feedback	Percentage of cost incurred to total cost per term Average number of absenteeism in feedback collection per course
4	Assessment	Average time in evaluating the quizzes (in minutes) Average task repetitions in assessment due to manual errors per evaluation per course (before and after standardization)
5	Grading	Average number of overall grade changes per course in a term
6	Common to all five process listed	Average number of reworks (per term), average number of defects (per term), average number of e-mails transacted, average waiting time, average student movement (in meters), average process lead time (in minutes), average process time (value added) (in minutes), and non-value added time (in minutes)

Table XII. Performance measures to evaluate the impact of LT implementation

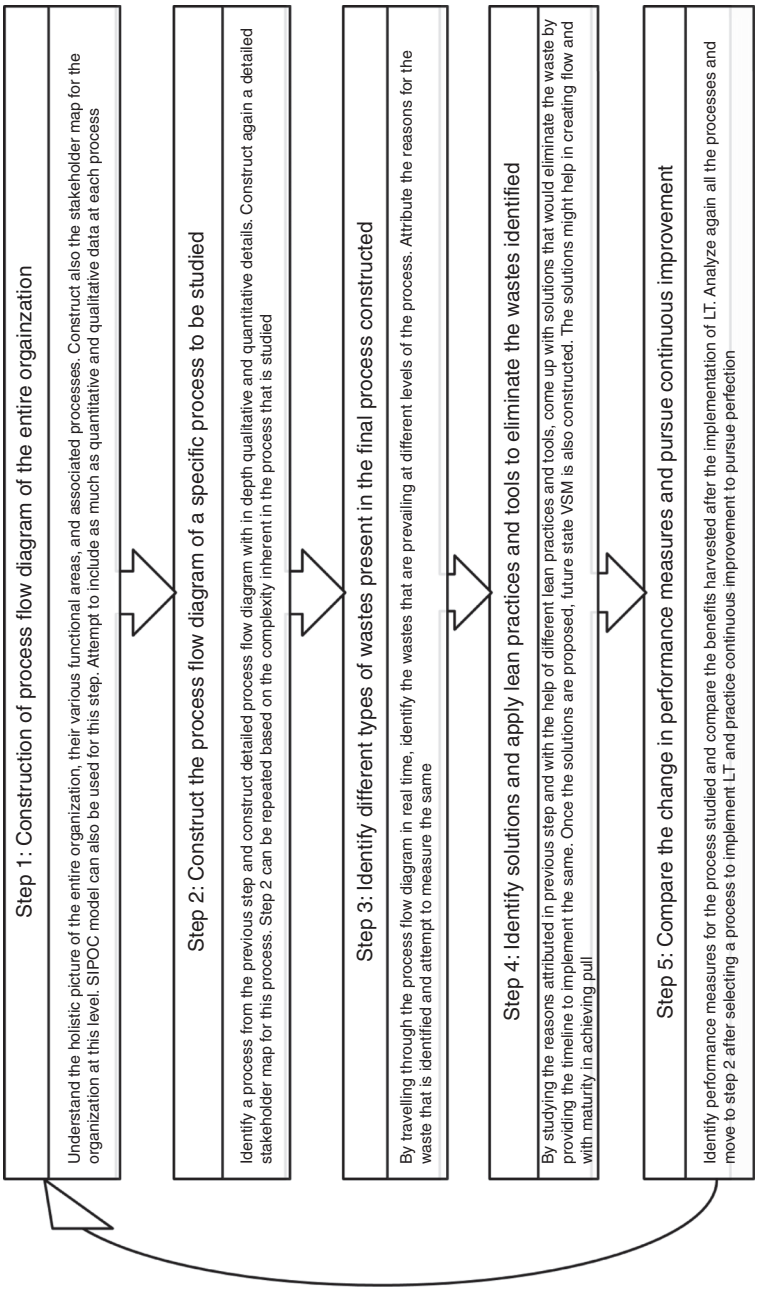


Figure 6.
Five-step framework for LT implementation in an educational institute

A process from Step 1 needs to be selected for further analysis. Specific stakeholders related to the selected process have to be involved. Stakeholder map constructed in Step 1 would help in identifying the process-specific stakeholders. Process selected can be further split into subprocesses based on the complexity involved and a suitable subprocess can be selected for LT application. A detailed process flow diagram of the selected process has to be constructed with in-depth qualitative and quantitative details. Qualitative and quantitative details would help in identifying wastes and quantification of benefits using performance metrics:

- Step 3 – identify different types of wastes present in the final process constructed.

From the data provided in the process flow diagram and by direct observation, different types of wastes that are prevailing at different levels of the process have to be identified. Seven wastes proposed within lean manufacturing can be suitably adapted to the context of LT in services as some of the wastes mentioned in manufacturing were not directly relevant to the context of educational institute. A modified set of six wastes identified in particular to this context were rework, motion, waiting, overprocessing, overproduction, and defects. The new waste introduced in this study namely "rework" differs from the traditional waste "defects." Defects that can be rectified can be categorized under reworks whereas those which cannot be rectified can be categorized directly under defects. For example, incorrect grading in the assessment step can be rectified by correcting the mistakes and changes can be notified to both the students and concerned administration. Hence, this can be called as rework. Absenteeism of students for sessions, incorrect question in a quiz identified after it has been conducted, incorrect or non-availability of reading materials for a session, etc., are some of the mistakes that cannot be rectified as the event has already occurred. Hence, these wastes will be categorized under defects. The quantum of wastes needs to be measured as it plays a significant role in achieving continuous improvement of the process:

- Step 4 – identify solutions and apply lean practices and tools to eliminate the wastes identified.

Lean tools and practices can be selected from the already existing comprehensive list. In addition, LT being a flexible methodology, its implementers can adapt the existing tools and practices to be more specific and applicable in the context of educational institutes. Once the solutions are proposed, future state VSM is constructed. The solutions might help in creating the flow and on achieving the results based on the implementation of basic tools, the institute can focus on implementing other advanced tools that can help in achieving pull:

- Step 5 – compare the change in performance measures and pursue continuous improvement.

Performance measures play a significant role in understanding the success of implementation of LT. Moreover, it helps in understanding the current situation and also provides the roadmap for continuous improvement based on the present or existing process performance measures. The benefits harvested can also be compared by evaluating the performance measures before and after the implementation of LT. Identification of performance metrics usually is left to the choice of implementers and completely depends on the nature of the process studied. After comparing the benefits, all the processes (including the one to which LT was applied) need to be analyzed and one process needs to be selected again to repeat from Steps 2 to 5 to pursue perfection through furthering kaizen (continuous improvement).

5.1 Coherence of the framework with five tenets of lean

The implementation framework proposed in this study specifically modified for the context of educational institutes is in alignment with the five tenets of lean proposed by Womack *et al.* (1990) which includes the following:

- Tenet 1: identify customers and specify value.
- Tenet 2: identify and map the value stream.
- Tenet 3: create flow by eliminating waste.
- Tenet 4: respond to customer pull.
- Tenet 5: pursue perfection.

Steps 1 and 2 of the framework proposed in this study dealt with specifying which service/output/program creates value and listed out all the steps along the process chain which forms the first two tenets (Tenets 1 and 2). Steps 3 and 4 of the proposed framework are related to Tenets 3 and 4. It helps in identifying the wastes, i.e. non-value adding activities from the customers' perspective and suggest the practitioner to suitably use lean practices as solutions to eliminate the wastes identified. The final step of the proposed framework dealt with assessment of the improvements attained by measuring the changes in performance metrics. Thus, Step 5 is in alignment with the last tenet of lean (Tenet 5). As the steps within the process of lean implementation move back and forth and also circles within the five tenets of lean, the proposed five-step framework also moves back and forth while implementing LT and circles within while progressing with LT implementation from one process to another (as shown in Figure 7). Moreover, the proposed framework clearly explains the relevant tools and techniques of LT for each stage of implementation. The proposed framework is also in alignment with the Define, Measure, Analyze, Improve, and Control (DMAIC) framework used in Six Sigma. Define is performed by Steps 1 and 2,

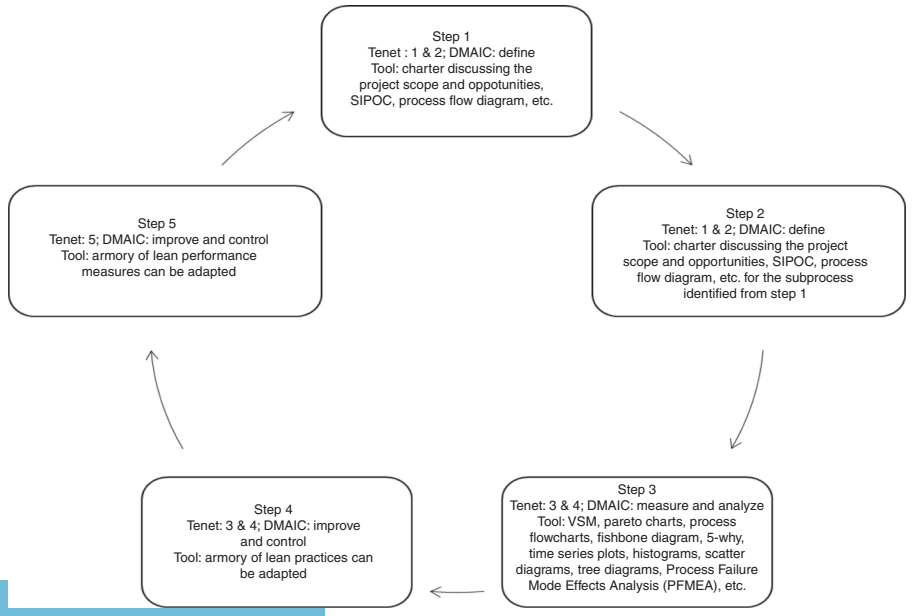


Figure 7.
Relationship of the five-step framework with tenets and DMAIC and possible tools for its implementation

Measure and Analyze is addressed by Step 3, and finally, Steps 4 and 5 is related to the phases of Improve, and Control. Some of the tools that can be borrowed at different steps from the armory of DMAIC and LT are listed in Figure 7. In addition, Figure 7 documents the correspondence of the tenets of lean and DMAIC with five steps of the proposed framework.

6. Conclusion

A literature review has shown the absence of a study describing the implementation of LT in the education sector from the Indian context. Research has not been pursued to develop a step-by-step detailed procedure to implement LT in the education sector. Hence in this study, by using ARM, the experience of implementing LT in an educational institute was documented. Based on the experience, a detailed framework has been proposed for implementing LT in educational institutes. This answers the *RQ1* raised in the beginning of this paper. In response to *RQ2*, the current study has identified the general set of wastes and performance metrics that an educational institute should consider while implementing LT.

6.1 Research implications and limitations

A comprehensive literature review on LT in the education sector documented in this study can act as a ready reckoner for future research. The study is first to empirically capture the impact of LT implementation on an educational institute by analyzing its archival data. The study is also the first to document and demonstrate the implementation of LT in the processes of an educational institute and propose an empirically grounded framework, especially from an Indian context. The implementation framework proposed in this study is also in alignment with the five tenets of lean and DMAIC.

The limitation of the proposed framework is its generalizability as the framework is developed from the experience of a single institute. To improve the generalizability of the proposed framework, future study can attempt to empirically validate by applying it in multiple educational institutes. The current study is also limited in only documenting the initial experience of lean implementation in an educational institute. Future study can document the effect of LT implementation by studying its impact over a longer period of time. Studies in future can consider several other performance metrics (listed in Table XII) for the evaluation of improvements attained through LT implementation in an educational institute. In addition, ARM-based research can be extended to study the behavioral aspects of employees of educational institutes toward LT implementation to identify the drivers and barriers of lean implementation.

6.2 Practical implications

The study develops a comprehensive framework for assisting practitioners in implementing LT in an educational institute. A step-by-step description of the implementation experience is expected to help in easy imitation of the framework in other educational institutions in future. Demonstration of tools such as the process flow diagram, SIPOC, rough-cut VSM, etc., can assist practitioners in deploying the same while implementing LT. Mapping of inefficiencies in the case institute's processes to lean wastes and addressing the wastes using different lean tools and practices can act as a lookup table for practitioners. Practitioners are introduced to a diverse set of performance measures for evaluating the impact of LT implementation in an educational institute. The positive results obtained in this study can encourage the educational institutes to consider LT as a potential tool for improving the processes.

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Note

1. http://data.gov.in/catalog/state-wise-enrolment-through-regular-mode-various-levels#web_catalog_tabs_block_10 (accessed June 4, 2014).

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(The Appendix follows overleaf.)

Appendix

Institute name	Solution proposed (lean practices)	Performance measures
The University of Central Oklahoma	Implemented lean practices by following a four-step model. A manager was appointed in the office of process improvements to oversee the lean initiatives, track the old initiatives, and constantly identify new opportunities for improvement	Number of pieces of paper generated, annual paper cost, average number of touches, average age of work order waiting at assignment, and percentage of work order submitted by e-mail
The University of Wisconsin – Madison	Implemented lean six sigma practices on close to 25 projects	Award setup project (reduced the average award setup time from 113 days to 20 days), collaborative research approval (reduced the time to get approvals from 4 days to 1 day), developing grant sub-agreements (reduced process steps from 12 steps to 6 steps and reduced the average process time from 378 days to 56 days), and corrective non-salary cost transfer (reduced process time from 29 days to 5 days)
University of Virginia	Implemented lean principles by using a team approach involving process owners in the creative process, front-line employees in problem-solving, and by employing a variety of improvement and organizational change tools	Conference organization and planning, print publications, facilities management, procurement analysis, records management, faculty exit procedures, academic certification tracking, etc.
University of Michigan (UM)	Implemented lean in UM healthcare system	80% reduction in wait time and 23% reduction in the overall process time in the clinical billing unit, 4 hour reduction in the average processing time for MRI orders to scan, 50% reduction in process time in accounts payable approvals, and a 90% reduction in payment process time in the human subject incentive program
Miami University	Implemented LT using the LEAN (Leveraging Efficiencies and Aligning Needs) initiative	The University was able to save almost $16,000 per year in one of their projects in housing and dining and a solution implemented to change the types of disposable products used in food service was projected to save $123,000 per year
St. Andrews University	Attempted to become a lean university by identifying three major goals, namely, culture change (to create a drive for continuous improvement), effectiveness (to ensure all business process meet existing and emerging needs), and finally efficiency (to maximize the use of all resources to deliver maximum services)	A closer working relationship between estates and finance was achieved. Financial transactions were completed quickly with high customer satisfaction. Staff time and effort were saved. The lean team at this university identified 8 wastes which were traditional seven lean wastes plus "skills misuse" as the eighth waste
University of Washington	Implemented lean in its finance and facilities department and has successfully completed several projects. The tools implemented in various projects include supplier registration and procurement services, university audits, facilities services 5S, records management, furniture procurement, campus alterations, etc.	Study the improvement tasks in Finance & Facilities (F2) by using operational-dashboard measures, balanced scorecard methodology, quality and process improvement fundamentals, and recognition and teamwork. With an F2 dashboard, department tracks the key performance measures of all the operations connected with the F2 department. This tracking helps in monitoring F2 strategies and its impact on operations and assists in meeting customer needs

Table AI.
Educational institutes that have implemented LT

Source: Adapted from Kallam (2013)

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