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Incorporation of Information Systems Economics into Engineering Economic Analysis Courses

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Abstract

In this paper, we propose the inclusion of economics of information systems into Engineering Economic Analysis curriculum. Information system projects are unique projects with several distinguished characteristics. They are also subject to several conditions of risk. Several graduates would be expected to analyze information system related projects from engineering point of view. Engineering economic analysis techniques play major roles in the evaluation of privately and publicly funded projects. The present understanding of engineering graduates is that these techniques are sufficient and applicable to all privately funded projects. However, there are pieces of evidence that these techniques are not sufficient for evaluating information system projects. Most of these projects have unique characteristics that are not found in other privately or publicly financed and operated businesses. Hence, there is a need to teach economics of information systems within engineering economic analysis curriculum to educate students about information system projects' unique characteristics and cautions to take when using available techniques. Such inclusion will help to place engineering students in a more competitive position for their future career goals.

Introduction

There has been a continued integration of information systems into all fields of engineering, especially industrial engineering. Several academic departments have changed their names to reflect this integration and others have started courses that integrate information systems into their traditional areas of teaching and research. Information systems (IS) are powerful and valuable tools that support communication and decision making in an organization[1]. They use information technology (hardware and software) to capture, transmit, store, retrieve, manipulate, or display information. The era of information systems has changed completely; IS have become essential tools for businesses to operate and survive. Information systems are very critical for online and offline businesses and their applications are visible in several companies. They can be classified into office automation system, communication system, transaction processing system, management (executive) information system, decision support system, and execution system[2]. The initiation and development of information system projects cut across all fields of engineering.

The decision to invest in an information system requires proven economic analysis. Information system projects are technology projects intended to meet the information processing needs of an organization. These projects are beyond software development. IS projects are unique projects with several distinguished characteristics, such as the level of professionalism involved, their high technological nature, time sensitivity of projects, and intense collaboration of different stakeholders. They are also subject to several conditions of risk as a result of the combination of these characteristics. In this information driven era, there are tremendous demands for engineers who can combine technical skills with business insight to create value for their organizations using information technology, whether they work in information systems' positions or elsewhere. Therefore, there is a need to equip students with the knowledge and tools they need to analyze, design, build, evaluate, and implement information systems taking into account both technological and business factors. Engineering economic analysis offers tools and techniques for evaluating risky projects, such as information system projects. However, there is a need to incorporate the teaching of information systems economics into engineering economic analysis curriculum in order to give engineering students a complete knowledge of the unique characteristics of information system projects and cautions needed to observe when analyzing these projects using engineering economic analysis techniques. Since the initiation and development of information system projects cut across all fields of engineering, this inclusion will benefit all students irrespective of their backgrounds. This inclusion will be similar to the special interest given to public projects economics as a result of their unique features.

Economics of Information Systems

Information system projects are intended to meet the information processing needs of an organization. They require the intense collaboration of different groups of stakeholders (internal and external): the project sponsor, users, suppliers, project team, support staff, customers, and even opponents to the project. Hence, IS projects involve group-oriented activities, organized and executed in teams; therefore, subject to all the benefits and problems of group dynamics, interactions, coordination, and communication[5]. These unique characteristics contribute to the failure rates of IS projects and they are not found in other privately or publicly financed and operated businesses.

Techniques used to evaluate IS projects have been categorized as Benefit-Cost Analysis, Risk Analysis, and Financial Comparisons[1,4]. Generally, the benefit-cost analysis is the ratio of discounted benefits to discounted costs and it is normally used for the evaluation of public projects. This decision has its roots in federal legislation (The Flood Control Act of 1936)[6]. In engineering economic analysis, project benefits are favorable consequences of the projects and project costs are monetary disbursements required of the sponsor. The term disbenefits is also used to represent the negative consequences of a project to the public. In relation to public projects, these terms can be easily estimated within reasonable accuracy. A public project is acceptable if the benefit-cost ratio (B-C ratio) is greater or equal to 1.0. Incremental analysis is used when there are several mutually exclusive projects or mutually exclusive combinations of independent projects that satisfy this condition. The idea of comparing benefits and costs for IS projects may sound logical but it has limitations[2]. Predicting either the benefits or the costs of a project may be difficult, for example, if the purpose of an information system project is to provide management information, to transform the organization, or to upgrade the IS infrastructure. Other issues also include the difference between tangible and intangible benefits, the tendency to underestimate costs, the effect of the timing of costs and benefits[1], and the magnitude of B-C ratio for project acceptability. Information system project costs are tangible but many of the benefits are intangible. Intangible benefits are important and should be accounted for adequately. IS cost analysis usually include the cost of hardware, software, and programming. There are several other cost components that are easy to overlook, such as costs relating to problem analysis, training, and ongoing operation of the system. In reality, training, implementation, and troubleshooting consume so much time and effort that their costs far exceed the original cost of the hardware and software. IS project timing is another major concern. The timing of costs and benefits is typically of different streams. If the development takes longer, there will be a delay in accruing benefits and it is possible that the benefits may not be as originally anticipated. These are some sources of incomplete information in costs and benefits estimations for a valid B-C ratio analysis.

Risk analysis is also usually used to evaluate IS projects. However, the risk analysis needs to be measured in some special way because these projects are especially risky endeavors. Several IS projects suffer major disappointment including the possibility that the desired benefits will not be achieved, the project will be completed late or over the budget, the inadequacy of system's technical performance, lack of user acceptance, and reduction in project importance as a result of a shift in priorities[2]. These deviations from the ideal situation require a more integrated approach for analyzing the risks involved.

Financial comparisons are based on the fundamental engineering economic analysis measures of worth, such as Net Present Value (NPV), Internal Rate of Return (IRR), and Discounted Payback Period (DPP). These measures also take into consideration streams of costs and benefits and they are subject to the inadequacies in costs and benefits estimations stated above. Therefore, none of these measures can be said to be sufficient for analyzing IS projects with indefinite streams of costs and benefits.

In spite of these shortcomings, IS projects are evaluated using one or more of these techniques. The implication of this decision has been expressed in the literature. The Standish Group reported in 1995 that 31% of new ISPs were cancelled before completion at a cost to industry of over $81 billion. An additional $59 billion was lost due to budget overruns of those projects reaching completion[7]. It was further reported that more than 20% of software projects fail and only less than 18% of software projects are completed on time and within budget. According to the report, the lost opportunity cost could be in trillions of dollars. Overall, studies continue to indicate that about 85% of all projects end in failure[3] and that less than 1% of all system development projects were delivered on schedule and met requirements[9]. The 2001 extreme CHAOS report of the Standish Group indicate that most of the projects on time and within budget have been overly estimated. According to the report, some groups used the traditional methods to "first get their best estimate, multiply by two and then add a half!"[8]. The conclusion of the report is that some of the traditional methods are outdated. Some of the underlining problems of these findings are managerial, technical, and, of course, inappropriate economic evaluation techniques. Inappropriate economic evaluation techniques could lead to the selection of the wrong projects, under-budgeting, or over-budgeting. These indicate that there is a need for an integrated approach for evaluating information system projects.

Teaching Information Systems Economics

Engineering Economic Analysis (EEA) courses are offered at both the undergraduate and the graduate levels at several universities. These courses focus on techniques for evaluating private and public sector projects. Because of some unique features of public projects, special attention is given to the teaching of these projects. This focus has enhanced the confidence of engineering graduates in analyzing public projects. This attention has also increased research interests in public projects. By virtue of their training, most engineering graduates would be called upon to evaluate IS projects. The current understanding of these graduates is that information system projects can also be evaluated using any of the available techniques for evaluating private sector projects without consideration for the unique characteristics of such IS projects. However, the above section shows that the use of these criteria is ineffective when they are applied to the wrong projects. They are most applicable for projects with easily estimated benefits and costs, such as replacement of a well-understood process or replacement of some software or hardware within an established process with definite costs, benefits, and timeline. Because several IS projects do not fall into this category, there is a need to teach economics of information systems within engineering economic analysis curriculum. Such inclusion will enhance the preparedness of the students for the future challenges and also place them in a more competitive position for their future career goals. The benefits of such inclusion will include:

- Better understanding of information system economics
- Better economic analysis of risky IS projects
- Enhancement of the application of engineering economic analysis to IS projects
- Integration of conflicting tools and techniques for evaluating IS projects
- Enhancement of research for integrated models for evaluating IS projects

Information system economics within EEA curriculum will specifically include cost estimating techniques, financial comparisons, effects of inflation, minimum attractive rate of return (MARR), and risk analysis.

There is a need for integrated techniques for estimating costs and benefits for IS projects. Time series and cost engineering techniques may be inadequate because of the unique features of each information system project and because there are no many historical data to be used. Subjective technique such as Technological Forecasting may be more appropriate; however, they require the complete understanding of the characteristics of projects involved. Case studies may be used to help students develop skills needed for IS project costs and benefits estimation.

A good cost estimating technique will guarantee a better financial comparison. Because there may be a delay in accruing IS project benefits, there is a need for integrated financial comparison that will account for such delay, a technique of accounting for deferred benefits may be introduced. Effects of inflation are important in economic analysis, especially when dealing with indefinite streams of costs and benefits. This should be accounted for in terms of all the unique features of each project. Determining the appropriate MARR to use in economic evaluations is also a source of concern. MARR for IS projects should be project-dependent. However, to come up with such final value will involve critical analysis of when the costs will be made, when the benefits are expected, and when the benefits may actually start to come in.

Comparing risky projects is usually a challenge. There are several advanced techniques for comparing risky projects but undergraduate EEA curriculum focuses on nonprobabilistic techniques that are not sufficient for IS projects. Decision rules such as Maximin (or minimax), Maximax (or Minimum), Laplace, Hurwicz, and Minimax Regret rules may be introduced where probability of occurrence of each possible outcome is not known.

Economics of Information systems is available as a part of the information sciences or computer sciences curriculum in several universities; however, the course is taught from software development or information exchange and transfer perspectives that do not give detailed consideration for IS projects. In addition, engineering students are normally not required to take this course because of the understanding that engineering economic analysis courses are sufficient for them. Teaching information systems economics within EEA will help engineering students answer IS related questions such as:

- How to estimate project cost streams,
- How to estimate project benefit streams,
- What to do if there are delayed benefits,
- What MARR is appropriate at various stages of the project,
- What combination of risk analysis techniques should be used,
- How to evaluate mutually exclusive and independent IS projects.

Such inclusion will benefit all students in engineering economy classes irrespective of their backgrounds. The proposed curriculum will include topics such as:

- Cost estimating techniques for IS projects such as function point analysis,
- Techniques for evaluating IS projects such as effectiveness/cost ratio,
- Techniques for accounting for and evaluating deferred project benefits,
- Cost of Capital and selecting MARR for IS projects,
- Risk analysis techniques for evaluating IS projects.

There may be a need to modify these topics to meet the needs of a group of students. Additional research efforts may also demand the inclusion of other methods and techniques.

Conclusions

Many poor decisions in IS projects selection can be traced to the use of inappropriate evaluation techniques. Information system projects have several unique features that are outstanding from other privately and publicly financed projects. The present curriculum of engineering economic analysis does not make provision for the analysis of such projects. Hence, it does not prepare engineering graduates for the challenges of evaluating IS projects. The inclusion of information system economics in engineering economy curriculum will help to place engineering students in a more competitive position for their future career goals. It will also enhance research for integrated models for evaluating such projects.

Bibliography

1. Alter, S. (1999), "Information Systems: A Management Perspective," Third Edition, Addison Wesley Longman, Reading, Massachusetts.
2. Alter, S. (2002), "*Information Systems: Foundation of E-Business*," Fourth Edition, Prentice Hall, Upper Saddle River, NJ.
3. Ambler, S., (1999), "Comprehensive Approach cuts Project Failure," *Computing Canada*, 25(1), pp. 15-16.
4. Boehm, Barry W., (1981), "*Software Engineering Economics*," Prentice-Hall, Englewood Cliffs, NJ.
5. Ewusi-Mensah, K., (1997), "Critical Issues in Abandoned Information Systems Development Projects," *Communications of the ACM*, Vol. 40, No 9, pp. 74-80.
6. Sullivan, W.A, E.M. Wicks, and J.T. Luxhoj (2003), "Engineering Economy," Twelfth Edition, Prentice Hall, New Jersey.
7. The Standish Group International, Inc. (1995), "The CHAOS Report," West Yarmouth, MA.
8. The Standish Group International, Inc. (2001), "Extreme CHAOS," West Yarmouth, MA.
9. Ward, J.A. (1999), "Productivity through Project Management: Controlling the project variables," *Information Systems Management*, 11(1).

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