Introducing System Controls for Control Theory

Subasinghage Maduka Nuwangi
Information Systems School
Queensland University of Technology
Brisbane, Australia
Email: maduka.subasinghage@qut.edu.au

Darshana Sedera
Information Systems School
Queensland University of Technology
Brisbane, Australia
Email: d.sedera@qut.edu.au

Shirish C. Srivastava
HEC, Paris, France
Email: srivastava@hec.fr

Abstract

Control theory focuses exclusively on manual control mechanisms, where the control instructions over the organizational employees are executed by a person (e.g. project manager). With the advancement of computer systems, contemporary organizations have commenced handing over employee control aspects to computer systems. In this research, we introduce "system controls", where a computer system is executing control instructions over the employees. Moreover, we discuss the characteristics, limitations and issues in system controls when added as a perspective of control theory.

Keywords

Control theory, Information Systems Development, Systems

INTRODUCTION

Control theory (Kirsch 1996; Ouchi 1979) has been employed to provide a powerful theoretical foundation for explaining control mechanisms between various stakeholders in organizations (Maruping et al. 2009; Tiwana and Keil 2009). The term "control" in control theory is viewed as an attempt to ensure employees are working according to an agreed-upon strategy for achieving the organizational goals and objectives (Kirsch 1996). Studies employing control theory (Kirsch 1996; Ouchi 1979) focus solely on "*manual controls*", where the control instructions over the organizational employees are executed by a person (e.g. project manager).

Systems have been considered as an important factor in the advancement of modern civilization and technology (Golnaraghi and Kuo 2010). Further, they have been employed to support the time-consuming and labor-intensive activities in a variety of domains including aviation (Pritchett 2009), robotics (Glass et al. 2014), automobile production (Zetka 1992) and manufacturing (Altintas 2012). Systems are used by the organizations to perform work in a timely manner, which helps to meet workload requirements (Grigori et al. 2004).

With the advent of computer systems that mimic organizational routines, organizations have started handing over employee control aspects to computer systems. In this research, "*system controls*" refer to situations, where the control instructions over the employees are executed by computer systems. System controls are distinct from manual controls as manual controls are executed by a person. Since controlling the employees involves decision making and planning, we acknowledge that human involvement is required for specifying initial conditions of system controls. For instance, bug tracking systems include procedures to organize issues, assign work, and follow team activities. Initially, a human operator is required to specify the procedures in the bug tracking system. After the initial procedure is specified, bug tracking systems automatically execute control instructions over the employees. Since system controls are pre-defined and standard, employees tend to follow system controls rather than manual control mechanisms such as project manager controls. Likewise, implementing system controls in organizations also impacts manual control mechanisms. To the best of our knowledge, literature on control theory (Kirsch 1996; Ouchi 1979) has overlooked the role of system controls, in which a

computer system is executing control instructions over the organizational employees. Therefore, it is our endeavour to discuss the novel phenomenon of system controls, adding a new perspective to the control theory.

This study identifies the role played by system controls for managing employees in Information Systems Development (ISD) projects. An ISD project is a complex (Maruping et al. 2009) and dynamic (Choudhury and Sabherwal 2003) process in which the employees of ISD companies interact in different ways to produce and deliver the software products according to the client's requirements (Nuwangi et al. 2012). Most ISD projects involve interdependencies between various stakeholders such as project managers, consultants, and clients (Maruping et al. 2009; Nuwangi et al. 2013b). In such a context, the success of an ISD project largely depends on the control mechanisms between different stakeholders (Choudhury and Sabherwal 2003). According to recently published reports (Carlos 2014; McManus and Wood-Harper 2008), most projects have failed to deliver their intended benefits due to lack of control mechanisms. Therefore, ensuring efficient control between the team members has been identified as a central problem in ISD projects (Jiang et al. 2004). Most ISD organizations attempt to address this issue by experimenting with new control mechanisms, such as system controls. ISD organizations utilize systems such as bug tracking systems for several tasks, including project scheduling, tracking and personnel management (Jones 2013). Those systems improve the efficiency, quality and consistency of the ISD process. According to the Gartner Group (2011), by 2014, more than 30% of organizations will experience a proliferation of systems to support project management.

The presence of complex and large-scale ISD projects create the need for system controls. Although system controls are visible in most ISD projects, almost all the past studies on control theory (Maruping et al. 2009; Tiwana and Keil 2009) have focused solely on manual control mechanisms such as management controls. Therefore, the effective use of system controls represents an important gap in understanding. Thus, the main objectives of our study are: 1) to explore the role of system controls in control theory; and 2) to identify the characteristics, limitations and issues in system controls. This research-in-progress paper conceptualizes and reports our early observations on system controls. The preliminary analysis and recommendations presented in this paper aim to provide insights into the landscape of system controls in the control theory.

THEORETICAL BACKGROUND

Control theory has been employed extensively to understand nuances in managing relationships between the stakeholders of ISD projects (Maruping et al. 2009; Tiwana and Keil 2009)[1]. In control theory, control mechanisms are conceived as formal and informal controls (Kirsch 1996). In this research, we only focus on the use of system controls for executing formal control mechanisms. Formal controls involve controlling the employees through performance evaluation in which either outcomes or behaviors of the employees are measured, evaluated and rewarded (Kirsch 1996). Formal control can be further subdivided into outcome-based and behavior-based modes. The outcome-based mode includes the mechanisms that specify the expected outcomes (Kirsch 1996), whereas the behavior-based mode is implemented through the mechanisms influencing appropriate behaviors (Zu and Kaynak 2012). Choudhury and Sabherwal (2003) discussed variety of techniques which can be used for executing manual controls such as formal documents, meetings and project plans. Informal control uses social or people strategies (Kirsch et al. 2002) to control the employees. According to Jaworski (1988, pa. 27), informal control mechanisms are "unwritten, typically worker-based mechanisms that influence individual or group behavior". The informal control consists of clan and self-control modes. Ouchi (1978) describes clan control as promoting common values and beliefs within a clan, which is defined as a group of individuals who share a set of common goals. In contrast, self-control occurs when the employees of the company control their own actions (Manz and Angle 1986).

Control theory has often been employed to understand factors influencing the exercise of control such as project characteristics (Kirsch 2004), relationship characteristics (Alarifi and Sedera 2013; Rao et al. 2007) and task characteristics (Remus and Wiener 2012). Several studies have discussed the choice of control modes such as outcome control (Kirsch 1997), behavior control (Eisenhardt 1985), clan control (Kirsch 1996; Ouchi 1979), and self-control (Henderson and Lee 1992). Moreover, the control theory literature highlighted different advantages of using systems to control organizational processes such as: 1) ensuring organizations achieve their organizational goals (e.g. quality end products and client satisfaction) (Maruping et al. 2009), 2) motivating the individuals to work in accordance with the organizational goals and objectives (Jaworski 1988), 3) managing information technology outsourcing relationships (Choudhury and Sabherwal 2003), 4) ensuring cooperation among individuals, who have partially congruent objectives (Ouchi 1979), 5) monitoring, evaluating and providing feedback for the employees (Snell 1992), and 6) increasing the team performance (Henderson and Lee

[1] As opposed to agency theory.

1992). Winer (1988) and Green and Welsh (1988) have discussed control as cybernetic regulatory process that directs an iterative activity for a specific purpose. Cybernetic view consider control as a dynamic process instead of a state (Green and Welsh 1988; Ouchi 1977).

Three gaps in prior research on control theory are particularly noteworthy. First, it has focused almost exclusively on manual controls, where a person is executing control instructions over the employees (Kirsch et al. 2002; Tiwana 2010). System control perspective is therefore missing. Second, control theory assumes the desired outcomes are unique and it requires iterative control (Gregory et al. 2013; Nuwangi et al. 2013a). For example, expected outcomes of ISD projects are evolving with the time (Cao and Ramesh 2008). Although the manual control mechanisms are capable of handling the evolving expectations of the projects, system controls are not yet capable of handling the evolving expectations. Third, control theory assumes that the outcomes of ISD projects are negotiable (Henderson and Lee 1992; Kirsch et al. 2002). This assumption is accurate for most of the ISD projects as the expected outcomes are not fixed, where the outcomes can be negotiated and revaluated. For example, formal documents such as business requirement specifications[2] can be amended according to the changes of the outcomes. Although existing control theory adequately addresses the ISD project control in collaborative environments, where people can discuss and amend the outcomes, it does not address the static, non-collaborative environments with system controls. System controls provide a static control execution, where either the outcome can be accurate or inaccurate without providing the ability for collaboration. Although an involvement of human operator in system controls may provide the ability for collaboration, after specifying the conditions for system controls, it automatically executes static control instructions over the employees. However, a theoretical explanation for this remains absent. Therefore, to address this gap, our study tries to explore this uncovered, yet essential perspective of system control.

The Role of System Controls

The role of systems in governance and control is increasing in ISD projects. Over the years, with small and incremental influences, systems are now extensively used for controlling purposes of ISD projects. It is this perspective that we believe is missing in the current control theory. We highlight that the "system perspective" is an integral part of the Engineering studies (Ferrell and Sheridan 1967; Golnaraghi and Kuo 2010), which aptly recognizes the role of systems to automate organizational processes such as manufacturing. Although the Engineering studies (Ferrell and Sheridan 1967; Golnaraghi and Kuo 2010) discusses the use of systems to control the organizational processes, it does not describe situations where a system execute control instructions over the employees of an organization.

Golnaraghi et al. (2010) identified the basic ingredients of engineering control systems as: 1) the objectives of control; 2) the control system components and; 3) the results or outputs. Moreover, Golnaraghi et al. (2010) have discussed the systems that support organizations to manage process execution quality by providing several features such as analysis, prediction, monitoring, control and optimization. Adamo-Villani et al. (2009) discussed different levels of automation using systems such as the device level (sensors, machines and infrastructure systems), control level (machine and computer controllers), management execution level, enterprise resource planning level and multi-enterprise network level. According to Engineering studies (Ferrell and Sheridan 1967; Sheridan 2006), use of systems to control organizational process can be subdivided into two groups as 1) automatic controls, and 2) supervisory controls. Automatic control is where a system performs the necessary tasks independently without human interaction (Ferrell and Sheridan 1967), whereas the supervisory controls require human intervention. Ng et al. (2003) highlighted the importance of automation for minimizing the use of human resources. Past research (Hajri et al. 2014; Khosravi et al. 2012; Rezvani et al. 2012; Sedera et al. 2004) discussed that enterprise systems automate and streamline the business processes. According to Sheridan (2006), new word processing systems and business information management systems include automated features. Advantages of use of systems for controlling purposes include increased productivity, reduction of the manual workload and automate routine operations (Salim 2013; Wiener and Curry 1980; Yi et al. 2009). Consumer resistance, low levels of alertness of human operators and lower job satisfaction can be considered as disadvantages (Wiener and Curry 1980). According to Brinkkemper (1996), the application of ISD methods should be supported by systems. Past research (Brinkkemper 1996; Jones 2013) discussed the use of systems as tools, whereby a person uses a system as a tool to design or to develop control instructions. For example, project managers utilize Microsoft Project to design the project plans, which specify the expected outcomes of a project.

[2] Business requirement specifications are formal documents, which include expected outcomes and behaviours of ISD projects.

As explained in control theory, the management staff of ISD organizations use manual controls to ensure that other employees work according to the organizational goals. Moreover, contemporary ISD organizations utilize system controls for project management purposes. Although the use of systems in different domains such as biomedical applications, machine tools and flexible robotics is explained in the Engineering literature (Glass et al. 2014; Golnaraghi and Kuo 2010), the use of systems for controlling employees in the organizational setting is not described. The Engineering literature (Golnaraghi and Kuo 2010) has focused almost exclusively on discrete systems such as a machine or a robot complete some organizational tasks. Due to new technological innovations, contemporary ISD organizations tend to use systems to control employees in a more dynamic manner. Therefore, the use of system controls represents an important gap in knowledge.

RESEARCH METHODOLOGY

As the phenomenon being examined is relatively new and unexplored, we followed the case study method to capture the richness of the context in which the phenomenon is situated (Yin 2003). Moreover, the qualitative case study method is recognized to be appropriate for exploratory research of complex environments (Klein and Myers 1999) and contemporary events (Benbasat et al. 1987). Three conditions formed benchmark for the selection of the research sites. First, the company should have systems that are mature. Second, the employees of the company should be aware of the systems. Third, the company must be sufficiently large, with a standard hierarchy of employment. According to these criteria, we selected two case sites for our study. Company-A[3] had been performing software development activities for over 10 years, and employed over 300 staff. Company-A developed capital market automation software including the functionalities of multiple trading methods (such as auctions, continuous matching), multiple asset classes (such as equity and fixed income) and multiple market structures. Company-B employed over 7100 people in different branches in the US, UK, Hungary, India and Sri Lanka. Company-B was involved in global IT services, providing IT consulting, technology and ISD services.

Thirty-eight (38) semi-structured interviews, each lasting between 20-30 minutes, were conducted at two companies (24 in Company-A and 14 in Company-B). The sampling method was non-probability, purposive and employed the snowball technique, where the interview participants were appropriate opinion leaders with well-developed views on the research topic (Minichiello et al. 1995). At the beginning of the interview, the participants were briefed about objectives of the study. At the end of the interview, the participants were asked to suggest other employees who were knowledgeable about the control mechanisms in projects. The participants were diverged as new employees converged to the sample in the interview process, according to recommendations from previous participants (Ramaswami 1996). All the interviews were recorded for subsequent data analysis purposes. While conducting the interviews, additional notes were taken whenever necessary. The interview data was supplemented with formal documents and access to different control systems. These documents and control system access increased the validity and reliability of the collected data. Following the guidelines of Eisenhardt (1989), data analysis was performed in tandem with the data collection to take advantage of the flexibility that a case study affords. The emergent concepts in one interview were verified in the subsequent interviews until the state of theoretical saturation was reached, which is the point where it is possible to comprehensively explain the findings (Eisenhardt 1989). Theoretical saturation was identified when the incremental learning was minimal during the interviews. For example, when the number of interviews was close to 24 in Company-A, the data became repetitive, ensuring that most or all of the perceptions that might be important were already uncovered. Control theory formed the initial set of themes through which we analyzed the interview data. In the early interviews, we recognized some emerging concepts about the system controls. While some of the emerging concepts were verified by the case evidence, some were revised or disconfirmed. Replication logic was utilized, whereby each case study was treated as an experiment with each case serving to confirm or disconfirm the findings (Eisenhardt 1989).

FINDINGS

In order to achieve our research objectives, first we identified different types of system controls used in ISD process. Then we explored the characteristics, limitations and issues of system controls.

System Controls

We identified several system controls in ISD projects. Those include 1) bug tracking software products, 2) software quality inspection systems, 3) timesheets and 4) Integrated Development Environments.

The ISD companies utilized a variety of bug tracking software products to execute control instructions over the employees. For instance, bug tracking systems were utilized to organize issues, assign work, and follow team

[3] To maintain confidentiality, the names of the companies were disguised.

activities. Jira software was used as the bug tracking software by Company-A. When the quality assurance team conducted the testing process, they recorded the identified issues in the Jira software as a Jira ticket. These Jira tickets were assigned to the relevant software engineers, who had to resolve the issue mentioned in the Jira ticket by amending the relevant software code. Other than managing the issues raised by the quality assurance team, Jira was used to manage issues with the software specifications. R[4]05 explained: *"Basically we have an issue management system, which controls all the changes that we do. There are workflows. If there is a document-related issue, there is a specific work flow in this system. Likewise if there is a software issue, there is a separate flow."* This indicates that employees had to follow the workflows of bug tracking systems. Those workflows can be considered as behaviour controls which are executed by systems. Company-B utilized VForge software to manage the ISD process. VForge works as a bug tracking system by providing facilities for managing the issues of the ISD process. It assists time management by equipping users with Gantt charts and calendars. Moreover, it includes automatic feeds and email notifications. R25 specified: *"The other main information source is the bug tracking system, where we track all the issues"*. Since the bug tracking software had a pre-defined procedure for issue management process, employees had to follow the procedure. This indicates that bug tracking software controlled the employees of the organization by executing control instructions. Although bug tracking systems controlled employees, a human operator had to specify the initial procedure in the system and monitor the issue management process in required situations.

Software quality inspection plays an important role in the ISD process (Sneed and Merey 1985). Traditionally, organizations performed the software quality inspection using the techniques of manual controls such as formal code reviews and structured walk-throughs. With the invention of systems, contemporary ISD organizations tend to use systems to automate the inspection process (Van Emden and Moonen 2002). Company-A utilized the Verifix automated testing tool for the quality assurance process. Verifix automatically detects the errors of software products, which reduces the time span of the information system development and quality assurance processes. Moreover, the Verifix software automatically execute different testing processes at the allocated times. Therefore, software quality inspection systems work as a control for software engineers as they have to provide the software products to the expected quality.

Both the companies in the case study (Company-A and Company-B) used timesheets to record the day-to-day operations of the employees. Each employee automatically received a timesheet on a daily basis, in which they must specify the completed tasks for each day. This functioned as a control instruction over the employees, reminding them that they have to complete a particular amount of work every day. For this reason, timesheets can be considered as a system control over the employees. Moreover, software engineers used a variety of Integrated Development Environments (IDEs) to improve the quality of the software code. Components of IDEs include a source code editor (which helps to edit the source code), automation tools (which automate the day-to-day activities of a software engineer including compiling and running tests) and a debugger (which can be used to identify errors in the source code). While Company-A utilized IDEs such as Microsoft Visual Studio, Eclipse and Linux vi Editor, Company-B used the Microsoft Visual Studio and Verclips systems. The software engineers used these systems for software coding and software testing purposes. Since IDEs automatically identify the errors in the software codes by syntax highlighting and code compilation techniques, software engineers had to write the software code accurately. Therefore, IDEs can be considered as a system control over the software engineers.

Characteristics of System Controls

Control Routine Work

System controls govern the routine tasks of the employees. In the case organizations, timesheets were maintained to track the employee performance regularly. R17 stated: *"They have the timesheets to track our work"*. According to R15: *"We had a time management system. Everybody had to send the time sheets."* All the routine tasks which were conducted by the employees of the ISD companies were followed using the daily timesheets. Time sheets generated control instructions over the employees, reminding them that they have to finish assigned tasks on a daily basis. This controlled the day-to-day work of the employees.

Moreover, system controls maintain a general performance level of ISD teams. For example, project managers of Company-A identified the acceptable issue count for each project using the Jira bug tracking software. Based on these issue counts, the performance of each team was traced. According to R4: "*We say that you have one critical bug, two medium level bugs or three low level bugs. So, then we monitor performance of the team against those criteria"*. R19 explained: *"To see how many change requests are resolved, how many bugs are resolved, we were used to monitor Jira daily"*. As the project managers utilize bug tracking systems to monitor

[4] Respondent

performance level of employees, when an issue is assigned to an employee, they tried to resolve the issue as soon as possible. Herein, employees had to halt previous tasks they were involved in. This indicates that control instructions generated by systems impacted on employees' day-to-day operations.

Furthermore, bug tracking systems controlled the routine work of software quality assurance engineers. Since bug tracking systems included a procedure for issue management, software quality assurance engineers had to follow the procedure. This highlights that control instructions generated by systems governed the routine work of the employees.

Improve the Efficiency

Bug tracking systems were utilized by the companies for the quality assurance process. According to R03: *"When our quality assurance team tests the software we have developed, they find a bug, issues or there is something wrong in the specification, they log it to the Jira system"*. Since the bug tracking systems had a pre-specified structure for issue management, employees had to follow the structure of the bug tracking systems. Therefore, bug tracking systems improved the efficiency of the organization's ISD process. Furthermore, bug tracking systems such as Jira included automated functionalities. For example, when a Jira ticket was updated, the system automatically sent emails to all the respondents specified in the Jira ticket. Likewise, control instructions executed by system controls improved the efficiency of the ISD process. Moreover, system controls increased volume of the tasks of the ISD organizations. For example, the Verifix automated testing tool provided the ability to automate some testing processes such as regression testing. This increased the volume of quality assurance engineers' day-to-day operations, thereby improving efficiency of ISD process.

Improve the Consistency

According to Nuseibeh (2000), consistency plays a major role in ISD process.. Consistency of the software code is one of the main requirement for software quality (Travassos et al. 1999) and reliability (Boehm et al. 1976). IDEs improved the consistency of the software code by guiding the software engineers to follow the same notations, terminologies and symbols. Furthermore, the system controls improved the consistency of the control mechanisms. Manual controls, where a human being executing control instructions over other employees of the organization, can be biased. For example, project manager controls can vary according to the level of personal relationship the project manager has with each team member. The utilization of system controls provided the ability to maintain unbiased control mechanisms. Bug tracking software like Jira increased the unbiased controlling by providing standardized controlling processes. Due to timesheets, employees had to mention the completed tasks on a daily basis. These timesheets increased the transparency of the tasks completed by the employees, thereby allowing unbiased controlling in ISD organizations.

Improve the Quality

Company-A utilized automated testing tools such as Verifix for the quality assurance of the software products. Since Verifix automatically detected the errors in the software code, the software engineers had to write the software code accurately. Therefore, the Verifix software increased quality of the software products. Moreover, the ISD companies used a variety of IDEs to improve the quality of the software code. IDEs and supportive tools, which include automatic error detectors, can be considered as controls over the software engineers which guide the ISD process.

Automation

System controls automated the ISD process. The utilization of timesheets helped organizations to automate the monitoring process of employees. Since timesheets were automatically sent to employees, project managers were not required to request information from employees on a daily basis. When an employee received a timesheet, they had to fill in completed tasks and send it back to the timesheet server. Filled timesheets were automatically recorded in the server. Moreover, when the software quality assurance team conducted the quality assurance function, they raised issues in bug tracking systems. In Company-A, when an issue in Jira was updated, the system automatically sent emails to the respondents specified in the Jira issue. R11 stated: *"If a new issue is assigned to you, you will get an email from Jira"*. Therefore, relevant employees received automatically generated notification emails from bug tracking systems. This indicates that issue tracking process can be automated using system controls. Furthermore, automated testing tools such as Verifix automatically detect the errors in the software products. The scheduling capabilities of automated testing tools automatically execute different testing processes at the allocated times.

Control the Transparency Level

Systems controlled the transparency level of ISD projects. When organizations use bug tracking systems such as Jira, the visibility level of issues which were raised by the quality assurance team was controlled by Jira. In some

ISD projects, clients were able to access the issues raised by the software quality assurance team through Jira system. According to R1: *"This Jira bug tracking system is visible to the client. So they know what they are getting"*. In some projects, client access to issues was not allowed by Jira system. After a human operator specified whether client access to issues should be allowed or not, system controls executed the instructions accordingly. This indicates that system controls managed the transparency level of ISD process.

Provide the Authority of Control

System controls increased the authority of control by providing different authorization levels. Bug tracking systems include authorization levels, where the company can restrict the unauthorized access to the issues reported by the quality assurance team. For example, the issues reported in the bug tracking system can be viewed or amended by the people who have the required authorization levels. This indicates that control instructions executed by bug tracking systems provided the authority of control for the organizations.

Limitations and Issues of System Controls

Some limitations and issues of the system controls in ISD projects can be identified. Control literature (Kirsch 1996; Srivastava and Teo 2012) discuss the concept of a controller who monitors and evaluates the performance of a controlee. According to Kirsch (1996), characteristics of a controller include: 1) knowledge of the transformation process, whereby the person who is controlling other employees know the precise behaviors and processes that will transform inputs into outputs, 2) the ability to measure the outcomes of the controlees, and 3) the ability to observe the behavior of the employees. Although a person can accomplish these mentioned tasks, system controls are not yet advanced enough to conduct those functionalities without human involvement. For example, a project manager in Company-A had to log in to the bug tracking system, extract the issue counts for each person and send the emails to each employee. Functionalities like automatically sending customized reports to relevant people were not provided by the system. R12 stated: *"Project managers are using the Jira system and from that they gather data to a sheet and email it"*. Therefore, human involvement is still required for system controls. Some system controls created extra work for the employees in the case organizations. For example, some employees refused to fill in the timesheets because they believed it was a waste of time. According to R12: *"At first everybody sent the timesheets. At the end of the day, it is not going very well because people are busy with other work and actually they don't like to fill the timesheets as long as they deliver the work."* This highlights that some employees ignored the control instructions executed by systems.

Furthermore, the organizations had issues with the system downtimes and update times. For example, due to the downtimes, the quality assurance staff of Company-A were unable to record the identified issues in the Jira system. This delayed the quality assurance process. Moreover, the companies had some issues due to misuse and misunderstandings of system controls. For example, Company-B reported issues through the bug tracking system, even when a client did not provide clarification for a query. The misuse of system controls created problems in the ISD organizations. According to R38: *"Our job is to report the process-related issues. Even when some person did not answer for a question, we submit defects. So, we are wasting time in meetings resolving fights that occur due to these problems"*. This indicates that when control instructions for systems are not specified accurately, it can originate issues in organizations.

DISCUSSION

The objectives of this research were to explore the role of system controls in control theory and to identify the characteristics, limitations and issues of system controls. Control theory solely focuses on manual controls, where control instructions over the employees are executed by a person. Based on the data analysis, we introduced system controls, where a computer system is executing control instructions over the employees. This highlights the importance of considering system controls as a control execution method. We observed that organizations execute formal controls either utilizing manual controls or system controls. For instance, a project manager provides a contract to the employees and monitor whether they follow the contract, can be considered as a manual control. An example for system control includes a bug tracking system providing procedures for issue management. Therefore, control theorists should consider the method of executing control instructions over the employees. Moreover, we identified characteristics, limitations and issues in system controls.

Our study has the potential to influence practice. First, it allows practitioners to understand the role of system controls in ISD projects. Second, it points out the characteristics, issues and limitations in the system controls. Considering those characteristics, practitioners can select the best system controls for their organizations. Moreover, they can maximize the use of system controls in their organizations. Our paper has implications for the conference theme, "Integral IS - The Embedding of Information Systems in Business, Government and Society" and also for the conference track, "Enterprise System Services and Management" as it discusses a novel

aspect of systems, where the systems are executing control instructions over the organizational employees. Furthermore, our paper explains the role of system controls in project governance.

With our research efforts still being in-progress, we caution the reader about the limitations of our study. We encourage researchers to further explore and look into the phenomenon of system controls. ISD projects were selected as the domain of our study. Based on the data, we identified the role of system controls in ISD projects. In other domains, there can be systems which include more automated features, which can control employees with less/no human involvement (e.g. expert systems). Therefore, future research could examine the role of system controls in other domains such as manufacturing and automobile production. Moreover, in this research we only focused on formal control mechanisms. System controls can be better applied for executing formal controls, which evaluate the employee performance by measuring outcomes or behaviors. Since informal controls rely on social or people strategies, using system controls for executing informal control mechanisms can be problematic. Therefore, future research is required to examine the role of system controls in executing informal control mechanisms.

CONCLUTIONS

Our research objectives include 1) explore the role of system controls in control theory; and 2) identify the characteristics, limitations and issues in system controls. Although Control theory considered manual controls as the only control execution method, our findings highlight that the system controls have been largely utilized to execute control instructions. Therefore, system controls should be included as a control execution method in control theory. Moreover, we identified characteristics, limitations and issues in system controls. Characteristics include 1) control routine work, 2) improve the efficiency, 3) improve the consistency, 4) improve the quality, 5) automation, 6) control the transparency level and 7) provide the authority of control. Need of human involvement in system control was identified as a limitation. Furthermore, some system controls created extra work for employees. Issues of system controls include system downtimes and update times. Other than that, companies had some issues due to misuse and misunderstandings of system controls.

Our preliminary study results are encouraging, and further work is underway to establish our research objectives. A survey to validate the initial findings is currently underway. Although past studies have observed manual controls (Maruping et al. 2009; Tiwana and Keil 2009), we are yet to identify any studies on system controls, where a computer system is executing control instructions over the employees.

REFERENCES

Adamo-Villani, N., Antsaklis, P.J., Aragon, C.R., Bagheri, N., Baiden, G., Balasubramanian, P., and Zak, S.H. 2009. "Handbook of Automation ", S.Y. Nof (ed.). Springer, p. 1812.

Alarifi, A.H.E., and Sedera, D. 2013. "Enhancing Enterprise Social Network Use: A Control Theory Study," *24th Australasian Conference on Information Systems*, Melbourne, Australia.

Altintas, Y. 2012. "Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations and Cnc Design." Cambridge, New York, Melbourne, Madrid, Cape Town: Cambridge University Press.

Benbasat, I., Goldstein, D.K., and Mead, M. 1987. "The Case Research Strategy in Studies of Information Systems," *Management Information Systems Quarterly* (11:3), pp. 369-386.

Boehm, B.W., Brown, J.R., and Lipow, M. 1976. "Quantitative Evaluation of Software Quality," in: *International Conference on Software Engineering*. San Francisco, California, USA: IEEE Computer Society Press, pp. 592-605.

Brinkkemper, S. 1996. "Method Engineering: Engineering of Information Systems Development Methods and Tools," *Information and Software Technology* (38:4), pp. 275-280.

Cao, L., and Ramesh, B. 2008. "Agile Requirements Engineering Practices: An Empirical Study," *IEEE Software* (25:1), pp. 60-68.

Carlos, T. 2014. "Reasons Why Projects Fail." from http://www.projectsmart.co.uk/reasons-why-projects-fail.html

Choudhury, V., and Sabherwal, R. 2003. "Portfolios of Control in Outsourced Software Development Projects," *Information Systems Research* (14:3), pp. 291-314.

Eisenhardt, K.M. 1985. "Control: Organizational and Economic Approaches," *Management Science* (31:2), pp. 134-149.

Eisenhardt, K.M. 1989. "Building Theories from Case Study Research," *The Academy of Management Review* (14:4), pp. 532-550.

Ferrell, W.R., and Sheridan, T.B. 1967. "Supervisory Control of Remote Manipulation," *IEEE Spectrum* (4:10), pp. 81-88.

Glass, B.J., Dave, A., McKay, C.P., and Paulsen, G. 2014. "Robotics and Automation for “Icebreaker”," *Journal of Field Robotics* (31:1), pp. 192-205.

Golnaraghi, F., and Kuo, B.C. 2010. "Automatic Control Systems ". John Wiley & Sons, p. 944.

Green, S.G., and Welsh, M.A. 1988. "Cybernetics and Dependence: Reframing the Control Concept," *Academy of Management. The Academy of Management Review* (13:2), pp. 287-301.

Gregory, R.W., Beck, R., and Keil, M. 2013. "Control Balancing in Information Systems Development Offshoring Projects," *MIS Quarterly* (37:4), pp. 1211-1232.

Grigori, D., Casati, F., Castellanos, M., Dayal, U., Sayal, M., and Shan, M.C. 2004. "Business Process Intelligence," *Computers in Industry* (53:3), pp. 321-343.

Hajri, Z.A., Xu, W., Nuwangi, S.M., and Sedera, D. 2014. "Individual Innovative Use of ERP Systems," in: *European Conference on Information Systems*. Tel Aviv, Israel: pp. 1-14.

Henderson, J.C., and Lee, S. 1992. "Managing I/S Design Teams: A Control Theories Perspective," *Management Science* (38:6), pp. 757-777.

Jaworski, B.J. 1988. "Toward a Theory of Marketing Control: Environmental Context, Control Types, and Consequences," *Journal of Marketing* (52:3), pp. 23-23.

Jiang, J.J., Klein, G., Hwang, H.G., Huang, J., and Hung, S.Y. 2004. "An Exploration of the Relationship between Software Development Process Maturity and Project Performance," *Information & Management* (41:3), pp. 279-288.

Jones, C. 2013. "Software Project Management Tools." Namcook Analytics

Khosravi, P., Rezvani, A., Subasinghage, M., and Perera, M. 2012. "Individuals’ Absorptive Capacity in Enterprise System Assimilation " in: *Australasian Conference on Information Systems*. Geelong, Australia: pp. 1-7.

Kirsch, L.J. 1996. "The Management of Complex Tasks in Organizations: Controlling the Systems Development Process," *Organization Science* (7:1), pp. 1-21.

Kirsch, L.J. 1997. "Portfolios of Control Modes and Is Project Management," *Information Systems Research* (8:3), pp. 215 - 239.

Kirsch, L.J. 2004. "Deploying Common Systems Globally: The Dynamics of Control," *Information Systems Research* (15:4), pp. 374-395.

Kirsch, L.J., Sambamurthy, V., Dong-Gil, K., and Purvis, R.L. 2002. "Controlling Information Systems Development Projects: The View from the Client," *Management Science* (48:4), pp. 484-498.

Klein, H.K., and Myers, M.D. 1999. "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly* (23:1), pp. 67-93.

Manz, C.C., and Angle, H. 1986. "Can Group Self-Management Mean a Loss of Personal Control: Triangulating a Paradox," *Group & Organization Studies* (11:4), pp. 309-339.

Maruping, L.M., Venkatesh, V., and Agarwal, R. 2009. "A Control Theory Perspective on Agile Methodology Use and Changing User Requirements," *Information Systems Research* (20:3), pp. 377-399.

McManus, J., and Wood-Harper, T. 2008. "A Study in Project Failure." BCS The Chartered Institute for IT.

Millrood, B. 2011. "Project Manager 2014," in: *Why Should Anyone be Led by a Project Manager*. Gartner Group, Inc.

Minichiello, V., Aroni, R., Timewell, E., and Alexander, L. 1995. *In-Depth Interviewing: Principles, Techniques, Analysis*, (2 ed.). Melbourne: Longman:

Ng, C.S.P., Gable, G., and Chan, T. 2003. "An Erp Maintenance Mode," *International Conference on System Sciences*, Hawaii: IEEE.

Nuseibeh, B., Easterbrook, S., and Russo, A. 2000. "Leveraging Inconsistency in Software Development," *Computer* (33:4), pp. 24-29.

Nuwangi, S., Sedera, D., and Srivastava, S.C. 2013a. "Information Systems Development Outsourcing: The Role of Control Configurations," in: *Thirty Fourth International Conference on Information Systems*. Milan, Italy.

Nuwangi, S.M., Sedera, D., and Murphy, G. 2012. "Multi-Level Knowledge Transfer in Software Development Outsourcing Projects: The Agency Theory View," in: *33rd International Conference on Information Systems*. Orlando, FL.

Nuwangi, S.M., Sedera, D., Srivastava, S.C., and Murphy, G. 2013b. "Intra-Organizational Information Asymmetry in Offshore Isd Outsourcing," *VINE : The Journal of Information and Knowledge Management Systems* (44:1), pp. 94-120.

Ouchi, W.G. 1977. "The Relationship between Organizational Structure and Organizational Control," *Administrative Science Quarterly* (22:1), pp. 95-113.

Ouchi, W.G. 1978. "The Transmission of Control through Organizational Hierarchy," *Academy of Management Journal* (21:2), pp. 173-192.

Ouchi, W.G. 1979. "A Conceptual Framework for the Design of Organizational Control Mechanisms," *Management Science* (25:9), pp. 833-848.

Pritchett, A.R. 2009. "Aviation Automation: General Perspectives and Specific Guidance for the Design of Modes and Alerts," *Reviews of Human Factors and Ergonomics* (5:1), June 1, 2009, pp. 82-113.

Ramaswami, S.N. 1996. "Marketing Controls and Dysfunctional Employee Behaviors: A Test of Traditional and Contingency Theory Postulates," *Journal of Marketing* (60:2), Apr 1996, pp. 105-120.

Rao, M.T., Brown, C.V., and Perkins, W.C. 2007. "Host Country Resource Availability and Information System Control Mechanisms in Multinational Corporations: An Empirical Test of Resource Dependence Theory," *Journal of Management Information Systems* (23:4), pp. 11-28.

Remus, U., and Wiener, M. 2012. "The Amount of Control in Offshore Software Development Projects," *Journal of Global Information Management* (20:4), pp. 1-26.

Rezvani, A., Subasinghage, M., and Perera, M. 2012. "How Does Contingent Reward Affect Enterprise Resource Planning Continuance Intention? The Role of Contingent Reward Transactional Leadership," in: *Australasian Conference on Information Systems* Geelong, Australia: pp. 1-9.

Salim, S.A. 2013. "Cloud Erp Adoption-a Process View Approach.," in: *17th Pacific Asia Conference on Information Systems*. Jeju Island, South Korea.

Sedera, D., Gable, G.G., and Chan, T. 2004. "Measuring Enterprise Systems Success: The Importance of a Multiple Stakeholder Perspective," *European Conference on Information Systems (ECIS)*, Turku, Finland.

Sheridan, T.B. 2006. "Supervisory Control," in *Handbook of Human Factors and Ergonomics*. John Wiley & Sons, Inc., pp. 1025-1052.

Sneed, H.M., and Merey, A. 1985. "Automated Software Quality Assurance," *IEEE Transactions on Software Engineering* (11:9), Sep 1985, pp. 909-916.

Snell, S.A. 1992. "Control Theory in Strategic Human Resource Management: The Mediating Effect of Administrative Information," *Academy of Management Journal* (35:2), pp. 292-327.

Srivastava, S.C., and Teo, T.S.H. 2012. "Contract Performance in Offshore Systems Development: Role of Control Mechanisms," *Journal of Management Information Systems* (29:1), pp. 115-158.

Tiwana, A. 2010. "Systems Development Ambidexterity: Explaining the Complementary and Substitutive Roles of Formal and Informal Controls," *Journal of Management Information Systems* (27:2), pp. 87-126.

Tiwana, A., and Keil, M. 2009. "Control in Internal and Outsourced Software Projects," *Journal of Management Information Systems* (26:3), pp. 9-44.

Travassos, G., Shull, F., Fredericks, M., and Basili, V.R. 1999. "Detecting Defects in Object-Oriented Designs: Using Reading Techniques to Increase Software Quality," *SIGPLAN Not.* (34:10), pp. 47-56.

Van Emden, E., and Moonen, L. 2002. "Java Quality Assurance by Detecting Code Smells," *9th Working Conference on Reverse Engineering*, pp. 97-106.

Wiener, E.L., and Curry, R.E. 1980. "Flight-Deck Automation: Promises and Problems," *Ergonomics* (23:10), pp. 995-1011.

Wiener, N. 1988. *The Human Use of Human Beings: Cybernetics and Society*. Da Capo Press.

Yi, F., Purao, S., Clark, S., and Raghuram, S. 2009. "Surfacing Automation Criteria: A Process Architecture Approach," *Americas Conference on Information Systems (AMCIS)*, San Francisco, California.

Yin, R.K. 2003. *Case Study Research: Design and Methods*, (3 ed.). Thousand Oaks, CA: Sage Publications.

Zetka, J.R. 1992. "Mass-Production Automation and Work-Group Solidarity in the Post-World War Ii Automobile Industry," *Work and Occupations* (19:3), August 1, 1992, pp. 255-271.

Zu, X., and Kaynak, H. 2012. "An Agency Theory Perspective on Supply Chain Quality Management," *International Journal of Operations & Production Management* (32:4), pp. 423-446.

COPYRIGHT