AC 2011-424: EVALUATING QUALITY MANAGEMENT COURSES IN GRADUATE ENGINEERING MANAGEMENT CURRICULUMS

Kate D. Abel, Stevens Institute of Technology

Kate Abel serves as the as the Director of Undergraduate Academics and On Campus Channels in the School of Systems and Enterprises at Stevens Institute of Technology. She holds a Ph.D. in Technology Management and Applied Psychology. She has been both the President of the Engineering Management Division of ASEE and the President of Epsilon Mu Eta, the Engineering Management Honor Society. She teaches courses in Total Quality Management, Engineering Economics, Entrepreneurial Analysis of Engineering Design, Statistics for Engineering Managers, Engineering Management and Senior Design. Her research areas include knowledge engineering, as well as, knowledge and information management. She has published over 18 refereed journal articles, book chapters and conference papers.

Anirban Ganguly, Stevens Institute of Technology

Anirban Ganguly is a Lecturer with the School of Systems and Enterprises at Stevens Institute of Technology. He obtained his PhD in Engineering Management from Stevens Institute of Technology in 2009. He also has a MS from Stevens in Technology Management and a MBA from the University of Calcutta, India. His major research interest comprises of innovation and technology management, enterprise agility, supply chain management and risk management. He has co-authored a number of journal articles, conference proceedings, a workbook and two book chapters. He is one of the chapter authors for the Engineering Management Handbook published by American Society of Engineering Management.

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Evaluating Quality/Process Management Courses in Graduate Engineering Management Curriculums

Abstract

The present day business environment governed by intense competition and rapid globalization has made Quality and Process Management very important tools in the repertoire of any Engineering Manager. With this in mind, an investigation into the current aspects of Quality /Process Management courses as taught within an Engineering Management (EM) graduate education was undertaken. The fundamental objective of the current research rests in exploring the structure of Quality/ Process Management courses that are taught as part of EM graduate curriculum. A set of Quality and Process Management topics were identified and subsequently prioritized, using a survey of the Quality instructors or EM Program Directors, to assess their relative criticality. The findings of this research are expected to provide a guideline to EM curriculum developers to evaluate and improve the structure of their own Quality /Process Management courses, and in the process improve the overall quality of their EM program.

Keywords: Quality Management, Process Management, Engineering Management (EM), Ranking, Graduate Engineering Management Programs

Introduction

Over the years, quality management has been applied as a way of improving activities and performance in organizations [3, 6, 7]. The corporate sector has universally recognized the importance of quality in their products and services as a vital tool for achieving and sustaining competitiveness [5]. The importance of quality management has subsequently transcended from the industry to academia and has become an integral part of most graduate Engineering Management programs. This is especially true in EM since the blurring boundaries between management and engineering leads to a large number of graduate engineering managers being part of project teams that involve a substantial amount of quality / process management activities. As a result, it has become imperative for any graduate EM program to include quality/process management as a part of their EM curriculum. These courses on quality/process management introduce the graduating engineering manager to a plethora of quality/process management topics. However, not all of them receive an equal emphasis by the instructor, nor potentially by the organization they join post graduation, as well. However, there is a considerable dearth of open literature on EM education discussing the relative importance of quality/process management topics that are taught as a part of any graduate EM program. It is expected that the current research will shed some light on the current importance of the discussions within this topic.

The purpose of this paper is to evaluate the relevance of quality/process management topics as taught in any graduate engineering management curriculum. Beginning with a brief discussion on the relevance of quality/process management, the paper goes on to identify a set of relevance topics that should form the part of any quality/process management course. The identified topics are subsequently prioritized with the aid of a survey in order to assess their relative criticality. Conclusions were then drawn from the research results and recommendations provided along

with possible directions for future research. Engineering management program directors and course developers can utilize the findings of this study to help orient and restructure their quality/process management courses to better reflect current trends in graduate engineering management programs, with particular emphasis on certain topics over others.

Importance of Quality / Process Management to any EM Curriculum

Globalization of the manufacturing base, coupled with advances in information technology, has dramatically changed the role of engineering managers in organizations [4]. As such, Quality/process management, along with other domains of management, have been major influences in the EM field. As a result, quality/process management is embraced by engineering managers as a part of their organizations logistics and project management process. An effective practice of quality/process management improves the effectiveness of a system as a whole by addressing the overall process, rather than the 'silo' (i.e., the lack of collaboration and standardization between business units) approach. Quality/process management can control variation within the system in order to produce more consistent quality, in the process improving the competitive edge of an organization. Furthermore, quality / process management practice can integrate employees, suppliers and customers in the overall process. In addition, it enhances customer satisfaction through customer focus. Since all of these issues are integral for a successful engineering management practice, in it evident that quality / process management should hold a position of extreme importance to any engineering.

Research model

The fundamental question that the present research attempts to answer deals with the evaluation and prioritization of a set of quality/ process management topics pertinent to any graduate EM curriculum. Figure 1 provides the reader with an overview of the proposed research.

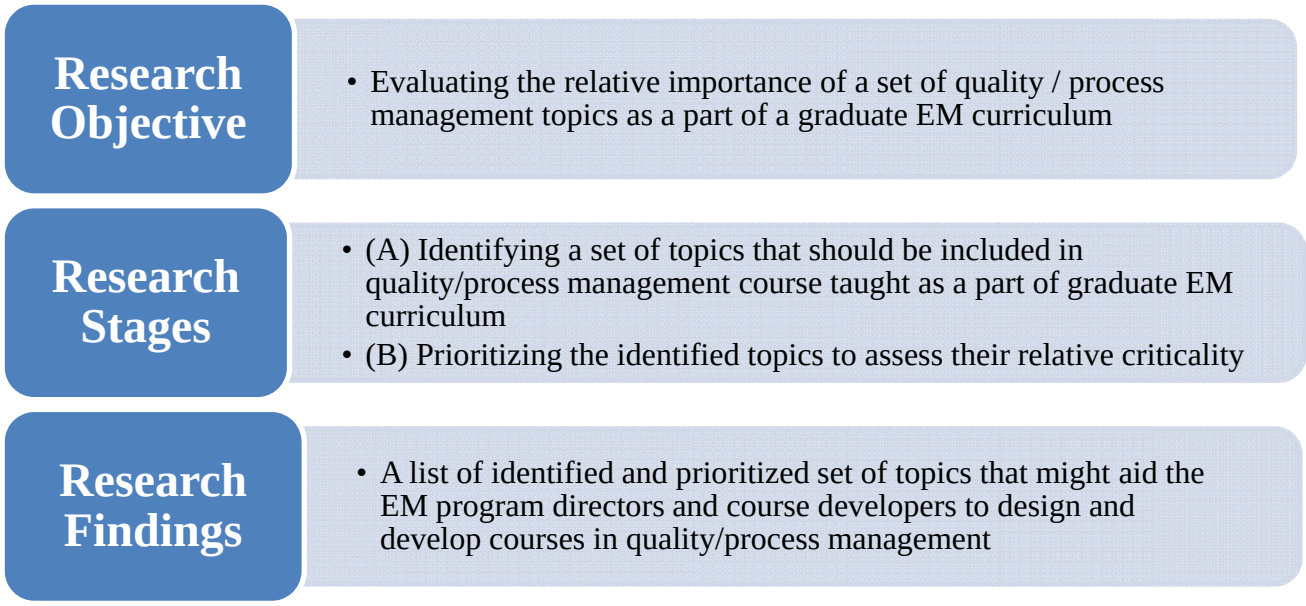

Figure 1. Overview of the proposed research

Figure 1 divides the overall research process into three phases – objective, stages and findings. Discussions with the EM academicians revealed that in spite of the vast importance of quality/process management as a part of any EM curriculum, the courses were not always structured properly and assigning weights to assess the relative importance of the topics was subjective and therefore, potentially inaccurate. These discussions, coupled with the severe dearth of open literature on this issue, served as a motivation for the research. Once the objective of the research was determined, the next stage was to identify and subsequently prioritize a set of important topics that were deemed to be a part of most quality / process management courses taught in a graduate EM program. The detailed methodology followed in conducting the current research is discussed in the following section on research methodology. The findings of the research were a well-defined and prioritized set of topics that should form an integral part of any quality/process management courses taught in an EM program.

Research methodology

Following the development of a conceptual model representing the main ideas of interest, the next stage was to determine the research methodology. The methodology for the research and data gathering was based on a previous research conducted by Ganguly et al. [2]. Literature reviews, brainstorming, discussions and surveys comprised the main techniques used to arrive at the research results. Choosing the set of quality /process management topics was based on a review of the literature on quality management and in-depth discussions with the EM educators who were involved with courses on quality/process management. The Engineering Management handbook [1] published by the *American Society of Engineering Management* was also used as a guideline for selection of the topics to be identified and ranked. The data were gathered and then subsequently transformed into a survey whose results provided the basis of prioritization of the quality/process management topics. The designed survey was sent out to EM program directors for their inputs. Respondents were selected based on their ABET or ASEM accreditation status, or reputation of the university's EM program. The survey responses (response rate of 56%, 15 out of 27 responded) were analyzed to arrive at the prioritized set of the identified topics.

Research results and findings

As mentioned in the previous section, the overall objective of the research was to identify and prioritize a set of topics that were important to quality/process management courses. Therefore, based on reviews of graduate EM programs in other universities across the country, the authors were able to list a substantial number of quality/process management topics relevant to the current research. Then, based on discussions and brain storming with EM educators across the country, the authors managed to condense the list to highlight only a set of twenty four (24) topics – thereby separating the vital few from the trivial many. This is provided to the readers in Table 1.

Table 1. List of quality/process management topics

List of Quality/Process Management Topics		List of Quality/Process Management Topics
Evolution of Quality Management		DMAIC
Overview of Quality Management		Cost of Quality
Overview of Process Management		Quality Function Deployment (QFD)
Statistical Quality Control (SQC)		Lean Management
Statistical Process Control (SPC)		Quality Standards
Six Sigma		Quality Management for Service Industries
Quality Assurance		Leadership and teamwork
Inspection		Ethics in Quality / process Management
Continuous Process Improvement (CPI)		Project Management
Taylor's Scientific Management		Concurrent Engineering
Baldridge & Deming Awards		Benchmarking
Design of Experiments		Quality Standards (ISO 9000, etc.)

The next stage of the research process involved the prioritization of the identified topics to assess their relative importance. This was done through a survey analysis on the set of the identified topics exhibited in Table 1. The survey was comprised of a structured questionnaire requesting the respondents to evaluate the importance of the identified topic to Quality/Process Management, on a scale of ranging from *'Not important'* (indicated by 1) to *'Extremely important'* (indicated by 5). The survey feedback from the respondents was analyzed to determine the overall value of the identified quality/process management topics. The overall value of the quality / process management topics was then calculated based on Equation (1).

$$Q_i = \frac{\sum_{j=1}^{n}(x_{ij})}{n} \qquad (1)$$

Where,
Q_i = The value of the i^{th} topic
x_{ij} = The importance of the i^{th} topic as provided by the j^{th} respondent
n = Total number of respondents.

Provided below are the detailed steps followed to determine the ranking of the identified quality / process management topics.

1. A survey questionnaire comprising of a set of identified quality / process management topics was constructed to form the backbone of the ranking process. The descriptions of the terms were not entered in the survey as the survey respondents were thought to be intimately familiar with the terms. The survey questionnaire forms Appendix A of the paper
2. The identified quality / process management topics (indicated in table 1 later on in the paper) were given a scale of 1 – 5, with 1 being not important to the curriculum and 5 being extremely important to the curriculum. This scale was subsequently used by the respondents to rate the importance of the identified topics.

3. A set of survey respondents were shortlisted and the survey was sent out to them for their responses. As stated earlier, 15 out of 27 respondents responded to the survey. The names of the survey respondents were not included in the paper in order to preserve confidentiality.
4. Once the survey responses were gathered and organized, the data was incorporated into equation (1) in order to determine each topic's mean overall value based on all the responses.
5. The mean overall values were then subsequently ranked in the descending order of their magnitude in order to arrive at the final ranking of the topics. This is provided in Table 2.

Table 2. Quality/process management topics ranking

Quality/Process Management Topics	Mean	Standard Deviation	Rank
Six Sigma	4.545	0.934	1
Lean Management	4.273	0.467	2
DMAIC	4.091	1.044	3
Statistical Quality Control (SQC)	4.000	0.632	4
Statistical Process Control (SPC)	4.000	0.447	4
Overview of Process Management	3.727	0.786	6
Overview of Quality Management	3.637	0.809	7
Continuous Process Improvement (CPI)	3.636	0.505	8
Cost of Quality	3.636	0.924	8
Quality Function Deployment (QFD)	3.545	0.824	10
Project Management	3.545	1.036	10
Quality Management for Service Industries	3.543	0.820	12
Leadership and Teamwork	3.540	1.128	13
Quality Standards	3.455	0.934	14
Quality Assurance	3.364	0.924	15
Quality Standards (ISO 9000, etc.)	3.273	0.786	16
Concurrent Engineering	3.000	1.000	17
Ethics in Quality / process Management	3.182	1.079	18
Design of Experiments	3.182	1.250	18
Evolution of Quality Management	3.091	0.831	20
Benchmarking	2.909	1.300	21
Inspection	2.727	1.009	22
Baldridge & Deming Awards	2.364	1.027	23
Taylor's Scientific Management	2.182	0.982	24

The value of the identified topics along with their standard deviation is provided in Table 2. Furthermore, in most cases, the standard deviation indicated that the respondents were fairly in agreement with each other, in spite of being surveyed separately, regarding the relative importance of the indentified set of topics that should be a part of quality/process management courses associated with graduate EM programs.

It should also be noted that there was a fairly large set of quality/process management topics that were identified to assess their relative criticality. Furthermore, there were some topics that were similar to each other (example, Six Sigma, DMAIC, Lean Management; Quality Standards, Quality Assurance; etc.). However, upon examining Table 2, it was seen that the topics that were similar to each other were ranked very similarly (or closely) and had very similar overall mean values – thereby, further proving the validity of the research results

As an endnote, it should be repeated that the set of the identified and enlisted topics in the research are under no capacity a holistic set. Rather, they can be stated as a set of important topics that should be considered while designing a course on quality/process management as a part of a graduate EM program. The set of topics provided can be modified, expanded or reduced depending upon the EM program and the nature of the quality/process management course that is being developed. Finally, it should also be mentioned that the relative importance of the topics as exhibited in table 2 could also vary depending on the focus of the course and direction of the graduate EM program.

Discussion and direction of future research

As it was seen from the research findings, Six-Sigma received the highest overall ranking by the respondents. This was not surprising considering the immense popularity that six-sigma has managed to gain over the years. This was followed by lean management – another 'hot' concept in the industry that many organizations are using as a part of their operational processes and logistics. It was also noticed that some of the more traditional topics of quality management, like Taylor's scientific management and inspection, achieved a very low rank – thereby indicating a shift of paradigm from the more traditional, to the more industry relevant, topics among the EM educators.

The ranking of the identified quality/process management topics also indicated an interesting insight. The topics that were ranked comparatively higher were mostly quantitative in nature and analyzed the mathematical/statistical aspect of quality/process management. On the other hand, the qualitative topics were ranked comparatively lower in the list. Although warranting further investigation, this insight might be an indicator of a paradigm among engineering managers highlighting the quantitative aspects engineering management as a whole. In other words, this might demonstrate that to have a quality/process management course without great emphasis on the quantitative tools is not valuable in today's competitive environment where engineering managers needs quantitative skills to distinguish themselves, and therefore, have an edge in the industry. Although at its stage in infancy, this insight could form an important part of further research.

It was also noticed that in spite of reasonably low standard deviations associated with most of the identified topics, the respondents did show some variation in ranking in the case of certain ones. This issue could be further investigated as a part of the future research. One possible avenue to look into this matter is to increase the sample size. Another important direction of future research could be to survey industry professionals and compare their rankings with the ones here gathered from academicians. This will give the EM educators a clearer idea about the quality / process management topics that are demanded by industry, and in so doing, will enable them to design more industry oriented quality/process management courses. However, it is expected that the findings of this research will provide a basic guideline to the EM academicians to improve the

structure of their quality/process management courses, and in the process further improve the overall value of their graduate EM program.

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Appendix A - The research survey questionnaire

A Survey to Assess the Relative Importance of Quality / Process Management Topics within the Graduate Engineering Management (EM) Curriculum

Name (optional): _____
Institution: _____
Do you currently offer a course in quality / process management? Yes No
Is this quality/process management course part of the EM curriculum? Yes No
If no, state in which curriculum the quality/process management course is taught_____
If you answered yes to either of the previous questions, please indicate the level of criticality of inclusion of the topics listed below for the proper instruction of quality management / process management, on a scale of 1 – 5, with 1 being not important and 5 being extremely important.

QUESTIONS						
		1 Not Important	2	3	4	5 Extremely Important
1	**Evolution of Quality Management**	☐	☐	☐	☐	☐
2	**Overview of Quality Management**	☐	☐	☐	☐	☐
3	**Overview of Process Management**	☐	☐	☐	☐	☐
4	**Statistical Quality Control (SQC)**	☐	☐	☐	☐	☐
5	**Statistical Process Control (SPC)**	☐	☐	☐	☐	☐
6	**Six Sigma**	☐	☐	☐	☐	☐
7	**Quality Assurance**	☐	☐	☐	☐	☐
8	**Inspection**	☐	☐	☐	☐	☐
9	**Continuous Process Improvement (CPI)**	☐	☐	☐	☐	☐
10	**Taylor's Scientific Management**	☐	☐	☐	☐	☐
11	**Baldridge & Deming Awards**	☐	☐	☐	☐	☐
12	**DMAIC**	☐	☐	☐	☐	☐
13	**Cost of Quality**	☐	☐	☐	☐	☐
14	**Quality Function Deployment (QFD)**	☐	☐	☐	☐	☐
15	**Lean Management**	☐	☐	☐	☐	☐
16	**Quality Standards**	☐	☐	☐	☐	☐
17	**Quality Management for Service Industries**	☐	☐	☐	☐	☐
18	**Leadership and teamwork**	☐	☐	☐	☐	☐
19	**Ethics in Quality / process Management**	☐	☐	☐	☐	☐
20	**Project Management**	☐	☐	☐	☐	☐
21	**Concurrent Engineering**	☐	☐	☐	☐	☐
22	**Benchmarking**	☐	☐	☐	☐	☐
23	**Quality Standards (ISO 9000, etc.)**	☐	☐	☐	☐	☐
22	**Design of Experiments**	☐	☐	☐	☐	☐
23	**Others (please specify):**	☐	☐	☐	☐	☐