EFFECT OF CONTROL ON INFORMATION SYSTEMS DEVELOPMENT PERFORMANCE: A META-ANALYSIS

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ABSTRACT

Control modes are critical for promoting information systems development (ISD) performance, however the relationship is elusive. Further, control is typically discussed in terms of the use of portfolios of control comprised of both formal (outcome and behavior) and informal (clan and self) mechanisms. Yet, the extent to which formal and informal controls individually relate to both performance and each other is still not fully established. This research utilizes meta-analysis to examine these relationships. The results indicate that control does enhance performance, although the strength of the relationship varies across types of control and different measures of performance. The results also show a significant relationship between formal and informal control modes, providing support for views of complementarities between modes within portfolios of control. It appears, however, that only clan control is positively associated with formal control. Building on these findings we suggest future directions for the study of control in ISD.

Keywords: control modes, information systems development, performance, meta-analysis

INTRODUCTION

The success of information systems development (ISD) projects often depends on the ability to incorporate complementary skills and knowledge from different stakeholder groups (i.e. IT managers, development team members, business managers, and end users) [29]. Problems in managing the behavioral processes in ISD are often more profound than those stemming from technical issues [45]. This highlights the need to implement various control modes as an important method for motivating stakeholder behavior as well as managing behavioral issues that can negatively impact project outcomes.

There has been significant interest and study of control in the IS literature, most of which has focused on the antecedents of control and the choice of specific control modes [9]. Much of this research is predicated on the assumption that greater control improves performance. However, findings supporting the relationship between control and performance are mixed. While there are a number of studies that measure both control modes and performance only some of these explicitly test the relationship between these constructs, often using control modes as a moderator or control variables [e.g. 43, 52]. Other studies fail to find significant relationships between modes of control and performance [e.g. 30, 53]. Therefore, untangling the relationship between various modes of controls and ISD project outcomes represents an important area of study.

Another key concept in the discussion of control is that of *portfolios of control* comprised of various combinations of control modes used in managing ISD projects [25]. The relationship between the different control modes that make up these portfolios, however, is largely unexplored. Understanding the links between control and performance and between different control modes is critical for developing effective IS project management practices. Accordingly, this research looks at both the relationship between the use of formal and informal control modes and relationship between level of control and ISD performance.

This study utilizes meta-analysis, a quantitative method used to synthesize empirical results from multiple studies to get a broader view of a particular research context [16]. Meta-analysis has important advantages over more typical narrative reviews. It allows researchers to synthesize the current findings in a field of study as well as to test hypotheses based on the cumulative results [19]. While meta-analysis is widely used in other disciplines, it is still underutilized within the IS community as a tool for cumulating results and knowledge across studies [23]. Meta-analysis provides an opportunity to examine what has been learned from research to date and provides insight into directions for the future.

The rest of the paper proceeds as follows. In the next section a review of the control literature is presented. The literature review frames the hypotheses in addition to providing the definitions and views of control and performance used in the meta-analysis. The meta-analytic methodology and the results are then presented. The paper concludes with a discussion of the finding and implications for practitioners and directions for future.

THEORETICAL BACKGROUND

Control in organizations has many meanings and interpretations. Prior research has identified three perspectives of control – sociological, administrative and psychological [21, 50]. Sociologists propose that control is accomplished through structural mechanisms of rules, policies, and hierarchy, while administrative theorists view control as a process of planning, measurement, evaluation and feedback [4]. Finally, psychologists view control as process of goal setting, establishing intrinsic and extrinsic reward structures and interpersonal influence [51]. These perspectives form the foundation for behavioral control theory which includes all organizational actions taken to ensure adherence to organizational strategies, plans and objectives [50]. Previous studies has applied many theoretical views including agency theory [12], organizational control theory [39], and cognitive evaluation theory [11] to understand the role of control in managning subordinate behaviors. These theoretical perspectives suggest that multiple control modes can be employed to achieve desired objectives.

A central premise of agency theory is that principals and agents have divergent goals [12, 13], and are concerned with the design of systems that align the incentives of principal and agent so that both parties desire the same outcome. Two control modes are primarily used – outcome and behavior control. The choice between outcome and behavior control depends on two primary factors: (1) the relative costs of measuring behavior versus outcomes, and (2) the various forms of uncertainty that create risk in the environment. Behavior control is used when measuring inputs is less expensive than measuring outcomes and

when uncertainty puts the agent at risk. Conversely, outcome control is used when measuring outcomes is less expensive than measuring inputs and when environmental uncertainty is low. It is deployed by establishing reward structures where the agent is rewarded if the outcome desired by the principal is achieved, while behavior control rewards are based on the extent to which the agent follows predefined rules and procedures.

Organization control theory addresses the control issue under the premise that measuring inputs, outputs and/or behaviors may be impossible, or that good measures may not exist [39]. Thus it introduces clan control, which is used when the principal does not know how, or what behavior or outcome to assess to achieve the desired results. The objective of clan control is to inspire loyalty and group norms using socialization mechanisms which in turn will lead to internalization of goals and reduce goal incongruence [40].

Cognitive evaluation theory focuses on control from a motivational perspective. The premise of this theory is that individuals prefer activities to be self-determined rather than determined by others [11, 27, 34]. Consequently, studies in this area introduce self-control which are deployed through reward structures and feedback programs to foster greater range of intrinsically motivated attributions. The success of control is influenced by the agent's perception about his or her success or failure and depends on the degree to which it promotes the intrinsic motivation of the agent. These studies reveal that principals implement self-control when behavioral performance measures or standardized process cannot be adequately measured.

ISD research uses all the above theoretical perspectives to examine influence of control in ISD projects. Control in the ISD project context is defined as *all managerial actions that help ensure the individuals in the project are acting in a manner consistent with the project goals and objectives*. The relationship between stakeholders in IS projects can be viewed from the perspective of dyadic controller-controllee relationship where the "controller" exerts influence on a "controllee" [25]. Prior IS research has evaluated several different controller/controllee arrangements with much of the research focused on IS-client (horizontal control) relationships across groups, but within the same organization [29]. Other arrangements that have been studied include project manager-team members (vertical control) within the project team [38], virtual teams [20], and outsourced arrangements across organizations [8].

MODES OF CONTROL

ISD control research is framed around four basic control modes, broken down into formal modes (outcome and behavior) and informal modes (self and clan) [24]. Formal modes rely on measurement of outcomes and behavior while informal modes focus on people based strategies.

Formal Control Modes

Two formal control modes defined in the ISD control literature are outcome and behavior control [24]. In *outcome control*, the controller articulates desired goals, outcomes and performance targets and then provides rewards for meeting these goals [25]. The outcomes can be either interim objectives such as phase completion, or final outcomes such as completion of the project. Outcome control is achieved by specifying desired outcomes. Rewards are based on the extent to which the controllee delivers the specified outcomes. Budget and schedule targets are examples of outcome controls commonly used in ISD. This type of control is most effective when outcomes can easily be measured.

Behavior control is implemented when the controllee's behavior is known and can be measured. Here the controller seeks to influence the process or the means of goal achievement by explicitly stating specific rules and procedures that must be followed. The controller then observes the controllee's behaviors and offers rewards based on the extent to which they follow the stated procedures [25]. Behavior control can be implemented through either direct observation (e.g. weekly reports) or indirect observation mechanisms that specify behaviors (e.g. use of a methodology) [12].

Informal Controls

Informal controls include clan control and self control. *Clan control* is used to converge values and beliefs between the controller and the controllee by promoting common values, beliefs, and philosophy within a clan, which is defined as a group of individuals who are dependent on one another and who share a set of common goals, or by identifying and reinforcing acceptable behaviors through shared experiences, rituals, and ceremonies [27]. Clan control operates through interpersonal dynamics of membership within a group. Consequently, the success of clan control depends on the degree to which all members of the group identify and enforce the same values (for example, using similar problem-solving approaches) and commitment to achieving group goals [40].

Finally, in *self-control* the controller allows the controllee to align their efforts guided by their individual objectives and standards [27]. To utilize self-control, the controller specifies general boundaries so individuals can work independently and monitor their own progress. The rewards are based on how well the controlled individuals manage and regulate their own work. Self-control is based on the idea that self-managed individuals are intrinsically motivated to achieve their objectives and requires the work environment to be structured to encourage self-management [34].

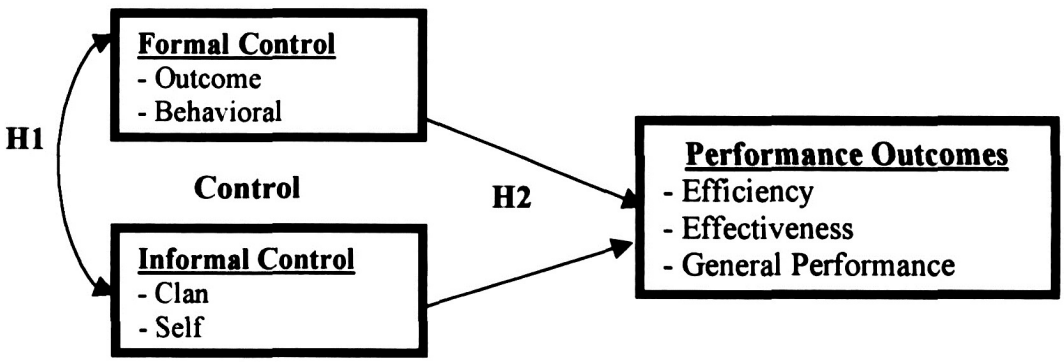

FIGURE 1. Research model

RESEARCH MODEL AND HYPOTHESES

While most management control research studies posit that control modes influence important job consequences such as performance and satisfaction [7], the ISD literature exhibits some unexpected and ambiguous findings on the effects of control indicating that the impact of control on performance needs further analysis. This study analyzes the relationship between the use

of formal and informal control modes (H1). Following this we examine the overall impact of control modes on performance and the relationship with respect to the individual effects of formal and informal control modes (H2). In addition, this study examines potential moderating factors that may be present across studies in order to better understand the nature of the relationships. This includes exploring the impact of formal and informal control modes on different aspects of performance to identify differences between the impacts of these two types of control. The research model is shown in Figure 1.

Relationship between Formal and Informal Control

The ability to examine formal and informal control modes together provides an opportunity to enhance prior findings and addresses questions concerning the underlying relationship between modes of control. It is commonly asserted that controllers use portfolios of controls [8], which are often developed through a series of decisions [25]. Controllers often tend to utilize well established standards and accepted practices as the foundation of the portfolio of control modes. This may explain why research has found that formal controls are more heavily used than informal controls. Informal control modes, however, can play an important role and are particularly important when characteristics of the project prohibit extensive use of formal controls [29]. Management control research supports that desired objectives can be more effectively achieved by blending formal and informal controls synergistically [51]. However, different views are offered on the relationship between formal and informal controls and whether they act as complements or substitutes [54]. The notion of primary controls and secondary controls has been used in looking at possible roles played by each [21]. For instance, when formal controls are predominant they can be seen as primary controls with informal controls serving a secondary role. There can be high control situations where both formal and informal controls are used in high levels; there can also be low control situations where all controls are used in low levels. It has been found that formal controls play a role in shaping informal controls [4]. A common agreement among all these studies is that harmonious use of multiple control modes is necessary for performance [7]. Further, control modes are viewed as consequences of situational characteristics. The underlying argument is that as the total amount of control increases performance also increases [51]. However, whether informal control increases or decreases with formal control is a matter of debate. Some research argues that there is a trade-off between controls such that an increase in formal control results in a decrease in informal control and vice-versa [7, 50]. Others argue that the overall level of control can be increased by using a variety of controls simultaneously [51]. Consequently, we hypothesize:

Hypothesis 1 (H1): There is a positive relationship between levels of formal and informal control.

Effect of Control on Performance

One of the fundamental tenets that underlies control research, including control in ISD, is that the appropriate control modes will align goals and behaviors and enhance performance [37]. However, the empirical results are far more equivocal, as the relationship between control and performance is often weakly or totally unexplained within individual studies [30]. In some instances control modes had no direct impact on outcomes [17]. Some studies argue that certain control modes are more strongly associated with performance than other modes [18]. The effect of control modes on performance could vary depending on the control episode and different controls could be appropriate under different situations [32]. Since the purpose of control modes is to align the actions of the controllee to the goals of the controller, any control mode used to accomplish this should lead to greater performance.

The ISD literature indicates different aspects of performance that can be measured to reflect ISD success. The two most widely discussed aspects of performance focus on efficiency and effectiveness [2, 35]. Efficiency reflects a measure of process performance, which describes how well the software development process has been undertaken. This aspect of performance often focuses on adherence to budgets and schedules set for the project. Effectiveness reflects a measure of product performance, or the functionality of the actual system delivered to users. Other measures of performance focus on general assessments of success or psychological outcomes [2]. While control modes in general may be expected to have a positive effect on measures of performance, it is possible that different controls have stronger effects on different aspects of performance. Efficiency and effectiveness focus on process and product outcomes, which are the emphasis of the formal controls. Similarly, informal controls emphasize intrinsic motivation and group socialization that might be measured by feelings of overall project success. Based on these arguments, we hypothesize:

Hypothesis 2 (H2): Both formal and informal controls are positively related to performance, but the strength of the relationship will vary by the type of control and the aspect of performance that is measured.

METHODOLOGY

The hypotheses are tested using a quantitative meta-analytic approach which combines results from studies with the same or similar research constructs to estimate overall effect sizes for the relationships in question [16]. A key advantage of meta-analysis is that it overcomes human information processing limitations inherent in narrative reviews [31]. That is, narrative reviewers must keep a vast amount of information in their minds regarding the effect sizes, sample sizes, and study characteristics (e.g., measures used, methodological weaknesses, etc.) even for moderate reviews (e.g., reviews with roughly 10-20 articles). Simply put, human information processing limitations preclude individuals from accurately and reliably doing this [19]. Thus, the mathematical or statistical accumulation of results via meta-analysis is a more reliable and accurate summary of scientific literature at any point in the development of that body of literature.

Meta-analysis provides results that take into account the relative effect and sample sizes of the included studies, and allows integration of studies with both significant and insignificant effects to explain and resolve inconsistencies [19]. Thus, it overcomes a key limitation, that is, small sample sizes associated with relatively low power to find significant results and one is therefore likely to find a patchwork literature of significant and insignificant correlations that are difficult to meaningfully interpret in a field as a whole [19].

The above considerations may be particularly relevant to the control research which occurs at the project level. That is, there are multiple individuals in project teams and the numbers of project teams are naturally smaller than the number of individuals in the teams. As a result this literature often has smaller sample sizes (e.g., 50 to 100 project managers or project team members). Thus, analyses at the project level are likely to involve lower statistical power and more natural levels of variability and higher levels of sampling error. All of these factors may obfuscate underlying patterns of results. In conclusion, meta-analysis of this literature is at least as critical as the accumulation of studies at the individual level of analysis.

Inclusion Rules

To be included in this analysis, each study had to meet three criteria. First, studies had to be in the ISD context and assess at least one control mode (outcome, behavior, self, clan). Studies not having explicit reference to the four control modes were considered if the research constructs could be mapped to one of the modes of control (discussed in more detail in the Measurement section). Second, the studies had to contain at least one measure of systems development performance. Studies not measuring performance were only considered for assessing the association between formal and informal controls if the study included measures for both types. Finally, to be included, the studies also had to provide zero-order correlations, sample sizes and use independent samples.

Identification of Studies

Standard procedures [19] were used for identifying published articles and chapters, unpublished doctoral dissertations, conference papers, and relevant unpublished manuscripts that fit the inclusion criteria. Initially, a number of electronic databases (e.g. ABI/Inform, EBCOHOST, InfoTrac, Social Citation Index, and Digital Dissertations) were searched using a variety of keywords including "information systems development", "project performance", "software development", and "control". Cited reference searches were also performed to find articles that referenced influential articles in the IS control literature. Additionally, abstracts of top IS journals were manually searched from 1990 to the present to find potential articles that may have been missed during the database searches. The reference sections of the articles were also scanned to identify additional articles. To avoid potential bias toward published articles [46] we contacted researchers working in the areas of control and ISD. Finally, we also searched proceedings from recent scholarly meetings and performed supplemental internet searches to look for unpublished working papers.

A total of 36 studies were identified with potential for inclusion through the search procedures. Of the identified studies, several were excluded because zero-order correlations or data that could be transformed into these correlations was not reported and could not be obtained even after contacting the authors through email and telephone requests. Other potential studies were excluded after evaluation as not containing appropriate measures. A total of 25 studies were included in our analyses. Details of these studies are shown in Appendix A.

It is important to note that there is no set number of studies required for meta-analysis. Analyses with fewer numbers of studies will result in more unstable effect size calculations, but this is largely based on the nature of the studies themselves. Prior literature recommends a minimum of at least 15 studies to avoid inflated Type I error rates [15]. Importantly, the power of meta-analysis does not lie in the number of studies included, but the accuracy in applying the technique [19]. Notwithstanding that observation, the number of studies included for this analysis is consistent with other meta-analysis studies within IS research [22, 49].

Coding

Protocols were constructed to capture the critical study characteristics. These protocols were refined during two preliminary rounds of coding. Coding sheets were used to capture all of the information reported in the studies pertaining to control and project performance outcomes. This information included observed correlations, reliabilities of independent and dependent variables, as well as other useful qualitative information of the study.

Given the judgment calls inherent in meta-analyses [56], all the articles were coded by two authors independently. The initial agreement among the coders was 82% across all coded constructs. In the case of disagreements the coders met to resolve the discrepancies. By the end of second coding round 94% agreement was achieved between the coders. Final resolutions resulted in either excluding studies when an agreement could not be reached or reclassifying measures into higher level categories. The *administrative coordination* construct [14] represents an example of the disagreement resolution process. Items measuring this construct include both outcomes and behaviors, so initially coders disagreed about how it should be classified. After discussion it was concluded that the construct could not be considered specifically either behavior or outcome control because it had elements of both. To resolve the issue that construct was used only as a formal control and not included in analysis at the lower level. The same procedures were used for the classification of both control modes and performance types. The specific classifications are described in more detail in the following section and summarized in Appendix A.

Control Modes Measures

Within the studies identified for this research, the concept of control is often elucidated using a variety of synonymous terms such as "coordination" and "process formalization", among others. Since the intent was to look at the impact of the various modes of control on performance, it was necessary to accurately categorize controls based on the control mode definitions. When constructs were not explicitly defined as outcome, behavior, clan, or self control, the definitions and measures provided in the articles were used to map them to the control modes defined by [18, 24], two central studies in the IS control literature on the basis of citations in the social citation index. In cases where there was not sufficient information available to group the variables into the above four control modes, higher level categories were used, indicating the control modes as formal, or informal. This was carried out when the construct and its measures clearly fit the definition of a control, but the measure included elements from multiple control modes. Details are shown in the Appendix A.

Project Performance Measures

ISD performance is seen as a multi-faceted construct that can be conceptualized in terms of product performance, process performance, or general measures of project success [2]. The performance measures used in the studies included in our meta-analysis were classified as either measures of efficiency, effectiveness, or general performance. Efficiency measures include those constructs focused on measuring how well the underlying development process was carried out. This includes measures of productivity and adherence to budgets and schedules. Effectiveness measures reflect those performance constructs that focus on the specific product outcomes such as system quality. General performance measures represent other aspects of performance outcomes such as overall or subjective evaluations of success or satisfaction with systems development. The project performance variables included in our study include dimensions pertinent to at least one of these outcome categories. However, in studies including multiple dimensions to measure performance only those for which correlations were available were included. The classification of the performance constructs used in each study is shown in Appendix A.

Meta-Analytic Procedure

The basic goal of the meta-analytic procedures is to estimate the strength of a relationship between two variables of interest and to identify the presence/influence of any moderating relationships if possible. The Comprehensive Meta-Analysis V2 software package [6] which incorporates meta-analytical approaches suggested by [47] was used to perform the analysis. Calculations of the mean observed correlations, significance levels, and confidence intervals that are reported assume a random effects model [23]. Random effects approaches assume that population effect sizes vary from study to study. This approach often results in larger confidence intervals, but allows better generalization to possible studies not included in the sample. We report significance levels and 95% confidence intervals as measures of the relationship between the variables of interest.

For each relationship considered in the meta-analysis only one correlation was used from each study. Since many of the studies included multiple modes of controls or multiple measures of performance, a composite of the correlations was calculated for the constructs of interest where necessary. For example, if a study had more than one mode of control, the "all controls" analysis was conducted using a composite correlation score calculated from each of the individual controls in that study. This was done to insure independence in our data so as not to violate the assumptions upon which the meta-analytic formulae are based [57].

TABLE 1. Formal-Informal Control Modes Relationship Meta-Analysis Results

	K	N	Mean Observed Correlation	95% Confidence Interval
Formal - Informal	9	796	0.146*	.028 – .260
Formal - Clan	8	740	0.250**	.135 – .359
Formal - Self	4	377	-0.061	-.325 – .212

** p < .05, ** p < .01; K: number of studies, N: total number of observations across all studies*

RESULTS

Relationship between Formal and Informal Control Modes

H1 addresses the relationship between the formal and informal control modes that exists within a broader portfolio. The results of this analysis are shown in Table 1. The mean corrected correlation between all formal and informal controls is calculated to be .146 ($p < .05$) with a 95% confidence interval of .028 to 0.26. The positive correlation between formal and informal controls is consistent with the arguments posed within the ISD control literature on the use of multiple complementary modes within portfolios of control. That is, rather than simply using formal or informal controls alone, increases in one relate to increases in the other as well.

While the overall results indicate a significant positive relationship between formal and informal controls, the relationship appears to be relatively modest. To further explore potential differences between modes of control we investigate the relationships between formal and clan and formal and self-controls separately. The mean correlation between formal controls and clan controls was .25 ($p < .01$) with a 95% confidence interval ranging from .135 to .359. The mean observed correlation between formal and self-control was -.061 (n.s.) with a 95% confidence interval of -.325 to .212. These results suggest that the relationship between formal and informal modes of control may vary depending on the type of informal control being examined. Clan controls appear to be positively and significantly associated with formal controls while self control appears to have no relationship with the use of formal controls. These findings must be seen as somewhat exploratory because of the limited number of studies available within the sample for each type of control. Interpretation of the results at this level must be done with some degree of caution. Even considering the limited number of studies for self-control, these findings provide insight into the relationships that exist within portfolios of control. We particularly note that the mathematical accumulation of these results offer the most comprehensive analysis to date of the relationship between formal and informal controls.

Relationship between Control and Performance

H2 addresses the relationship between the use of control and performance within the ISD context. The results of the analysis of this hypothesis are shown in Table 2. When all control modes and all performance measures are considered together ($k = 22$, $n = 1954$), the mean observed correlation of .266 ($p < .01$) indicates that control as a whole has a significant positive relationship with performance. The 95% confidence interval has a range of .211 to .320. Similarly, both formal ($k = 20$, $n = 1824$) and informal controls ($k = 10$, $n = 684$) also have significant positive relationships when all measures of performance are considered. The mean observed correlation for formal controls is .274 ($p < .01$) with a 95% confidence interval of .21 to .336. Informal control has a mean observed correlation of .246 ($p < .01$) and a 95% confidence interval between .232 and .354. These results supports the assertion that both formal and informal modes of control are positively related to performance.

Additional analysis was performed to further explore the underlying relationship in H2, by looking at the relationship between the modes of control and different aspects of performance. This analysis examines whether the type of performance being considered moderates the relationship between the various modes of control and performance outcomes. The term moderation here applies specifically to its application in meta-analysis; in this context it refers to whether artifacts of the research (such as the use of particular measures) impact the results. As noted in the description of the coding used for this study, all performance measures were identified as either general measures of performance or specific measures of efficiency (process) or effectiveness (product). Studies were grouped according to these classifications to perform subgroup comparisons, making it possible to compare the effect sizes calculated within each subgroup to test for moderation [23].

The results for general measures of performance show significant positive relationships with all measures of control, as well as formal and informal modes separately. The mean observed correlation between all controls and general performance measures ($k = 12$, $n = 1217$) is .282 ($p < .01$) with a 95% confidence interval of .196 to .363. Formal control has a mean observed correlation of .225 ($p < .01$) with a 95% confidence interval of .101 to .343 and informal control has a mean observed correlation of .285 ($p < .01$) and a 95% confidence interval ranging from .15 to .41. While the effect of informal control appears to be slightly higher than formal control, the magnitude of the effects and size of the confidence intervals are similar.

The results for the relationship between the different modes of control and efficiency and effectiveness suggest that formal and informal controls may have different impacts on these performance outcomes. All controls together ($k = 12$, $n = 919$) have a mean observed correlation of .26 ($p < .01$) and a range of .198 to .321 for the 95% confidence interval. Formal control ($k = 10$, $n = 815$) has a mean observed correlation of .269 ($p < .01$). Informal control ($k = 5$, $n = 363$ has a mean observed correlation of .105 (n.s.) and a 95% confidence interval of -.045 to

.251. While the point estimate is positive the confidence interval includes zero indicating that some population estimates based on these studies for this relationship are zero. The difference in results between formal and informal controls indicates that the type of performance being measured moderates the relationship between modes of control and performance. Both formal and informal controls have similar effects on general measures of performance, but formal control has a significant effect on measures of efficiency and effectiveness while informal control does not. Together these results suggest that both formal and informal controls promote increased performance in ISD, but the nature of the performance gains could vary across modes or at least vary by how performance is measured.

TABLE 2.Control - Performance Meta-Analysis Results

	K	N	Mean Observed Correlation	95% Confidence Interval
All Performance Measures				
All Controls	22	1954	0.266**	.211 – .320
Formal	20	1824	0.274**	.210 – .336
Informal	10	684	0.246**	.232 – .354
General Performance				
All Controls	12	1217	0.282**	.196 – .363
Formal	7	854	0.225**	.101 – .343
Informal	7	447	0.285**	.15 – .41
Efficiency and Effectiveness				
All Controls	12	919	0.26**	.198 – .321
Formal	10	815	0.269**	.176 – .358
Informal	5	363	0.105	-0.045 – .251

** p < .05, ** p < .01 K: number of studies, N: total number of observations across all studies*

DISCUSSION

The use of various controls modes and improved performance in ISD is a fundamental premise in the literature [26]. This relationship, however, has largely been under-emphasized in empirical research, which primarily focuses on the antecedents rather than the consequences of control. Furthermore, the limited evidence concerning the effects of control on performance in ISD has not provided clear guidance about the underlying nature of the control-performance relationship. While this relationship is intuitively appealing it is necessary to reconcile the different findings to get a "big picture" view of the impact of control on ISD outcomes. One of the main objectives of this study has been to evaluate this relationship by integrating results across existing studies. While the results support the importance of control to performance in ISD, the results also provide interesting new insights and potential directions for future research.

Importantly, the meta-analytic findings show that the use of control is positively related to performance. This bolsters views supporting the importance of control in aligning the various stakeholders and improving performance. Scholars have taken different positions on whether formal or informal controls may be more strongly associated with performance than the other [38]. Based on the results, differences in the relationships between formal and informal modes of control and performance do appear to exist. These differences, however, appear to be associated with the type of performance being considered. When looking across all measures of performance, formal control appears to have a slightly stronger relationship to performance than informal controls. This difference seems to be driven primarily by the relationship between formal control and efficiency and effectiveness. In terms of facilitating efficiency and effectiveness informal controls appear to have little or no effect. This might suggest the superiority of formal controls. However, when looking at other measures of performance not specifically associated with product outcomes or process efficiency, informal controls appear to be at least as influential, if not more so than formal controls. This would imply that in implementing control, it is necessary to consider the aspects of performance that an organization wishes to emphasize.

The existence and need for portfolios of control represents a recurring theme in the ISD control literature [25]. However, again there is little research that analyzes the composition of portfolios and the relationship between the control modes that comprise them. This has led to speculation as to whether controls act as complements or substitutes [7]. Those with the perspective that the various controls modes are substitutes for each other, emphasize the differences between controls, suggesting that formal controls can inhibit the effectiveness of informal controls, and vice-versa. For example, the empowerment of self-control can be contrasted against the restrictiveness of behavioral control so that the use of one restricts the use of the other [33]. Conversely those with the perspective that controls are complements emphasize how combinations of controls may play a role in shaping the effectiveness of each other. Studies in the management domain (e.g., [4]) suggest that informal controls can play a role in shaping the effectiveness of formal controls, while ISD research (e.g., [25]) contends that balance between formal and informal modes is important. The existence of these competing perspectives highlights the need to better understand the nature of the relationship between controls.

This research provides insight into the relationship between formal and informal controls justifying views of formal and informal controls as both complements and substitutes. Our meta-analytic results find an overall positive relationship between the two types of controls suggesting that when the overall use of control goes up or down, this difference is spread across formal and informal controls. This result supports the perspective of modes of control being complementary, which posits that increases in formal control may require an increase in informal controls in order to be effective or the use of a single type of control may actually limit effectiveness. While the overall relationship is positive and significant, it also appears that it is also relatively modest. The strongest relationship is between formal and clan controls. This could indicate that use of self control may be a different consideration from decisions to enact control through behavior, outcome, or clan. Behavior, outcome, and clan control may represent complements to each other while the use of self control may represent a substitute to the others.

LIMITATIONS

The concept of control is increasingly important in the literature; however, there are a limited number of quantitative studies in this research area. While both qualitative and quantitative studies are important for understanding control, more quantitative studies allow for broader generalization across organizations and settings. The limited number of studies does not eliminate the importance or applicability of meta-analysis, but the results must be interpreted with this in mind and it should been seen as a call for more research in this area.

This study was also limited by the sparse information in the studies about potentially important moderators of the relationship between control and performance. Lack of similarity across research designs limited the ability to look at how various methodological choices impacted the results (such as whether respondents were controlees or controllers). Our analysis includes a number of different measures that map to the definitions of control, but we cannot distinguish if differences between the measures themselves affect the results. Although steps were taken to alleviate the issue, our results may reflect publication bias where the published studies we could include are more likely to reflect significant findings (also called the file-drawer problem [47]). These difficulties highlight both the need for more research in the area and the need to develop consistent measures.

DIRECTIONS FOR FUTURE RESEARCH

This research looks at the various modes of control based on commonly understood categories of formal (outcome and behavior) and informal (clan and self) control and the impact of these modes on performance outcomes. Further research into portfolios of controls and the relationship of formal and informal control modes as substitutes or complements is necessary. This includes exploration of effective combinations of control modes. Second, quantitative studies are needed using consistent measures of control modes and the dependent variable of performance. The consistency of independent and dependent variables will allow future analysis across studies, particularly with respect to factors that moderate the relationship to performance. One way of accomplishing this would be focusing on the dimensions of the control modes in terms of the measurement, evaluation, rewards/ sanctions, and roles and relationships [12, 26].

This study has shown how different aspects of performance are impacted differently by formal and informal controls, but many other factors such as project related knowledge [26, 29] level of trust between the controller and controllee [10] and culture [8] could also impact this relationship. Exploring these factors can shed deeper insights on effectiveness of control modes in ISD projects.

An inherent shortcoming of much of the research on the choice and antecedents of control is the static treatment of IT projects [9]. Previous qualitative studies offer useful insights about control modes, and present glimpses on the dynamic nature of changing control modes over the course of a project. For example, one study observed that as the relationship between controller and the controllee changed over the course of a project, control modes were adjusted correspondingly to the escalation of the team members' commitment [32]. In another study it was found that contextual factors such as team composition and quality of client-vendor relationship influenced choice of control modes [8]. Kirsch [26] too found that control modes changed over the different phases of a project. Consequently, events over time could alter the effectiveness of controls and should be further explored.

CONCLUSION

This research makes several contributions to the study of control in IS development. First, the results support general assumptions about the positive impact of control on ISD outcomes. It highlights that the positive relationship to performance differs across modes of control, although the ways that each impacts performance may still not be fully understood. It also highlights the distinction between different control modes. Finally, this research provides additional evidence about the nature of portfolios made up of multiple modes of control.

This paper reviews and advances the literature on control modes in IS development. IT researchers have looked at this topic for over two decades, but there have not been prior attempts to synthesize the research to look at the relationship between the use of control and performance. Our results support this relationship, but they also highlight the need for continued work in this area. Factors that moderate this relationship are suggested, highlighting the importance of exploring when and how different controls best promote performance. Further work is also needed to understand the complementarities between the modes and mechanisms that make up effective portfolios.

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APPENDIX A. MEASURES OF CONTROL MODES AND PERFORMANCE

Study	N	Construct Name	Control Mode	Performance Construct	Performance Type
[1]	84	Social Integration	Clan	ISD project performance	General
[2]	84	Clear Goals	Outcome	Task Outcome	Effectiveness
				Psychological Outcome	General
				Organizational Outcome	General
[3]	40	Coordination Strategy	Formal	Software Development Process Satisfaction	General
				Team Productivity	Efficiency
[5]	75	Formal Planning	Behavior	Cost Gap	Efficiency
		Internal Integration	Clan	System Quality	Effectiveness
[14]	69	Software Methods	Behavior	Team Effectiveness	Effectiveness
		Administrative Coordination	Formal	Team Efficiency	Efficiency
[17]	66	Structured Methods	Behavior	Team Performance	General
		Production	Clan		
[18]	48	Managerial Behavior Control	Behavior	Efficiency	Efficiency
		Managerial Outcome Control	Outcome		
		Team-Member Outcome Control	Clan	Effectiveness	Effectiveness
		Team-Member Self Control	Self		
[24]	101	Behavior Control	Behavior	None	None
		Outcome Control	Outcome		
		Clan Control	Clan		
		Self Control	Self		
[29]	69	Behavior Control	Behavior	None	None
		Outcome Control	Outcome		
		Clan Control	Clan		
		Self Control	Self		
[28]	95	Reward mechanisms of Formal Control	Formal	None	None
		Team-based Clan Control	Clan		
[30]	212	Managerial Behavior Control	Behavior	Project Performance	General
		Managerial Outcome Control	Outcome		
[35]	64	Horizontal Coordination	Clan	Project Performance	General
		Vertical Coordination	Formal		
[37]	64	Horizontal Coordination	Clan	Project Performance	General
		Vertical Coordination	Formal		
[36]	64	Horizontal Coordination	Clan	Process Performance	Efficiency
		Vertical Coordination	Formal	Product Performance	Effectiveness
[38]	58	Standardization of Methods	Behavior	Process Performance	Efficiency
		Standardization of Performance Criteria	Outcome		
		Decentralization of Methods	Self	Competitive Performance	General
		Decentralization of Performance Criteria	Self		
[41]	60	Process Formalization	Behavior	Process Performance	Efficiency
				Outcome Performance	Effectiveness
[42]	95	Development Process Modeling	Behavior	Performance	General
[43]	230	Role Ambiguity	Behavior	Performance	General
		Goal Specificity	Outcome		
[44]	123	Formalization of Analysis	Behavior	Product Quality	Effectiveness
		Formalization of Reusability	Behavior		
		Process Control	Outcome	Process	Efficiency
		Quality Orientation and Reward	Outcome		
		Quality Policy and Goal	Outcome		
[48]	65	Managerial Control	Formal	Satisfaction	General
		Team-Member Control	Clan		
		Self Control	Self		
[52]	89	Behavior Control	Behavior	ISD Efficiency	Efficiency
		Outcome Control	Outcome	ISD Effectiveness	Effectiveness
[53]	120	Behavior Control	Behavior	System Development Ambidexterity	Efficiency
		Outcome Control	Outcome		
		Clan Control	Clan		
[54]	59	Process Control	Behavior	Alliance Performance	General
		Outcome Control	Outcome		
[55]	42	Relational Capital	Clan	Project Success	General
Unpublished Working paper	136	Behavior Control	Behavior	Project Performance	General
		Outcome Control	Outcome		