Investigating the Interactive Effect of Control in Information Systems Development Projects

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Abstract
The choice of control mechanisms in information systems development projects has been extensively studied in prior research. However, the impact of control on project performance and the dynamics of formal and informal controls remain underexplored. This study addresses these issues using data from 158 project managers. The results reveal an interesting pattern: formal controls have direct effect on project performance, informal controls do not, yet informal controls augment the impact of formal controls on project performance.

Higher levels of knowledge of ISD process have been found to influence the choice of control mechanisms. Nevertheless, how it affects the efficacy of controls on performance has not been examined. This research shows that higher levels of knowledge of ISD process have a direct impact on project performance. More interestingly, higher levels of knowledge of ISD process was found to improve the effectiveness of informal controls on project performance.

1. Introduction
A central problem in managing information systems development (ISD) process is facilitating cooperation from various stakeholders involved in the development process [12, 17]. One of the major challenges in ISD projects is to ensure all the actions performed by the stakeholders are consistent with desired project objectives. The purpose of control mechanisms is to regulate stakeholder behaviors so that their actions will lead to the attainment of project objectives [17]. This is important considering the fact that only 34 percent of ISD projects are successfully completed [31].

Prior ISD research has consistently highlighted the role of control in managing complex relationships and achieving positive outcomes [5, 19]. Both formal (outcome, behavior) and informal (self, clan) controls have been used to stimulate desired behaviors. Formal controls involve outcome based and performance evaluation mechanisms. Informal controls utilize social and people oriented mechanisms [22, 29].

Implementing controls are costly and requires significant effort [7]. Accordingly, it is important to know the consequences of using various forms of control. Much of the prior research implicitly assumes that greater control improves IS project performance focusing instead on the antecedents of control. Thus the primary objective of this study to explore the relationship between controls, both formal and informal controls, and IS project performance.

Prior control research suggests using a portfolio (combination) of controls is most beneficial [18]. However, there is no common agreement on how the controls interact. Some studies argue that informal controls substitute for formal controls in some situations (e.g., [10]), others solely emphasize the role of formal controls [5]. In sum, the dynamics of control, that is, how formal and informal controls interact with each other remains underexplored. This is important considering the effort involved in designing effective control mechanisms [19]. Thus the second objective of this study is to explore the interactive effects of formal and informal controls on IS project performance.

Finally, prior research has found that the knowledge of the systems development process is consequential for ISD performance [32] as well an antecedent of control [18, 19]. However, it is not clear how knowledge of the systems development process affects the impact of control on project performance. Does higher knowledge of ISD processes help improve the efficacy of control? If so, is it similar for both formal and informal controls? Thus the third objective of this study is to examine how knowledge of the ISD process influences the effect of controls on IS project performance.

In particular, this research addresses three research questions –
RQ1: How do formal and informal control mechanisms affect IS project performance?

RQ2: How does the combination of formal and informal controls alter their influence on IS project performance?

RQ3: How does knowledge of ISD process influence the effect of formal and informal control mechanisms on IS project performance?

In the next section the treatment of control in the literature is discussed. Following that the research model and hypotheses are developed. The methodology and the results are then presented. The paper concludes with a discussion of the finding and its implications.

2. Background Literature

2.1 Conceptualization of Control

In the organizational and information systems literatures, control is defined as the organization’s attempt to increase the probability employees will behave in ways that lead to the attainment of organizational objectives [9, 17]. The enactment of control requires mechanisms that are used to encourage individuals to act in accordance with agreed upon strategies to achieve desired objectives [14]. A control situation typically involves a controller who monitors and evaluates the performance of a controllee.

ISD literature focuses on four modes of control grouped into formal controls (outcome, behavior) and informal controls (clan, self) [18]. Formal controls use performance based evaluation mechanisms, where the controller observes the controllee’s behavior or states desired outcomes [28]. Informal controls differ from formal controls in that they utilize social and people oriented mechanisms to achieve desired objectives [14, 30].

Formal controls are based on an underlying assumption drawn from agency theory that controllers and controllees have incongruent goals that must be aligned through the use of rewards [7]. In outcome control the controller articulates the desired goals or outcomes and sets up performance targets and rewards the controllee for meeting these goals [7]. The use of mechanisms that specify desired outcomes help the controller measure the controllee’s performance with respect to the specified outcome. Outcome controls include mechanisms such as benchmarks, quality metrics, and outcome measurement criteria such as productivity standards or timetables [18].

Behavioral controls, rather than focusing on outcome, specify desired behaviors involved in task execution. The controller seeks to influence the process, or the means to goal achievement, by explicitly stating specific rules and procedures, observing the controllee’s behaviors, and rewarding the controllee based on the extent to which they follow stated procedures [18]. The use of behavioral controls often occurs when knowledge of the processes is high [22]. An example of a behavioral control is the use of standard methodologies.

While formal modes focus on deliverables and desired outcomes, informal controls focus on social and interpersonal bonds within a team context [22]. Clan control is used to synchronize values and beliefs between the controller and the controllee. The success of clan control depends on the degree to which all members of the work group identify and enforce the same values (e.g., adopt similar problem-solving approaches) and commit to achieving group goals [30].

Self-control is a function of individual objectives and standards [16]. The controller sets broad goals, objectives and standards such that individuals can work independently, develop specific goals and monitor their own progress without significant monitoring. The rewards are based on how well the individuals (controllee) manage their work to meet the goals set by the controller [16]. This is based on the idea that self-managed individuals are intrinsically motivated to achieve their objectives which requires the work environment be structured to encourage the exercise of self-control [12].

2.2 IS Control and Project Performance

Project performance is typically defined in three dimensions – time, budget and scope. An ISD project is successful when it is completed within or near an estimated schedule and budget and meets the set expectations [2]. A common assertion among the majority of ISD control studies is that greater control enhances project and team performance [3, 17]. Often implications are provided in terms of when to use a particular control mode or, the factors that have to be manipulated to implement a particular control form. While we agree with the premise that control mechanisms attempt to align the interests of the controller and controllee, it is important to directly consider the relationship between control and performance. From a practical standpoint it is vital to
know the benefits of designing and implementing control mechanisms. This is especially true considering the fact the developing control mechanisms are costly and requires a lot of effort [7].

In addition, some studies posit that certain types of controls (formal) are more strongly associated with performance than other modes [12]. Others argue that a balance between formal and informal controls is needed to enhance performance [18]. Consequently, it's not clear how formal and informal control individually effects IS project performance. Again referring back to the effort rendered towards control mechanisms, it is imperative to determine the individual effect of formal and informal controls on IS project performance. From a broader view point, each form of control taps into different mechanisms that may impact performance. Exploring the individual effects of formal and informal controls can help us better understand the make-up of portfolios of control that are most beneficial to ISD projects.

2.3 Knowledge of IS Process

ISD projects involve complex processes which require significant knowledge and skills to manage. The high uncertainty and technology unpredictability surfacing during ISD projects makes it difficult to monitor the process unless the project manager has in-depth understanding of the development process. The project manager plays a vital role in developing and implementing the system requirements, thus the project objectives can be effectively interpreted only if the project manager has a thorough understanding of the project [22]. As noted by recent studies knowledge of IS process can influence IS project performance [32].

From a control standpoint, previous studies observe that a knowledgeable controller is likely to be more confident, and more inclined to specify the exact process the controllee should follow [17, 22]. In particular, knowledge of IS process helps the controller to make better control choices [22]. However, there is little empirical evidence to confirm how knowledge of ISD process facilitates the impact of control on IS project performance.

3. Research Model and Hypotheses

The research model for this study is show in Figure 1. The main argument is that both types of control – formal and informal controls will have direct effect on IS project performance. In addition, it is argued that formal and informal controls will interact in way that it alters their effect on IS project performance. Finally, knowledge of ISD process will help facilitate IS project performance. From a control standpoint, it will augment the efficacy of the impact of both formal and informal controls on IS project performance.

![Figure 1: Research Model](image)

3.1 Formal Controls and Project Performance

Formal controls use specific outcomes, standard rules and procedures to regulate controllee behavior. There are two types of formal control – outcome control and behavior control.

Outcome controls focus on articulating specific measures to assess performance. In the context of software development, prior research has noted that issues such as gold plating, lack of use of standard performance metrics and goal ambiguity lead to wastage of time and resources [1, 26]. These problems can be overcome by establishing set rules and standards. Project managers use documents such as project plans and requirements analysis to explicitly specify functions which have to be implemented [17]. Moreover, the team member rewards are based on the extent to which they achieve the set targets, motivating them to deliver the desired outputs.

Similarly, through behavior control the controller explicitly prescribes specific rules and procedures, observes the controllee’s behaviors, and rewards the controllee based on the extent to which it follows stated procedures [5]. In ISD projects, behavior control is often exercised through software development methodologies [27]. The project manager develops standard reporting practices and actual planned approaches to ensure that controllee’s
actions do not deviate from the desired target. The controller’s rewards depend on the extent to which they adhere to the predefined procedures, thus providing motivation to perform according to the processes defined by the chosen methodology. Developing a standard set of performance criteria, either outcomes or behaviors, make it easier to measure project progress which in turn facilitates project performance. Therefore we hypothesize:

**H1:** Formal controls will be positively associated with IS project performance.

### 3.2 Informal Controls and Project Performance

Informal controls are implemented through mechanisms that minimize the differences between controller’s and controllee’s preferences. There are two types of informal controls — self-control and clan control.

Prior studies suggest (e.g., [12]) that software development teams are more effective if team members have greater control over how they undertake their work, especially if their task requires high levels of technical expertise. In self-control, the controller grants autonomy to the controllee, the controllee determines both the goals and the actions through which it should be achieved. Granting autonomy requires a certain degree of trust in the intentions of the controllee [20]. In the software development context, the project manager and the team members may lack an integrated set of objectives; however, the team member is less likely to act in opportunistic manner because it would hurt the entire project which can affect his or her job growth. Moreover, self-control allows team members to display their technical expertise without interference to complete the project in a manner that they believe will best satisfy the project needs. Doing so helps them secure both intrinsic (self-esteem) and extrinsic (promotions) rewards.

Like self-control, clan control also relies on the controllee engaging in behavior consistent with the best interests of the controller. Prior studies have emphasized the role of shared norms, values, and beliefs in motivating desired behaviors [19, 21]. Clan operates by fostering individual commitment, the logic here is highly committed members are less likely to deviate from desired objectives [30]. Within ISD context, using clan control helps develop a strong sense of belongingness and cooperation among project team members and managers [21]. Moreover, it has been noted that clan control promotes knowledge sharing and learning, as well as successful project outcomes [8]. Therefore we hypothesize:

**H2:** Informal controls will be positively associated with IS project performance.

### 3.3 Knowledge of ISD process and IS Project Performance

Managing ISD projects involves defining technical requirements, estimating time, effort and costs required to accomplish the tasks, and allocating resources to complete the tasks [11]. Thus to manage ISD projects demands individuals with in-depth knowledge of both functional and technical activities [6]. For example, if the project manager lacks sufficient technical knowledge to understand the nuances of a software project, it is very likely the project is not going to meet the set expectations[18].

Previous studies have demonstrated a positive relationship between individual expertise and satisfactory project outcomes[11]. In particular, higher levels of knowledge of the IS process can result in productivity boost for the project[11, 22]. Therefore we hypothesize:

**H3:** Higher levels of knowledge of IS process will be positively associated with IS project performance.

### 3.4 Formal Controls, Informal Controls and IS Project Performance

The nature of relationship between formal and informal controls has been elusive. Some studies argue that both controls complement each other, thus using a portfolio of controls is more beneficial[18]. However, other researchers contend that there is no definite distinction between the type of controls, insomuch, clan control is a form of behavior control (e.g., [10]).

Research examining control-performance relationship reveal the impact of controls on project outcomes vary depending on the context it is used [5]. Some studies find strong association between formal controls and performance but a weak relationship between informal controls and performance [5]. On the contrary, organizational control research support the notion that formal controls are primary controls and informal controls are secondary controls, that is, informal control will enhance the effect of formal controls [24]. Recent studies emphasize that informal controls supplement formal controls in highly uncertain situations [32]. Therefore we hypothesize:
H4: Use of informal controls will enhance the impact of formal controls on IS project performance.

3.5 Knowledge of ISD Process and Formal controls

Prior theory and research suggest that implementing formal controls is a function of information availability, particularly for complex tasks [17]. In particular it was found that as behavior observability increases, the use of behavior control also increases, but only for those controllers who understand the ISD process. Similar results were also found in horizontal relationships (client-IS manager) [22]. In the software development context, the project manager has to have a firm understanding of the development process and the overall project objectives to set specific goals and procedures. It is also possible to argue that one need not be knowledgeable about the ISD process to set rules and procedures because most of outcome metrics can be manipulated through use of technological tools. However, in this case the project manager will not be able to interpret the results in an effective manner which in turn can lead to poor monitoring and direction of team behaviors. Therefore we hypothesize:

H5: Higher levels of project manager knowledge of ISD processes will enhance the impact of formal controls on IS project performance.

3.6 Knowledge of ISD Process and Informal Controls

In informal control the controller uses various mechanisms to converge the values and beliefs. In the ISD context, the project manager has to be knowledgeable about the ISD process in order to effectively participate in the project team meetings, understand the project teams’ goals, norms, and values. If the project manager is not knowledgeable about the ISD process then it can be more difficult to evaluate the project team’s goals and problem-solving approaches which is required to instill and embrace shared project goals and values [25]. As a result, the interactions between the project manager and the team members will not foster a sense of trust and commitment which are necessary for exercising informal controls [22].

From a performance standpoint, even though the team members choose both the goals and the actions through which it should be achieved, the project manager needs a firm understanding of the project processes in order to reciprocate, interpret and guide team member behaviors and actions. Without this knowledge, informal controls will have less of an impact on IS project performance. Therefore we hypothesize:

H6: Higher levels of project manager knowledge of ISD processes will enhance the impact of informal controls on IS project performance.

4. Methodology

Most items were derived from earlier work. Measures for control were adapted from [22], knowledge of IS process measures from [17, 22] and project performance measures from [23]. All items were assessed using a 7 point Likert scale. Standard psychometric techniques were followed in validating the measures. Table 1 shows the Cronbach’s alpha and inter-correlations for the constructs. Factor analyses were performed to examine convergent and discriminant validity. Behavior and outcome controls loaded together as formal controls and clan and self-controls loaded together as informal controls with factor loadings above .70. Other items loaded on the appropriate constructs without cross-loading and all constructs had high reliabilities. All the items are listed in the Appendix.

A large-scale questionnaire survey of IS project managers of systems development projects was conducted to test the hypotheses. The questionnaire was deployed online to a database consisting of IT professionals. The data used in this analysis was collected as part of a larger effort exploring IT project dynamics. Several checkpoints such as project duration, percent completed, and team size were used to ensure the quality of responses. A total of 158 project manager responses were obtained and included in this analysis.

<table>
<thead>
<tr>
<th>Table 1. Interconstruct Correlations and Reliabilities</th>
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<tr>
<td>Variable</td>
</tr>
<tr>
<td>1. Formal Control</td>
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<tr>
<td>2. Informal Control</td>
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<tr>
<td>3. Knowledge of ISD Process</td>
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<tr>
<td>4. IS Project Performance</td>
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Bolded diagonal scores indicate scale reliability. * <.05, **<.01

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5. Analysis and Findings

The means and standard deviations of the measures of the constructs are shown in Table 2. Regression analysis conducted with SPSS 17 software was used for hypothesis testing.

The regression results are shown in Table 3. The results provide support for H1. As expected formal controls had significant effect on IS project performance. The direct effect of informal control on IS project performance was not found to be significant failing to provide support for H2. Additionally, knowledge of the ISD process was significantly and positively related to performance, indicating the importance of project manager knowledge and providing support for H3.

The interaction between formal and informal control was significant. Figure 2 shows the nature of the interaction in terms of how levels of formal and informal controls alter the effects of each other on performance. More interestingly, the informal control augments the relationship between formal controls and IS project performance. This is consistent with the argument that informal controls act as secondary controls, that is, it facilitates the implementation of formal controls [15].

The interaction effect between knowledge of IS process and formal controls (H5) was not significant. However, the interaction effect between informal controls and knowledge of IS process was significant, supporting H6. From the control standpoint, this implies that knowledge of IS process plays a significant role in improving the efficacy of informal controls but not formal controls.

Figure 3 shows the nature of interaction between knowledge of ISD process and informal controls. The curve indicates that higher levels of knowledge of ISD process helps improve the effectiveness of informal controls on IS project performance. This finding is consistent with the prior research which suggests that knowledgeable controllers may be inclined towards using informal controls because it provides them more opportunity to share their expertise with the controllees and costs less in terms of monitoring [32].
6. Discussion and Implications

This study was motivated by the need to better understand the role of control in ISD projects. Designing and deploying controls are costly and requires significant effort [17]. Therefore it is important to understand the consequences of using controls in ISD projects. The findings showed that controls do have a direct effect on IS project performance. However, this was true for formal controls and not for informal controls. This does not mean that informal controls should be discarded. Using ever increasing levels of formal controls is not always possible, especially in a team context, because of the difficulty involved in specifying desired individual behaviors with enough accuracy and the challenge of measuring individual contributions to team outcomes [19]. The use of formal controls requires the ability to monitor either outcomes or behaviors, which may become increasingly difficult as more and more control is required.

The interaction effect between formal and informal controls implies that the presence of informal controls augments the effectiveness of formal controls. For instance, the greater requirements volatility in ISD projects may force the controller to frequently change the set of tasks to perform, which raises the difficulty to meet the goals established at the outset of the project. The controllee may be reluctant to adapt to the changing environment due to the fear that it may lower his or her performance on the outcome metrics. In such cases, the controller can use self or clan control to build good faith and confidence in the controllee, which might motivate the controllee to be more flexible in accommodating controller requests or the demands of the changing environment[4]. From a practitioner standpoint, the findings indicate that managers should focus attention first on formal controls, because it helps establish standard practices and specific goals. Once the processes are well defined then managers can leverage informal controls to improve the efficacy of formal control mechanisms.

ISD projects are becoming more strategically important which demands project managers to have in-depth knowledge in functional and technical domains [8]. The knowledge of ISD process had direct effect on IS project performance. This finding, consistent with prior research, implies that having an in-depth understanding of the software development process facilitates manager’s ability to interpret and guide team member behaviors[6]. The interaction between knowledge of ISD process and informal controls was significant but the same was not true for formal controls. This suggests that to exercise formal mechanisms may not necessarily require high levels of knowledge of ISD process in order for it to be effective. This may be based on the fact that when using formal mechanisms of control, managers monitor, assess, and reward individual efforts using outcome metrics that may be fairly standardized. In some cases such measures can be automated using technological applications. Informal mechanisms, on the other hand, focus on fostering relationships with individuals, building trust and confidence, and encouraging learning and innovation[4]. Thus to exercise informal controls the controller requires higher levels of knowledge of ISD process in order to promulgate the thoughts and ideas that make these controls effective.

7. Conclusion

This study examined the impact of formal and informal controls on information systems project performance. The results both confirm prior findings and offer additional insights. Consistent with previous research, this study reaffirms that control plays an important role in ISD projects. In addition, this research provides much needed empirical evidence about the relationship between control and project performance. The results suggest that informal controls supplement the effect of formal controls on project performance. The findings also suggest that higher level of knowledge of ISD process help improve project performance. More interestingly, higher levels of knowledge of ISD helps leverage the effect of informal controls on project performance.

Overall, this study is an initial step in understanding how controls and knowledge of ISD process enhance systems development through both direct and interactive effects. Researchers can extend these findings in several different directions. First, it would be useful to examine the role of control in other types of ISD projects such as outsourced projects. Second, this study focused on traditional team environment, it would be valuable to study the dynamics of control in online and distributed team environments to see if these same relationships exist in other contexts. Finally, as senior executives expand the role of IS project managers, they expect them to be knowledgeable in broader domains [13]. Thus it may be worthwhile to see how other types of knowledge may impact project performance.
8. References


### Appendix A:

#### Survey Items

<table>
<thead>
<tr>
<th>A1: Measures for Different Types of Control Used</th>
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<tbody>
<tr>
<td><strong>Control</strong></td>
<td>For this project I… (1 – never used, 7 – Strongly used)</td>
</tr>
<tr>
<td><strong>Outcome Control</strong></td>
<td>…place significant weight upon timely task completion</td>
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<td></td>
<td>…evaluate team member’s performance based on the extent to which project goals are accomplished, regardless of how the goals are accomplished.</td>
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<td><strong>Behavior control</strong></td>
<td>…expect team members to follow an understandable written sequence of steps toward the accomplishment of project goals.</td>
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<td></td>
<td>…assess team members’ performance on the extent to which existing written procedures and practices are followed during the development process.</td>
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<tr>
<td><strong>Self Control</strong></td>
<td>…give team members significant freedom as to what they will do in the project.</td>
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<tr>
<td></td>
<td>…give team members significant freedom as how they do their work in the project</td>
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<tr>
<td><strong>Clan Control</strong></td>
<td>…assess team members performance based on the extent to which they are committed to team values and norms</td>
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<tr>
<td></td>
<td>…place significant weight on understanding the project team’s goals, values, and norms.</td>
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<tr>
<th>A2: Project Performance Measures</th>
<th>(1 – not at all agree, 7 – strongly agree)</th>
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<tbody>
<tr>
<td>1. The project will be completed within its original schedule</td>
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<tr>
<td>2. The project will be completed within its original budget</td>
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<tr>
<td>3. Deliverables will meet all the expectations originally specified</td>
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<td>4. The scope of this project will meet the original specifications</td>
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<tr>
<td>5. This project will perform as well as planned</td>
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<td>6. Overall, this project will be completed successfully</td>
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<tr>
<th>A3: Knowledge of ISD process Measures</th>
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<tbody>
<tr>
<td>1. Solid understanding of the systems development process</td>
</tr>
<tr>
<td>2. Knowledge about how to build and implement systems</td>
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