New Orleans JAZZED about Engineering Education

Paper ID #14661

A Comprehensive Analysis of Current and Future Offerings of Risk Management Topics in the Engineering Management Curriculum

Dr. Maryam Tabibzadeh, California State University, Northridge

Maryam Tabibzadeh, PhD, is an Assistant Professor at the Manufacturing Systems Engineering and Management Department, California State University, Northridge. She received her PhD in Industrial and Systems Engineering from the University of Southern California. Her research has been focused on risk analysis in complex, safety-critical and technology-intensive industries. In her PhD dissertation, she concentrated on risk analysis of human and organizational factors, along with technical elements, in offshore drilling safety with an emphasis on negative pressure test. She has been able to present and publish papers in the area of risk assessment and safety management in different conferences and scientific journals.

Dr. S. Jimmy Gandhi, California State University, Northridge

Dr. S. Jimmy Gandhi is an assistant professor at California State University, Northridge. His research interests and the courses he teaches includes Quality Management, Lean Manufacturing, Innovation & Entrepreneurship,Sustainability as well as research in the field of Engineering Education. He has over 30 conference and journal publications and has brought in over $500K in research grants to The California State University, Northridge.

A Comprehensive Analysis of Current and Future Offerings of Risk Management Topics in the Engineering Management Curriculum

Abstract

The dynamic society in which we live is full of uncertainties. The component of risk is present in all systems settings and it is becoming increasingly prevalent in this rapidly changing and interactively complex society. As a result, risk management concepts and methods have become a critical topic to be understood by engineers and engineering managers.

Historically, risk management was typically focused on schedule and cost analysis and considered a topic for upper management to deal with. However, as projects become more complex and the uncertainty associated with technical aspects of them increases, the risks related to not only those projects but also the environment have to be considered from a holistic or systemic perspective. In this dynamic environment, it is important for engineers and engineering managers to understand various aspects of risk management such as risk identification, risk tracking, risk impact assessment, risk prioritization and risk mitigation planning, implementation and progress monitoring.

In this paper, the authors review all the existing courses in their Engineering Management (EM) program and analyze the current offerings of risk management topics in the presented curriculum to future engineering management graduates. Based on this analysis, they will then make recommendations on how to incorporate risk management aspects, in an integrated way, into the curriculum of various courses in their EM program. The goal of conducting this study is to provide a systemic or holistic perspective on risk management to engineering management graduates, which will more effectively prepare them to serve in scientific and engineering communities and industries.

Introduction

With increasing complexity of engineering projects, the focus on risk and risk management is not only increasing but it is also changing considerably. Risk management in engineering firms that deal with large complex projects, is generally done by systems engineers in conjunction with the project manager. Historically, risk management focused on schedule and cost issues and less on technical risks. However, larger projects have increased the uncertainty for the technical aspects of the projects – specially the integration aspects of different parts, components and sub-systems coming together to form the finished end product that is delivered to the end user. This aspect of integration risks coming to the forefront are becoming increasingly common as large firms, more often than not, have supply chains that extend into different parts of the world. Hence, differences

in culture and the work environment that could affect the technical output of the project also have to be considered as potential risks.

As a result of these changes occurring in industry, particularly over the last decade, it is important for engineers and even more so for engineering managers, to understand risk from a holistic perspective. Engineering managers in particular also need to be aware that risk can be considered from many angles and can be related to different aspects of execution and management of technical projects. This means that in addition to the basic understanding of risk, an engineering manager has to be aware of risk management being used as a decision tool in different forms.

In order to meet this changing need of industry, the authors of this paper have talked about understanding of risks and incorporating risk management into various courses offered as part of the engineering management program at the California State University, Northridge.

What is Risk?

The term "risk" refers to potential problems or issues that could arise and adversely impact the progress or outcome of a project.[1] Risk is a part of every project and is usually associated with adverse outcomes; hence, it is generally perceived as negative or an adverse effect.[2,3] For the purpose of this paper, the authors would like to define risk as the product of probability of an event occurring and the consequence of occurrence.[3,4] Thus, when evaluating risk, engineering or project managers should think of both the probability of how often this negative outcome could occur and also evaluate that if the risk were to occur, what the impact or consequence of that occurred risk would be.

What is Risk Management?

The process of risk management usually begins with a study to identify the potential risks that a project could generate or to which it could be exposed. A formal risk analysis is then conducted to measure the various individual risks as well as the overall risk to the system.[5] This effort could either be a quantitative or qualitative evaluation or in many cases, a combination of both, depending on the data available to the analyst or upon the circumstantial evaluations needed.[6] For example, when analyzing risk from a 30,000 foot level, it is generally more qualitative so that a general overall understanding for the risk can be understood and considered. However, when we are evaluating risk on a more operational level, it could be more quantitative and specific to the process under consideration. Hence, as engineering managers, our students should be aware of and be able to analyze risks quantitatively as well as qualitatively. This is because in their roles as engineering managers, they would be responsible for the day to day operations of the processes in projects they are overlooking and would also need to understand the overall risks from a high-level perspective for the overall project they are managing.

In this paper, the authors would like to emphasize the importance of risk management in the Engineering Management (EM) curriculum at the California State University, Northridge. For this purpose, we have examined the major courses offered as part of the EM curriculum and discussed strengths and weaknesses of those courses with respect to analyzing the extent to which risk management is covered in those courses.

The authors have talked about various phases of risk management that EM students should understand and then transition to discussions related to systemic risk management and its importance to engineering managers. Lastly, we have evaluated the offerings of these important risk management topics in the existing EM curriculum and changes that can be made thereof.

Phases of Risk Management and Their Importance to Engineering Managers

One of the entities that extensively discusses the role and applications of risk management is the Project Management Institute (PMI). According to the *Project Management Body of Knowledge (PMBOK) Guide*,[7] as the main publication by the PMI, risk management process consists of six phases or steps as follows:

1. Plan Risk Management
2. Identify Risks
3. Perform Qualitative Risk Analysis
4. Perform Quantitative Risk Analysis
5. Plan Risk Responses
6. Control Risks

Several other references in the literature,[8,9] consider very similar phases for risk management process. Figure 1 depicts these main phases and their interdependence.

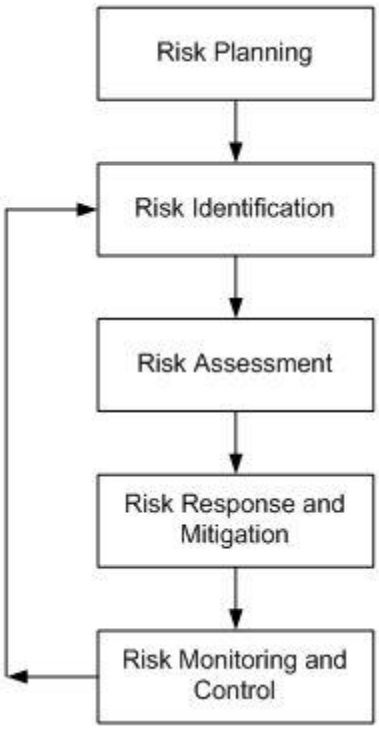

Figure 1: Phases of Risk Management Process

In this process, the initial phase is developing a plan in order to explicitly outline needed procedures and methods to implement the next five phases of risk management process and the detail of the schedule to complete each phase.

After developing a risk management plan, the first phase towards implementing this plan is identifying existing risks in the context of the problem, project, or the system which is studied and analyzed. This phase is one of the most crucial steps in the risk management process because if some of the involved risks are not identified, there will be no further analysis on how critical they are in the matter of their likelihood of occurrence and/or consequence(s). Consequently, there will be no developed response plan to prevent their occurrence or minimize their negative consequences if they occur.

The phase of identifying risks requires a broad approach. This phase and process needs to be inclusive and engage all involved stakeholders; e.g., management, staff, volunteers, in a studied system.[10] The main objective of the risk identification phase is to detect and categorize risks which have the potential to adversely impact the studied system or project and document those risks.[10]

There are different techniques that can be used for risk identification. Some of the main examples of these techniques are brainstorming, scenario planning, interviews with experts, and group data elicitation methods such as Delphi. In addition, documents and sources such as historic data,

checklists, organized lessons learned, and published commercial databases, as well as academic studies, are very useful in providing necessary information to identify risks more comprehensively.

The third phase within the risk management process is risk assessment. The purpose of the risk assessment phase is to offer an idea of the probability and impact of identified risks in the previous step. It is also possible to evaluate the level of risk acceptability by comparing the value of risk with a threshold, as a risk tolerance level. Both qualitative and quantitative risk assessment can be considered as part of this phase. Qualitative and quantitative risk analyses are considered as two separate phases in the *PMBOK Guide*[7] as stated above. However, we combined them into one phase, which is illustrated in Figure 1, based on the explained purpose of the risk assessment phase, which can include qualitative, quantitative, or both types of assessment.

As the name of these two types of risk assessment methods indicates, in qualitative analysis, the risk characterization produces non-numerical estimates of risk while quantitative tools rely on numbers to express the level of risk.[11] Typically, quantitative risk assessments have more transparency, and it is easier to determine the validity of the analysis. In addition, quantitative risk assessment relies on models, which can range from simple to complex.

There have been different developed methods in the literature related to both qualitative and quantitative risk analyses. Several examples of qualitative risk analysis methods include risk urgency assessment, risk probability and impact assessment, probability risk matrix, risk influence diagram, and expert judgement. Expert judgement can be considered as a quantitative risk assessment method as well depending on the type of elicited data and analysis. On the other side of the spectrum, some examples of quantitative risk assessment methods are expected monetary value (EMV) analysis, decision tree analysis, Monte Carlo analysis, failure mode and effect analysis (FMEA), fault tree analysis and event tree analysis.

The fourth phase within the risk management process is risk response and mitigation. Risk response and mitigation strategies are the approaches we can make to deal with the risks we have identified and assessed, qualitatively and/or quantitatively. A response strategy can be determined based on risk tolerance, which was previously discussed. If the value of risk is not within an acceptable tolerance level, necessary response actions must be taken to reduce its value, by reducing its probability of occurrence and/or mitigating its negative consequences.

There are different criteria for effective risk response strategies. Hillson[12] states the following criteria in this regard: appropriate, affordable, actionable, achievable, assessed, agreed, allocated, and accepted.

Finally, we have the last phase within the risk management process, which is risk monitoring and control. According to Anderson, Molenaar, and Schexnayder,[13] this phase includes the capture,

analysis, and reporting of project performance as compared to the risk management plan. Risk monitoring and control assists in contingency tracking and resolution.

The main objectives of risk monitoring and control phase are to: (a) systematically track the identified risks and the effectiveness of their associated response and mitigation plan, (b) identify any new risks, and (c) capture lessons learned for future risk assessment efforts.[13]

It is noteworthy that risk management is not a process that we go through only once, rather it is a structured, consistent, and continuous process across the whole organization studied.[14] Such continuation has been illustrated in Figure 1 by using a feedback loop from the risk monitoring and control phase to the risk identification phase.

The dynamic society in which we live is full of uncertainties. The component of risk is present in all systems settings and it is becoming increasingly prevalent in this rapidly changing and interactively complex society. As a result, risk management concepts and methods have become a critical topic to be understood by engineers and engineering managers. To be more specific, it is critical for engineers and engineering managers to understand various aspects and phases of risk management process, which were previously discussed in detail. Risk identification enables engineering managers to detect and list risks that can potentially impact their studied system. Risk assessment and risk prioritization allow them to analyze identified risks, based on their likelihood of occurrence and potential influence(s). It is then possible to develop appropriate risk response and mitigation strategies for risk reduction. Finally, continuous risk monitoring and renewing the whole risk management process is a vital step towards effective implementation of such process.

Historically, risk management was typically focused on schedule and cost analysis and considered a topic for upper management to deal with. However, as projects become more complex and the uncertainty associated with technical aspects of them increases, the risks related to not only those projects but also the environment have to be considered from a holistic or systemic perspective, which will be discussed in more detail in the next section.

In this section, we described the risk management process, its phases and their importance to engineering managers. In the next section, we transition to explain the concept of systemic risk and its importance to engineering managers.

Systemic Risk Management and its Importance to Engineering Managers

Our world is becoming increasingly complex and interdependent. Dynamic and diverse systems are often considered more productive, while static and monotypic systems are generally considered less productive. There are a wide variety of examples of complex, dynamic and diverse systems ranging from automobiles to airplanes and from agriculture to immigration. Even a device which could be considered to be simple such as a cell phone, is a dynamic and diverse system due to all

the other systems it interacts with. Thus the cell phone could be considered to be a system within a number of other systems, which is called a System of Systems (SoS).

In such complex scenarios, the traditional risk management approach will not suffice as it is a linear process and does not take into consideration the external factors that could affect a project. Furthermore, and most importantly, in many traditional risk management evaluations, the risks were evaluated in silos and the interactions between various risks involved were not considered. Lastly, today we live in an interconnected world. To illustrate, 30 years ago an earthquake in China or Japan would have seen fairly localized effects, but today, such an event would have almost immediate effects in cities across the globe such as Detroit and Frankfurt.

Figure 2 shows how risk management has evolved over the past 20 years and shows how risk management has gone from being focused on transferring risk to reducing the costs of risks when they occur and then finally to the optimization of risks to achieve the overall organizational goals. Initially, when organizations started evaluating risks about three decades ago, they considered low frequency, high impact events when thinking about risks; an example being the industrial disaster in Bhopal, India in December 1984.[15] However, in today's business environment, the majority of organizations consider varying types of risks with different impacts—thus making it even more crucial for an engineering manager to be aware of this topic.

Figure 2: Evolution of Risk Management over the Past Few Decades, Adapted from [16]

Another interesting trend that was observed three decades ago and continues to plague industry even today is that risks are unfortunately considered only after a disaster happens. This is a reactive approach which tends to cost organizations a lot more than if they were to implement a proactive approach. Thus it is imperative for engineers, and especially engineering managers, to have an awareness of risks earlier on in the project and be able to do proactive risk management.[15] Furthermore, risk management has evolved from being more technical to more strategic in recent times.

Since the traditional approaches to risk management are thought to be insufficient, a new type of risk management called Systemic Risk Management was developed and implemented initially in the finance industry. This practice of systemic risk then spread to different industries. Systemic risk is thought of as a risk that originates from multiple sources, affects multiple agents and propagates quickly among individual parts or components of the network.[17] Systemic risk could also be considered to be the probability that cumulative losses will accrue from an event that sets in motion a series of successive losses.[17] Finally, Systemic Risk has a number of constituents which are thought to be interconnected. It also constitutes of external factors that affect relationships between the various constituents. This is particularly applicable in today's interconnected business world, and hence of extreme importance for engineering managers to understand.

As shown in Figure 3, the systemic risk management framework not only considers the interconnectedness of the various risk components but also takes into consideration the various external factors such as technology, environment, time, and a political situation that could affect these risks. Furthermore, most complex organizations that function as system of systems also need to have a risk management and governing body. It is important for an engineering manager to understand his or her role to this governing body and also be aware that the governing body will have constraints to work within, which are very likely to affect the risks and the way they can be managed.

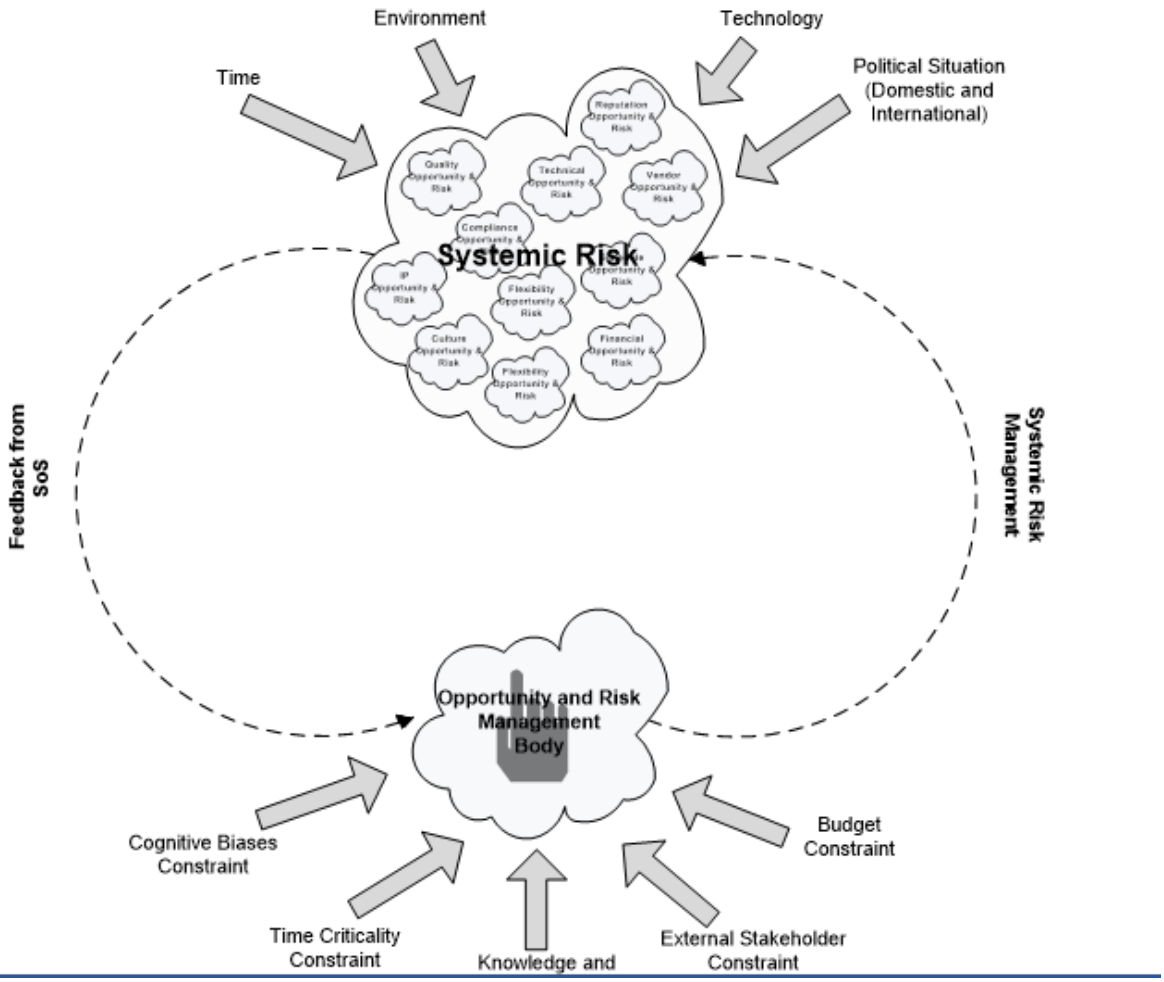

Figure 3: Systemic Risk Management Framework for SoS (adapted from [18])

The Engineering Management Curriculum at the California State University, Northridge

The Engineering Management (EM) Program at the California State University, Northridge has been offered since 2000 and has constantly been evolving based on industry feedback and needs. This program is taught by faculty with professional engineering management experience and offers the opportunity to develop technical management and entrepreneurial skills pertinent to the management of existing and emerging technologies. The program stresses the development of technological decision-making as well as entrepreneurial abilities, while also enabling continued intellectual growth in an area that meets professional needs. Engineering management program graduates have been assuming leadership roles in industry since the early 1970s.

Due to the changing leadership roles that engineering managers have experienced in the last 30 years, which include the increasing need of an engineering manager to understand risk management, the authors of this paper felt the need to analyze the current course offerings in the EM program at the California State University, Northridge and make recommendations about how

modules of risk management or a flavor of risk management can be incorporated into existing courses. One of the main program objectives is to create an awareness towards risk and an understanding of risk management methodologies and tools in order for engineering management graduates to be better equipped for their future jobs. You can see the details of this analysis in the next section. This is to deal with the constant constraint of total number of units in a program that have been laid down by the college and the university and also to implement new materials with the least demand on department resources.

The EM program at the California State University, Northridge is a 33 credit program, with 15 credits for core or required classes, 15 credits of electives, and the last three credits for a culminating experience which can be either a comprehensive exam, an industry project, or a research thesis (up to a maximum of six units). The core courses include courses in decision making, entrepreneurship, engineering economy, operations management and quality management. Some of the elective courses offered include: Lean Manufacturing, Human Resource Management, Statistics, Systems Engineering, Six-Sigma, and Supply Chain Management.

Analysis of Risk Management Offerings in the EM Curriculum of the California State University, Northridge

In this section, the main courses of the EM program at the California State University, Northridge and the current offerings of risk management in those courses have been analyzed. In addition, some recommendations regarding the modification of those analyzed courses based on their current incorporation of risk management concepts and applications have been explained. There are separate sub-sections for courses and two sub-components for each to describe 1) current offerings of risk management and 2) recommend modifications.

1) MSE-504: An Introduction to Engineering Management

- **Current Offering in Risk Management**
  No formal module currently offered in this course to address risk management.

- **Recommended Modifications**
  There is a need for a dedicated module on introduction to risk management. This is required as most of the students in the EM program are from traditional engineering backgrounds in which risk management is not included in the curriculum. The module on risk management in this introductory class should include an understanding of risk, the risk management process and a creation of awareness of risk assessment models with an emphasis on the importance of quantitative methods.

2) **MSE-505: Decision and Risk Analysis**

- **Current Offering in Risk Management**
  There are different points of discussion on the application of risk and uncertainty; e.g. while explaining decision analysis tools such as decision tree or concepts such expected monetary value (EMV), or through introducing probability functions and their application in uncertain decision making, or through the explanation of sensitivity analysis concepts.

- **Recommended Modifications**
  There could be more theories and analyses on other risk assessment methodologies in this course since this is one of the most relevant courses to introduce risk management concepts and applications; especially, by knowing that some of these concepts and theories are discussed in subsequent chapters of the main textbook for this course.

3) **MSE-507: Lean Manufacturing**

- **Current Offering in Risk Management**
  Risks and how to manage them in relation to changes made to processes in order to make them more lean and efficient are discussed. The importance of including the customer in the "value definition process" is discussed and the risks of not doing so are also discussed.

- **Recommended Modifications**
  The authors believe that necessary and relevant concepts and applications of risk management have been already offered in this course.

4) **MSE-600: Decision Tools for Engineering Managers**

- **Current Offering in Risk Management**
  The concept of risk and the importance of uncertainty is discussed in different components of this course. The main key components that include risk and uncertainty are forecasting methods, sensitivity analysis of optimization models and their results, statistical analysis, and decision analysis techniques such as decision trees and simulation models.
- **Recommended Modifications**
  The authors believe that necessary and relevant concepts and applications of risk management have been already offered in this course.

5) **MSE-602: Innovation & Entrepreneurship**

- **Current Offering in Risk Management**
  Risk management is discussed throughout the course as risk is synonymous with innovation and entrepreneurship. Currently the risks are discussed in a qualitative manner.

- **Recommended Modifications**
  Quantification of the risks discussed should be formally incorporated by assigning a dollar value to the risks if they were to occur during the startup phase of your company. This is related to the consequence analysis piece of risk management. Additionally, we should also include a section on using risk assessment methods such as fault tree analysis or FMEA to assess the likelihood of the occurrence of a particular risk.

6) MSE-604: Engineering Economy

- **Current Offering in Risk Management**
  The concept of risk and uncertainty analysis is discussed in one of the sessions of this course. In addition, the concept of sensitivity analysis is introduced to students in another session.

- **Recommended Modifications**
  The authors believe that necessary and relevant concepts and applications of risk management have been already offered in this course based on its scope and the limit on the number of weeks in one semester.

7) MSE-606: Production & Operations Management

- **Current Offering in Risk Management**
  The application of risk management is discussed in some components and sessions of this course. For example, how risk is important in defining operations strategies in global environments or in developing better schedules in project management by introducing critical path method (CPM) and PERT. The concept of risk analysis is explained in maintenance and reliability as well.

- **Recommended Modifications**
  The concept of risk and the application of risk management has to be explained in almost all components of this course, and not only in few areas. All operations management-related subjects, from manufacturing capacity planning, aggregate planning, time and work measurement and studies, inventory management, and project management to maintenance and reliability, have to deal with risk and uncertainty.

8) MSE-608B: Leadership of Engineering Professionals in High Tech Firms

- **Current Offering in Risk Management**
  No formal module is currently offered in this course to address risk management.

- **Recommended Modifications**

Risk from a liability perspective has to be explained and also concepts like workers compensation, which is related to managing engineering personnel, have to be included in this course.

9) MSE-617: Seminar in Quality Management

- **Current Offering in Risk Management**
  This course focuses on Statistical Process Control which indirectly talks about risk and uncertainty through the application of probability. This portion of the course is currently more focused on quantitative analysis -- even though it is not purely focused on risk management.

- **Recommended Modifications**
  Inclusion of a module on risk management and its effects on quality management should be added. Furthermore, the risk of not implementing quality and how it can have a cascading effect on other potential risks for projects should be discussed, which should be quantified in the form of lost sales, dissatisfied customers as well as costs to acquire new customers.

10) MSE-618: Six Sigma

- **Current Offering in Risk Management**
  No formal module currently offered in this course to address risk management.

- **Recommended Modifications**
  Each stage of the DMAIC lifecycle should have a flavor of risk management included explaining what the potential risks are for each stage if not done properly. Quantification of the impact of the risks should also be understood at each stage of the DMAIC cycle.

11) MSE-695: Sustainability for Engineers

- **Current Offering in Risk Management**
  Risk management is discussed in relation to changes made to processes in order to make them more sustainable. This is a qualitative approach of risk management to understand overarching risks associated when changes are made to processes to make them more sustainable.

- **Recommended Modifications**
  The authors believe that necessary and relevant concepts and applications of risk management have been already offered in this course.

Conclusions

Based on the previous section analysis, the authors would like to make the following recommendations:

- We recommend that new courses should not be created for the purpose of incorporating risk management into the EM curriculum. This is in order to work around the constraints of total number of units in the EM program and also to take into consideration the availability of resources in the department / college. Instead, new topics should be incorporated into the existing curriculum.
- Some of the courses, because of their subject matter, inherently have more of a risk management flavor to them versus others. For those types of courses, we have some of the courses which cover the topic sufficiently and others that need more of a focus, which we have addressed in the previous section. These risk management related courses should inherently have a focus on the quantitative aspect of risk management.
- On the other end of the spectrum, there are courses which do not focus at all on risk management. This could be because risk management is not perceived to be directly related to those topics. For these courses, an application of risks in that area should be understood from a high-level perspective. For example, in the course titled, "Leadership of Engineering Professionals," the aspect of workers compensation should be discussed in the class. Even though it is not traditionally a topic discussed in a risk management lecture, it is definitely a cause of risk concern for most organizations that operate in the United States—particularly in states where the workers compensation laws are strict and strongly in favor of the employee.
- Finally, we believe that the provided analysis in this paper and the stated recommendations on the incorporation of risk management concepts and applications are generalizable to other EM programs since engineering management graduates need to be equipped with such important and critical subject matter. Moreover, our provided method of analysis can be adopted by other universities that offer an engineering management program.

Future Research

As a follow up to this paper, future research includes coming up with customized pedagogy for incorporating risk management into each of the courses mentioned in this paper. Since the courses vary significantly from one another, it is not possible to have a single pedagogy that can be implemented across the board. Hence, it would be of great value to develop individual pedagogy to talk about how risk management can be incorporated differently into all the courses in the EM program.

References

[1] Taylor, H. (2007). Outsourced IT projects from the vendor perspective: Different goals, different risks. *Journal of Global Information Management*, *15*(2), 1-27.

[2] Poitras, G. (2006). *Risk*. Burnaby, British Columbia, Canada: Simon Fraser University.

[3] Gandhi, S. J., Gorod, A., Sauser, B. (2012). Prioritization of outsourcing risks from a systemic perspective. *Strategic Outsourcing: An International Journal*, *5*(1), 39-71.

[4] Hull, K. (1991). *Risk analysis techniques in defence procurement*. London, England: Controller HMSO.

[5] Budgen, P. J. (2009). *Why risk analysis?* MAI Limited.

[6] Hubbard, D. W. (2009). The failure of risk management: Why it's broken and how to fix it. Hoboken, NJ: John Wiley & Sons.

[7] Project Management Institute. (2013). *A guide to the project management body of knowledge (PMBOK® Guide)* (5th ed.). Newton Square, PA: Author.

[8] Hopkin, P. (2013). *Risk management*. London, England: Koganpgae.

[9] Jeynes, J. (2002). *Risk management: 10 principles*. New York, NY: Routledge.

[10] Dinu, A-M. (2015). Tools and techniques for risk identification and assessment. *Knowledge Horizons—Economics*, *7*(2), 139-141.

[11] U.S. Army Corps of Engineers. (2015). *Risk assessment: Quantitative methods* [Chapter 1: Quantitative Methods; Online Course]. Retrieved from http://www.corpsriskanalysisgateway.us/lms/course.cfml?crs=14&crspg=168

[12] Hillson, D. (1999, October). *Developing effective risk responses*. Proceedings of the 30th Annual Project Management Institute 1999 Seminars and Symposium, Philadelphia, PA.

[13] Anderson, S., Molenaar, K., & Schexnayder, C. (2010). *Guidebook on risk analysis tools and management practices to control transportation project costs*. National Cooperative Highway Research Program (NCHRP). Report 658. Washington, DC: National Transportation Board of the National Academies. National Academy of Sciences.

[14] Enterprise Risk Management Program, University of Vermont. (2012). *Guide to risk assessment and response*. Retrieved from http://www.uvm.edu/~erm/RiskAssessmentGuide.pdf

[15] Knowledge@Wharton. (2015). *What have the last 30 years taught us about risk management? [*Podcast]. Retrieved from http://knowledge.wharton.upenn.edu/article/past-30-years-taught-us-managing-risk/

[16] Serena, R. (2015). *Implementing an enterprise risk management program*. Retrieved from http://www.slideshare.net/RobertSerenaRiskMana/robert-serena-implementing-an-enterprise-risk-management-program-47212114

[17] Kaufman, G., & Scott, K. (2003). What is systemic risk and do bank regulators retard or contribute to it? *Independent Review*, *7*(3), 371.

[18] Gandhi, S. J. Gorod, A., Hofbauer, G., Ireland, V., Sauser, B., & White, B. (2015). A systemic risk management framework for system of systems (SoS). In G. Haufbauer (Ed.*), Challenges, research and perspectives: Trust in social, economic and financial relations* (pp. 147-165). European Research and Working Group, Munich, Germany