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Communication and control in outsourced IS development projects: Mapping to COBIT domains

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ABSTRACT

Internal control over information technology (IT control) in complex outsourced information system development (ISD) projects is an ambiguous and sensitive issue. In this study we bring together Information Systems and Accounting perspectives to investigate how internal controls are incorporated into existing communication practices in outsourced ISD projects. The paper proposes that tools used for client-vendor communication are capable of supporting some of the IT control functions governed by the COBIT framework. In addition, it analyzes the influence of project complexity on the performance of communication tools as informal IT controls. Perceptual field data for the analysis were collected from project managers through an online survey instrument.

The findings suggest that control objectives and types of project complexity are each supported by different communication tools. The level of support varies across communication tools categories and control objectives. Early analysis of a project's complexity can help with selection of communication tools which reinforce project support of control objectives while improving communication between client and vendor.

1. Introduction

Information system (IS) control is an important consideration for both the *product* and *process* of system development. Section 404 of the Sarbanes Oxley Act of 2002 focused much attention on controlling the *product* – the collection, manipulation, storage and reporting of business data – on the part of a company's management and its auditors. This paper looks at controlling the IS development (ISD) *process* – and specifically concentrates on communication-enabled control in complex development projects that involve an outsourcing arrangement. Does the type of communication tool chosen in an outsourcing relationship matter– from both IT control and communication effectiveness perspectives? Two kinds of complexity – project complexity and communication complexity – are studied to see how each reflects the usefulness of the project team's communications tools.

Implementation of an information system is a complex and ambiguous process which can transform the face of the organization but can also lead to serious financial consequences if it is not managed or controlled well (e.g., Wailgum, 2009). A recent study of complex ISD projects found that one in six experienced cost overruns averaging 200% and time overruns of 70% (Flyvbjerg and Budzier, 2011). While not all development overruns reach this level of excess, most project managers would attest that budgets and deadlines are oftentimes surpassed.

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Development of large, complex information systems is highly likely to be contracted to an external provider. Partnering with an outsourcing vendor lowers the riskiness of the undertaking because the vendor provides the knowledgeable staff and project management skills the project requires. However, control over the development process becomes increasingly challenging when these project team members need to communicate across organizational borders. In the U.S., Sarbanes Oxley Section 404 requires organizations to assess the effectiveness of their internal control structure and procedures. When the ISD process is outsourced, companies also need to factor in additional reporting standards[1] in order to monitor the level and quality of control over work performed by the vendor.

The challenges of monitoring control within IT organizations have confronted auditors for decades. IT auditors frequently rely on a well-structured IT governance framework (specifically, COBIT) to guide ISD and to monitor the controls adopted for the development process. COBIT (originally, Control Objectives for Information and related Technology) is a comprehensive framework that provides guidance on effective management and documentation of IT activity, while recognizing the need to support innovation and creativity in developing new products and solutions (ISACA, 2012). Based on best control practices, COBIT provides an internally consistent conceptual model for assessment of IT-related control (Tuttle and Vandervelde, 2007). The framework is frequently referenced in IT audit guidelines published by the Information Systems Audit and Control Association (ISACA), and widely used by the community of IT audit practitioners. The newest version, COBIT 5 was positioned to fit with the assessment requirements of SSAE 16 and other standards to aid in its application to assurance practice. COBIT addresses “the increasing dependency of enterprise success on external business and IT parties such as outsourcers…” (ISACA, 2012), which suggests that it affords a suitable structure within which to situate our study of communication and control.

The interorganizational nature of outsourced work increases importance and complexity of project management and communication practices (e.g., Bosch-Rekveldt et al., 2011). These complex knowledge and communication-intensive environments call for control systems combining formal and informal mechanisms (Choudhury and Sabherwal, 2003; Kirsch, 1997). Such mechanisms encompass written or unspoken project policies and procedures, scheduled or ad hoc meetings, adoption of project-specific or familiar communication and record-keeping technologies, and many others. Each formally or informally adopted mechanism may contribute to a repository of the project's content as well as enable sharing of progress, concerns or documents among members of the team. As both the project repository and the process under which progress is achieved are subject to scrutiny as part of the IT audit, it becomes particularly important to assess all of the documentation and communication methods the team adopts.

In this study we examine the informal control mechanisms embedded in the client-vendor communication tools adopted for use in complex outsourced ISD projects. We unearth patterns of tool use corresponding to the control domains in the COBIT framework. We also assess how differences in project complexity relate to the choice of communication tools made by project teams. A field survey of project managers belonging to the international Project Management Institute resulted in a usable data set about 432 large-scale outsourced ISD projects, complete or nearing completion. This large sample provides strong evidence of the patterns of control associated with communication practices adopted by client-vendor teams.

We draw on the COBIT framework to operationalize the use of communication tools for specific control purposes. We find that the flexibility of well-suited communication tools and their involvement in every step of the project makes them useful for some control activities covered by COBIT, especially risk management and performance assessment, which are central to an outsourcing relationship. More extensive use of communication tools for control purposes is linked to more effective communication between the client and vendor. In particular, Web-based communication tools (such as shared online documents, Wikis and discussion forums) appear to be underutilized by interorganizational teams and are perceived as the least beneficial for control purposes, but their support of control objectives increases as the projects become more complex.

These results confirm the need for auditors to assess not only formal but also informal methods of control in an outsourcing arrangement, as they play an important role in the ISD process. The results also speak to how communication methods and tools should be carefully chosen to provide control over outsourced processes even as they assist team members in their functional responsibilities. IT management should become aware of how the choice and use of technology-based tools can assist them in providing evidence to support the control assurance process.

The paper is structured as follows. The next section provides an overview of the interplay between control and communication in complex outsourced projects, and presents the hypotheses to be addressed. The study methodology and data collection are discussed next. The paper concludes with a discussion of findings and suggestions for future research.

2. Background

2.1. Control research in the accounting and IS literatures

Given the pervasiveness of large-scale, complex ISD activity in companies, and the increasing awareness of the importance of control in managing these processes, it is not surprising that IT control has attracted the attention of researchers in both the accounting and IS domains. That said, we note that accounting and IS researchers traditionally study control through different lenses. Relative to this study, control of outsourced IT projects has drawn significant attention among IS researchers. IS research on control focuses on outsourcing aspects such as contractual and relational governance (e.g. Heiskanen et al., 2008), the role of formal and informal control in complex inter-organizational settings (e.g., Tiwana, 2010; Weiner et al., 2015), and control in

[1] Statement on Standards for Attestation Engagements (SSAE) No. 16 and globally, International Standards for Assurance Engagements (ISAE) No. 3402 require outsourcers to provide a service auditor's report on their system of IT control to the client organization (ISAE 3402, 2016, p.338).

creative knowledge-intensive environments (e.g., Levina and Ross, 2003). The IS literature, however, rarely looks into the application of specific control mechanisms or regulatory compliance (Cleven and Winter, 2009).

In contrast, the accounting information systems literature favors studies involving the efficacy and impact of compliance standards including COSO, "a leading framework for designing, implementing and conducting IT control and assessing the effectiveness of IT control" (COSO, 2013, p.iii) and COBIT, a business framework for the governance and management of enterprise IT. The level of analysis is frequently the firm, foregoing control assessment of project team interaction or work methods, as well as the relationship between business partners and IT control (Janvrin et al., 2012). Perhaps because of this focus, accounting research pays scant attention to the role of control in IT outsourcing arrangements and overlooks the added compliance challenges created by projects' complexity and inter-organizational contexts (Gopal and Gosain, 2010). This study will draw on both research streams to assess the role of communication practices in providing control mechanisms in an outsourcing arrangement.

2.2. Control in IT outsourcing arrangements

The accounting literature often adopts a definition of internal control based on the COSO and COBIT frameworks. The latter defines internal control as the "standards, plans and procedures, and organizational structures designed to provide reasonable assurance that enterprise objectives will be achieved and undesired events will be prevented or detected and corrected" (ISACA, 2012, 93). Similar definitions are used by IS researchers, for example, "…a process of regulation and monitoring for the achievement of organizational goals" (Das and Teng, 2001, 258). Although the two versions are conceptually similar, the IS one tends to be less specific and allow for broad, often abstract, interpretation. It is this looser focus that appears to fit more closely with much of the extant work on IT outsourcing control.

Early work on control in outsourcing arrangements adopted a principal-agent vantage (e.g., Bahli and Rivard, 2003). Project managers were warned about vendors' opportunistic behavior (e.g., Barthélemy and Quélin, 2006) and low reliability of vendor-supplied information with respect to their internal control (Hall and Liedtka, 2007). Client management was advised to draft very detailed contracts and to specify in writing the control mechanisms to be used in the project (e.g., Ngwenyama and Sullivan, 2007). Control frameworks promote communicating client's objectives and requirements to the vendor but do not consider bidirectional, partnership-like communication with the vendor important for internal control.

As outsourcing arrangements became more technically and organizationally complex, the emphasis of IT outsourcing research refocused onto human capital and relationship issues (Cram, 2009; Weiner et al., 2015). Successful outsourcing arrangements were found to balance a well-written contract with the flexibility of partnership relations (Sabherwal, 1999).

Intensive ongoing communication (e.g., Faraj and Sproull, 2000) and effective control mechanisms (e.g., Kern and Willcocks, 2000) have both been established as critical success factors for ISD projects. Scholarly research provides insight into the interplay among communication, trust and control (e.g., Anderson and Narus, 1990; Das and Teng, 2001; Heiskanen et al., 2008). These findings suggest that communication practices used in client-vendor relationships would play an important role in applying control over the vendor's processes and the final product.

2.2.1. Control progression

Tasks in complex development projects are usually highly interdependent and their effective coordination requires structure and discipline (i.e., control), often defined in the outsourcing contract. At the same time, no contract can predict and capture all possible contingencies. ISD projects often take years to complete, and involve changes and re-negotiations of expectations and requirements (Gopal and Gosain, 2010) resulting in the evolution of control to include unplanned or informally adopted mechanisms. Moreover, a prevalence of formalized controls inhibits the spirit of innovation and encourage vendors to offer simple tangible solutions instead of state-of-the-art systems tailored to a client's requirements (Levina and Ross, 2003; Clegg et al., 2004). Many outsourced projects start with a few simple controls, with more controls evolving over time, creating a more complex overall control environment (Choudhury and Sabherwal, 2003; Kirsch, 1997). The resulting formal and informal control mechanisms are flexible, evolve during the project, and are closely intertwined with a team's communication tools.

2.3. Communication tools

Communication tools provide the mechanisms through which team members coordinate efforts, discuss issues, record and impart accomplishments. Documentation and sharing are fundamental to establishing and monitoring a set of controls. The 2013 COSO Framework (COSO, 2013) used by the audit profession to document and manage internal control requirements stresses the importance of communication in two of its 17 internal control principles, emphasizing the need to select relevant methods of communication for both internal and external parties.

2.3.1. Communicating across boundaries

Communication in complex outsourced IT projects has been approached from different theoretical perspectives, from media richness theory (e.g., Sharma et al., 2008) to game theory (e.g., Bandyopadhyay and Pathak, 2007). We adopt the boundary spanning theoretical lens which views communication among people with varied backgrounds and different objectives as a process of spanning a personal, professional or organizational boundary. One of the central themes in the boundary spanning literature is the selection and enactment of "boundary objects" – "abstract or physical artifacts that support knowledge sharing and coordination between different communities of practice by providing interfaces" (Abraham, 2013). A boundary object succeeds when it is "plastic enough to adapt to local needs and constraints" (Star, 1989, 46), provides concrete means for everybody to learn about differences and dependencies across the boundary, and facilitates the process of knowledge transfer (Carlile, 2002). Such diverse artifacts as sales presentations (Levina, 2005), design review sessions (Gopal and Gosain, 2010) or system prototypes (Carlile, 2002) may serve as boundary objects in different situations (see Table 1 for more examples from the literature). The usefulness of a certain communication tool as a boundary object depends on the way it is enacted by participants of a particular project rather than on the inherent properties of the artifact itself. One criterion for a successful evolution of an artifact into a boundary object is that it is accepted by all communicating participants (Levina and Vaast, 2005). This criterion is also used by COBIT in its Maturity Model for Internal Control (ISACA, 2012, 21) and further in the Process Capability Model (ISACA, 2012, 44) as a sign of the highest, "Optimized" level of Internal Control Maturity.

2.3.2. Boundary complexity

Users' expectations and perceptions about communication complexity can drive the selection and use of communication tools (i.e., boundary objects). Carlile (2002) discusses three incremental levels of perceived "boundary complexity" that reflect knowledge exchange across boundaries. Working across a boundary requires boundary objects capable of supporting the boundary's complexity level.

With *syntactic* boundaries, the parties simply transfer the information assuming shared understanding and "common language" on both sides of the boundary. Approaching the boundaries as *semantic* recognizes the need for not only sharing but also explaining, translating the information (since people have different backgrounds) and may even use different terminology. The highest, *pragmatic* level of boundary complexity considers also differences in interests, and the fact that the newly created knowledge should be negotiated among the parties, and thereby transformed. In settings with pragmatic boundaries the knowledge is "localized, embedded and invested in practice" (Carlile, 2002); in order to support spanning of such a complex boundary, communication tools should be capable of handling rich and informal communication.

Syntactic boundaries must be crossed within all team-based projects, whether in-house or outsourced. When team members must communicate across intra- or interorganizational boundaries, semantic and pragmatic borders also must be navigated. Their resident knowledge bases are reflected in the language they employ, the assumptions they draw upon, and methods used in prior assignments. Clients and vendors also bring different objectives and cultures to a team, requiring dealings at the pragmatic level. Our study focuses on the impact of tool choice given the more complex situation resulting from these additional borders, and therefore our interest focuses upon the usage and added value of boundary objects at the semantic and pragmatic levels.

Which objects or tools best span each of these three types of boundaries? Starting from the initial classification of boundary objects by Star (1989); Carlile (2002) matched up the three levels with characteristics of boundary objects. *Syntactic* boundaries are spanned by tools that are used for common reference, provide measures, labels and shared definitions for solving problems. Tools that span *semantic* boundaries provide format, structure and language that help define and categorize differences and potential consequences across different settings. *Pragmatic* boundary spanning needs simple or complex representations demonstrating "form, fit, and function" of the differences and dependencies at the boundary. Examples of these include assembly drawings, mockups or physical prototypes. In addition, *pragmatic* level tools help to transcend the dependencies between different groups or functions and help manage resources, deliverables, and deadlines (e.g., objects, models and maps). These distinctions drive the categorization of tool types used in this study.

2.3.3. Communication tool effectiveness

Another important trait of successful communication tools is that they can be adapted to changing communication needs as the project evolves, and become "boundary objects in practice" while other proposed communication tools are rejected (Levina and Vaast, 2005). This parallels the notion of attempted and realized control mechanisms, introduced by Tiwana and Keil

Table 1
Examples of tools used as boundary objects.

Source	Boundary object
Levina (2005), Brown and Duguid (2001)	Shared documentation
Levina (2005)	Unstructured requirements: "wish lists", "a day in user's life" etc.
Barrett and Oborn (2010)	Specs
Brown and Duguid (2001)	Business processes
Levina (2005)	Use case scenarios (in UML)
Star (1989), Levina (2005), Star and Griesemer (1989)	Maps of boundaries, site maps
Levina (2005)	Sales presentations
Gopal and Gosain (2010)	Code inspections, design reviews
Bechky (2003), Bødker et al. (1998), Henderson (1991)	Design drawings; engineering sketches
Laumann and Rosenkranz (2009)	Domain specific languages
Bechky (2003), Carlile (2002)	Prototypes
Gal et al. (2008)	Modeling technology (CAD)
Levina (2005)	"Wireframe design"
Brown and Duguid (2001), Yakura (2002)	Timelines, schedules
Barrett and Oborn (2010), Pavlou and El Sawy (2006), Brown and Duguid (2001)	PM tools
Gal et al. (2008)	Contract
Bødker et al. (1998), Pawlowski and Robey (2004)	Computer systems and applications

(2009). They show that more formally adopted control mechanisms are attempted in outsourced projects compared to "in house" ones; however, the effectiveness of these controls and their contribution to the project performance are much lower than those that serve an informal control role.

Research suggests that both communication and control in complex outsourced projects should involve formal and informal mechanisms and be adaptable to changing situations (Weiner et al., 2015). Gopal and Gosain (2010) argue that successful communication on the client-vendor organizational boundary (i.e., boundary spanning) improves the effectiveness of the vendor's controls, and that most communication tools (i.e., boundary objects) also serve as behavioral controls. This reasoning suggests that tools used for communication and knowledge management may play an important (and probably informal) role in control applied by a client organization due to their flexibility and acceptance by project participants. Routine use has been shown to lead to increased tool acceptance (Brooks et al., 2013). Building controls into day-to-day activities is also encouraged by COSO (COSO, 2013).

Based on this prior research, we expect that communication practices shared by client and vendor organizations in outsourced ISD projects will support the project's control objectives. These practices must address the pragmatic and semantic levels of boundary complexity encountered by outsourcing teams. As such, tools selected for communication that correspond to these higher levels of boundary complexity will also play an important role as the project's informal IT control mechanisms.

H1. ISD project managers perceive their projects' communication tools and practices to be useful for supporting control objectives.

H1a. Communication tools that span semantic level boundaries are useful for supporting control objectives.

H1b. Communication tools that span pragmatic level boundaries are useful for supporting control objectives.

2.4. Project complexity

The notion of system or project complexity has received increasing attention in both the project management and IS literatures. While there is no single commonly accepted definition of ISD project complexity (Bosch-Rekveldt et al., 2011), many researchers mention the involvement of a large number of self-organizing agents, dynamic non-linear interactions among the self-organizing agents, and path dependency (e.g., Cilliers, 1998), all of which lead to technological challenges during implementation. Each of these is evident in a large-scale outsourcing project.

Outsourced projects involve at least two companies, which in itself complicates the style and purpose of communication within the ISD process. Complex projects involve multiple stakeholders with multiple and possibly competing objectives and approaches, who then require boundary spanning at the highest pragmatic level. Complex projects therefore should benefit from boundary objects capable of supporting communication on the pragmatic level more than projects with less complexity. Thus we expect to see more and different boundary objects in use in more complex projects, especially boundary objects capable of supporting the pragmatic level of boundary spanning.

Based on taxonomies reported in prior work (Bosch-Rekveldt et al., 2011; Xia and Lee, 2004; Vidal and Marle, 2008; Hartmann et al., 2011), we identified three types of project complexity that affect communication and control processes in outsourcing arrangements. These are technical (i.e., integration of different platforms and technologies, users from different business units), organizational (i.e., major changes in the client organization related to the implementation of the new system) and inter-organizational (i.e., multiple vendors, significant off-shore involvement) complexity. Given this range of complexity types, each type is likely to have different control needs, addressable through different mechanisms. We expect to see different sets of boundary objects in projects with different types of complexity.

H2. Project complexity affects the choice of communication tools.

H2a. Complex projects use a greater variety of communications tools than less complex projects.

H2b. Complex projects are more likely to use communications tools associated with the pragmatic level of boundary spanning than less complex projects.

H2c. Technical, organizational and inter-organizational complexity have differing effects on the choice of communications tools.

Complexity is closely connected to the uncertainty faced by the project, and the level of uncertainty is positively associated with the number of different control mechanisms (Rustagi et al., 2008). That is, complex projects are more likely to employ a greater variety of control mechanisms compared to projects with low complexity.

Enforcing compliance in a project with multiple or offshore vendors can become particularly challenging. Although many vendors claim that they have the resources and expertise to handle control and reporting requirements, this is often not the case (Hall and Liedtka, 2007). Auditing and monitoring a remote vendor involves higher costs, increased risk of vendor's unwillingness or lack of capability to create and maintain the required control mechanisms, and additional effort to obtain the required information from the vendor (Ibid.). To address these challenges, we expect complex projects to benefit more from the informal control mechanisms embedded in communication compared to projects with low complexity.

Table 2
Variables and calculated indices used in the study.

Variable	Description	Scale
The use of communication tools in the project		
DocStand	Documents: standards	Dichotomous 1 — yes, 0 — no
DocSpec	Documents: specifications	
DocUCase	Documents: use cases, rules lists	
DocCode	Documents: design or testing documents	
VisUML	Visuals: flowcharts, diagrams	
VisCAD	Visuals: engineering charts	
Track	Issue tracking systems	
PM	Project management tools	
Beta	Prototypes and beta versions	
WebShDocs	Web tools: shared documents	
WebBlog	Web tools: blogs, wikis, forums	
WebNet	Web tools: virtual social networks	
Usefulness of communication tools for four control objectives		
"How useful are these tools for communicating your company's strategic goals and directions to the vendor?"		
APO_Doc	"Align, Plan and Organize" — documents	3 — very useful; 2 — useful; 1 — somewhat useful; 0 — not useful
APO_Vis	"Align, Plan and Organize" — visuals	
APO_TR	"Align, Plan and Organize" — issue tracking tools	
APO_PM	"Align, Plan and Organize" — project management tools	
APO_Beta	"Align, Plan and Organize" — prototypes and beta versions	
APO_Web	"Align, Plan and Organize" — web based tools	
"How useful are these tools for introducing and re-negotiating changes in requirements and procedures?"		
BAI_Doc	"Build, Acquire and Implement" — documents	3 — very useful; 2 — useful; 1 — somewhat useful; 0 — not useful
BAI_Vis	"Build, Acquire and Implement" — visuals	
BAI_TR	"Build, Acquire and Implement" — issue tracking tools	
BAI_PM	"Build, Acquire and Implement" — project management tools	
BAI_Beta	"Build, Acquire and Implement" — prototypes and beta versions	
BAI_Web	"Build, Acquire and Implement" — web based tools	
"How useful are these tools for resolving conflict situations and misunderstandings between your company and the vendor?"		
DSS_Doc	"Deliver, Service and Support" — documents	3 — very useful; 2 — useful; 1 — somewhat useful; 0 — not useful
DSS_Vis	"Deliver, Service and Support" — visuals	
DSS_TR	"Deliver, Service and Support" — issue tracking tools	
DSS_PM	"Deliver, Service and Support" — project management tools	
DSS_Beta	"Deliver, Service and Support" — prototypes and beta versions	
DSS_Web	"Deliver, Service and Support" — web based tools	
"How useful are these tools for monitoring project progress?"		
MEA_Doc	"Monitor, Evaluate and Assess" — documents	3 — very useful; 2 — useful; 1 — somewhat useful; 0 — not useful
MEA_Vis	"Monitor, Evaluate and Assess" — visuals	
MEA_TR	"Monitor, Evaluate and Assess" — issue tracking tools	
MEA_PM	"Monitor, Evaluate and Assess" — project management tools	
MEA_Beta	"Monitor, Evaluate and Assess" — prototypes and beta versions	
MEA_Web	"Monitor, Evaluate and Assess" — web based tools	
Computed indices		
The average usefulness for tools supporting semantic and pragmatic levels of boundary complexity was computed by averaging the tools usefulness responses (measured on a scale ranging from 0 to 3). Documents and issue tracking tools are capable of supporting semantic level of boundary complexity, while visual aids, project management tools, prototypes and beta versions, and Web 2.0 tools can support communication at the highest, pragmatic level of boundary complexity For example, Avg_Sem_APO is the mean of APO_Doc and APO_TR Avg_Pr_APO is the mean of APO_Vis, APO_PM, APO_Beta, and APO_Web		
The usefulness index for each communication tool category was computed by averaging the respective responses (measured on a scale ranging from 0 to 3) to the four control objective questions related to the same tool. For example, UI_Doc is an average of APO_Vis, BAI_Vis, DSS_Vis, MEA_Vis		
The usefulness score for each control objective was computed by summing the tools usefulness responses (measured on a scale ranging from 0 to 3) for all tools used in the project. For example, US_APO is a sum of APO_Doc, APO_Vis, APO_TR, APO_PM, APO_Beta, APO_Web		
The average usefulness for each control objective was computed by averaging the tools usefulness responses (measured on a scale ranging from 0 to 3) for all tools used in the project. For example, Avg_APO is an average of APO_Doc, APO_Vis, APO_TR, APO_PM, APO_Beta, APO_Web		

Table 2 *(continued)*

Computed indices		
Project complexity measures		
Cx_Tech	Technical complexity (integration of multiple platforms; users from many business units)	Dichotomous
Cx_Org	Organizational complexity (business process reengineering, organizational changes)	1 – yes,
Cx_IntOrg	Interorganizational complexity (multiple vendors, off-shoring) Degree of project complexity:	0 – no
Cx_HiLo	Low if (Cx_Tech + Cx_Org + Cx_IntOrg) = 0 or 1 High if (Cx_Tech + Cx_Org + Cx_IntOrg) = 2 or 3	Dichotomous 0 – low 1 – high

H3. Complex projects are more likely to benefit from communication tools' ability to support control than projects of lower complexity.

Since communication in complex projects involves more boundary spanning at the highest (pragmatic) level, we expect that boundary objects capable of supporting all levels of boundary spanning will be more valued in complex projects compared to less complex projects, in regards to internal control objectives. At the same time, communication tools not capable of supporting the pragmatic level of boundary spanning may be perceived by project managers as less effective for control purposes in the complex projects, compared to projects with lower complexity. Finally, given the different project-related challenges posed by each of the three types of complexity, we propose that different tools will support control when a project faces technical, organizational and inter-organizational complexity.

H4. Communication tools' ability to support internal control will differ depending on the project's complexity type.

3. Research methodology

Post-hoc perceptual field data of outsourced project characteristics and tool use were collected through an online cross-sectional survey created with Qualtrics software. The survey instrument was developed in several stages. The initial pool of items and communication tools was created based on an extensive literature review and discussions with several academic and field experts through personal and phone interviews. The first version of the survey instrument was pre-tested on two experienced project managers using the cognitive interviewing technique (Willis, 2005), wherein the respondent is asked to fill out the survey while "thinking aloud" to explain her understanding of the questions and the reasoning behind the answers. The survey was subsequently edited based on the feedback from the cognitive interviews. This was followed by a pilot survey on a convenience sample of 26 project managers, leading to additional minor revisions to the questions. The pilot survey also led to revision of the list of tools commonly used for communication in IS development projects, assuring that the tool list reflected current project management practice.

The collected data cover use of various tools in client-vendor communication, the perceived usefulness of these tools for achieving control objectives, metrics for project complexity, and client's perception of communication quality. All variables and calculated indices are listed in Table 2 and explained in the following sections.

3.1. Communication tools

After a thorough review of literature on boundary spanning and knowledge management in complex projects (refer back to Table 1) a categorization of tools supporting different levels of boundary complexity in ISD projects was assembled. This list was slightly modified following discussions with practitioners, the cognitive interviews, and the pilot survey. The final list includes twelve tools divided into six categories, covering all three levels of boundary complexity (see Table 3 and Fig. 1). Four tools comprise the documents category, with two tools in each of the Visual aids and Web 2.0 based categories. The issue tracking, project management, and Beta versions and prototypes[2] categories each contain a single tool by the same name.

The first column in Table 3 reflects the linkage between tool type and boundary level as defined by Carlile (2002), applied to the second and third columns. Since outsourced projects' and in-department teams' communications both involve tools at the syntactic level, only tools that support the semantic and pragmatic levels provide differentiating insight into outsourcing practices.[3] For the purposes of this study then, tools capable of supporting only the simplest syntactic boundary (i.e., Standards and Specifications) were excluded from the analysis so that the results would provide insight into the higher levels of boundary complexity outsourced projects exhibit.[4]

[2] Prototypes and betas here refer to interim versions of the system under development, and not early versions of communications tools covered by the other categories.

[3] As demonstration of the commonplace nature of syntactic level tools on project teams, 91% of the project managers responding to our survey reported usage of the two syntactic level tools (standards and specifications).

[4] Although not used in the analysis reported in this paper, usage data on Standards and Specifications were collected for use in a related study.

Table 3
Boundary objects used for data collection.

Boundary complexity level per Carlile (2002)	Tool	Category	Source
Syntactic	Standards	Documents	Brown and Duguid (2001)
Syntactic	Specifications	Documents	Barrett and Oborn (2010)
Syntactic/semantic	Use cases	Documents	Levina (2005), Brown and Duguid (2001)
Semantic	Design and testing documents	Documents	Gopal and Gosain (2010)
Semantic	Issue tracking tools		Gopal and Gosain (2010)
Semantic/pragmatic	Flowcharts, diagrams	Visual aids	Bechky (2003), Bødker et al. (1998) Henderson (1991), Laumann and Rosenkranz (2009)
Pragmatic	Engineering charts	Visual aids	Bechky (2003), Bødker et al. (1998), Henderson (1991), Gal et al. (2008)
Pragmatic	Project management tools		Barrett and Oborn (2010), Pavlou and El Sawy (2006), Brown and Duguid (2001), Yakura (2002)
Pragmatic	Prototypes and beta versions		Levina (2005), Bechky (2003), Carlile (2002)
Syntactic/pragmatic	Shared documents	Web 2.0 based tools	Willis et al. (2014)
Syntactic/pragmatic	Wikis, blogs, forums	Web 2.0 based tools	Arazy and Gellatly (2013)
Syntactic/pragmatic	Virtual social networks	Web 2.0 based tools	Leonardi et al. (2013)

Study participants were asked to focus on their most recent project, whether completed, close to completion or ongoing, and indicate which tools they used for client-vendor communication in it, using the pre-defined list of tools (Fig. 1). They could also enter up to three additional tools into text fields. Ninety-nine respondents opted to do so and listed at least one other tool. Most of these entries turned out to be the names of specific tools (for example, SharePoint or MS Project) or communication venues and not tools (such as e-mail or videoconferencing). The text field entries were manually mapped to the existing six categories during data cleaning in preparation for analysis.

3.2. COBIT control objectives

The COBIT framework was chosen to operationalize the usefulness of client-vendor communication tools for achieving IT control objectives for the client organization. Released in 2012, COBIT 5 integrates several components that draw on several ISACA guidance documents. One of these components, the Process Reference Model, represents an evolution of the domain and process-based COBIT 4.1 framework.

COBIT 5 defines thirty-two IT processes for management of enterprise IT, and maps them into four broad interrelated domains: Align, Plan and Organize (APO), Build, Acquire and Implement (BAI), Deliver, Service and Support (DSS) and Monitor, Evaluate and Assess (MEA) (Fig. 2). Organizations may not need to apply all COBIT processes, since their processes are structured in different ways. The processes can be also altered or combined to fit each enterprise.

We drew on the outsourcing and project management literature to identify key processes in each of the four domains that most closely relate to assessing client-vendor communication in a complex project environment and its impact on the client's IT management.[5] These literatures emphasize the importance of viewing complex IT projects strategically rather than as service arrangements (AP06 and P06); promoting thorough development of requirements and communicating them to the vendor as well as any further changes (BAI02 and BAI06) (e.g., Carlile and Rebentisch, 2003; Gopal and Gosain, 2010; Lacity and Willcocks, 2004; Leimeister and Krcmar, 2008; Lin, Pervan and McDermid, 2007). Unrealistic expectations along with failure to manage conflicts (DSS03) and monitor project progress (MAI01) are repeatedly mentioned as the main reasons for IT projects failures (e.g., Haughey, 2014; Kappelman et al., 2006).

For each category where at least one tool was selected, the respondents assessed the usefulness of the tool category during the project for achieving each of the four control domains from Table 4. These twenty-four variables (six categories of tools across four control domains) were measured on a 4-point Likert scale, with 3 meaning "very useful", 2 — "useful", 1 — "somewhat useful" and 0 — "not useful at all". We also provided an option to report situations when a communication tool seemed to be counterproductive in supporting internal control. Few respondents selected this option (see Table 5); during data analysis it was merged with "Not useful at all".

[5] COBIT 5 represents a major revision over COBIT 4.1. COBIT 4.1 lists 34 IT processes vs. the 37 governance and management processes in version 5. One of the 4.1 processes, "Communicate management aims and directions," is not specifically retained in version 5. Given the focus of this research project, we felt it important to include it on this list. Note that its exclusion would have no impact on the results of the analysis.

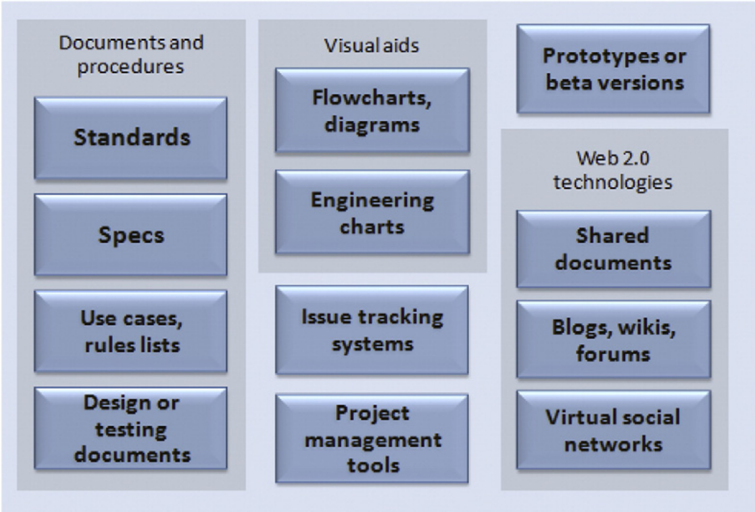

Fig. 1. Communication tools used in the study (survey screenshot). Instructions given to respondents: "Click once on tools and aids that you and your vendor adopted in The Project. Click twice on tools and aids that were tried or proposed during The Project, but have not been adopted for any reason (the buttons will turn purple). Select at least one tool".

3.3. Project complexity

The contribution of technical, organizational and inter-organizational project complexity to the choice and use of tools as communication and control mechanisms was assessed in this study. The classification and operationalization of complexity types are based on taxonomies from previous research (Bosch-Rekveldt et al., 2011; Xia and Lee, 2004; Vidal and Marle, 2008; Hartmann et al., 2011). Each complexity type was captured with two dichotomous variables and subsequently recoded into one dichotomous variable. The project is considered technically complex if it involves integration of different platforms or serves several business units; organizational complexity is introduced by either business process re-engineering or major changes in the client organization related to the implementation of the new system; and interorganizational complexity comes from working with multiple vendors or sending significant part of the project offshore.

4. Data analysis

Most data analyses in this study are based on comparing means of independent (for example, projects with and without complexity) or related (for example, usefulness of a tool for different control objectives in the same project) samples, and on

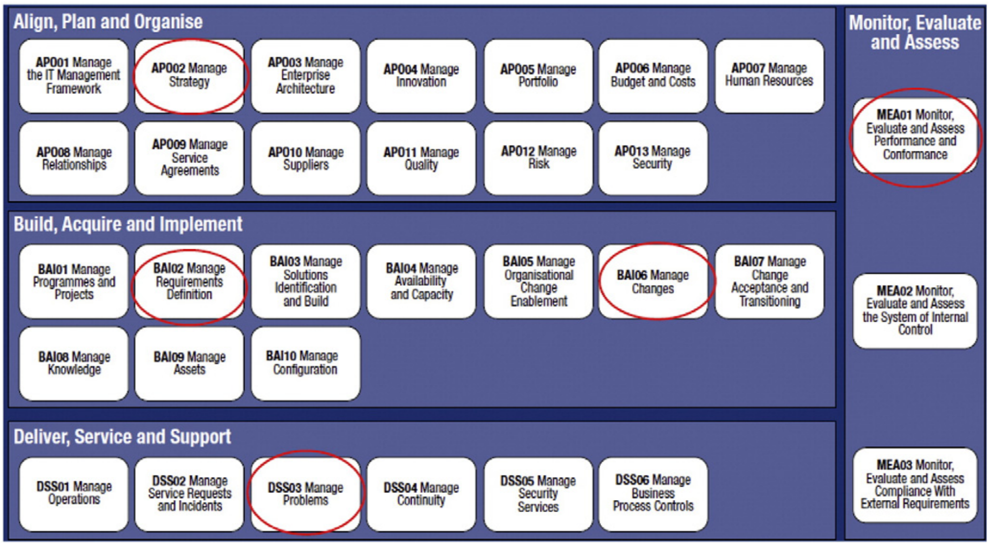

Fig. 2. Processes for management of Enterprise IT (COBIT 5).

Table 4
Four COBIT domains, and IT processes used in this study.

COBIT domains	Process code (s)	Process description	Survey question
Align, Plan and Organize (APO)	APO6 PO6 (COBIT 4.1)	Manage strategy Communicate management aims and directions	How useful are these tools for communicating your company's strategic goals and directions to the vendor?
Build, Acquire and Implement (BAI)	BAI02 BAI06	Manage requirements Manage changes	How useful are these tools for introducing and re-negotiating changes in requirements and procedures?
Deliver, Service and Support (DSS)	DSS03	Manage problems	How useful are these tools for resolving conflict situations and mis-understandings between your company and the vendor?
Monitor, Evaluate and Assess (MEA)	MEA01	Monitor, evaluate and assess IT performance and conformance	How useful are these tools for monitoring project progress?

correlations between the use of communication tools for control purposes, and communication quality metrics. These methods of analysis are appropriate for our purposes, since we do not hypothesize causality between tools' effectiveness for communication and control purposes.

4.1. The sample

432 project managers of recently completed or close to completion outsourced ISD projects provided full valid responses to the survey. Examples of projects include implementations of ERP systems, integrations of existing systems and new modules, migrations of data or major software and infrastructure upgrades. The majority of study participants (369 responses, or 85.4% of the sample) responded to an email invitation sent to the members of IS Community of Practice (IS CoP) of the Project Management Institute (PMI), the world's leading non-profit membership association for the project management profession. At the time of data collection, IS CoP enlisted almost fourteen thousand members worldwide; not all of them are practicing project managers. Also,

Table 5
Projects where communication tools were found not useful or counterproductive for internal control purposes.

	Total	"Not useful"		"Counter-productive"	
		N	%	N	%
Documents and procedures					
Align, Plan and Organize (APO)	423	47	10.9%	3	0.7%
Build, Acquire and Implement (BAI)	423	17	3.9%	4	0.9%
Deliver, Service and Support (DSS)	422	24	5.6	2	0.5
Monitor, Evaluate and Assess (MEA)	422	50	11.6	4	0.9
Visual aids					
Align, Plan and Organize (APO)	315	31	7.2	1	0.2
Build, Acquire and Implement (BAI)	316	27	6.3	1	0.2
Deliver, Service and Support (DSS)	316	35	8.1	0	0
Monitor, Evaluate and Assess (MEA)	316	29	6.7	1	0.2
Issue tracking tools					
Align, Plan and Organize (APO)	333	96	22.2	4	0.9
Build, Acquire and Implement (BAI)	333	16	3.7	3	0.7
Deliver, Service and Support (DSS)	333	18	4.2	3	0.7
Monitor, Evaluate and Assess (MEA)	334	11	2.5	2	0.5
Project management tools					
Align, Plan and Organize (APO)	341	63	14.6	2	0.5
Build, Acquire and Implement (BAI)	343	26	6.0	1	0.2
Deliver, Service and Support (DSS)	342	27	6.3	1	0.2
Monitor, Evaluate and Assess (MEA)	342	6	1.4	1	0.2
Prototypes and beta versions					
Align, Plan and Organize (APO)	182	31	7.2	4	0.9
Build, Acquire and Implement (BAI)	182	15	3.5	1	0.2
Deliver, Service and Support (DSS)	182	24	5.6	1	0.2
Monitor, Evaluate and Assess (MEA)	181	28	6.5	3	0.7
Web 2.0 based tools					
Align, Plan and Organize (APO)	231	69	16.0	1	0.2
Build, Acquire and Implement (BAI)	231	58	13.4	4	0.9
Deliver, Service and Support (DSS)	232	56	13.0	2	0.5
Monitor, Evaluate and Assess (MEA)	231	56	13.0	4	0.9

Table 6a
Age of study participants.

Category	N	% of total 416
Less than 35	86	20.7%
35–45	141	33.9%
45–55	125	30.0%
55+	64	15.4%

only managers of complex outsourced projects, recently completed or close to completion, were eligible to participate in the study. These two restrictions explain the relatively low response rate of 2.7% among the IS CoP members. No reminders were permitted to be sent by the PMI policy. No signs of non-response bias were found in the data set. The remaining 63 participants (14.6% of the sample) were recruited through other PMI communities of practice and the authors' personal networks. Their answers are not statistically different from the answers of participants recruited through PMI.

The software also allowed saving an incomplete survey to finish later. 92.6% of the respondents completed the survey in less than an hour with average time of 20:45 min and median of 17:58 min. The survey included additional questions intended for data collection for other studies.

266 survey participants (61.6%) represent client organizations, 88 (20.4%) work for an outsourcing vendor and 78 (18%) are consultants on either the client or vendor side. The questionnaires for each of the three categories of participants were tailored to be worded slightly differently to ensure compatibility of the collected data. For example, the vendor's version would say “your client's organization” where the client's version says “your organization”. The answers on survey questions of clients, vendors and consultants do not differ statistically.

The sample is well balanced in terms of age, education and gender (Tables 6a, 6b and 6c). Most represented industries are Finance, Manufacturing, Healthcare, and Hi tech and Bio tech (Table 7). Participants were allowed to report up to two industries. Some participants reported having both M.S. and MBA degrees.

4.2. Use of tools for communication and support of control objectives

The data show that project managers use a variety of tools for communication with outsourcing vendors. Most projects use semantic and pragmatic level tools as three of four projects rely on project management and issue tracking tools (Table 8).

Following this overall assessment, we next examined tools' usefulness for supporting each of the COBIT domains. The mean values for perceived usefulness of each tool category for supporting each control domain are listed in Tables 9a and 9b, along with average usefulness of each tool across all control domains.

In each category (except for Web 2.0 based tools), usefulness of the tool for achieving control objectives differs significantly across control domains (Table 9a) and across tools categories. Notably, Web-based tools are consistently the least useful in comparison with any other tool for achieving any of the control objectives.

The mean score for each of the tools is between 1 (“somewhat useful”) and 2 (“useful”). In fact, leaving out Web 2.0 based tools, the average ratings of tools' usefulness are between 1.82 and 2.00 (where 0 is “not useful”, 1 is “somewhat useful”, 2 is “useful” and 3 is “very useful”). This supports Hypothesis 1, as ISD project managers perceive their projects' communication tools and practices as useful for supporting control objectives. Both semantic and pragmatic level tools are perceived as supporting control objectives (Table 9b), which is in accordance with Hypotheses 1a and 1b. It can be also noted that semantic level tools are perceived as more supportive for all four control domains (Table 9b).

Although most cell entries suggest that the tool category is useful within the control domain, there are also notable differences among tools' usefulness for control purposes among the tools and across control domains. Documents, charts (“Visual aids”) and prototypes and beta versions are most useful in supporting change management (Build, Acquire and Implement domain), and least useful for monitoring project performance (Monitor, Evaluate and Assess domain). Issue Tracking and Project Management tools, in contrast, are most useful in the Monitor, Evaluate and Assess domain. For each of these tools, the lowest perceptions of usefulness are in the Align, Plan and Organize domain. This suggests that an effective system of IT control should rely on a portfolio of tools in order to cover a variety of control objectives.

Table 6b
The highest completed degree by study participants.

Category	N	% of total 425
B.S.	203	47%
M.S.	93	21.5%
MBA	112	25.9%
PhD	5	1.2%

Table 6c
Gender of study participants.

Category	N	% of total 416
Female	115	27.6%
Male	301	72.4%

4.3. The role of project complexity

As explained earlier, three types of project complexity were assessed in this study: organizational, interorganizational and technical, in order to analyze how the project's complexity affects the usefulness of communication tools as control mechanisms. In addition, we compared projects with low (none or one of the three complexity types) and high (two or three types) complexity. Frequencies for complexity types and degrees of complexity are summarized in Tables 10a and 10b.

Table 11 summarizes the variety of communication tools categories used in projects of different degree and type of complexity. Overall, high complexity projects adopted tools from 4.34 categories vs. 3.64 categories for the low complexity projects, a statistically significant difference. All types of project complexity lead to higher variety of tools categories adopted for communication.

Table 12 compares adoption of specific tool types based on degree of complexity, while Table 13 breaks this down further by the three complexity types. All categories of communication tools, spanning both semantic and pragmatic boundaries (except for the prototypes and beta versions, where the difference is not significant) are used more often in more complex projects. However, when separately examining the three types of complexity, we note several differences among tool categories as project complexity increases:

- Regardless of the type of project complexity, Issue Tracking and Project Management tools are more popular in complex projects relative to less complex ones.
- Drawings and charts ("Visual aids") are adopted equally in all types of projects, but technical or organizational complexity affects their adoption more than interorganizational complexity.
- Geographically distributed projects (i.e., those exhibiting interorganizational complexity) adopt more documentation tools compared to co-located ones.
- Finally, organizational complexity has no effect on the adoption of Web 2.0 based communication tools, while interorganizational complexity leads to high increase in their popularity. In the case of technical complexity the difference in Web 2.0 tools adoption comes from disproportionally low adoption of these tools in projects with no technical complexity.

These findings confirm that the choice of communication tools for a project depends on the degree and type of project's complexity, and therefore, support Hypothesis 2 as well as sub-Hypotheses 2a, 2b and 2c. Greater variety in tool adoption is found in more complex projects, in order to support their more complex pragmatic boundaries.

We expected that greater tool variety also provides stronger support for internal control objectives. To test this, we calculated a "Usefulness index" – summing of all communication tools of the project usefulness for control purposes. Mean comparisons of the "Usefulness index" for projects of high and low complexity (Table 14a) and for each control domain and each type of complexity (Table 14b) provide support to Hypothesis 3. The results vary among the different control objectives and types of complexity, but overall, more complex projects find communications tools more helpful for control purposes than simpler projects. Delving deeper, Technical and Organizational complexity are more likely to benefit from increased support of control objectives embedded in communication mechanisms. This is not true, however, for projects with Interorganizational complexity where only certain control objectives see significant differences.

Differences in usefulness of specific tool categories for control purposes related to project complexity are presented in Table 15. Only a few of these differences are statistically significant. We then summarize the differences in tools use for communication

Table 7
Industries of client companies represented in the study.

Industry	N	% of total 424
Finance	100	23.6%
Manufacturing and construction	49	11.6%
Hi tech and bio tech	42	9.9%
Healthcare	41	9.7%
Transport and energy	37	8.7%
Communication and media	36	8.5%
Public services	34	8.0%
Wholesale and retail	27	6.4%
Professional services	24	5.7%
Education	6	1.4%
Tourism and entertainment	5	1.2%
Other	39	9.2%

Table 8
Categories of tools used for communication in outsourced projects.

	N	% of total 432 observations
Documents[a]	364	84.3
Visual aids	319	73.8
Issue tracking tools	334	77.3
Project management tools	343	79.4
Beta versions and prototypes	183	42.4
Web based tools	245	56.7

[a] Only those document tools supporting semantic and pragmatic levels of boundary complexity.

and tools usefulness for control purposes introduced by project complexity in the complexity maps depicted in Fig. 3. The first rows in each map reflect the increases in the use of the tool category for communication purposes (reprising Table 13); the other four rows in each map capture differences in tools' usefulness for the four control domains. Plus signs indicate an increase in use for communication or a higher perception of tool's usefulness for control in the more complex projects. Minus signs show the opposite tendency – tools lose their usefulness for a particular control domain in more complex projects (compared to simpler ones). We mapped only statistically significant differences.

Several observations can be made based on these maps regarding the effect of complexity on the usefulness of communication tools for control purposes. First, more frequent use of a specific tool category for communication purposes does not necessarily mean that the tool is more useful for control purposes. For example, more frequent use of issue tracking tools in complex projects is not accompanied by better support of any control objectives by these tools regardless of the type of complexity. On the other hand, in most cases communication tools do not lose their ability to support control objectives as the projects and the communication boundaries become more complex.

Second, complexity introduced by multiple and off shore vendors (interorganizational complexity) is the only one of the three complexity types, where the role of communication tools in internal control notably changes with introduction of complexity. The other two complexity types do not affect the usefulness of specific tools categories for achieving control objectives.

Finally, same communication tools contribute to control activities differently in projects of different complexity types. One example is prototypes and beta versions. Technical complexity negatively affects their usefulness in supporting change management (BAI domain). This does not happen in projects with interorganizational complexity; however, this type of complexity reduces the

Table 9a
Mean values for usefulness across control domains[a].

How useful are the following tools for … (mean values)		Documents	Visual aids	Issue tracking tools	Project manage-ment tools	Proto-types and beta versions	Web based tools	Avg for control domain
Highest supported level of boundary complexity		Semantic	Pragmatic	Semantic	Pragmatic	Pragmatic	Pragmatic	
… communicating strategic goals (APO)	N	363	315	333	341	182	231	430
	Mean	1.93	1.95	1.42	1.60	1.69	1.21	1.63
	St. dev.	1.00	0.98	1.16	1.05	1.09	1.01	0.81
…. managing changes in requirements (BAI)	N	363	316	333	343	182	232	430
	Mean	2.23	2.00	2.08	1.92	2.03	1.31	1.94
	St. dev.	0.83	0.95	0.90	0.94	0.97	0.98	0.66
… resolving conflicts (DSS)	N	362	316	333	342	182	231	430
	Mean	2.09	1.87	2.11	1.84	1.94	1.25	1.85
	St. dev.	0.91	1.00	0.90	0.93	1.06	1.00	0.74
…. monitoring performance (MEA)	N	362	316	334	342	181	231	430
	Mean	1.72	1.82	2.33	2.49	1.63	1.31	1.94
	St. dev.	0.99	0.95	0.82	0.73	1.04	1.00	0.66
Average for the tool	N	363	316	334	343	182	233	
	Mean	2.00	1.91	1.98	1.96	1.82	1.26	
	St. dev.	0.69	0.73	0.69	0.70	0.77	0.84	
Friedman chi^2[b]		80.12	12.13	176.3	236.1	27.2	3.53	70.85
N		361	315	331	341	181	229	430
Asympt. significance		0.000	0.007	0.000	0.000	0.000	0.317	0.000

[a] Usefulness is measured with 4-point Likert scale, where 3 means "very useful", 2 is "useful", 1 is "somewhat useful", 0 is "not useful at all" or "counterproductive".
[b] Non-parametric Friedman test for several related samples is used for comparison of means.

Table 9b
Mean values for usefulness of semantic and pragmatic level tools across control domains.

	N	Mean for semantic	Std. dev. (semantic)	Mean for pragmatic	Std. dev. (pragmatic)	t	Sig. (2-tailed)
APO	389	1.68	0.955	1.60	0.851	2.023	0.044
BAI	391	2.15	0.760	1.78	0.746	9.242	0.000
DSS	390	2.10	0.812	1.69	0.811	10.720	0.000
MEA	390	2.01	0.792	1.90	0.15	2.782	0.006

usefulness of prototypes and betas for communication of strategic goals (APO domain) and monitoring performance (MEA domain). Organizational complexity at the same time does not change the usefulness of prototypes and betas for any of the control objectives.

Another interesting example is Web 2.0 based tools. The ability of tools in this category (shared documents; blogs, forums and Wikis; virtual social networks) to facilitate knowledge exchange and collaborative work makes them a good choice for communication across boundaries at the pragmatic complexity level (e.g., Arazy and Gellatly, 2013). However, projects of organizational complexity, which is defined as changes within the client organization, do not use Web 2.0 tools more often with their vendors, neither for communication nor for control. In technically complex projects Web 2.0 tools are employed for communication more often compared to projects that are less technically complex; however, the increased use for communication does not affect the perceived usefulness for control purposes. Only in projects with multiple or remote vendors (interorganizational complexity) is the increased use of Web 2.0 tools accompanied by increased usefulness, but only in one control domain – Deliver, Service and Support.

These observations support Hypothesis 4: A communication tool's ability to support control across these COBIT domains differs depending on the type of the project's complexity.

5. Discussion

Analysis of 432 surveys on communication in outsourced IS development projects completed by project managers provides strong support to the initial proposition of this study: tools that support quality communication in outsourced ISD projects also support the internal control function, and enhance compliance with requirements of the IT audit control framework COBIT. The ability of communication tools to support control objectives, however, differs across categories of communication tools and control domains. Some tools are more universal, and can be instrumental for achieving control objectives from several control domains (such as Visual aids); others are more useful in one domain than in others (Project Management tools, for example, are reported to be especially useful for monitoring performance).

5.1. Tool categories and control objectives

The contribution of different tools to different control activities varies. Change management (BAI domain) is best supported with Documents, while Project Management tools are most useful for monitoring performance (MEA domain), closely followed by Issue Tracking tools.

Unexpectedly, throughout different data analyses, Web-based tools (shared documents; blogs, forums, and Wikis; and virtual social networks) consistently appear least useful for both communication and control. Web-based tools support the most complex, “pragmatic” type of communication; they are increasingly recognized as facilitators of information sharing and collaboration in IT projects (e.g., 1stwebdesigner.com, 2015). However, a lack of agreement on their use in the specific project may impede communication instead of facilitating it (Levina and Vaast, 2005; Tiwana and Keil, 2009). According to the COBIT Maturity model for IT control, the lack of a planned process for tool usage characterizes the lowest, “Initial/Ad Hoc” level of maturity (ISACA, 2012, 21). Preliminary planning and clear definition of the use of Web-based tools in outsourced projects may increase their usefulness in achieving control objectives and ultimately their contribution to project success.

Preliminary planning would also be helpful at earlier stages of the project. Our findings indicate that the APO control domain benefits the least from the support of communication tools. One possible reason for this is that in many cases communication tools are selected later in the project, after the planning stages conclude (e.g., Choudhury and Sabherwal, 2003). Having a plan for implementing, integrating and using tools across the enterprise is also essential for achieving higher levels of IT control

Table 10a
Frequencies of complexity types.

Complexity type	N	%
Organizational complexity	282	65.3%
Interorganizational complexity	202	46.8%
Technical complexity	384	88.9%

Table 10b
Frequencies of degrees of complexity.

Complexity level	N	% of total 432	Complexity level	N	% of total 432
0	14	3.2%	Low	124	28.7%
1	110	25.5%			
2	166	38.4%	High	308	71.3%
3	142	32.9%			

maturity (ISACA, 2012, 21). Another explanation is that the activity within this domain is relatively unstructured, and there are few tools that facilitate control when there is less structure and less progress to inspect.

5.2. The role of project complexity

Project complexity is an important factor in the selection of tools for client-vendor communication. A tool's more extensive use for communication purposes in more complex projects is not necessarily associated with its increased contribution to achieving client's control objectives. The appropriateness of communication tools for supporting various control objectives is also affected by the project's complexity.

Generally speaking, more complex projects use more tools. Yet, the type of complexity faced by the project determines which tools categories are adopted. The usefulness of the specific tool category for supporting internal control objectives is also related to the type of project complexity. Most of the tools retain their usefulness for informal control purposes in more complex projects despite the increased complexity of communication. However, in some cases, especially with geographically distributed projects, challenges introduced by project complexity reduce the usefulness of some communication tools in supporting informal control. We observed the opposite tendency as well –Web 2.0 tools' ability to support complex pragmatic level communication is better utilized for control purposes in geographically distributed projects compared to co-located ones.

Overall, complex projects require more intensive communication and employ more communication tools. Even though the tools, in most cases, provide equivalent support for internal control objectives as in non-complex projects, complex projects benefit from control embedded in communication more than simpler projects, due to the higher number of tools and their increased use for communication purposes.

Any type of complexity leads to more frequent use of Project Management and Issue Tracking tools. The increase in use and usefulness for control purposes of other tool categories varies.

Technically complex projects employ more Visual Aids, and they are similarly helpful for control purposes as in projects without technical complexity. Prototypes and beta versions of the final product are more helpful at the development stages of IS when the system is less technically complex. In complex projects prototypes no longer serve as boundary objects. Managers of technically complex projects should take this into account and consider ways to substitute or complement system prototypes and beta versions with other communication tools and control mechanisms. Communication tools in technically complex projects support conflict resolution (DSS domain) and monitoring performance (MEA domain); managers of these projects should pay attention to utilizing the internal control embedded in client-vendor communication. They also need to pay special attention to APO and BAI domains since they are not supported by communication tools as well as the other two domains.

Projects exhibiting organizational complexity involve many stakeholders of different backgrounds therefore calling for more intensive use of pragmatic level tools, in addition to Project Management and Issue Tracking tools. Hence we note their increased use of Visuals, even though the more intensive use does not affect the perceptions of Visuals' usefulness for control purposes. Organizationally complex projects benefit from tools' ability to support internal control objectives to the same extent as projects with no organizational complexity; however, due to the increased variety of communication tools in use, the overall perceived usefulness of communication tools for control purposes in organizationally complex projects is higher at all project stages beyond the planning stage.

Projects experience interorganizational complexity by involving multiple and/or off-shore vendors. This requires more project documentation; however, more extensive documentation exchange does not provide better support of control

Table 11
Number of tools categories adopted in ISD projects based on degree and type of project complexity.

	Not complex			Complex				
	N	Mean	St. dev	N	Mean	St. dev	t	Sig. (2-sided)
Overall (low/high) complexity	124	3.64	1.42	308	4.34	1.23	−4.83	0.000
Technical complexity	48	3.52	1.27	384	4.22	1.31	−3.47	0.001
Organizational complexity	150	3.82	1.43	282	4.31	1.23	−3.535	0.000
Interorganizational complexity	230	3.95	1.34	202	4.36	1.28	−3.231	0.001

Table 12
Adoption of tools categories in projects with low and high complexity.

	Low complexity		High complexity		Total			
	N using the tool	% of total 124	N using the tool	% of total 308	N using the tool	% of total 432	Pearson chi^2	Sig. (2-sided)
Documents	94	75.8%	270	87.7%	364	84.3%	9.369**	0.002
Visual aids	78	62.9%	241	78.2%	319	73.8%	10.78**	0.001
Issue tracking tools	80	64.5%	254	82.5%	334	77.3%	16.24**	0.000
PM tools	88	71.0%	255	82.8%	343	79.4%	7.56**	0.006
Prototypes and betas	52	41.9%	131	42.5%	183	42.4%	0.013	0.910
Web based	59	47.6%	186	60.4%	245	56.7%	5.91*	0.015

* Significant at 0.05 level.
** Significant at 0.01 level.

objectives. Interorganizationally complex projects are more likely to rely on Web 2.0 based tools and their ability to support control objectives. In projects of this kind, additional attention should be paid to the APO and MEA domain. Geographic distribution adds challenges to monitoring project progress and makes embedding planning stage controls into communication less effective.

Our findings suggest that regulatory compliance in complex information-intensive organizational settings can be promoted by considering the informal internal control embedded in communication mechanisms. The level of support of internal control objectives varies across different communication tools and different types of projects. Early analysis of a project's complexity can lead to a better match between project needs and suitable communication tools. Proper selection among communication options reinforces project support of control objectives while improving communication between client and vendor. Careful selection thus can help achieve effective and efficient regulatory compliance. Because many of the tools also facilitate stored repositories of communication, project managers should develop appropriate processes for client-vendor communication to ensure proper collection of relevant data needed to address the requirements of COBIT and their auditors.

Table 13
Adoption of tools categories in projects with different complexity types.

Technical complexity

	Not complex		Complex		Total			
	N using the tool	% of total 48	N using the tool	% of total 384	N using the tool	% of total 432	Pearson chi^2	Sig. (2-sided)
Documents	37	77.1%	327	85.2%	364	84.3%	2.097	0.148
Visual aids	29	60.4%	290	75.5%	391	73.8%	5.039*	0.025
Issue tracking tools	31	64.6%	303	78.9%	334	77.3%	4.991*	0.025
PM tools	31	64.6%	312	81.3%	343	79.4%	7.246**	0.007
Prototypes and betas	22	45.8%	161	41.9%	183	42.4%	0.267	0.606
Web based	19	39.6%	226	58.9%	245	56.7%	6.454*	0.011

Organizational complexity

	Not complex		Complex		Total			
	N using the tool	% of total 150	N using the tool	% of total 282	N using the tool	% of total 432	Pearson chi^2	Sig. (2-sided)
Documents	120	80.0%	244	86.5%	364	84.3%	3.143	0.076
Visual aids	95	63.3%	224	79.4%	319	73.8%	13.14**	0.000
Issue tracking tools	101	67.3%	233	82.6%	334	77.3%	13.05**	0.000
PM tools	111	74.0%	232	82.3%	343	79.2%	4.094*	0.043
Prototypes and betas	61	40.7%	122	43.3%	183	42.4%	0.270	0.603
Web based	85	56.7%	160	56.7%	245	56.7%	0.00	0.989

Interorganizational complexity

	Not complex		Complex		Total			
	N using the tool	% of total 230	N using the tool	% of total 202	N using the tool	% of total 432	Pearson chi^2	Sig. (2-sided)
Documents	184	80.0%	180	89.1%	364	84.3%	6.728**	0.009
Visual aids	163	70.9%	156	77.2%	319	73.8%	2.251	0.154
Issue tracking tools	165	71.7%	169	83.7%	334	77.3%	8.72**	0.003
PM tools	174	75.7%	169	83.7%	343	79.4%	4.22*	0.040
Prototypes and betas	103	44.8%	80	39.6%	183	42.4%	1.181	0.277
Web based	119	51.7%	126	62.4%	245	56.7%	4.957*	0.026

* Significant at 0.05 level.
** Significant at 0.01 level.

Table 14a
Perceived total usefulness of all communication tools based on level of project complexity.

"Usefulness index" (sum of all usefulness variables for the domain)	Low complexity (122)		High complexity (308)			
	Mean	St. dev	Mean	St. dev	t	Sig. (2-tailed)
… communicating strategic goals (APO)	6.27	4.09	6.98	4.25	−1.58	0.114
…. managing changes in requirements (BAI)	7.33	3.80	8.34	3.91	−2.43	0.016
… resolving conflicts (DSS)	6.89	3.92	8.06	4.18	−2.66	0.008
…. monitoring performance (MEA)	7.02	3.83	8.34	3.58	−3.37	0.001
Average	6.88	3.58	7.93	3.53	−2.77	0.006

5.3. Limitations

Communication is a complex process, and communication practices are highly situational. Data collection through a survey instrument uses linear scales for assessing communication practices, usefulness of tools and project complexity. This approach inevitably misses many aspects of rich projects' contexts that would be more easily captured by longitudinal case studies. However, the objective of this study is identifying and assessing general tendencies, and the selected methods are well suited for this goal.

We surveyed a single project manager for each project. Due to anonymity requirements and an inability to re-canvas for missing responses, collecting and matching views of both clients and vendors of the same project was not possible. We are not alone in this deficiency: other researchers have also based their studies on individual perspectives of one project manager, even when the client-vendor relationship was their main focus (e.g., Kim and Chung, 2003; Lee, 2001; Lee and Kim, 1999).

5.4. Contributions and outcomes

The subject of control in outsourced ISD projects has been addressed in the literature of several research disciplines including information systems, management and accounting. There is little interaction, however, among these three areas of scholarship on this subject. IS and management researchers rarely consider accounting control frameworks. Similarly, the accounting literature may not draw on relevant findings from IS and management publications. One contribution of this study is in bringing the IS and accounting fields together to advance our understanding of internal control in complex outsourced ISD projects. This study contributes to knowledge about the challenges of embedding control in communication, which is critical for communication-intensive creative environments that are sensitive to formality and flexibility of control mechanisms.

An audit's (and audit framework's) goal is to provide a formal assessment of the state of internal control, which may be difficult with creative knowledge intensive projects where third parties are involved. We show that tools supporting communication can also support internal control especially as denoted through the COBIT framework, and that the extent of this support is moderated by the level and type of project complexity. Unlike the COBIT framework, we consider bidirectional communication between client and vendor which involves discussions and negotiations, rather than one-way communication of client's requests to the vendor as it is viewed by COBIT.

The findings of this study are of immediate value for practitioners. Early analysis of a project's needs and priorities accompanied by conscious selection of communication practices can be recommended to practitioners in order to achieve best support for internal control objectives and compliance with reporting requirements. We suggest developing communication policies and

Table 14b
Perceived total usefulness of all communication tools based on type of project complexity.

"Usefulness index" (sum of all usefulness variables for the domain)		Technical complexity				Organizational complexity				Interorganizational complexity			
		Mean	St. dev	t	Sig. (2-tailed)	Mean	St. dev	t	Sig. (2-tailed)	Mean	St. dev	t	Sig. (2-tailed)
APO	Not complex	5.94	3.64	−1.47	0.142	6.28	4.23	−1.78	0.077	6.78	4.10	0.002	0.998
	Complex	6.89	4.27			7.04	4.19			6.78	4.34		
BAI	Not complex	7.56	3.52	−0.934	0.351	7.49	4.00	−2.18*	0.029	7.70	3.64	−2.00*	0.045
	Complex	8.12	3.95			8.35	3.82			8.46	4.15		
DSS	Not complex	6.48	3.62	−2.23*	0.026	7.16	4.20	−2.09*	0.038	7.32	3.82	−2.17*	0.030
	Complex	7.88	4.17			8.03	4.08			8.2	4.43		
MEA	Not complex	6.48	3.40	−2.99**	0.003	7.41	3.88	−2.27*	0.024	7.64	3.69	−1.92	0.055
	Complex	8.16	3.69			8.26	3.57			8.33	3.68		
Average	Not complex	6.62	3.12	−2.10*	0.036	7.09	3.70	−2.31*	0.021	7.36	3.45	−1.68	0.094
	Complex	7.76	3.61			7.92	3.48			7.94	3.68		

* Significant at 0.05 level.
** Significant at 0.01 level.

Table 15
Complexity type differences of tool usefulness for control purposes.

		Technical complexity				Organizational complexity				Interorganizational complexity			
		Mean (not comp-lex)	Mean (comp-lex)	t	Sig. (2-tailed)	Mean (not comp-lex)	Mean (comp-lex)	t	Sig. (2-tailed)	Mean (not comp-lex)	Mean (comp-lex)	t	Sig. (2-tailed)
Docu-ments	APO	1.92	1.93	−0.06	0.95	1.89	1.95	−0.49	0.62	2.01	1.85	1.49	0.14
	BAI	2.16	2.24	−0.56	0.57	2.16	2.27	−1.24	0.22	2.24	2.23	0.15	0.88
	DSS	2.05	2.10	−0.29	0.77	2.07	2.11	−0.41	0.68	2.12	2.07	0.58	0.56
	MEA	1.57	1.75	−1.05	0.29	1.68	1.75	−0.64	0.53	1.86	1.60	2.53	0.01**
Visual aids	APO	2.28	1.92	1.89	0.06	2.02	1.92	0.85	0.40	1.92	1.98	−0.55	0.58
	BAI	2.31	1.97	1.83	0.07	2.05	1.98	0.61	0.55	1.95	2.06	−1.00	0.32
	DSS	1.93	1.86	0.34	0.73	1.94	1.84	0.76	0.45	1.78	1.96	−1.59	0.11
	MEA	1.72	1.83	−0.57	0.57	1.93	1.77	1.29	0.20	1.80	1.85	−0.47	0.64
Issue tracking tools	APO	1.35	1.42	−0.32	0.75	1.35	1.45	−0.74	0.46	1.53	1.30	1.82	0.07
	BAI	2.27	2.06	1.22	0.22	2.11	2.06	0.46	0.64	2.10	2.05	0.57	0.57
	DSS	1.97	2.13	−0.93	0.35	2.07	2.13	−0.54	0.59	2.13	2.10	0.32	0.75
	MEA	2.16	2.35	−1.19	0.23	2.34	2.33	0.11	0.92	2.27	2.38	−1.24	0.21
Project manage-ment tools	APO	1.45	1.62	−0.83	0.40	1.69	1.56	1.11	0.27	1.72	1.47	2.20	0.03*
	BAI	2.03	1.92	0.65	0.52	2.03	1.88	1.33	0.18	1.97	1.89	0.73	0.46
	DSS	1.85	1.85	0.01	0.99	1.89	1.83	0.60	0.55	1.87	1.83	0.41	0.68
	MEA	2.33	2.51	−1.30	0.19	2.48	2.49	−0.14	0.89	2.43	2.55	−1.45	0.15
Proto-types and beta versions	APO	1.82	1.67	0.60	0.55	1.61	1.73	−0.70	0.48	1.85	1.47	2.40	0.02*
	BAI	2.64	1.95	3.17	0.00**	2.07	2.02	0.29	0.77	2.08	1.97	0.74	0.46
	DSS	1.77	1.97	−0.81	0.42	1.97	1.93	0.20	0.84	1.91	1.99	−0.47	0.64
	MEA	1.86	1.60	1.13	0.26	1.69	1.60	0.54	0.59	1.78	1.43	2.30	0.02*
Web 2.0 based tools	APO	1.00	1.23	−0.91	0.37	1.13	1.25	−0.82	0.41	1.14	1.28	−1.05	0.30
	BAI	1.28	1.32	−0.17	0.86	1.16	1.40	−1.81	0.06	1.21	1.41	−1.55	0.12
	DSS	1.00	1.27	−1.11	0.27	1.17	1.30	−0.90	0.37	1.12	1.38	−1.96	0.05*
	MEA	1.00	1.35	−1.39	0.16	1.26	1.36	−0.69	0.49	1.28	1.36	−0.60	0.55

* Significant at 0.05 level.
** Significant at 0.01 level.

Technical complexity

	DOCS	VIS	TRK	PM	BETA	WEB
Tools Use		⊕	⊕	⊕		⊕
APO						
BAI					⊖	
DSS						
MEA						

Organizational complexity

	DOCS	VIS	TRK	PM	BETA	WEB
Tools Use		⊕	⊕	⊕		
APO						
BAI						
DSS						
MEA						

Interorganizational complexity

	DOCS	VIS	TRK	PM	BETA	WEB
Tools Use	⊕		⊕	⊕		⊕
APO				⊖	⊖	
BAI						
DSS						⊕
MEA	⊖				⊖	

Fig. 3. The effect of complexity type on the adoption and perceived usefulness of communication tools for control purposes*. * Changes shown with circled plus and minus signs are significant at 0.05 level. A+ sign indicates that complexity correlates with higher perceived usefulness. A− sign means complexity correlates with lower perceived usefulness.

routines early on during the projects that would help structure the collection and storage of information. Understanding the value of the many communication mechanisms can also assist auditors in assessing the system of internal control in ISD projects.

The internal control literature is dominated by normative and opinion papers; most empirical work is based on qualitative methods of analysis. This study is positivist and based on quantitative analysis of primary field data, which makes it a valuable addition to the existing body of knowledge.

5.5. Directions for future research

This study provides a foundation for further investigation of the role of communication practices with external vendors in successfully communicating across borders while providing effective internal control. By analyzing different types of tools, control objectives and projects, the study opens up several directions for future inquiry.

First of all, the embeddedness of control in communication in cases of knowledge-intensive collaborative projects deserves additional attention. This is a rich and complex phenomenon; longitudinal studies and qualitative research methods suitable for in-depth investigation would help to explain the trends noted in our findings. Tools selected for communication across a boundary depend on the boundary spanners' perceptions of boundary complexity (Carlile, 2002). This warrants an inquiry into the ways managers form their perceptions. A more focused inquiry into the role of tool categories and different types of project complexity would allow for developing guidelines for practitioners to assist in tool selection across a project's lifecycle. As new tools come into wider use and a new generation of developers enters the marketplace, the categorization of the tools must be updated to reflect current practice.

This study touches only the tip of the iceberg of internal control and compliance in outsourced IT projects. Representative control objectives were included that relate closely to project management processes and products and, at the same time, represent all four domains of COBIT framework. Future research can expand this setting and perform more comprehensive testing of COBIT's Enterprise IT Management framework in the context of IS development projects. Project Management professionals already consider COBIT's value for controlling practices, although the adoption rate of the COBIT for project management is still low (Bernroider and Ivanov, 2011). The comprehensive approach of COBIT 5, which consolidates several previous frameworks and addresses such important issues as risk and security management (ISACA, 2012) should attract more attention by practitioners and increase COBIT adoption.

Finally, the findings open the door to future audit research on the processes that accompany the product of the system development process. Auditors should consider the relative value and contribution of both formal and informal control mechanisms within their control assessment, as well as client-vendor communication about internal control. They need to cover the types and degree of complexity that affect what controls are needed and how they are best supported. The relative contributions of communication tools should also be considered, as many of these may support internal control in informal ways.

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References

1stwebdesigner.com, 2015. 30 greatest online project management and collaboration tools. Web Design Professionals — 1stWebDesigner (Accessed April 15, 2015. http://www.1stwebdesigner.com/project-management-collaboration-tools/).

Abraham, R., 2013. Enterprise architecture artifacts as boundary objects — a framework of properties. Presented at the ECIS (Retrieved from http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1343&context=ecis2013_cr).

Anderson, J.C., Narus, J.A., 1990. A model of distributor firm and manufacturer firm working partnerships. J. Mark. 54 (1), 42–58.

Arazy, O., Gellatly, I.R., 2013. Corporate wikis: the effects of owners' motivation and behavior on group members' engagement. J. Manag. Inf. Syst. 29 (3), 87–116.

Bahli, B., Rivard, S., 2003. The information technology outsourcing risk: a transaction cost and agency theory-based perspective. J. Inf. Technol. 18 (3), 211–221.

Bandyopadhyay, S., Pathak, P., 2007. Knowledge sharing and cooperation in outsourcing projects: a game theoretic analysis. Decis. Support. Syst. 43 (2), 349–358.

Barrett, M., Oborn, E., 2010. Boundary object use in cross-cultural software development teams. Hum. Relat. 63 (8), 1199.

Barthélemy, J., Quélin, B.V., 2006. Complexity of outsourcing contracts and ex post transaction costs: an empirical investigation. J. Manag. Stud. 43 (8), 1775–1797.

Bechky, B.A., 2003. Sharing meaning across occupational communities: the transformation of understanding on a production floor. Organ. Sci. 312–330.

Bernroider, E.W.N., Ivanov, M., 2011. IT project management control and the control objectives for IT and related technology (CobiT) framework. Int. J. Proj. Manag. 29 (3), 325–336.

Bødker, S., 1998. Understanding representation in design. Hum. Comput. Interact. 13 (2), 107–125.

Bosch-Rekveldt, M., Jongkind, Y., Herman, M., Bakker, H., Verbraeck, A., 2011. Grasping project complexity in large engineering projects: the TOE (technical, organizational and environmental) framework. Int. J. Proj. Manag. 29 (6), 728–739.

Brooks, J.M., Bodeau, D., Fedorowicz, J., 2013. Network management in emergency response: articulation practices of state-level managers — interweaving up, down, and sideways. Adm. Soc. 45 (8), 911–948.

Brown, J.S., Duguid, P., 2001. Knowledge and organization: a social-practice perspective. Organ. Sci. 12 (2), 198–213.

Carlile, P.R., 2002. A pragmatic view of knowledge and boundaries: boundary objects in new product development. Organ. Sci. 13 (4), 442–455.

Carlile, P.R., Rebentisch, E.S., 2003. Into the black box: the knowledge transformation cycle. Manag. Sci. 49 (9), 1180–1195.

Choudhury, V., Sabherwal, R., 2003. Portfolios of control in outsourced software development projects. Inf. Syst. Res. 14 (3), 291–314.

Cilliers, P., 1998. Complexity and Postmodernism: Understanding Complex Systems. Routledge, London ; New York.

Clegg, S.R., Kornberger, M., Rhodes, C., 2004. Noise, parasites and translation: theory and practice in management consulting. Manag. Learn. 35 (1), 31.

Cleven, A., Winter, R., 2009. Regulatory compliance in information systems research — literature analysis and research agenda. Enterprise, Business-Process and Information Systems Modeling, pp. 174–186.

COSO, 2013. IT Control — Integrated Framework. Executive Summary. The Committee of Sponsoring Organizations of the Treadway Commission (http://www.coso.org/IC.htm).

Cram, A., 2009. Success factors for information systems outsourcing: a meta-analysis. Proceedings of the 15th Americas Conference on Information Systems, 554. San Francisco, California.

Das, T.K., Teng, B.S., 2001. Trust, control, and risk in strategic alliances: an integrated framework. Organ. Stud. 22 (2), 251.

Faraj, S., Sproull, L., 2000. Coordinating expertise in software development teams. Manag. Sci. 46 (12), 1554–1568.

Flyvbjerg, B., Budzier, A., 2011. Why your IT project may be riskier than you think. Harv. Bus. Rev. (http://hbr.org/2011/09/why-your-it-project-may-be-riskier-than-you-think/ar/1).

Gal, U., Lyytinen, K., Yoo, Y., 2008. The dynamics of IT boundary objects, information infrastructures, and organizational identities: the introduction of 3D modeling technologies into the architecture, engineering, and construction industry. Eur. J. Inf. Syst. 17 (3), 290–304.

Gopal, A., Gosain, S., 2010. The role of organizational controls and boundary spanning in software development outsourcing: implications for project performance. Inf. Syst. Res. 21 (4), 960–982.

Hall, J.A., Liedtka, S.L., 2007. The Sarbanes-Oxley act: implications for large-scale IT outsourcing. Commun. ACM 50 (3), 100.

Hartmann, R., Wiener, M., Remus, U., 2011. The amount of control in offshore software development projects: an investigation of twelve projects. System Sciences (HICSS), 44th Hawaii International Conference, pp. 1–10.

Haughey, D., August 30, 2014. Avoiding Project Failure: It's Not Rocket Science Retrieved October 7, 2015, from https://www.projectsmart.co.uk/avoiding-project-failure-its-not-rocket-science.php.

Heiskanen, A., Newman, M., Eklin, M., 2008. Control, trust, power, and the dynamics of information system outsourcing relationships: a process study of contractual software development. J. Strateg. Inf. Syst. 17 (4), 268–286.

Henderson, K., 1991. Flexible sketches and inflexible data bases: Visual communication, conscription devices, and boundary objects in design engineering. Sci. Technol. Hum. Values 16 (4), 448–473.

ISACA, 2012. Cobit 5. https://cobitonline.isaca.org/.

ISAE 3402, 2016. http://www.ifac.org/system/files/downloads/b014-2010-iaasb-handbook-isae-3402.pdf.

Janvrin, D.J., Payne, E.A., Byrnes, P., Schneider, G.P., Curtis, M.B., 2012. The updated COSO IT control — integrated framework: recommendations and opportunities for future research. J. Inf. Syst. 26 (2), 189–213.

Kappelman, L.A., McKeeman, R., Zhang, L., 2006. Early warning signs of IT project failure: The dominant dozen. Inf. Syst. Manag. 23 (4), 31–36.

Kern, T., Willcocks, L., 2000. Exploring information technology outsourcing relationships: theory and practice. J. Strateg. Inf. Syst. 9 (4), 321–350.

Kim, S., Chung, Y.S., 2003. Critical success factors for IS outsourcing implementation from an interorganizational relationship perspective. J. Comput. Inf. Syst. 43 (4), 81–90.

Kirsch, L.S., 1997. Portfolios of control modes and IS project management. Inf. Syst. Res. 8 (3), 215.

Lacity, M., Willcocks, L., 2004. Managing Stakeholder relationships Across Six Phases. In Global Infromation Technology Outsourcing. John Wiley & Sons, pp. 281–310.

Laumann, M., Rosenkranz, C., 2009. Overcoming language barriers for business process and information systems integration — a theoretical model. AMCIS 2009 Proceedings. San Francisco, CA.

Lee, J.-N., 2001. The impact of knowledge sharing, organizational capability and partnership quality on IS outsourcing success. Inf. Manag. 38 (5), 323–335.

Lee, J.-N., Kim, Y.-G., 1999. Effect of partnership quality on IS outsourcing: conceptual framework and empirical validation. J. Manag. Inf. Syst. 15 (4), 29–61.

Leimeister, S., Krcmar, H., 2008. Exploring relationships in information systems outsourcing: a typology of IS outsourcing relationships. In: Oshri, I., Kotlarsky, J., Willcocks, L. (Eds.), Outsourcing global services.

Leonardi, P.M., Huysman, M., Steinfield, C., 2013. Enterprise social media: definition, history, and prospects for the study of social technologies in organizations. J. Comput.-Mediat. Commun. 19 (1), 1–19.

Levina, N., 2005. Collaborating on multiparty information systems development projects: a collective reflection-in-action view. Inf. Syst. Res. 16 (2), 109–130.

Levina, N., Ross, J.W., 2003. From the vendor's perspective: exploring the value proposition in IT outsourcing. MIS Q. 27 (3), 331–364.

Levina, N., Vaast, E., 2005. The emergence of boundary spanning competence in practice: implications for implementation and use of information systems. MIS Q. 29 (2), 335–363.

Lin, C., Pervan, G., McDermid, D., 2007. Issues and recommendations in evaluating and managing the benefits of public sector IS/IT outsourcing. Inf. Technol. People 20 (2), 161–183.

Ngwenyama, O., Sullivan, 2007. Outsourcing contracts as instruments of risk management. J. Enterp. Inf. Manag. 20 (6), 615.

Pavlou, P.A., El Sawy, O.A., 2006. From IT leveraging competence to competitive advantage in turbulent environments: the case of new product development. Inf. Syst. Res. 17 (3), 198.
Pawlowski, S.D., Robey, D., 2004. Bridging user organizations: knowledge brokering and the work of information technology professionals. MIS Q. 28 (4), 645–672.
Rustagi, S., King, W.R., Kirsch, L.J., 2008. Predictors of formal control usage in IT outsourcing partnerships. Inf. Syst. Res. 19 (2), 126–143.
Sabherwal, R., 1999. The role of trust in Outsourced IS development projects. Commun. ACM 42 (2), 80–86.
Sharma, R., Apoorva, S.R., Madireddy, V., Jain, V., 2008. Best practices for communication between client and vendor in IT outsourcing projects. J. Inf. Inf. Technol. Organ. 3.
Star, S.L., 1989. The structure of Ill-structured solutions: boundary objects and heterogeneous distributed problem solving. In: Huhn, M., Gasser, L. (Eds.), Readings in Distributed Artificial Intelligence. Morgan Kaufmann, Menlo Park, CA, pp. 37–54.
Star, S.L., Griesemer, J.R., 1989. Institutional ecology, translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. Soc. Stud. Sci. 19 (3), 387.
Tiwana, A., 2010. Systems development ambidexterity: explaining the complementary and substitutive roles of formal and informal controls. J. Manag. Inf. Syst. 27 (2), 87–126.
Tiwana, A., Keil, M., 2009. Control in internal and outsourced software projects. J. Manag. Inf. Syst. 26 (3), 9–44.
Tuttle, B., Vandervelde, S.D., 2007. An empirical examination of CobiT as an IT control framework for information technology. Int. J. Account. Inf. Syst. 8 (4), 240–263.
Vidal, L.A., Marle, F., 2008. Understanding project complexity: implications on project management. Kybernetes 37 (8), 1094–1110.
Wailgum, T., 2009. 10 Famous ERP Disasters, Dustups and Disappointments. (Retrieved January 19, 2016, from) http://www.cio.com/article/2429865/enterprise-resource-planning/10-famous-erp-disasters–dustups-and-disappointments.html (March 24).
Weiner, M., Remus, U., Heumann, J., Mahrung, M., 2015. The effective promotion of informal control in information systems offshoring projects. Eur. J. Inf. Syst. 24, 569–587.
Willis, G.B., 2005. Cognitive Interviewing: A Tool for Improving Questionnaire Design. Sage Publications.
Willis, M., Sharma, S., Snyder, J., Brown, M., Østerlund, C., Sawyer, S., 2014. Documents and distributed scientific collaboration. Proceedings of the Companion Publication of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing. ACM, New York, NY, USA, pp. 257–260 http://dx.doi.org/10.1145/2556420.2556491.
Xia, W., Lee, G., 2004. Grasping the complexity of IS development projects. Commun. ACM 47 (5), 68–74.
Yakura, E.K., 2002. Charting time: timelines as temporal boundary objects. Acad. Manag. J. 956–970.