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IT Project Management from a Systems Thinking Perspective: A Position Paper

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ABSTRACT

We propose a Systems Thinking approach to the study of IT project management and show how this approach helps project managers in controlling their projects. To illustrate our proposal, we present an example model of the dynamics of IT outsourcing projects. The example model explains these dynamics in terms of feedback loops consisting of causal relations reported in the literature. The model provides insight in how coordination, trust, information exchange and possibilities for opportunistic behaviour influence each other and together influence delivery quality, which in turn influences trust. The integration of these insights provided by applying the Systems Thinking perspective helps project managers to reason about how their choices influence project outcome. The Systems Thinking perspective can serve as an additional tool in the academic study of IT project management. Applying the Systems Thinking perspective also calls for additional research in which this perspective is itself the object of study.

Keywords

Systems Thinking, Systems Dynamics, IT Project Management, IT Outsourcing, Coordination, Trust

INTRODUCTION

Many IT projects fail in one way or another: while the exact percentage depends on the definition of failure and way of measuring, failure rates reported are usually higher than 50% (Gemino et al., 2007). In this paper, we define IT projects as projects in which some desired IT functionality is created for an internal, non-commercial or external, commercial customer organization. This can be in the form of in-house software development by software engineering or in the form of outsourcing to an external organization.

IT projects are complex systems that consist of different kinds of components, such as stakeholders, work products, procedures, and project controls. The interaction of these components determines the outcome of the project. Similar to van Ekris (2008), we use a broad definition of project outcome: project outcome is any change in the material or mental state of the customer caused by the project. Project outcome is not determined at a single moment in time, but by a process consisting of multiple interactions with members of the customer organization. These interactions include the delivery of partial project results, consultations with members of the customer organization, and delivery of progress reports. In other words, the project outcome is governed by the dynamics of a complex system, which IT project management aims to control.

The dynamics of a complex system emerges from the interactions between the components of the system, and can often be explained by feedback loops within the system. For instance, consider a project in which partial project results have been rejected by users because they found that the results do not fit their way of working. This may lead to a decrease in trust in the project, which may lead to a decrease in knowledge sharing between the project and the (disappointed) project users, which in turn leads to subsequent project results that fit even less.

In other words, dynamics cannot be fully explained by isolated correlations between two variables, as this neglects feedback loops. However, current research in the Information Systems area mainly focuses on such isolated correlations, for instance the impact of top management support (independent variable) on project success (dependent variable). Therefore, a holistic approach that studies parts of the system not in isolation, but as the parts of a greater whole has the potential to extend current research insights in a way that practitioners need to successfully manage projects.

Systems Thinking (Sterman, 2000; Maani and Cavana, 2000) is an approach to problem solving based on a holistic view in which a problem is explained as emerging from the dynamics of the underlying system. The contribution of this paper is a proposal to apply Systems Thinking in the area of IT project Management, providing a way to capture the dynamics of IT projects. Using an application in the area of outsourcing projects as an example, we show how applying Systems Thinking in IT project management helps project managers to understand how their decisions influence project success, which in turn helps them to stay in control.

SYSTEMS THINKING: BACKGROUND AND RELATED WORK

The history of Systems Thinking can be traced back to research in general (mathematical) systems theory as developed in the mid of the previous century. Systems Thinking grew out of Forrester's work in which he applied general systems theory to organizational systems in business. Two paradigms can be distinguished in Systems Thinking: Systems Dynamics and Soft Systems Methodology (SSM). Systems Dynamics (the paradigm pioneered by Forrester) focuses on modelling feedback loops consisting of cause-and-effect relations between system components and on computer simulations to study system dynamics. Systems Dynamics primarily deals with quantitative models, but as early as 1983 qualitative approaches have been proposed (Wolstenholme and Coyle, 1983; Wolstenholme, 1983). Other examples of qualitative applications have been presented by Dangerfield (1999), and by Swart and Powell (2006). This paper follows the tradition of qualitative Systems Dynamics.

The Systems Dynamics approach is what Pollack (2007) calls a 'hard' approach to Systems Thinking. According to Maani and Cavana (2000), in the 'hard' approaches the systems model is seen as a representation of the real world. Further assumptions are that stakeholders agree on a "clear and single dimensional (single objective)" problem definition (Maani and Cavana, 2000). Maani and Cavana (2000) also note that in the 'hard' approaches, organizational and people issues are not taken into account, and data is usually quantitative. Wolstenholme (1993) puts this into perspective: while his approach is 'hard' in the sense that his model is seen as an objective representation of the real world and there is a clear and single-dimensional problem definition, data is qualitative and organizational issues are taken into account. We concur with Wolstenholme (1993) and Pollack (2007) and assume that in 'hard' approaches, data is objective and based on empirical observations, but not necessarily quantitative.

According to Maani and Cavana (2000) and Pollack (2007), in 'soft' approaches (of which Peter Checkland's Soft Systems Methodology (Checkland, 1981) is probably the best-known example), the dynamic model is not seen as an objective representation of the real world, but as "a way of generating debate and insight about the real world" (Maani and Cavana, 2000). Thus, in the 'soft' approaches, a model is subjective and this reflects that different stakeholders may have different perceptions about how the real world behaves, and also about what the problem actually is.

In fact, both 'hard' and 'soft' approaches have a place in IT project management. A 'soft' approach has been used by Johnstone et al. (2006) to develop a holistic framework of conflict and conflict resolution in IT projects. Their framework appears to contain one (short) feedback loop: governance provides process adjustments to resolve conflicts, and observes whether this helps. The results of Johnstone et al. can be the starting point for a subsequent 'hard' approach that further explains the behaviour of the system-to-be-controlled in terms of internal feedback loops.

Mutschler et al. (2007) use a 'hard' approach to model the factors that influence implementation costs of what they call 'process-aware information systems'. The authors present quantitative, mathematical models of a large number of cost factors and use simulation to explain dynamic behaviour such as costs that rise exponentially over time, or costs that fluctuate around a certain level. Their work shows how a 'hard', quantitative approach can be used to model one aspect of project management (management of cost).

A SYSTEMS THINKING PERSPECTIVE ON IT PROJECT MANAGEMENT

Applying Systems Thinking to reason about (a problematic phenomena of) a system involves creating a model of the system. Sterman (2000) proposes a five-step, iterative process to do so. This process consists of the following steps: (i) problem articulation, (ii) formulation of the dynamic hypothesis, (iii) formulation of a simulation model, (iv) testing and (v) policy design and evaluation. These steps are conducted by problem stakeholders, possibly together with a consultant trained in Systems Dynamics. The hypothesis formulated in the second step is a conjecture of how

feedback loops in the system explain the behaviour of the system. These feedback loops are essential: without them, a general causal model is obtained that cannot describe dynamics. In quantitative systems dynamics, this hypothesis is then tested (step iv) using quantitative simulation techniques determined in step (iii) to assess the robustness to boundary cases, and to do sensitivity analysis. In qualitative Systems Dynamics, the hypothesis is validated using techniques such as obtaining expert feedback.

In this paper, we focus on what Sterman (2000) calls the dynamics hypothesis. This hypothesis explains the behaviour of the system in terms of interactions between its components and is usually formulated using some diagramming technique such as causal loop diagrams or stock and flow diagrams (Sterman, 2000; Maani and Cavana, 2000). A causal loop diagram (and also a stock and flow diagram, which is an extension of a causal loop diagram) consists of a number of variables and causal relations between them. A variable either describes some property of the system as a whole, or some part of it.

The position of this paper is that we propose to apply Systems Thinking to IT project management. This means that we propose to focus on the dynamic behaviour of a project: the behaviour of (everything in) a project changes over time, and IT project management is about proactively controlling this. Project managers do so by identifying feedback loops, creating causal models of the project and choosing control actions based on this model, similar to the process outlined above. We illustrate the kind of insight that this creates in the next section.

A CAUSAL MODEL OF IT OUTSOURCING PROJECT SUCCESS

In this section, we present, as an illustration of the Systems Thinking perspective, a causal model of dynamics in an IT outsourcing project. Our model, which is depicted in Figure 1, is based on the following vision of success of outsourcing projects. Outsourcing creates a relation between two economically independent actors (the outsourcer and the insourcer). The fact that the two actors are economically independent creates forces and tensions between them that in turn influence *delivery quality* as depicted in the model (words in italics refer to variables in Figure 1). During the project, both employ *information flows* to *coordinate* their activities. This information exchange, however, is influenced by the *trust* that they have in each other, which in turn is influenced by the *perception* of the outsourcer of the extent to which the insourcer is capable of *delivery*. As both actors are economically independent, we have to assume that each is self-interested and not unwilling to act in a way that advances its own interest in a way that is detrimental to the other (*possibilities for opportunistic behaviour*).

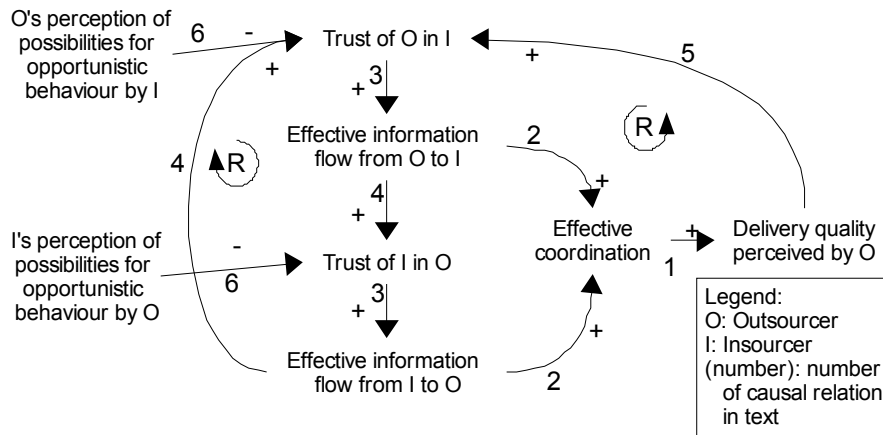


Figure 5: Operational success of outsourcing: causal model. A '+' indicates that an increase in one variable causes an increase in the other. A '-' indicates that an increase in one variable causes a decrease in the other. Two 'reinforcing' (letter 'R') feedback loops are indicated.

We claim that in outsourcing, there are at least two positive, or reinforcing, feedback loops which explains why outsourcing projects have a tendency to get out of control: for instance, if trust erodes, parties become less open in their communication, which affects delivery, which in turn further erodes trust, and so on. Of course, the feedback loop can also work in the opposite direction. The point is that the feedback loops make the dynamic aspects of the

project explicit. This is the distinguishing feature and primary benefit of applying the Systems Thinking perspective. The next subsections systematically describe the variables in the model as well as the relations between them.

Delivery quality: Operational success of IT outsourcing projects

With operational success, we mean that the project results in delivery of a solution, within time and within budget, that according to the customer has the quality agreed upon beforehand. Similar to van Ekris (2008), we view operational success as more than only delivering the right result on time.

Delivery quality as perceived by the outsourcer is in the model because it is the ultimate goal of at least the outsourcer and most probably also of the insourcer to deliver intermediate and ultimate project results that are perceived as quality results by the outsourcer. The precise operationalisation of delivery quality is case-specific. Thomas and Fernandez (2008) report results of a survey among 36 Australian companies with the aim to understand how these companies define project success. They found that project success is a multi-dimensional construct and identify several success criteria in three categories ('project management', e.g. on-time and on-budget, 'technical', e.g. system quality, and 'business', e.g. delivery of benefits).

Coordination

We follow Malone and Crowston (1994) and define coordination as "managing dependencies between activities." In the context of the current illustration, 'activities' are the common activities in software development, such as requirements engineering, programming, testing, and delivering the resulting software product. There are dependencies between these activities: certain activities can only start when others have finished, or certain activities may need access to the same resource. Coordination consists of all mechanisms employed and actions taken to ensure that these dependencies do not hamper the project.

Causal Relation 1 An increase in effective coordination causes an increase in delivery quality as perceived by the outsourcer.

We concur with Kraut and Streeter (1995) and mention that successful coordination is an important determinant of project success. Moreover, coordination is an area that is amendable to managerial control: project managers can choose coordination mechanisms in the project setup phase and can monitor whether coordination is successful when the project is carried out and intervene in a relatively easy way. Mirani (2007), in a recent paper, examines the relation between what he calls procedural coordination in offshore "software tasks" in two case studies.

Information exchange

In our model, successful coordination is in turn influenced by the effectiveness of information exchange between the insourcer and the outsourcer. We take the position that what Thompson (1967) calls 'reciprocal dependence' is the dominant type of dependence in the interaction between outsourcer and insourcer. Every project milestone in which (part of) the final product is delivered is an opportunity for the outsourcer to provide the insourcers with feedback concerning the quality of the product, which in turn enables the insourcer to create a new version, which is another opportunity for the outsourcer to provide feedback, and so on. The appropriate coordination mechanism according to Thompson is mutual adjustment based on information exchanged between the outsourcer and the insourcer. This works better when the information exchanges is of better quality, which justifies the inclusion of the following causal relation in the model:

Causal Relation 2 An increase in the quality of information (regarding the project) exchanged between the insourcer and outsourcer causes an increase in effective coordination.

Relations between information exchange and coordination are numerous in the scientific research literature. Many observations made by Mirani (2007) boil down to information exchange; for instance, the author observed that coordination improved when the offshoring company started to use a 'dedicated multi-tier Telecom infrastructure'.

Like in the area of coordination, it is relatively easy for project managers to install control mechanisms that facilitate effective information exchange across the whole spectrum from facilitating direct human-to-human communication to formalized document flows in the project. Managers can invest in modern communication technology to facilitate

meetings between stakeholders, increase travel budgets, place employees at each other's sites, or invest in tools such as shared workspaces for document exchange, workflow management systems, and bug trackers.

Trust

Although it is possible to facilitate information exchange by a vast number of social and technical means, whether the actors in an outsourcing relation actually use these means is influenced by the trust they have in each other. We follow Lewicki et al. (1998) and define trust of an actor X in another actor Y as the "confident positive expectations" that X has of the conduct of Y .

Trust is a dynamic concept: the amount of trust that one actor has in another may change over time. Lewicki and Bunker (1996) distinguish three types of trust (calculus-based, knowledge-based and identification-based trust) and describe the "stepwise evolution of trust" over time. It is thus possible to speak of the increase or decrease of trust, which allows us to include the following causal relations.

Causal Relation 3 An increase in the trust that an actor X has in actor Y causes an increase in the effectiveness of information transmission from X to Y .

Causal Relation 4 An increase of the effectiveness of information transmission from an actor X to an actor Y causes an increase in the trust that Y has in X .

Causal Relation 5 An increase in delivery quality as perceived by the outsourcer causes an increase in the trust that the outsourcer has in the insourcer.

Lewicki and Bunker (1996) discuss several mechanisms that play a role in trust development. These mechanisms also can be viewed as support for the causal relations. For instance, Lewicki and Bunker state that regular (and, presumably, effective) communication is key in developing knowledge-based trust. Lander et al. (2004) report similar findings. In particular, they state that "The importance of communication as a trust-building mechanism had the highest overall rating as the most important of the ten mechanisms examined. Study participants identified communication as a trust-building mechanism more frequently than any other mechanism." (Lander et al., 2004, p. 517). Nicolaou and McKnight (2006) investigated trust in what they call inter-organizational systems and found that an increase in perceived quality of information exchange results in an increase in trust.

Trust plays a central role in the causal model; it is the linking pin that connects all other variables. Trust can be manipulated by project managers via various means. As our model indicates, one way is to increase delivery quality. The literature on outsourcing discusses many other ways. Jarvenpaa and Leidner (1998), for instance, discuss how trust can be influenced on the inter-personal level (by making sure that project members meet face-to-face, etc.)

Perception of possibilities for opportunistic behaviour

The possibility that either, or both, of the actors involved in an outsourcing relation behaves opportunistically follows from Transaction Costs Analysis (TCA), an economic theory proposed by Coase (1937) and extended by Williamson (1981). Transaction Costs Analysis is rooted in a economic view of the world in which economic actors have bounded rationality and are not inherently 'good': economic actors are willing to bend the rules, breach contract, cheat, or engage in any other activity that advances them toward their goal, even if this harms other economic actors. Williamson calls this 'opportunism' (Williamson, 1993). The extent to which an economic actor has the possibility to act opportunistically differs for each relation that the actor engages in. This influences the amount of trust that one economic actor has in the other. We therefore include in our model a negative causal relation between possibilities for opportunistic behaviour and trust:

Causal Relation 6 An increase in the possibilities for opportunistic behaviour by an actor X as perceived by another actor Y causes a decrease of trust of Y in X .

The perception of the possibilities for opportunistic behaviour can be controlled by project managers, for example by making sure that such possibilities are covered by the contract governing the relation. In our model, this is currently the only way to balance the forces of the feedback loops that involve trust.

Discussion

In this section, we illustrated how the Systems Thinking perspective reveals feedback loops that explain the behaviour of an outsourcing project over time. The variables of the model indicate which control actions a project manager can take, and provide insight in why the project behaves as it does. Thus, the dynamic model provides a means for project managers to reason about their projects as a starting point for decision making.

The causal model presented in this section is not the only possible model that explains the dynamics of an outsourcing project. We are aware of several (almost obvious) possible extensions, which we discuss next. In fact, from the perspective of Systems Thinking methodology, this is of minor importance. Our model is a consolidation of the experience that we gained in studying outsourcing and inter-organizational systems development with several industrial partners. Thus, the model is not specific for one particular IT outsourcing project. When Systems Thinking is applied in a specific project context, completeness of the model is tested for that specific context as part of the process outlined before.

Possible extensions of the model include adding more variables. The literature on outsourcing and offshoring provides numerous suggestions, see Dibbern et al. (2004) for a comprehensive survey. For instance, especially in the case of offshore outsourcing, cultural issues are important factors in the success of an outsourcing relation. Also knowledge is a factor: the outcome of an outsourced IT project is influenced by the knowledge the insourcer has of the project context at the outsourcer. Knowledge is related to two variables that are present in our model: information exchange (as a way to 'build' knowledge) and trust (Levin and Cross, 2004).

CONCLUSION

Implications for research

Systems Thinking has been developed as a problem solving approach and not as a scientific research method. The question then is: Can IT project management from a Systems Thinking perspective result in scientific knowledge? In this section, we discuss two roles that we see for academic research in the area of Systems Thinking and IT project management.

In this first role, Systems Thinking is a tool in the academic study of IT project management. While Systems Thinking is not itself a scientific method, it contains elements that are related to scientific methodology. In our opinion, generalization of results obtained by applying Systems Thinking to a specific IT project management case can follow several different routes. One route is to apply the same causal model to a different case. This is what Lee and Baskerville (2003) call TE-generalization (from Theory to Empirical description): "generalizing a theory, confirmed in one setting, to descriptions of other settings". This route requires testing the model in the context of this different case as outlined by the process described before. The model thus becomes a kind of reference model that practitioners use as a starting point in the hypothesis formulation step.

The other route is to regard a causal model that is validated in a particular case as a representation of an empirical fact and derive from this a theory. This type of generalization underpins the case study research methodology of Yin (2003). Lee and Baskerville (2003) call this type of generalization ET (from Empirical description to Theory): generalization from description to theory. This type of generalization requires that the researcher carefully documents how the idiosyncrasies of the particular case are interpreted as instances of more general phenomena (Klein and Myers, 1999). We think that Systems Thinking is particularly useful for this: models such as causal loop diagrams describe the causal mechanism that explains the observed empirical fact.

The second role that we propose for academic research takes Systems Thinking itself as the object of study. In this role, academic research studies the application of Systems Thinking to IT project management with the aim to develop knowledge about best practices, and to develop new methods and tools that help practitioners to apply Systems Thinking in this context.

Implications for practice

We have illustrated how the Systems Thinking perspective on IT project management helps project managers to understand and reason about the causal mechanisms that explain project dynamics. Project managers can use this to decide which interventions to conduct to keep their projects under control. The Systems Thinking perspective

extends existing knowledge about IT project management that is of a more static nature, such as knowledge of success factors and risks.

This practical implication applies to the phase in which the project is running and managers have to exercise control by using the control mechanisms that the project provides. We see a second practical implication in the setup phase of the project: the Systems Thinking perspective supports design of project control mechanisms. In the setup phase, stakeholders have to decide on which mechanisms to use to control the project. These mechanisms form a system, which is an artefact that needs to be designed by the project stakeholders. One step in design is identifying solution alternatives and choosing the one(s) that can be expected to reach the goal of the design. Designers base this expectation on knowledge of the behaviour of each solution alternative. The Systems Thinking perspective equips project stakeholders with the tools to obtain this knowledge: the dynamic models explain how the different control mechanisms interact. Thus, the Systems Thinking perspective on IT project management not only allows project managers to control their projects, but also to design the set of control mechanisms that they employ to exercise control.

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