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Complexity and Risk in IS Projects: A System Dynamics Approach

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In spite of ongoing research on IS risks and the increased sophistication of the tools and techniques developed, IS risks continue to be a challenge to IS professionals and managers. Increased complexity leads to increased risks. When we are confronted with a complex system, our knowledge and understanding of how different components work and interact, and accordingly how the system as a whole works, will always be incomplete. While many researchers have dwelt on project management techniques, it is apparent that we cannot have all the answers in advance since we cannot foretell the future. Due to the increasing complexity of IS solutions it is seen that existing information system development methodologies do not tackle this adequately. The primary purpose of this paper is to highlight how System Dynamics which employs systems thinking can be used to deal with the study of organizations (companies, public institutions, and other human organizations) as complex systems of human activity, with plurality of interest and values. It also shows how System Dynamics models can help companies to manage the risks and uncertainties related to complex IS projects. This paper partly describes some variables in an ongoing research where we aim to use the system dynamics methodology to create a better understanding of the link between information quality and customer satisfaction. We critically look at two variables that we deem important in the search for this relationship. These are complexity and risk in IS projects.

Introduction

The concept of risk is highly visible in any development effort and the best way to deal with it is to contain it. This can best be done by carrying out risk management. Risk management entails identifying risks, analysing exposure to the risks in the development effort and execution of the risk management plan.

There are a number of risks such as the following: Cost overruns, Cancelled projects, High maintenance costs, False productivity claims, Low quality, Missed schedules, and Low user satisfaction.

Inspite of ongoing research on IS risks and the increased sophistication of the tools and techniques developed, IS risk continues to be a challenge to IS professionals and managers. The major driver of risk appears to be the exponential growth in IS complexity and use of IS solutions. Our society is becoming more complex through the use of more complex technologies and organisational forms. This brings about more unpredictability giving rise to systems that are becoming more unpredictable and more unmanageable (Beck, et al., 1994).

Although great advances have been made in implementing information systems, problems still remain (Kenneth and Schneider, 2002). The following are some of the problems facing the development of IS:

- The implementation of IS has often been fraught with uncertainty (Alter and Giznberg, 1978) and have always faced cost and time overruns (Zmud, 1980).
- Resourceful employees (including many young employees) burn out and suffer serious psychological scars as a result of managing projects. Consequently, many of them change jobs and lose the courage they need for project management and the company loses valuable resources (Amtoft and Vestergaard, 2002).
- There is a culture of project management in many organisations that sees it as a sign of weakness and poor management to ask questions or openly acknowledge that you do not have all the right answers (Amtoft and Vestergaard, 2002).
- Traditional proffessional knowledge is not well suited to coping with complex and unique situations. Problem solving as encountered in mathematics and physics brings forward a narrow, technical rationality, emphasizing a rationalist framework for intepreting knowledge. The related problem-solving strategies are too limited in scope (Klabbers, 1996). This is because organisations are information systems within which information is used for decision-making and business process support.

Software development metholodologies attempt to reduce risk by gathering information and using structured processes. It is assumed then that following a good methodology and identifying risk factors, failure could be avoided (Kenneth and Schneider, 2002). However, persistent software failures attest to the fact that there are risks that cannot be overcome by traditional approaches. Therefore, the purpose of this paper is to highlight how system dynamics can be used to create a better understanding of the development and implementation effort of Information systems. System Dynamics models can help companies to manage the risks and uncertainities related to complex IS projects. System Dynamics is concerned with creating models or representations of real world systems of all kinds and studying their dynamics or behavior. The purpose in applying System dynamics is to facilitate understanding of the relationship between the behavior of the system over time and its underlying structure and strategic policies or decision rules (Caulfield and Maj, 2002).

System dynamics has been demonstrated to be an effective analytical tool in a wide variety of situations, both academic and practical and may be a good way to help us understand information systems development and implementation (Williams, 2004). Systems dynamics models are widely used in project management including large scale projects in shipbuilding (Sterman, 1992). System Dynamics involves simulation which is a dynamic representation of reality. During the course of simulation, the model mimics important elements of what is being simulated. The model is used as a vehicle for experimentation in a "trial and error" way to demonstrate the likely effects of various policies. Those policies which produce the best result in the model will be implemented in real life (Williams, 2004). In such situations, simulation can be an effective, powerful and universal approach to problem solving of systems that would be too complex for mathematical analysis. System dynamics involves interpreting real life systems into computer simulation models that allow one to see how the structure and decision-making policies in a system create its behavior (Forrester, 1999). Simulation allows us to experience the long-term side effects of decisions in just a few minutes.

Challenges of is projects

Despite improved methods for system development and implementation, a number of challenges still exist as discussed in the subsections that follow below:

Requirements Volatility

A lot of emphasis has been placed in the information systems literature on developing complete requirements. Therefore, project managers often believe that gathering complete and consistent requirements can specify a system well enough that risks can be avoided. Unfortunately, correct and complete requirements are difficult for users to specify in systems because of the complexities of systems and limitations in human information processing capabilities (Kenneth and Schneider, 2002). Relying on complete requirement analysis may actually contribute to failure because of overconfidence and because of ignoring risks since requirements change over time (Williams, 2002).

IS Complexity

A complex system is an entity which is coherent in some recognizable way but whose elements, interactions and dynamics generate structures admitting surprise and novelty which cannot be defined in advance (Batty and Torrens, 2001).

Although significant numbers of IS projects are routinely completed successfully, a recent study on the state of IS in the UK carried out by Oxford University and Computer weekly reported that a mere 16% of IS projects were considered successful (Sauer and Cuthbertson, 2003). This is attributed to the increasing complexity of IS solutions and that existing information system development methodologies do not tackle this adequately. This is because such methodologies were developed at a time when IT complexity was at a much lower level, that these methodologies have not scaled regarding complexity (Sauer and Cuthbertson, 2003). In addition to this, new methodologies addressing the growth in complexity have not been developed. IS complexity has grown as the number of components and their integration has increased. This means that the complexity of IS development and use continues to grow substantially. Schneberger and McLean (2003) define complexity as dependent on a system's number of different types of components, its number of types of links and its speed of change. Increased complexity leads to increased risks. When we are confronted with a complex system, our knowledge and understanding of how different components work and interact, and accordingly how the system as a whole works, will always be incomplete. The components may act and interact in ways we cannot fully predict. Such unpredicatable behavior may cause the complex system as a whole to behave in totally unpredictable ways. This brings about the concept of feedback, which is of course very important.

Many IS projects are designed to improve the operation of business activities that are dynamic, complex, non-linear systems which cannot be readily understood by using static modeling approaches. The dynamic systems are characterized by interactions of closed chains (or feedback loops) that, when combined, define the structure of the system and hence how it behaves over time (Kennedy, 2001). This affects correctness of output and makes it difficult to estimate the exact expenditures and therefore benefits (Marquez and Blanchar, 2004). What has become clear is that people and processes have a greater effect on project outcome than technology (Sabherwal et al., 2005)

Risk

Research in IS shows that risk management is one of the most neglected aspects of project management (Sauer and Cuthbertson, 2003). Risk management involves the definition of hazards that could threaten progress such that earlier problems can be identified, the greater the chance that they be corrected or compesated for with minimal disruption to the project (Sauer and Cuthbertson, 2002). Predicting the future is always a difficult feat especially in today's complex ever-changing world. Unanticipated opportunities and threats can result in catastrophic failures (Vitale, 1986). Projects are said to be successful if they reach their targets of scope, quality, time and cost. However, a project may satisfy these goals but fail because business needs may change between project conception and implementation. A bank may suffer a system failure during an upgrade and have hundreds of thousands of transactions worth billions of dollars being held in suspense (Boyd, 2002). This risk can be managed by using System Dynamics which generates insights into how the whole development process can be achieved, without having to build the real system first. This enables the project manager to stand back and reflect on the project as a whole. Managers and policy makers operate within complex organizations that are riddled with interdependencies, delays, and nonlinearities. Such dynamic complexity challenges decision makers to learn about the underlying causal relationships to make effective decisions and thus minimize risk (Connoly, 1999).

Uncertainty

Pich et al (2002) state that uncertainty is directly related to information adequacy. This means that the better the information quality that the manager receives, the less the uncertainty. As a direct result of uncertainty, project failures are numerous in practice, there are budget and schedule overruns, compromised performance, and missed opportunities, (Morris and Hugh 1987, Tatikonda and Rosenthal 2000).

Visualization

IS project outcomes are effectively invisible. This visualization problem is a source of many IS project failures. Senior managers may ask for functions that are overambitious, or even impossible to deliver, without having any sense of the level of complexity entailed in meeting their request (Sauer and Cuthbertson, 2003). Dynamic Synthesis Methodology helps in bringing out this visualization in form of models and eventually in the Simulation experiments over time. Using simulation, risks are easily visualized by carrying out sensitivity analysis on the variables used in the modeling process. This helps everyone involved to properly understand the inherent risks at an early stage before implementation. Thus in the extreme, the project would not take off. This helps the Manager get a birds' eye view of the whole project scope before it is implemented.

Causal Loop Diagram

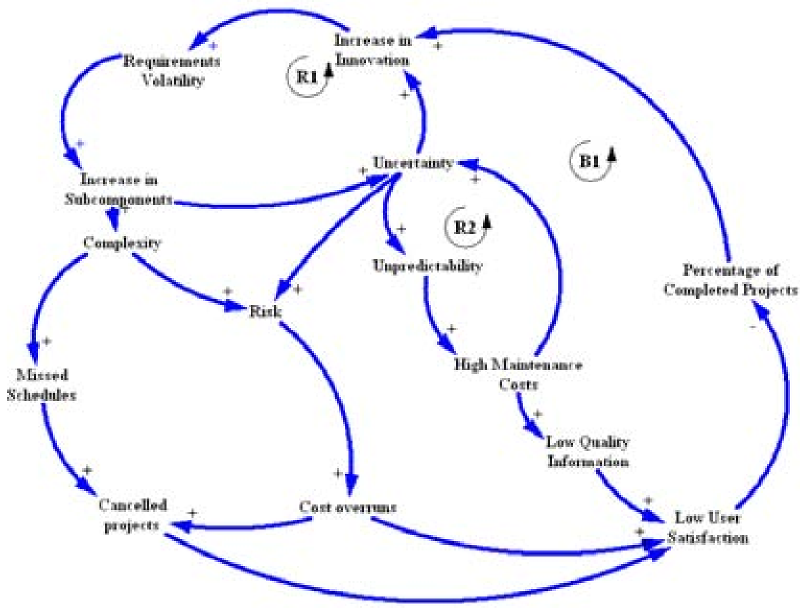
From the literature, we identify the following factors that affect the challenges of developing IS that are identified in the previous section.

- Increase in innovation
- Requirements volatility
- Increase in subcomponents
- Uncertainty
- Unpredictability
- Missed Schedules
- Risk
- Cost Overruns
- High Maintenance Costs
- Low Information quality
- Low User Satisfaction
- Cancelled Projects

It will be realised that factors such as Risk appear as factors since through feedback, risk increases through feedback.

Based on our study of the interaction of these factors, we develop a Causal Loop Diagram (CLD) shown in Fig.1 below:

Fig 1: Causal Loop Diagram of Identified Factors



Based on the CLD presented above, one can deduce that innovations increase over time because of pressures from industry and customers. This in turn leads to an increase in requirements volatility. The requirements volatility leads to an increase in the number of subcomponents in the system and hence contributing to complexity, risk and uncertainty. In like manner this drives the maintenance costs up, cost overruns and may also lead to missed schedules as well as cancelled projects. Uncertainty can lead to low quality information and hence low user/ customer satisfaction and may lower the percentage of completed projects. This in turn feeds back to the system, giving rise to an increase in innovations. The whole process then plays itself out again.

Conclusion

IS risks caused by uncertainty, and complexity leading to cost overruns and low user satisfaction continue to be a challenge to IS professionals and managers. System dynamics can be used to highlight the challenges and create better understanding in order to improve IS project outcomes before they are implemented.

Future work

Future areas of research will involve a field study in form of a quantitative study in two leading Telecommunications firms. To test this case study, another firm will be used for the validation of this study. After this, a system dynamics model will be built to test the dynamics of information quality on customer satisfaction in IS projects.

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