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A Study of the Use and Effectiveness of Controls in Agile Information Systems Development Projects: A Research-in-Progress (RIP) Paper

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A Study of the Use and Effectiveness of Controls in Agile Information Systems Development Projects

Research-in-Progress (RIP) Paper

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ABSTRACT

This study uses control theory as a lens to examine the use of control in agile information systems development (ISD) projects, specifically within software project teams that use agile methodologies. Traditionally, requirements for ISD projects have been defined at the outset and it has been the role of the project manager to control the project and help the team to achieve their goals. However, the goals of agile ISD projects are flexible and can change frequently, with the consequence that it can be difficult for a project manager to determine the most appropriate and effective type of control to use at each stage of a project. The aim of this research is to: develop a research instrument that will identify the control modes used by project teams in agile ISD projects; conduct a survey to collect data; and develop a framework for assessing the effectiveness of each control mode.

Keywords

IS project management, IS project control, IS project teams, IS control issues, agile methodology, agile systems development

INTRODUCTION

Information systems development (ISD) is a complex activity of designing, building, testing, implementing and maintaining a software system (Kirsch and Cummings, 1996, Nidumolu and Subramani, 2003). In the early days of information systems development, applications were typically constructed in an ad-hoc fashion. As systems began to grow in complexity, difficulties in controlling ISD projects came to the fore, ultimately leading to calls to establish a discipline of “software engineering” (Naur and Randell, 1969). At that time, software developers looked to the established branches of engineering, such as manufacturing and construction, for guidance on systematic methods and processes. There ensued through the 1970’s and 1980’s what Avison & Fitzgerald (2003, p537) refer to as the “methodology era”, during which time numerous formalised ISD methods were proposed. However, from the early 1980’s onwards, there grew an increasing level of discontent surrounding the suitability of methods founded on assumptions which did not seem to hold in the domain of ISD (Boehm, 1988, McCracken and Jackson, 1982). The backlash against “heavyweight” formalised methods gained further momentum with the emerging realization that not alone were those methods largely ineffective, but they could actually be counter-productive because there was a tendency for ISD project managers to become absorbed in self-serving “rituals” to the extent that the pursuit of the method became a goal of its own right, displacing the primary objective of developing a good system with covert defensive motives (Fitzgerald, 1996, Robey and Markus, 1984). It became clear that there was an incongruence between, on the one hand, the rigid, cumbersome procedures prescribed by formalised methods and on the other, the flexible and dynamic nature both of the systems development process itself and the wider business environment. Thus emerged a new paradigm of ISD project management and control, now known as “agile” methods (eXtreme

Programming, Scrum, DSDM etc.), which has grown out of earlier movements such as incremental, iterative and rapid development.

Business environments and information technology are changing at an extremely fast pace with organisations continuously revising projects (Elonen and Arto, 2003, Lee and Xia, 2005). It is suggested that businesses should be flexible in order to operate in such a dynamic and changing environment as the market expects high-quality software to be delivered in a short period of time (Highsmith and Cockburn, 2001, Nieminen and Lehtonen, 2008). As a result, it is important to the performance of the organisation how their systems development teams are controlled (Nidumolu and Subramani, 2003). Highsmith and Cockburn (2001) believe that agile systems development can address this need for dynamic, innovative approaches within organisations as agility is about “creating and responding to change”. Boehm (2002) concurs with this and is of the opinion that the traditional plan-driven approach to systems development does not work well when requirements change frequently. Developing and controlling systems development in this changing environment provides a major challenge for systems development managers as they must implement appropriate controls on their projects to cope with the these demands (Harris, Hevner and Collins, 2006, Simons, 1995). Previous studies such as Kirsch (1997) highlighted the lack of research about the modes of control used to manage ISD projects and even less focuses specifically on control modes used in agile ISD projects.

MOTIVATION FOR THE RESEARCH

Control in organisations has been a topic of interest to researchers for many years as it is generally recognised that control mechanisms are of critical importance in helping organisations to achieve their goals (Kirsch, 1996). Control can be viewed broadly as an attempt by an individual or a group of individuals to influence people to take actions and make decisions, which are consistent with the goals and objectives of the organisation (Das and Teng, 1998, Eisenhardt, 1985, Jaworski, 1988, Ouchi, 1979). The process of control can be defined as the process of monitoring behaviour, evaluating the outcomes that result from that behaviour, and providing feedback (Ouchi, 1977, Ouchi and Maguire, 1975). Researchers examining control in the context of ISD have studied the relationship between controller(s), who exercise the control, and the controllees, who deliver on the agreed tasks to meet the desired objectives (Henderson and Lee, 1992, Kirsch and Cummings, 1996, Kirsch, Sambamurthy, Ko and Purvis, 2002). This study adopts this view of control where the project manager acts as the controller and the project team as the controllees.

Prior research on control has focused on organisational control (Flamholtz, Das and Tsui, 1985, Ouchi, 1979, Ouchi and Maguire, 1975), management control (Otley, 1994), retail sales (Eisenhardt, 1985), marketing (Jaworski and MacInnis, 1989, Merchant, 1988), HR (Snell, 1992) and more recently ISD (Kirsch, 1996, Kirsch, 1997). Control research in an ISD context has examined, for example, control of internal systems development projects (Kirsch, 1996, Kirsch, 1997, Kirsch et al., 2002); the performance of project teams (Henderson and Lee, 1992); the factors influencing the choice of control modes on ISD projects (Kirsch, 1996, Kirsch, 1997); controlling a project from the client perspective (Kirsch et al., 2002) and controlling outsourced projects (Choudhury and Sabherwal 2003). However, existing research on ISD control has tended to be limited to projects that use a traditional, more plan-driven approach. In recent years there has been an increase in the number of organisations that have adopted agile practices or that use agile methodologies (Hovorka and Larsen, 2006, Nerur, Mahapatra and Mangalara, 2005) and only a few studies have examined control in the context of agile systems development projects (Harris et al., 2006). Such studies are clearly warranted as agile practices may fundamentally affect the way in which ISD projects are controlled. For example, on agile systems development projects

- the project manager’s role as is greatly reduced, and is more akin to that of a facilitator or coordinator (Alleman, 2002, Boehm and Turner, 2005, Lindstrom and Jeffries, 2004, Nerur et al., 2005). Traditionally, the project manager would have been the primary project controller.
- the development team is empowered and is forced to self-organise, creating a “pluralist environment” (Coram and Bohner, 2005, Nerur et al., 2005) due to the diverse backgrounds, attitudes, goals, and cognitive dispositions of the team members (Highsmith, 2004, Chin, 2004, Cockburn and Highsmith, 2001), all of which may have implications on the choice and implementation of controls.
- the organisation or team structure is “organic and flexible”, as opposed to traditional structures which are “mechanistic, bureaucratic and formalized” (Nerur et al., 2005).
- the project is completed through a series of iterations, each often as short as a few working days (Fowler and Highsmith, 2001, Fitzgerald, Hartnett and Conboy, 2006). This means that control may need to be more short-term,

may not be as rigid or binding, and may have to be implemented quickly ‘on the fly’, and is often based on incomplete or imperfect information.

- software is valued over documentation (Fowler and Highsmith, 2001). Agile methods attempt to minimise documentation, and although this may bring several advantages, such records would traditionally have served as a useful means of control.
- the customer plays a more continuous and embedded role, and thus is intrinsically involved in most decisions (Boehm and Turner, 2005, Coram and Bohner, 2005, Farell, Narang, Kapitan and Webber 2002, Griffin, 2001). This is in contrast to more traditional approaches where customers do not get involved in day-to-day operational development; rather their involvement is limited to intermittent events such as prototyping sessions and release meetings.
- developers are not confined to a specific specialised role as is usually the case with traditional approaches. Instead, the team are encouraged to self-organise, interchanging and blending roles on a continual basis (Nerur et al., 2005). Control over such non-static roles and responsibilities may be significantly more challenging.

Controls in ISD have been shown to evolve during the course of a software projects. However, minimal research has focused on how this evolution occurs in agile ISD. The most notable contributors to this are a study by Choudhury and Sabherwal (2003) which examines how controls change over time in outsourced ISD projects; a study by Kirsch (2004) which addresses the evolution of controls in large IS projects; and a study by Rustagi, King and Kirsch (2008) which looks at the extent to which a client uses formal control to exercise control over a vendor in outsourced ISD projects.

In addition, it is important not just to measure the extent to which control is applied to a project, but also to measure the effectiveness of these controls. Although control is often positively associated with performance (Henderson and Lee, 1992), this is not always the case. Excessive use or unnecessary tightness of controls may, in some instances, have a negative impact on performance (Merchant and Otle, 2007, Hartmann, 2000). A project manager must therefore identify an effective level of control, suitable to their project and its environment. As far as we are aware, no rigorous research has examined the effectiveness of controls in ISD, or within the context of agile systems development projects. This suggests that there is a need to examine control from this perspective.

RESEARCH OBJECTIVE AND QUESTIONS

The importance of control on ISD projects has been widely recognised and studied. Research on flexible or agile systems development is limited, but it is growing. As yet, little is known about how agile ISD projects are controlled. While previous studies have detailed control measures in traditional ISD projects there is a lack of valid, reliable measures for assessing the control modes used in agile systems development. This research-in-progress paper focuses on the control modes used in agile systems development projects with the aim of understanding how project managers control such projects. There are three objectives to this research:

Q1. What control modes are used in agile information systems development projects?

Q2. How and why do the control modes (both formal and informal) evolve during an agile information systems development project?

Q3. How effective are these control modes from the perspective of the project manager and the project team?

This research hopes to contribute to previous work on control in ISD projects by investigating the use of control modes in agile systems development projects and by developing/adapting and validating control measures for agile systems development projects. We also hope to provide a practical contribution by developing a framework that project managers and project teams can use to measure and assess the effectiveness of specific control modes at various stages throughout an agile project. It is envisaged that this framework may include facilitators/inhibitors of each control mode from the perspective of the project manager and the project team.

THEORETICAL FOUNDATIONS

Control theory is based in cybernetics, the science of control and communications. It has been applied to many areas such as motivation (Klein, 1989), self-management (Manz, 1986) and organisations (March and Simon, 1958, Tannenbaum, 1968).

The use of control theory in the context of organisations is of particular interest in the social sciences as an organisation is a social unit that is established with the explicit purpose of achieving specific goals (Blau and Scott, 1963, p1). Within an organisation it is the function of control to ensure that processes are followed and order is maintained in order to achieve these goals (Tannenbaum, 1962). In the past organisations have adopted one of two approaches to control: performance evaluation (referring to the cybernetic process of monitoring and rewarding performance), or to focus on people policies such as training and socialisation (Ouchi, 1979, Blau and Scott, 1963). More recently, control theory has been adopted to study control in smaller work units within an organisation, such as IS project teams (Henderson and Lee, 1992; Kirsch 1997). These smaller work units are the focus of this research, with the aim of gaining an insight on their approach to control.

The existing literature defines two broad categories of control: formal control and informal control (Eisenhardt, 1985, Jaworski, 1988, Ouchi, 1979). Formal control employs rules and procedures that require particular patterns of behaviour to be followed in order to achieve desired goals (Das and Teng, 1998, Nidumolu and Subramani, 2003). Behaviours or outcomes are measured and evaluated, and rewards are made in accordance with the tasks that have been achieved (Eisenhardt, 1985). This suggests that there are two types of formal control: behaviour-based control and outcome-based control. This stems from Ouchi’s (1979) concept of control as detailed in Figure 1 below which suggests that the optimal choice of control mechanisms is determined by characteristics such as task programmability (i.e. knowledge of the transformation process) and outcome measurability. If organisations know the precise behaviours and processes that will transform inputs into outputs they can use behavioural control, whereas if an organisation’s desired result can be measured, then outcome control should be used. If neither outcomes are measurable nor appropriate behaviours are known, then clan control is implemented.

		Knowledge of the Transformation Process	
		<i>Perfect</i>	<i>Imperfect</i>
Ability to Measure Outputs	<i>High</i>	Behaviour or Output Measurement	Output Measurement
	<i>Low</i>	Behaviour Measurement	Ritual and Ceremony “Clan” Control

Figure 1: Conditions determining the measurement of behaviour and output (Ouchi, 1979)

Behaviour control requires the identification of appropriate behaviour to complete a task (Nidumolu and Subramani, 2003). Behaviour control can be implemented on ISD projects by enforcing procedures and methods for tasks, for example, the use of a formal procedure to develop a project schedule or employing a formal systems development methodology (Kirsch, 1996). Outcome control can be implemented by specifying criteria that can be measured for example, quality metrics, meeting a schedule, or completing a project within budget (Nidumolu and Subramani, 2003).

Informal controls differ from formal controls in that they are social or people-based and they focus on the role that individuals or groups play in the exercise of control (Eisenhardt, 1985, Jaworski, 1988, Ouchi, 1980). They rely on common values and beliefs, or traditions among people or individuals (Ouchi, 1980). In Ouchi’s (1979) framework one informal control was identified, namely; clan control (see Figure 1), where clan control is defined as a group of individuals who are dependent on one another and who work together to achieve a common goal (Ouchi, 1980). Careful selection of members of a clan should result in a group of individuals with a strong sense of identity with and commitment to the group (Kirsch, 1996). Within a clan each group member can effectively function as both the controller and the controllee (Choudhury and Sabherwal 2003). Ouchi (1980) suggests that only certain organisations exhibit the characteristics of a clan. These organisations typically operate in industries where teamwork is common, technology changes often and it is difficult to clearly measure and evaluate employee performance (Ouchi, 1980). As a result, clan control evaluation and reward are a function of the group as a whole (Kirsch, 1996).

Since the development of Ouchi’s framework other researchers (Choudhury and Sabherwal 2003, Henderson and Lee, 1992, Kirsch, 1996) have suggested a second type of informal control called self-control in which individuals set their own goals; determine the actions by which those goals should be achieved; monitor their own work; and reward themselves accordingly. This is in contrast to clan control where individuals are socialised into a group (Jaworski, 1988). In some instances the goals and processes of individuals may not be formally documented (Kirsch, 1997), which means that organisations must ensure

that any decisions individuals make are consistent with the interests of the organisation (Harris et al., 2006). However, even if controllers do not directly exercise self-control over others, they may still encourage others to exercise self-control by appropriately structuring the work environment (Kirsch et al., 2002) by selecting the correct individuals and socialising them so that they understand and value the objectives of the organisation (Harris et al., 2006).

Each of these control modes consist of various characteristics which define them. A summary of the characteristics of each of these four modes of control is displayed in Table 1 below:

Mode of Control		Characteristic
Formal Control	Behaviour	Behaviours that transform inputs to outputs Controller monitors and evaluates controllees' behaviour Explicit link exists between extrinsic rewards and following behaviours
	Outcome	Desired task outcomes are known and measurable Controller evaluates whether outcomes were met Explicit link exists between rewards and producing outcomes
Informal Control	Clan	Task-related behaviours and outcomes are not pre-specified Goals are determined by clan and evolve during the task period Clan identifies and reinforces acceptable behaviours Rewards are based on acting in accordance with clan's values and attitudes Shared experiences, values, and beliefs among the clan members Members exhibit strong commitment to the clan
	Self	Controllee sets own task goals and procedures Controllee is intrinsically motivated Controllee engages in self-monitoring and self-evaluation Rewards are based partly on controllees' ability to self-manage

Table 1. Characteristics of Four Modes of Controls Adapted from (Kirsch, 1996)

The intention is to develop/adapt and validate constructs to measure each of these control modes as they are used within agile systems development projects and to develop a framework that will allow a project manager or a project team to assess the effectiveness of each of these control modes.

RESEARCH METHODOLOGY

To investigate the research questions detailed above a quantitative study is proposed. Currently, we are reviewing the literature to identify research instruments that may be suitable for this study. As the research instruments reviewed to date specify constructs that measure control in the context of traditional plan-driven ISD projects it is likely that these will need to be adapted to study control in the context of agile systems development projects. The proposed approach is not limited to identifying/adapting existing constructs, but may also identify new constructs that are more appropriate to agile systems development projects. Each construct will be measured using a Likert scale with a scale of at least one to five.

The research instruments reviewed to date identify: measures of behaviour, outcome, clan and self control in relation to the project leaders and client liaisons (Kirsch et al., 2002); measures of behaviour, outcome, clan and self control on ISD projects (Henderson and Lee, 1992, Kirsch, 1996), measures of self-control (Kirsch and Cummings, 1996); and measures of behaviour and outcome control (Snell, 1992). Kirsch et al. (2002) state that the measurement of clan control proved difficult as few researchers had previously operationalised this construct.

The advantage of using an existing research instrument or constructs means that the instrument/constructs have already been validated and are reliable.

Proposed Data Collection

The intention is to conduct a survey of approximately 1000 ISD project teams that use agile methodologies. The reason for this target number of respondents is to ensure that a reasonable number of responses is obtained. It is anticipated that participating project teams will: vary across different industry sectors; be of different sizes; may be geographically distributed; have different timelines for projects; and use different agile methodologies.

It is envisaged that the survey will consist of three sections. The first section of the survey will capture demographic information relating to the organisation and the project. The second section will detail the constructs that will measure each of the control modes using a scale measure. It is proposed that both project managers and members of project teams will participate in the survey to determine the control modes used on their projects and the effectiveness of these control modes. Even though the customer is an important member of agile systems development projects it is not proposed at this point to include customers in the survey as we anticipate that there may be difficulty in gaining access to these individuals. However, it may be appropriate to include a third section on the survey, which project managers will respond to, that relates to the level of participation of customers on the project and whether the project manager believed they had an influence on the specific controls modes that were utilised. For example, how often did customers request status reports, how often was the customer on-site, was the customer internal or external to the organisation?

In order to determine the use of specific control modes over time it is proposed that respondents will be asked to indicate the length of each iteration on their current project; the number of iterations in the current project; and the specific iteration in which the respondent is currently working. As the intention is to gather data from approximately 1000 organisations it is hoped that the amount of data collected will indicate which control modes are employed on agile teams at various stages of a project (e.g. 20% complete 50% complete, 75% complete). This is in an attempt to ensure that the results are generalisable.

It is proposed that both an on-line version of the survey and a paper version will be prepared for distribution to participants. It is anticipated that the majority of respondents will use the on-line version as they are likely to be comfortable with the use of technology. The survey will be pilot tested with a number of project managers and project team members prior to its general distribution. This may involve the use of focus groups or interviews with specific individuals to obtain qualitative feedback. Any feedback that is received from the pilot testing will be reviewed and may result in a revision of the content of the survey. Several iterations of pilot testing may be required to refine the research instrument before the final version is ready.

CURRENT STATUS OF THE PROJECT

The project to date has reviewed the literature on control in many different domains for example: organisation control, general control theory, management control, marketing control, and control in ISD. Literature relating to agile methodologies has also been reviewed. At this point the motivation for the research is clear, the overall research objective has been identified and the research questions are defined. Currently, various research instruments that relate to each of the specific control modes are being identified and critiqued for their suitability and applicability to this study. It is hoped that at least some of the constructs already detailed in the ISD control literature can be adopted, but the expectation is that some new constructs will need to be developed that relate specifically to control in agile systems development projects. Once the research instrument is defined and pilot tested the data collection will proceed. A database of 1000 organisations is available to the researchers for this study. Each of these organisations currently uses agile methodologies and is willing to participate in research.

DESCRIPTION OF WHAT THE AUTHORS PROPOSE TO PRESENT AT THE CONFERENCE

At the workshop we propose to present the following:

- A review of the literature conducted, which will demonstrate the need for research in this domain
- The conceptual framework used in this research and the proposed theoretical and practical contributions of the research
- The research objective and research questions
- The proposed research methodology and data collection
- A draft research instrument, which will be available for review and discussion
- Issues and problems

- Current status and next steps

We recognise that both formal controls (behaviour and outcome) will be relatively easy to measure due to their tangible nature. In contrast, the informal controls, particularly clan control, may prove more difficult to identify and capture. This has been acknowledged in prior research on control (Kirsch, 1996). It may be even more difficult in agile ISD projects, as opposed to traditional, plan-driven methods due to the softer, social and more intangible nature of interactions and artifacts. A discussion of these issues, the implications for the research and the extent to which our current research instrument copes with these challenges would be very valuable at the workshop.

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