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# Alignment within the software development unit: Assessing structural and relational dimensions between developers and testers

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ABSTRACT

Just as business-IT alignment has received significant focus as a strategic concern in the IS literature, it is also important to consider internal alignment between the diverse subunits within the IT organization. This study investigates alignment between developers and testers in software development to understand alignment within the IT unit. Prior evidence of tension between these sub-groups (and others as well) suggests that all is not necessarily well within the IT organization. Misalignment within the IT unit can certainly make it difficult for the IT unit to add strategic value to the organization. This study is an important initial step in investigating IT subunit alignment which can inform future research focusing on the alignment of other IT subunits such as architecture, operations, and customer-support. Using theoretical concepts from strategic business-IT alignment, we test a research model through a survey of professional software developers and testers. Results suggest that relational but not structural dimensions influence IT subunit alignment.



## 1. Introduction

In the past, the primary role of the information technology (IT) manager was to effectively and efficiently manage the functional aspects of the IT organization (Martin, 1982; Miller, 1980). Given our focus on the internal structure of the IT organization, the term unit and subunit will be used herein to refer to the overall IT organization and department levels respectively. From a traditional management-by-objectives perspective, this involved ensuring that the diverse internal subunits of the IT unit were united in terms of goals and coordination of work processes. The subunits comprised teams of requirement analysts, systems analysts, programmers, testers, database designers and computer operators. In a prominent paper from this time period that identified success factors for IT unit management, Miller (1980) noted that the management of IT departments is increasingly mode difficult given the technological and social complexities of information systems. With the advent of personal computing, networks, and the Internet, a new strategic imperative started changing the role of IT management as it grew in importance within the corporate organization. This shift was marked by the advent of the chief information officer (CIO) role that has become diverse in scope and strategic in orientation. New responsibilities, beyond the internal management of the IT unit, have appeared including leading or participating in organizational strategic planning, process improvement, outsourcing management, innovation planning, knowledge management, and others (Chun and

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Mooney, 2009). This shift was also marked by a new focus on the CIO as a member of the top management team and on the CIO's relations and interactions with other business unit leaders in the organization (Armstrong and Sambamurthy, 1999). As such, much of the current alignment research has followed this trend by focusing mainly on the strategic-level business-IT alignment (e.g., Avison et al., 2004; De Haes and Van Grembergen, 2009; Hsiao and Ormerod, 1998; Kearns and Sabherwal, 2007; Newkirk et al., 2008; Tallon, 2007/2008) and showed that business-IT alignment can have beneficial effects for firms (Chan et al., 2006; Cragg et al., 2002; Kearns and Lederer, 2000).

Recent research shows that, even though the focus of the role of the CIO seems to have shifted to a more strategic scope, the tactical aspects of internal IT management are still very important. Chen et al. (2010) show that a supply-side focus, which emphasizes internal management of the IT unit, contributes to the operational performance of the IT function which, in turn, positively impacts strategic business performance. Furthermore, Smaltz et al. (2006) find that important characteristics of CIO success are related to building metrics to show the value of IT, creating strong partnership within and outside of the IT unit, and developing the necessary internal IT skills for the IT unit. While these newer strategic roles and responsibilities related to business-IT alignment are important, we cannot forget that a necessary prerequisite for CIO success is how well the internal workings of the IT unit are managed. A well-aligned IT unit, whose subunits (such as systems development, database management, network operations, and architecture planning) are coherent, integrated, congruent, and in harmony, is essential for ensuring that the IT unit as a whole is able to meet all the emerging strategic responsibilities. In essence, to achieve strategic business-IT alignment and succeed at meeting the strategic goals of the organization, it is critical for the CIO to get the basics right in terms of aligning the inner workings of IT unit.

A recent report by CIO Magazine (2008) highlighted that CIOs are spending an average of 40% of their time with their IT staff, 22% with company executives, 18% with non-IT employees, 11% with IT vendors or service providers, and 9% with external business partners or customers. In the same survey, three of the ten key leadership competencies for CIO success pertained to the inner workings of the IT function: expertise in running the IT function, team leadership, and people development. These findings suggest that while working with the business organization at a strategic level is essential, an equally important part of current CIO's responsibilities still deal with the internal management of the IT subunits. Another study by Luftman and Ben-Zvi (2010) finds that CIOs spend 45% of their time on non-technical internal issues related to alignment as follows, time with: IT staff, 12%; devising strategies, 15%; governance, 10%; and human resources, 8%. The same study stresses the importance of relational components of the CIO's job in working closely with business counterparts to ensure efficient and effective IT operations in order to reduce costs and create new opportunities (Luftman and Ben-Zvi, 2010). To further illustrate the need for empirical research to re-examine the current inner workings of IT, one recent report from CIO Magazine (2007) showed that 29% of CIOs say that they spend the most time on managing crises arising from internal IT subunits.

In contrast to the above practitioner focus, and with a few notable exceptions (e.g., Chen et al., 2010), the management information systems (MIS) research literature has been shifting away from examining issues pertaining to the internal management of the IT unit in order to focus on higher-level business-related topics. As an example, Appendix A offers selected relevant research found in two of the top-rated MIS journals. Appendix A illustrates that prior to 1985, most studies were internally focused on the factors and practices of successfully running the IT unit, followed by the 1990s where more studies were externally focused on interactions of IT with other functional units of the overall business environment. We suggest, therefore, that more studies focusing on IT internal are needed. This study revisits the CIO's current role in managing the internal IT subunits, given the dual role CIOs have in not only ensuring business-IT alignment but also establishing subunit alignment within the IT unit. Because of the complex nature of alignment, Chan (2002) suggests that alignment is more likely to be achieved when the focus is on specific components of alignment rather than on the overall alignment. Similarly, it may be more beneficial to focus on the alignment of individual subunits rather than to directly tackle alignment for the entire IT unit.

IT units typically spend a large portion of their budget on software development and testing which reflects the importance of these activities. Alignment of these two subunits is critical for the success of the IT unit. For example, one report noted that average spending on software development and acquisition consumes a large percentage (20%) of IT operating budgets (Kelly and Siegel, 2008). Software development and acquisition spending represents a larger share of IT budgets, greater than spending on hardware (10%), networking (10%), external service providers (4%), and other categories (12%) (Kelly and Siegel, 2008). Luftman and Ben-Zvi (2010) also find that companies spend 39% of their IT budget on internal staff and 33% on infrastructure. To illustrate the challenges the CIO faces in managing internal IT subunits, the relationship between the development and testing subunits stands out as historically exhibiting substantial tension between these two groups (Cohen et al., 2004). Prior research has found that substantial disruptive relations tend to exist among these internal IT subunits (Ji et al., 2005; Pettichord, 2000; Zhang et al., 2008). The tension arises from developer and tester groups working within the same IT unit and both striving to produce effective software solutions, yet both diverging in their approaches to reaching the overall IT unit goals (Black, 2003). More specifically, both groups play an important role and their cooperation is important in developing software solutions for the company to meet business strategies, yet developers create software functionality and testers point out the functionality flaws in the developers' work (Ammann and Offutt, 2008; Black, 2003). These different roles often lead to antagonistic relationships and animosity between the members of these IT subunits (Cohen et al., 2004; Zhang et al., 2008). As such, our paper focuses on two individual subunits that have to work in tandem to create business value for the organization, and investigates subunit alignment between the development and testing subunits within the IT unit.

Our paper utilizes the salient constructs of the strategic business-IT alignment lens to investigate the inner workings of the IT software development unit, as well as to provide managers with a tool to improve the management of the IT unit, by empirically testing the structural and relational dimensions of alignment through a survey of software development and testing professionals. While our study focuses primarily on only two of the many subunits that can exist in an IT organization, it is our hope that this would be an initial step in investigating the dynamic and complex alignment relationships between all IT subunits. Prior research shows that business-IT alignment leads to tangible benefits for organizations in both cost reduction and revenue growth (Oh and Pinsonneault, 2007). Internal IT subunit alignment can facilitate strategic business-IT alignment. IT subunits are oftentimes not in a natural state of alignment as shown by research on conflict between subunits (Barki and Hartwick, 2001; Cohen et al., 2004; Zhang et al., 2008). IT subunits, however, tend to be diverse and make differing contributions to overall IT unit performance, especially in the case of developers and testers, thus making subunit management a more complex task.

Given the complexities of IT management, it is imperative that IT managers and academic researchers identify more effective and efficient ways to align the diverse and interrelated IT subunits. Resource-based theoretical views of the firm in strategic management (Barney, 1991; Melville et al., 2004) suggest that top management must put together (i.e., align) the appropriate resources that can benefit the firm. This suggests that the diversity of resources (i.e., subunits) making up the IT unit have to be aligned together to achieve optimal benefits to the organization. It is argued that if the IT subunits are not well aligned, the overall IT unit will have difficulty executing the higher-level strategic IT plans necessary for meeting the organization's strategic goals. An IT unit characterized by subunit misalignment cannot support business strategies effectively or efficiently. As we will argue in the next section, concepts from the strategic business-IT alignment literature can be usefully applied to study the inner workings of the IT unit per se. The strategic business-IT alignment literature has defined several relational dimensions (e.g., shared understating, partnerships, and competencies) as well as several structural dimensions (e.g., measurements/standards, governance, and process/architecture) needed to ensure proper overall alignment (Avison et al., 2004; Luftman and Kempaiah, 2007; Preston and Karahanna, 2009a; Reich and Benbasat, 2000). As such, the research question addressed in this study is: *how do the structural and relational dimensions of internal IT alignment influence overall subunit alignment?*

This article is organized as follows. The next section provides an overview of the alignment literature and discusses the unique nature of alignment in the within-IT unit context. We then introduce an Integrated Model of Alignment within the IT unit adapted from Luftman and Kempaiah (2007), which serves as the theoretical underpinning of this study. Subsequently, we advance an interrelated set of hypotheses designed to test the model. Next, the research methodology and results are presented. The article concludes with a discussion of the findings, as well as implications for theory and practice.

## 2. Hypothesis development

### *2.1. IT unit management*

Factors related to the internal management of IT have been studied since the 1970s. Research identified critical success factors for IT management (e.g., Henderson and Sifonis, 1988; Martin, 1982; Miller, 1980), governance structures for IT management (e.g., Brown, 1997; Sambamurthy and Zmud, 1999) and contingencies that influence the internal environment of IT (e.g., Lederer and Mendelow, 1987; Sambamurthy and Zmud, 1999; Wetherbe and Whitehead, 1977). This study suggests that the inner workings of the IT unit also merit scholarly attention. This study seeks to extend these dialogs by applying theoretical concepts from the strategic business-IT alignment literature to the internal environment of the IT unit showing that the alignment lens can be a useful approach to the investigation of the internal dynamics of the IT unit. The paper builds on the finding of Segars and Grover (1998) stating that alignment is an important antecedent of MIS success and examines internal IT management to investigate how alignment concepts can be applied to relations among subunits of the IT unit.

### *2.2. Strategic business-IT alignment*

Strategic business-IT alignment arises when the business goals and activities of an organization are in harmony with the information systems that support them (McKeen and Smith, 2003). Strategic business-IT alignment evolves along with the organizational model used by the business (Agarwal and Sambamurthy, 2002) in order for IT to support and enable the business strategy (Henderson and Venkatraman, 1993; Luftman and Kempaiah, 2007; Venkatraman, 1989). Business-IT alignment has been a top CIO interest for the past decade (Luftman and Kempaiah, 2007). High-level strategic alignment, where a strong fit occurs between business and IT strategy leads to superior corporate performance compared to the case where there is a weak fit between business and IT strategy, (Oh and Pinsonneault, 2007). Alignment has been decomposed and investigated using distinct perspectives – intellectual, structural, social, or relational (Reich and Benbasat, 2000). The intellectual or structural perspective tends to focus on aspects such as alignment of infrastructures and processes (e.g., Henderson and Venkatraman, 1993), alignment of strategies (e.g., Chan et al., 1997; Henderson and Venkatraman, 1993; Luftman and Brier, 1999; Sabherwal and Chan, 2001; Sabherwal and Kirs, 1994; Tallon et al., 2000), alignment of skills (Bassellier and Benbasat, 2004; Roepke et al., 2000), and alignment of missions and plans (e.g., Hirschheim and Sabherwal, 2001; Lederer and Mendelow, 1987; Lyles, 1979; Reich and Benbasat, 1996). The social or relational perspective tends to focus on the interactions, shared knowledge and shared understanding among the business and IT partners (e.g., Chan, 2002; Nelson and Cooprider, 1996; Preston and Karahanna, 2009a; Reich and Benbasat, 1996, 2000).

Empirical research indicates that both the structural and relational dimensions are important for achieving high levels of alignment (Luftman and Kempaiah, 2007; Reich and Benbasat, 2000). Other research focuses on the importance of relational and informal structural alignment for overall business-IT alignment (Gosh and Scott, 2009; Preston and Karahanna, 2009a,b) and shows that this type of alignment has become more important than formal structural alignment given today's organizational need for flexibility and adaptability (Chan, 2002). The evolution of the strategic business-IT alignment research began with studies focused on the structural aspects of the phenomenon, and moved on, in more recent studies, to the relational or social aspects of alignment such as shared meaning and understanding, demographic and experiential similarity, as well as partnership between units (Luftman and Kempaiah, 2007; Preston and Karahanna, 2009a). Additionally, much of the early research in the area has been conceptual, with few empirical studies investigating alignment and the relationships among its components (e.g. Chan, 2002; Chan et al., 2006).

Literature on strategic business-IT alignment has identified a host of antecedents to alignment that are related to structural and relational dimensions. The relational antecedents include: shared understanding, shared learning, experiential and demographic similarity, and learning opportunities (Preston and Karahanna, 2009a); as well as communication, value, and partnership (Luftman and Kempaiah, 2007). The structural antecedents include: governance structure; scope; processes; measurements and standards; and the architectures, tools and infrastructures that units employ to accomplish their mission (Brown and Magill, 1994; Chan, 2002; Henderson and Venkatraman, 1993; Luftman and Kempaiah, 2007).

### *2.3. Internal IT subunit alignment*

Prior research on strategic business-IT alignment lacks full consideration of the alignment of groups within the IT unit and often assumes that the various functional units that make up the total IT unit are appropriately aligned with each other. Internal alignment of IT subunits is not always a given as research has found that substantial misalignments tend to exist among internal subunits of IT (Cohen et al., 2004; Ji et al., 2005; Pettichord, 2000; Zhang et al., 2008). Business-IT alignment is built on IT subunit alignment (see Fig. 1), yet oftentimes IT subunits are not in a natural state of alignment. Research studies examining subunit alignment find that conflict between subunits has detrimental impacts on IT performance (Cohen et al., 2004; Zhang et al., 2008). As an example, consider the case of an IT unit that is responsible for business systems development. Several IT subunits have to work cooperatively for the overall success. These usually include subunits for requirements gathering, systems analysis and design, database design, architecture, programming, and testing. All these subunits need aligned goals and operations in order to deliver software applications that meet business needs. Thus, in order to ensure business-IT alignment (Level 1 in Fig. 1), IT managers and academic researchers need to find ways to improve IT subunit alignment (Level 2 in Fig. 1).

Chan (2002) proposes that IT alignment "is not a uni-dimensional phenomenon but a superset of multiple, simultaneous component alignments that bring together an organization's structure, strategy, and culture at multiple (IT, business unit, and corporate) levels" (p. 99). Accordingly, our study proposes a multi-level framework of alignment, and focuses specifically on the tactical, internal alignment between IT subunits. Level 1, business-IT alignment has been the focus of much prior research (e.g., Brown and Magill, 1994; Chan et al., 2006; Henderson and Venkatraman, 1993; Luftman and Brier, 1999; Luftman and Kempaiah, 2007; Preston and Karahanna, 2009a; Reich and Benbasat, 2000; Sabherwal and Kirs, 1994). Level 2, subunit alignment has not received as much attention in recent years, even though IT operations were the focus of many studies years ago (e.g., Miller, 1980; Martin, 1982; Pyburn, 1983; Wetherbe and Whitehead, 1977). Level 2 alignment can be complex given the different subunits that comprise an IT unit. At this level, the subunits of the IT unit can be grouped under some general categories such as administration, infrastructure and application services, strategic or tactical IT subunits and central vs. distributed IT services. While these groupings can be a useful tool for analysis, this study focuses on two individual subunits at the more tactical Level 2 alignment in order to examine how the structural and relational

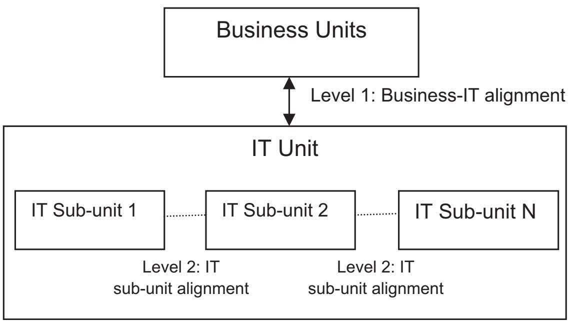


**Fig. 1.** Levels of alignment.

dimensions of internal IT alignment influence overall subunit alignment. This study revisits the inner workings of the IT unit using an alignment lens and provides a more granular view of the interaction between IT subunits.

We define alignment among the IT subunits as the congruence between the subunits along several relational and structural dimensions. Fig. 2 illustrates a conceptual delineation of the specific relational and structural dimensions from the established literature on strategic business-IT alignment (Luftman and Kempaiah, 2007) adapted to the IT subunit context. This model comprises relational and structural dimensions of alignment and serves as the basis for the hypotheses that were empirically tested.

Shared understanding, partnership, and competencies are considered relational dimensions and Preston and Karahanna (2009a) and Luftman and Kempaiah (2007) consider them to be part of the social antecedents of alignment between the business and IT units. The antecedents of business-IT alignment may be used to measure the drivers of IT subunit alignment. For example, shared understanding includes the social aspects of employee relationships; partnership measures the rapport between subunits and their interaction including issues of trust, shared goals, and values; while competencies measure ideas of management style, cultural locus of power, and the interpersonal environment which are all part of subunit relationships (Silva, 2007). Measurements/standards are considered a structural dimension as Luftman and Kempaiah (2007) use a similar construct labeled 'Value' as an antecedent to business-IT alignment. Applied to the IT subunit level Value deals with the metrics used to quantify the performance output of a subunit and its relative contribution to other subunit's output (Bannister, 2001). Henderson and Venkatraman (1993) as well as Reich and Benbasat (2000) consider governance and processes/architecture to be part of the structural dimension of strategic business-IT alignment. At the IT subunit level, governance refers to subunit organization of resources, plans, and processes while processes/architectures refer to structuring of the technical aspects of how the processes, standards, architectures, tools, and techniques are employed by the subunits.

The early literature in strategic business-IT alignment focused on the structural components of alignment (e.g., Henderson and Venkatraman, 1993; Hirschheim and Sabherwal, 2001; Sabherwal and Chan, 2001; Sabherwal and Kirs, 1994; Tallon et al., 2000). Later the relational components of strategic business-IT alignment were also found to be important (Chan, 2002; Preston and Karahanna, 2009a; Reich and Benbasat, 2000). Given this history, our research examines the relative balance and contribution of the two dimensions as they both influence IT subunit alignment. We seek to understand if this profile of the dimensions of strategic business-IT alignment is also applicable to the internal dynamics within the IT unit. The first three hypotheses presented below are related to the relational dimensions of subunit alignment while the last three are related to the structural dimensions of subunit alignment.

The first relational dimension of our Integrated Research Model of Alignment within the IT unit (see Fig. 3) is shared understanding which is based on the work by Preston and Karahanna (2009a) at the business-IT level. Following Preston and Karahanna (2009a), we define shared understanding as "the degree of shared cognition" between two subunits regarding their respective roles and responsibilities within the IT unit. Shared understanding includes, among other things, the effectiveness in the exchange of ideas and knowledge among IT subunits, enabling both to understand each other's strategies, plans, environments, risks, priorities, and how to achieve the stated goals. Both the existence and the effectiveness of communication mechanisms (e.g., formal meetings, informal exchanges, newsletters and bulletin boards) are needed to

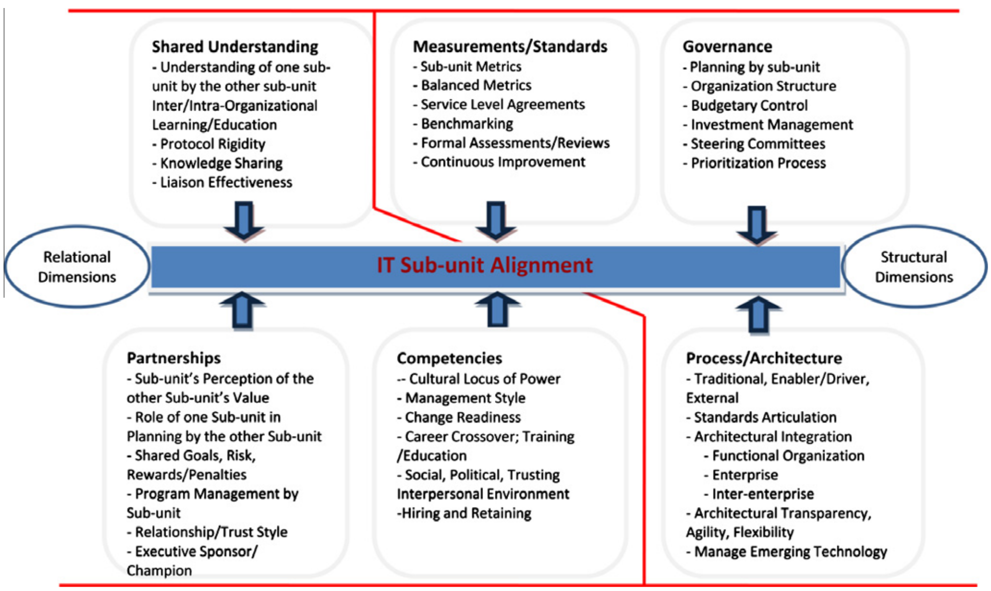


**Fig. 2.** Integrated Model of Alignment within the IT unit (adapted from Luftman and Kempaiah (2007)).

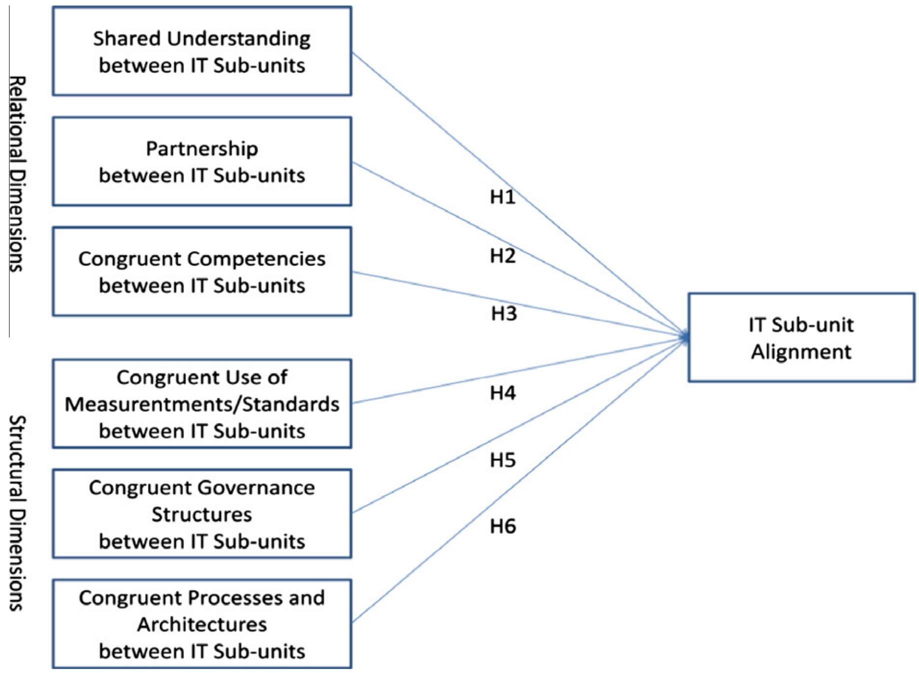


**Fig. 3.** Research Model of Alignment within the IT Unit.

foster shared understanding between subunits. Shared understanding between groups or subunits has been shown to facilitate the setting of common goals, improve communication, coherence, and coordination, and has also proven to be an important antecedent of business-IT alignment (Armstrong and Sambamurthy, 1999; Chan, 2002; Preston and Karahanna, 2009a; Reich and Benbasat, 2000).

To successfully develop software solutions that support business strategic goals, usually one IT subunit collects the business requirements and creates the use cases that delineate the features and functionality of the IT system; another IT subunit transforms those requirements and use cases into conceptual models such as entity-relationship diagrams, flow charts, and process configurations; and a different IT subunit converts the models into programmed software modules, which another IT subunit then validates and verifies (Pressman, 2005). The overall software development process with its various hand-offs between IT subunits runs better with a shared understanding among these groups as to subunit roles and responsibility as well as their goals and contributions to the overall software development project. For example, if those creating the requirements understand how the documents will be used later in the process, then they can make sure to include vital content that might be needed later in the software development process. Similarly, in Waterfall as well as Agile development environments, developers and testers working together in a common team also require a shared understanding of various aspects of the task even though they may be part of different subunits. Therefore we posit:

**H1.** *Shared understanding between subunits of the IT unit will positively influence alignment between them.*

Partnership is the subunit's role in defining the strategies of its partner subunits, the degree of trust between the subunits, and the degree of commonality between the initiatives of the two subunits (Luftman and Kempaiah, 2007). When individual groups jointly work on defining their strategies, this fosters the building of shared goals and plans and helps improve the level of trust among the individuals of the respective subunits. This means that everyone is working for the same outcomes. Trust between subunits, as well as shared goals and plans have been shown to positively influence business-IT alignment (Armstrong and Sambamurthy, 1999; Chan, 2002; Nelson and Cooprider, 1996), and it is anticipated that they will work at the IT subunit level in similar ways.

In the software development process, for example, subunits may finish their activities and then hand the output off without considering the effects on downstream units; this practice may not lead to the highest quality outcomes. Given that testing groups work on code written by development groups and defects are returned to developers for fixing, subunits need to consider how the product of their activity fits with other subunits activities (Hutcheson, 2003). Specifically, those creating system design specifications need to convey what information they need from the up-stream subunits, as well as know what downstream subunits need later in the process in order to ensure the designs are complete and usable. The more subunits are involved with each other in establishing their common strategies, goals, and objectives, the more they understand how their role fits within the entire process. This close interaction also creates trust among the subunits for gathering needed information. Close partnership and participation of one subunit in another subunit's activities can further foster a better understanding of common needs and operating procedures (Preston and Karahanna, 2009a). This in turn leads to better hand-off procedures between subunits and better subunit output that is customized to another subunit's requirements. Thus, partnership and participation of one unit in the other unit's decision making processes will positively influence the level of subunit alignment. Thus we posit:

**H2.** *Partnership between subunits of the IT unit will positively influence the level of alignment between them.*

Competencies pertain to facets of human resources, e.g., hiring, retention, training, performance feedback, encouraging innovation and career opportunities, and developing skills; which contribute to a readiness for change, capability for learning, and leveraging of new ideas (Peppard et al., 2000). Preston and Karahanna (2009a) find that similar and complementary skill sets foster alignment. To build such similar and complementary skill sets, IT subunits can employ mutually adjustable policies for hiring and cross-training. In addition, Roepke et al. (2000) show that management style and leadership in regard to human resource development can have a positive influence on alignment. Similarly, the management style and leadership of the IT subunits that foster a similar and complimentary subunit skill set will help strengthen the alignment between the subunits.

In the case of software development and testing, prior research has shown that testers tend to have significantly lower skills and confidence than developers (Zhang et al., 2008). Very often this is a result of developers taking on the challenge of creating functionality in software code while testers perform routine error-finding activities (Black, 2003; Pressman, 2005). Given the close interaction between developers and testers in the overall development process, these two units need a congruent set of skills which allows them to synchronize their work and support each other's efforts (Black, 2003). Testers need to be as technically proficient as developers (if not more) to be able to provide quality checking services for developers. Given the importance of congruent skill sets in the software development process, we posit that having such congruent skills will increase the level of alignment between the subunits of an IT unit:

**H3.** *Congruent competencies between subunits of the IT unit will positively influence the level of alignment between them.*

The first structural dimension of our Integrated Model of Alignment within the IT unit model is measurements/standards. The availability of defined measures and standards facilitates alignment by clarifying the reciprocal value contribution of each subunit (Luftman and Kempaiah, 2007). Relative metrics that are clearly understood and accessible by other subunits facilitate a better appreciation and understanding of the relative contribution of each subunit. Measurements/standards that emphasize metrics about different aspects of subunit performance help demonstrate the relative contributions of the IT subunits. The use of metric-based processes such as benchmarking, formal assessments/reviews and continuous improvement, helps foster subunit alignment (Luftman and Kempaiah, 2007; Tallon et al., 2000). Mutually accepted metrics regarding the level of services provided also support a better understanding of the mission of each group and of their responsibilities.

Measurements/standards play an important role in the operation of IT subunits by providing a set of mutually accepted expectations (Luftman and Kempaiah, 2008). For example, in some organizations code written by developers must meet pre-established coverage ratios before the testing group can begin integration testing. Typically, these coverage ratios are specified and accepted by both subunits to indicate the code's readiness for hand off from the development group to the testing group (Pressman, 2005). Also, common measures are required to assess the relative contribution of each subunit (Luftman and Kempaiah, 2008). Proper and commonly accepted measurements/standards act as "quality gates" between the subunits. Quality gates ensure the product being transferred from one subunit to another meets the specifications needed by the next-in-line subunit to efficiently and effectively complete its tasks (Dahmer et al., 2010). Thus we posit:

**H4.** *The use of measurements/standards between subunits of the IT unit will positively influence the level of alignment between them.*

Governance reflects who has the authority to make IT decisions and what structures are used at strategic, tactical, and operational levels to set priorities and allocate resources. Governance also reflects the internal structure of the subunits such as centralized versus decentralized or flat versus hierarchical reporting structures. The governance structure by which internal groups are organized should be congruent among the groups in order to achieve alignment (Brown and Magill, 1994; Chan, 2002; Henderson and Venkatraman, 1993). Governance should provide adequate structures and processes that are used for organizing and controlling functional units in such a way that there is a harmonious interaction among them (Duane and Finnegan, 2003). As a result of congruent governance structures, subunits are in a better position to share limited organizational resources and to allocate those resources in a way that supports the mission of each individual subunit and of the IT unit as a whole.

IT departments of large organizations typically comprise smaller subunits organized according to local needs and environments with some subunits being relatively bigger than others (Brown, 1997). Larger subunits tend to be more centralized and hierarchical, whereas smaller ones tend to be more decentralized and flat (Litterer, 1980; Sexton, 1970). Problems can arise when subunits with different governance structures interact. For example, some software development subunits comprise development groups that are larger and more centralized and hierarchical than their testing group counterparts (Page et al., 2009). As a result, junior testers may find it difficult to report defects found in code created by senior developers. Such misalignments can lead to poor communications between the subunits, where the seriousness of defects found is not properly communicated due to the reluctance of junior testers to confront senior developers (Page et al., 2009). Thus we posit:

**H5.** *Congruent governance structures between subunits of the IT unit will positively influence the level of alignment between them.*

Process/architecture is the provision of flexible infrastructures, application of emerging technologies, enablement of process changes, and delivery of solutions to other units within the business or within IT. The tools, techniques, processes and architectures used by the various groups that make up the IT unit must be well integrated to allow the seamless and efficient activity of the IT unit to achieve its business goals (Henderson and Venkatraman, 1993; Luftman and Kempaiah, 2007; Slaughter et al., 2006; Tallon, 2007/2008). The creation of a transparent and integrated infrastructure on which individual subunits can build and use customized applications that work seamlessly with the applications of other subunits, will help foster better application integration between subunits and thus make their interaction activities more efficient and effective. Similar and complementary processes amongst the IT subunits improve the shared mindset, shared knowledge and shared understanding of the individuals belonging to each subunit, which, in turn fosters alignment (Preston and Karahanna, 2009a).

An important issue facing software development in companies is the availability of common platforms and processes for undertaking code writing and testing (Black, 2003; Pressman, 2005). Some IT organizations are working towards securing enterprise architectures as a common platform that facilitates the integration of their internal IT subunits. With a common enterprise architecture, processes can be integrated and thus foster the efficient movement of activities along the software development process. Congruent processes and architectures for an entire IT unit provide a foundation for the activities of all IT subunits to take place. All subunits can use the same established processes and architectures, with customizations limited to specific needs. As a result, the entire IT unit would be operating under the same constraints and assumptions leading to greater alignment between the IT subunits. Therefore we posit:

**H6.** *Congruent processes and architectures between subunits of the IT unit will positively influence the level of alignment between them.*

## 3. Research methodology and results

We empirically test our research model by investigating structural and relational factors of internal IT alignment as compared across development and testing subunits. To achieve this purpose, the survey method presented the most effective approach. The sample, procedure, measures, and analysis are presented next.

### 3.1. Sample and procedure

The survey consisted of questions capturing the seven constructs in the research model (Fig. 2). A total of 1516 emails soliciting participation in the research were sent to software developers and testers who worked for US corporations. This particular survey was administered as a nationally-available online survey using surveymonkey.com. The sample frame was a combined set of testing and development professionals from professional online lists and organizational contacts from testing and development subunits. A total of 152 usable responses were received, representing a response rate of 10.03%. Of the total respondents, 143 (94.08%) were full-time employees while 9 (5.92%) were contract employees. Table 1 shows the demographic profile of participants who provided usable responses in this survey. An important control variable that can potentially influence perceptions of alignment is the size of the IT organization. We conducted a $\chi^2$ difference test to investigate if the perceptions of alignment differ based on the size of the IT organization, and found no significant difference

**Table 1**
Profile of respondents.

| Demographic variables | Category | Frequency ($n$ = 152) | |
|---|---|---|---|
| | | Testing subunit | Development subunit |
| Number of respondents | | 74 | 78 |
| Total employees in their subunit at their organization | 0–10 | 80 | 68 |
| | 11–20 | 13 | 15 |
| | 21–40 | 15 | 15 |
| | 41–100 | 18 | 20 |
| | 101–200 | 11 | 9 |
| | 201+ | 15 | 25 |

*Note*: Table 1 shows the breakdown of test and development subunit employee respondents. A $\chi^2$ test revealed no significant difference between the groups regarding their perceptions of alignment ($\chi^2$ = 2.4, sig. = .88). Hence, the two groups will be combined for further analysis.

between the organizational size categories presented in Table 1. Thus control variables were not included in subsequent analyses.

### 3.2. Measures

Special emphasis was placed on the operationalization of the constructs in the research model. A comprehensive review of the literature was undertaken to identify existing measures. Where validated scales did not exist, new items were created. All constructs were measured using multi-item scales. Appendix B provides the definition of each construct and the measures used grouped by construct. Most of the items were adapted from Luftman and Kempaiah (2007) and Preston and Karahanna (2009a). The survey was validated as follows: first with semi-structured interviews with development and testing professionals to assess content validity, second with an item-sorting exercise to evaluate discriminant validity, and third with a statistical analysis of the psychometric properties. We tried to minimize non-response bias by carefully designing the survey. Following guidelines proposed by Rogelberg and Stanton (2007), we assessed the face validity of the survey questions through walkthroughs with industry professionals and academics to make sure each item was readable and understandable. Items that were not readable or were deemed redundant were dropped from the study. The remaining items were piloted with additional industry professionals and academics to further ensure the face validity and quality of the survey questions. Minor changes to some items were made. In addition, the instructions included in our survey communicated to respondents the importance of their participation and assured them anonymity (Rogelberg and Stanton, 2007). Finally, the survey was emailed to participating organizations.

### 3.3. Data analysis

To establish the nomological validity of the research model, we chose partial least squares (PLS) (Barclay et al., 1995). The psychometric properties of all measures were assessed within the context of the structural model through the assessment of convergent and discriminant validity and reliability. In PLS, statistical significance was determined using two-tailed tests based on the bootstrap re-sampling method with 500 samples.

The psychometric properties of the measurement model were confirmed prior to examining structural model parameters (Anderson and Gerbing, 1988). To confirm sound psychometric properties, the convergent and discriminant validity (via item loading), as well as the reliability and internal consistency (via Cronbach's Alpha) of the measures were established (Gefen and Straub, 2005). All constructs were reflectively modeled. The psychometric properties of the measures were assessed in terms of item loadings, internal consistency, and discriminant validity (see Tables 2–4). Item loadings and internal consistencies or reliabilities must be greater than .70 to be considered acceptable (Fornell and Larker, 1981; Nunally, 1979). As can be observed from the factor loadings in Table 3 and reliability scores in Table 2, measures used in this study meet the acceptable guidelines for loadings of items on their respective construct as well as for the reliability of the items. While our factor structure exhibits some cross-loadings between the factors, the analysis of the average variance extracted indicates discriminant validity. Given that our measures are theory driven and based on prior research, we deemed these cross-loading items sufficiently stable and relevant to the construct and therefore suitable for inclusion to support the overall theoretical interpretability of the model. To further insure that cross-loadings between our antecedent constructs do not interfere with the correct statistical interpretation of our results and given the substantial number of antecedent variables present in our model, we conducted an analysis of multicollinearity. For this analysis, we calculated variance inflating factors (VIF) for each antecedent variable and the results indicated that multicollinearity is not present in our model since all VIF scores for the antecedents were below 2, which is well within the accepted threshold of 3.3 (Diamantopoulos and Siguaw, 2006). Also, given our reliance on single respondents, common method bias may influence the validity of the results of our data analysis. To control potential common method bias, we assured our respondents of the anonymity of their responses and ensured readability by reducing vagueness in our measurement items by conducting pilot tests and face validity checks (Podsakoff et al., 2003). Further, in order to check for common

**Table 2**
Descriptive statistics of variables.

| Study variables | Reliability (number of items) | Mean | Std. Dev. |
|---|---|---|---|
| *Exogenous constructs* | | | |
| Competencies | 0.86 (4) | 3.96 | 1.02 |
| Shared understanding | 0.93 (4) | 3.61 | 1.17 |
| Governance | 0.85 (3) | 3.52 | 1.01 |
| Measurements/standards | 0.90 (5) | 3.71 | .87 |
| Partnerships | 0.87 (2) | 3.42 | 1.06 |
| Process/architecture | 0.89 (5) | 3.49 | 1.15 |
| *Endogenous constructs* | | | |
| IT subunit alignment | 0.90 (4) | 3.70 | 1.21 |

**Table 3**
Factor loadings and cross-loadings.

| | Governance | Partnership | IT subunit alignment | Process/ architecture | Competencies | Shared understanding | Measurements/ standards |
|---|---|---|---|---|---|---|---|
| Governance1 | **0.89** | 0.23 | 0.29 | 0.30 | 0.39 | 0.34 | 0.57 |
| Governance2 | **0.83** | 0.29 | 0.37 | 0.37 | 0.36 | 0.29 | 0.49 |
| Governance3 | **0.66** | 0.23 | 0.23 | 0.11 | 0.24 | 0.27 | 0.46 |
| Partnership1 | 0.20 | **0.89** | 0.57 | 0.37 | 0.54 | 0.55 | 0.13 |
| Partnership2 | 0.36 | **0.86** | 0.49 | 0.42 | 0.54 | 0.47 | 0.38 |
| Alignment1 | 0.27 | 0.46 | **0.70** | 0.40 | 0.42 | 0.62 | 0.34 |
| Alignment3 | 0.31 | 0.52 | **0.89** | 0.40 | 0.65 | 0.57 | 0.43 |
| Alignment3 | 0.32 | 0.56 | **0.92** | 0.44 | 0.58 | 0.56 | 0.36 |
| Alignment4 | 0.37 | 0.49 | **0.85** | 0.37 | 0.58 | 0.49 | 0.38 |
| Process/Architecture1 | 0.26 | 0.37 | 0.35 | **0.72** | 0.37 | 0.23 | 0.27 |
| Process/Architecture2 | 0.21 | 0.33 | 0.25 | **0.76** | 0.38 | 0.23 | 0.25 |
| Process/Architecture3 | 0.25 | 0.39 | 0.39 | **0.86** | 0.46 | 0.34 | 0.31 |
| Process/Architecture4 | 0.30 | 0.27 | 0.34 | **0.80** | 0.44 | 0.24 | 0.42 |
| Process/Architecture5 | 0.30 | 0.38 | 0.48 | **0.79** | 0.40 | 0.34 | 0.34 |
| Competencies1 | 0.39 | 0.65 | 0.64 | 0.39 | **0.78** | 0.58 | 0.39 |
| Competencies2 | 0.35 | 0.49 | 0.54 | 0.40 | **0.82** | 0.40 | 0.47 |
| Competencies3 | 0.34 | 0.27 | 0.43 | 0.41 | **0.75** | 0.25 | 0.38 |
| Competencies4 | 0.16 | 0.45 | 0.41 | 0.46 | **0.78** | 0.37 | 0.22 |
| SharedUnderstanding1 | 0.31 | 0.57 | 0.65 | 0.36 | 0.52 | **0.90** | 0.31 |
| SharedUnderstanding2 | 0.27 | 0.48 | 0.53 | 0.23 | 0.42 | **0.89** | 0.28 |
| SharedUnderstanding3 | 0.35 | 0.52 | 0.56 | 0.36 | 0.44 | **0.90** | 0.34 |
| SharedUnderstanding4 | 0.37 | 0.48 | 0.58 | 0.32 | 0.49 | **0.83** | 0.40 |
| Measurement/Standards1 | 0.51 | 0.24 | 0.41 | 0.25 | 0.33 | 0.36 | **0.76** |
| Measurement/Standards2 | 0.56 | 0.32 | 0.46 | 0.32 | 0.47 | 0.40 | **0.88** |
| Measurement/Standards3 | 0.47 | 0.24 | 0.35 | 0.37 | 0.42 | 0.30 | **0.83** |
| Measurement/Standards3 | 0.49 | 0.14 | 0.30 | 0.37 | 0.39 | 0.19 | **0.82** |
| Measurement/Standards4 | 0.48 | 0.09 | 0.20 | 0.42 | 0.25 | 0.19 | **0.75** |

**Table 4**
Intercorrelations among study variables.

| | Competencies | IT subunit alignment | Governance | Measurements/ standards | Partnerships | Process/ architecture | Shared understanding |
|---|---|---|---|---|---|---|---|
| Competencies | **0.78** | | | | | | |
| IT subunit alignment | 0.66 | **0.84** | | | | | |
| Governance | 0.41 | 0.37 | **0.81** | | | | |
| Measurement/standards | 0.47 | 0.45 | 0.62 | **0.81** | | | |
| Partnerships | 0.61 | 0.60 | 0.32 | 0.28 | **0.87** | | |
| Process/architecture | 0.52 | 0.48 | 0.34 | 0.41 | 0.45 | **0.78** | |
| Shared understanding | 0.53 | 0.66 | 0.37 | 0.38 | 0.58 | 0.36 | **0.88** |

*Notes*: Pearson correlation coefficients are reported with coefficients >0.20 significant at $p < 0.01$; >0.15 significant at $p < 0.05$; The square root of the average variance extracted is in bold.

method bias after data collection, we conducted a common method bias test, by employing Harman's one factor method (Podsakoff et al., 2003). Using all of the items in our survey in an exploratory factor analysis, we examined the un-rotated factor solution for the number of factors with Eigen-value greater than one and for the variance explained by the first extracted factor. Our factor analysis extracted seven individual factors with Eigen-values larger than one. The first factor extracted from the factor analysis explained 37% of the variance in all the items used for our survey. These results indicate that common method bias is not a threat in our dataset (Malhotra et al., 2006). Finally, given our relatively low response rate we checked for non-response bias by comparing early and late respondents since late respondents are more likely to be similar to non-respondents than early respondents (Armstrong and Overton, 1977). We split the data on responses received during the first half of the survey period and responses received during the second half. We then compared the differences between the two groups on the constructs of interest and found no significant differences between the late and early respondents. Thus, we conclude that significant common method and non-respondent bias were not problems in our dataset.

Convergent validity was examined at the individual measurement level as discussed above and also at the construct level. Average variance extracted (AVE) was utilized to assess convergent validity at the construct level (Fornell and Larker, 1981). Referring to Table 4, all AVEs surpassed the recommended .50 threshold (Nunally, 1979). Hence, each measure demonstrated convergent validity at the individual item and construct levels.

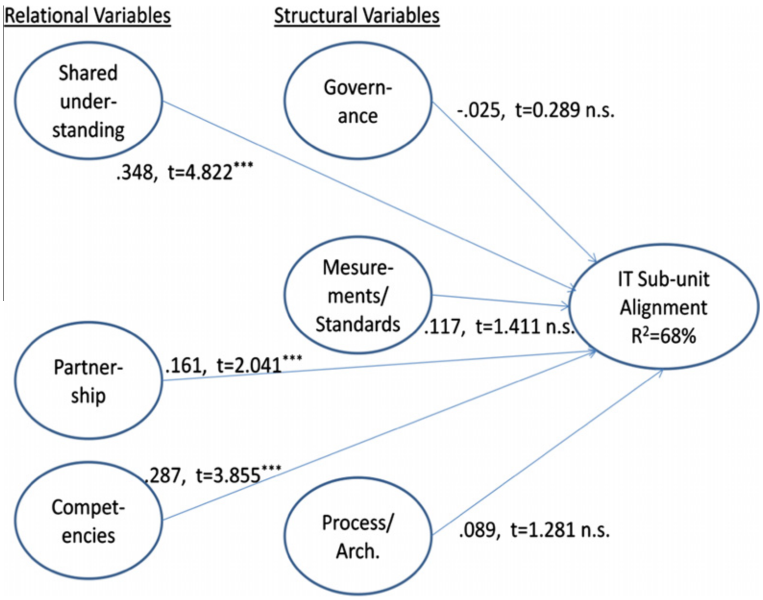


**Fig. 4.** PLS results. *Notes*: All constructs are modeled with reflective indicators; magnitude of the path coefficients are displayed. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$.

**Table 5**
Summary of findings.

| Significant paths are | Statistics |
|---|---|
| Shared understanding → IT subunit alignment | $\beta = .348$, $t = 4.822$ |
| Partnerships → IT subunit alignment | $\beta = .161$, $t = 2.040$ |
| Competencies → IT subunit alignment | $\beta = .287$, $t = 3.855$ |
| *Non-significant paths are* | |
| Measurements/standards → IT subunit alignment | $\beta = .117$, $t = 1.410$ |
| Governance → IT subunit alignment | $\beta = -.025$, $t = 0.288$ |
| Process/architecture → IT subunit alignment | $\beta = .089$, $t = 1.281$ |

Discriminant validity was assessed by comparing the square root of the AVE associated with each construct to the correlations among constructs (Fornell and Larker, 1981). In order to claim discriminant validity, the square root of the AVE associated with a particular construct must be greater than its correlations with other constructs (Fornell and Larker, 1981). According to the estimates provided in Table 4, each construct, sufficiently differed from the other constructs and therefore, the measures demonstrated discriminant validity. Combining the strong evidence for convergent and discriminant validity, the measurement model was deemed acceptable.

### 3.4. Structural model analysis

The results of the structural model analysis with path coefficients and explained variance are illustrated in Fig. 4. The demographic variables from Table 1 were examined as potential control variables prior to testing the hypothesized relationships by regressing the IT subunit alignment construct on each demographic variable separately resulting in no significant relationships. Thus, none of the demographic variables were included as control variables in all remaining analyses.

In testing the research model, confirming expectations, the relational dimension constructs of shared understanding, partnerships, and competencies were all found to be significant predictors of IT subunit alignment ($\beta = .348$, $p < .01$; $\beta = .161$, $p < .01$; $\beta = .287$, $p < .01$; respectively), supporting hypotheses H1, H2, and H3. The structural dimension constructs of governance, measurements/standards, and process/architecture were not found to be significant predictors of IT subunit alignment ($\beta = -.025$, $p$ = n.s.; $\beta = .117$, $p$ = n.s.; and $\beta = .089$, $p$ = n.s.; respectively), failing to support hypotheses H4, H5, and H6. The relational constructs of shared understanding, partnerships, and competencies explain 68% of the variance in IT subunit alignment. Table 5 summarizes these results.

## 4. Discussion

This study examined the perceptions of IT professionals about alignment between IT subunits. It specifically focused on the alignment between the development and testing subunits in software development which is a core responsibility of the IT organization. Most importantly, it examined relational and structural dimensions of subunit alignment. We used pertinent concepts from relevant research to develop and test a hypothesized research model based on prior theories of strategic business-IT alignment.

With respect to relational dimensions, our results illustrate that shared understanding between IT subunits is a strong predictor of subunit alignment. This suggests that managerial efforts designed to facilitate the exchange of ideas and knowledge between two IT subunits will help foster congruence in relation to strategies, plans, risks, and priorities. Lateral communication and liaison mechanisms for IT professionals working in diverse IT subunits are important to ensure that they share a common view on how resources are allocated, overall IT priorities are established, and the relative roles of each subunit are communicated. This finding is consistent with prior studies of strategic business-IT alignment that also found shared understanding as an important predictor of alignment (Preston and Karahanna, 2009a; Reich and Benbasat, 2000).

Our analysis also found that the partnership between IT subunits is a significant predictor of IT subunit alignment. This suggests that common participation in joint efforts fosters a strong sense of trust between IT subunits which helps ensure that they are aligned. In addition, partnership between subunits in areas of planning, goal setting and specifying objectives allows the subunits to manage resources efficiently and to better schedule specific activities. This facilitates a closer understanding between the subunits regarding resource base, specific capabilities, and impediments. Specific alignment mechanisms that foster perceptions of partnership plus a shared sense of goals and risks between IT subunits can positively influence the perceptions of alignment between IT subunits.

Strong linkages in competencies pertaining to human resources and skills management between IT subunits positively impacted IT subunit alignment. This suggests that there is value to ensuring that diverse IT subunits are equally competent and share common hiring, retention, training and feedback criteria and practices. Misalignments caused by the incompetence or inability-to-execute of one IT subunit can adversely impact the overall cohesiveness of the IT unit as it strives to meet its business and technology goals. This finding is consistent with prior studies of strategic business-IT alignment that also found competencies as an important predictor of alignment (Chen et al., 1997; Henderson and Venkatraman, 1993; Luftman and Kempaiah, 2007).

With respect to structural dimensions, the use of measurements and standards for clarifying the contributions of distinct IT subunits did not impact the overall alignment within the IT unit. This result differs from findings in the strategic business-IT alignment research. This suggests that taking a rigid "measure to manage" scientific approach towards interactions between IT subunits may not be optimal if the goal is to have them aligned in terms of plans, priorities, and strategies. In our context, which focused on testing and development subunits, this finding suggests that the interaction and collaboration between these subunits may be so complex that alignment cannot be facilitated by rigid measurement methods and precise service-level agreements (Li and Williams, 1999). This finding is in contrast to prior studies of strategic business-IT alignment that found measurements and standards were an important predictor of alignment (Luftman and Kempaiah, 2007). The lack of influence of measurements and standards on alignment is consistent with prior research suggesting that "structure is a means to an end" (Chan, 2002, p. 106). Chan (2002) finds that the informal structure, which is similar to some relational components presented in our study, is one of the most important aspects of IT alignment. Given the creative, non-routine, innovation-based nature of testing work (Elbert and Dumnke, 2007; Page et al., 2009), our findings support the notion that the relational, informal components of alignment are more important than structural components in potentially creating the flexibility and cooperative dynamics required for successful software development. A similar idea was proposed by Chan (2002) who suggests that IT success may require the flexibility and adaptability engendered by informal components of alignment. Additional research has identified relational and informal components as being paramount to strategic alignment (Chan, 2002; Gosh and Scott, 2009; Preston and Karahanna, 2009b).

Our study also found that congruence in the governance structures of IT subunits does not influence overall IT unit alignment. This is an interesting result suggesting that diverse IT subunits can be governed differently and still be aligned in relation to the overall IT mission. For example, a subunit that utilizes centralized governance and decision making structures can still be aligned with others that are more decentralized in their governance and decision making orientation. This finding is in contrast to prior studies of strategic business-IT alignment that found governance to be an important predictor of alignment (Chen et al., 1997; Henderson and Venkatraman, 1993; Luftman and Kempaiah, 2007).

We also found that congruent processes and architectures of IT subunits does not influence overall IT unit alignment. This suggests that enforcing common processes and the use of integrated development architectures on diverse IT subunits will not impact the alignment between them. This directly challenges arguments often made by software vendors who seek to provide IT units with integrated tools and techniques for software development. This finding is in contrast to prior studies of strategic business-IT alignment that found processes and architectures as an important predictor of alignment (Brown and Magill, 1994; Henderson and Venkatraman, 1993; Luftman and Kempaiah, 2007).

Overall, our findings suggest that the relational dimensions of shared understanding, partnership, and competencies are important while the structural dimensions of governance, measurements/standards and process/architecture exhibited no significant influence on determining the alignment among IT subunits (Level 2 in Fig. 1). Interestingly, prior research has

**Table 6**
Comparison of Levels 1 and 2 alignment.

| Constructs | Level 1:Business-IT Alignment* | Level 2: IT subunit Alignment |
|---|---|---|
| *Relational variables* | | |
| Shared understanding | Supported | Supported |
| Partnership | Supported | Supported |
| Competencies | Supported | Supported |
| *Structural variables* | | |
| Governance | Supported | Not supported |
| Measurements/standards | Supported | Not supported |
| Processes/architectures | Supported | Not supported |

* *Note*: Level 1 business-IT alignment findings based on Preston and Karahanna (2009a,b) and Luftman and Kempaiah (2007).

stressed the importance of the structural dimensions for strategic business-IT alignment (Level 1 in Fig. 1); however, our findings suggest that the relative importance of these dimensions may be different when examining alignment within the IT unit. An implication of this is that CIOs desiring a cohesive and well-aligned IT unit should not undervalue the contribution of relational dimensions such as partnerships, shared understanding, and congruent competencies among IT subunits. Table 6 juxtaposes the findings from prior studies of Level 1 business-IT alignment with the findings of our study for Level 2 IT subunit alignment.

In their recent paper, Preston and Karahanna (2009a) argue that the structural components are antecedents to relational components, which in turn influence the overall strategic alignment of an organization. To test this argument, we conducted a post hoc analysis to investigate whether relational factors mediate the relationship between structural factors and IT subunit alignment. To conduct this analysis, we created two additional second order formative constructs – a structural factor and a relational factor. The results of this analysis showed that, in our context, structural factors are not significant antecedents of relational factors. This provides additional support for our findings in Table 6. The results from the post hoc analysis are as follows: the relationship between structural factors and relational components is not statistically significant ($t = 0.923$, $p$ = n.s.); the relationship between the relational factors and IT subunit alignment is positive (.702) and statistically significant ($t = 15.552$, $p < 0.001$); the relationships between process/architecture, governance and measurements/standards and their respective second order formative construct – the structural factor – are all statistically significant ($t = 10.658$, $p < 0.001$; $t = 9.640$, $p < 0.001$; $t = 14.701$, $p < 0.001$; respectively). Similarly, the first order indicators for the relational factor are significant for shared understanding, partnership, and competencies ($t = 17.948$, $p < 0.001$; $t = 14.080$, $p < 0.001$; $t = 11.328$, $p < 0.001$; respectively). The variance explained for IT subunit alignment in the case of this model was $R^2 = 0.49$. This is lower than the variance explained ($R^2 = 0.68$) by our initial model.

Both the original and the post hoc model results provide support to the findings of recent studies (e.g., Chan, 2002; Gosh and Scott, 2009; Preston and Karahanna, 2009a, 2009b), which suggest that relational and informal components of alignment are more important in building strategic alignment. While these studies investigate the strategic level of alignment (Level 1 in Fig. 1), our study shows that at tactical levels too (Level 2 in Fig. 1), relational constructs may be more important than structural constructs in creating alignment between IT subunits.

## 5. Implications and directions for future research

Our study makes a case for the need to refocus empirical attention back on the core duties of the IT manager – that of efficiently and effectively managing the internal IT organization. Our work contributes to the IT management and alignment literatures in several important ways: (1) showing the value of alignment as an appropriate lens for understanding IT management at the subunit level within the IT unit, (2) identifying salient dimensions of focus for the internal IT unit environment given that it has received comparatively less attention recently, (3) illustrating that relational dimensions are important while structural dimensions are not significant in the internal context, and (4) demonstrating that measuring internal alignment is possible using empirical analysis thereby extending conceptual modeling and other alignment frameworks. Most importantly, we illustrate that strategic business-IT alignment concepts can be usefully applied to how subunits are managed within the IT unit, and show the importance of relational dimensions for subunit alignment. This finding is reflective of the strategic business-IT alignment literature that has seen the focus shift from structural issues to relational issues in the last 10 years. This appears to be consistent with the notion that at the subunit level, structural dimensions are relatively stable, consistent, and standardized causing them to become less of an issue. This finding suggests that strategic profiles (where strategic business-IT alignment is pertinent) may be different from those at the lower levels within the IT unit. Strategic managerial notions of governance and integrated structures may not be as pertinent to the context of day-to-day management of the IT unit. Given the findings of this study, the importance of contextual factors needs to be considered. Future research is needed to tease out the specific contextual causes associated with the dimensions of alignment examined in this study.

While our study examined the testing and development subunits, additional research is needed to extend our understanding of the dimensions relevant to interactions between other IT subunits. This is because besides software development, IT units provide a host of other important services to the business. Future research may want to replicate our study with other IT subunits that have to be closely aligned for overall IT success. This includes: architecture/networking subunits collaborating with software development subunits; IT planning subunits collaborating with IT operations subunits; and geographically disparate IT subunits collaborating on an overall IT mission. Assessing and improving the alignment between all IT subunits can lead to superior performance of the IT function as well as have beneficial impacts on the business as a whole. Another fruitful area of future research is to investigate if non-harmonious, misaligned, disruptive relations and structures at the internal subunit level can cause disruptions in strategic relations between the overall IT unit and other business units. The link between external and internal alignment is thus another potential area of future research that can show the impact of internal IT unit alignment on overall strategic business-IT alignment. These were labeled as Level 1 and Level 2 alignments in Fig. 1. Prior research shows that an effective CIO needs both external and internal capabilities (Chen et al., 2010). To be effective, a CIO needs to integrate diverse IT subunits and orchestrate available IT resources (Stephens et al., 1992), while being aligned with the firm's competitive strategy (Karimi et al., 1996). Similarly, to be effective, the subunits of an IT unit need to function harmoniously and support each other at the IT unit level, and the corporate strategy at the business level. Future research should investigate the alignment between multiple subunits of an IT unit, as well as the impact that IT subunit alignment has on IT-business alignment maturity.

It can be argued that pragmatic assessments of IT subunit alignment similar to that undertaken in our research can also provide a basis for strategic decisions pertaining to the organizational redesign of IT units. Future research can use the internal alignment framework provided by this study to assess managerial decisions pertaining to the outsourcing of distinct IT sub-functions. Constructs and concepts presented above can potentially be used to investigate the alignment between outsourcing vendors as well as the alignment between the vendors and the client company's IT units. For example, the structural and relational properties of outsourcing clients and vendors may impact the success of the partnership. Another fruitful area of future research is to compare internal to "outsourcee" alignment for better managing outsourcing contracts. Client and vendor alignment considerations focusing on software development (e.g., requirements analysis, design, development, testing, support, and maintenance) may warrant greater attention. Companies have found that software developed by vendors did not always meet quality expectations and resulted in unmet deadlines and extensive internal resource requirements (Lacity and Rudramuniyaiah, 2009; Lee, 2006). Research on governance in outsourcing suggests ways for setting up and implementing procedures to manage internal stakeholders or vendors (Obal, 2009), while research on relationship management offers insights into establishing and implementing procedures to manage issues and their solutions (Koh et al., 2004; Lee, 2006).

The value of the strategic business-IT alignment approach has recently been validated by Oh and Pinsonneault (2007) in relation to firm performance. They found that highly aligned firms with strong business-IT "fit" yielded superior firm performance. Luftman and Kempaiah (2007) have used six components of alignment (communications, value, governance, partnership, scope and architecture, and skills) to build alignment maturity models for organizations. They further empirically linked alignment maturity to firm performance in a inter-cultural and inter-industry study. Other maturity frameworks, such as the capability maturity model integration (CMMI) framework, also focus on the importance of relational and structural factors in software engineering. Kasse (2008) stresses the importance of capabilities, coordination, cooperation, measurement of outcomes and process in achieving CMMI software development maturity. The study further links this software development maturity to firm performance. Similarly, future researchers may want to investigate the performance impacts of internal IT unit alignment. For example, the business value of development-tester alignment may be best demonstrated using measures such as reduced defects, more efficient development processes, reduced software development time and cost. While this study uses IT subunit alignment as a dependent variable, future work may want to utilize a two-level model that considers the extended impacts of this construct and investigates the impacts of internal IT alignment on firm performance. Future research can also investigate dyadic alignment relationships between certain IT subunits and their business unit counterparts, as well as aggregate IT subunit alignment and its impact on the success of business functions or on the ability to achieve corporate goals. Additional multi-level alignment analysis may uncover which IT subunits' internal or external alignment has the largest impact on business success. Another fruitful direction for future research might be to focus on a single organization and investigate the details of alignment and how they link directly to the organization's performance. Our study's employment of a survey across multiple companies, while providing a more generalizable view, may have overlooked more granular aspects that may emerge if the focus of the research is on a single organization.

Our research also has implications for general managerial theories of strategy and organizations. First, there is value in combining theoretical notions of IT alignment with the resource based view of the firm (RBV) (Bharadwaj, 2000; Wernerfelt, 1984). This would consider organizational management as the alignment of diverse and strategic repositories of knowledge and resources as represented by organizational subunits. A key implication of our study for the RBV perspective is that the relative balance of structural and relational aspects needs to be considered as well. Second, agency theory focuses on contractual and other arrangements between principals and agents as a perspective to both the study and practice of managing organizations (Eisenhardt, 1989). Alignment of principal/agent arrangements could also be viewed in relational and structural terms as illustrated in our paper. Third, institutional theory focuses on three legitimization processes which are termed coercive, imitative, and normative (DiMaggio and Powell, 1983). Normative legitimization is a result of normative pressure stemming from professionalization and shared norms among various subunits. Future research may want to consider linking these three legitimization processes to alignment, especially with regard to normative legitimization focusing on shared norms as the basis for shared understanding. Another aspect would be to consider the relational and structural alignment perspectives of these legitimization processes. Our study can also be extended to focus on alignment between all subunits of an enterprise, as well as alignment among partners in supply chains or extra-organizational business ecosystems. For example, Hooper et al. (2007) have investigated alignment between the IT and marketing functions.

## 6. Conclusions and limitations

Overall, the above considerations give testimony to the applicability and value of our research model's predictive potential in the context of managing IT subunits. While providing a deeper understanding of the mechanisms facilitating alignment, it must be acknowledged that the study was limited in certain aspects. This research has empirically clarified the balance between structural and relational dimensions that impact alignment within the IT unit by concentrating on alignment between two distinct subunits in software deployment that have historically had a conflicted relationship and that has been a managerial challenge to CIOs (Cohen et al., 2004; Pettichord, 2000; Rothman, 2004; Zhang et al., 2008). While it might seem intuitive that sampling employees among all IT subunits would be a better choice than focusing on testing and development subunits, we believe the chosen sample provided a solid foundation for testing the research model because of the known misalignment between these two units. The generalizability of findings from this context within software deployment to relations among other subunits within the IT unit represents an important limitation that has to be recognized. We acknowledge that our respondents may differ from other IT professionals in other IT subunits (requirements gathering, database design, etc.). This would be a fruitful area of focus for future research.

Our model identifies relational components as being important for achieving development/testing alignment. As such, managers should focus on the three components of the relational dimension – shared understanding, partnership and competencies. Shared understanding can be achieved by building effective communication and liaison mechanisms between developers and testers and fostering an understanding of the company's strategies, plans, environment, risks, priorities and promoting a shared view of the role of each IT subunit in the overall IT unit strategy. Second, managers should encourage partnerships between their respective subunits by building trust between developers and testers and partnering with sister subunits in IS initiatives. Finally, human resources strategies for both subunits should be geared towards a readiness for change, increased capability for learning and leveraging new and innovative ideas. This would lead to increased quality and productivity of software development. Focusing on governance structures, standardized measurements, and process/architecture, on the other hand, may not prove to be as efficient a strategy.

Utilizing a relatively homogeneous group of individuals minimized the variation within the units of observation. As a result, we can attribute significant effects to the variables in the research model rather than exogenous factors, increasing our confidence in the results. We tested several demographic variables and found no significant effects. Although sample homogeneity is appropriate when the goal involves theory building and testing, the next step would involve testing the model with more heterogeneous groups of individuals. Thus, we can probably generalize the theoretical relationships among the variables to other IT subunits involving misalignment. Nonetheless, future research needs to sample more heterogeneous sets of individuals to determine what boundary conditions exist.

In a similar vein, our survey asked participants about general perceptions. For instance, personal conflict can vary considerably in different contexts and affect alignment. Therefore, types of misalignment at more granular levels could affect misalignment of subunits in distinct ways. Because the intention of this study was to gain a broad picture of the phenomenon, we chose to operationalize the variables at a more general level. This step, however, prevented us from determining how particular technologies and individual differences influence subunit misalignment. Future studies may want to explore the influence of such factors on alignment in a single organization in order to capture more subtle undercurrents of alignment.

Our reliance on single respondents from a random sample of testing and development professionals from multiple organizations also resulted in a relatively low response rate as well as potentially unstable factor loadings. Even though our measurement model exhibited adequate quality for discriminant and convergent validity, some high cross-lodgings are apparent in the factor structure. Even though such cross-loadings, may not interfere with the interpretation of our results, they can introduce instability in the overall model. Finally given that this study was an initial step in examining subunit alignment, future studies should consider further refinement of the measurement items. Future research can focus on refining and revising our measurement instrument in the context of a single organization where participation would be expected to be higher.

Finally, the use of cross-sectional data cannot provide conclusive evidence of temporal precedence. Although the data collection procedure is consistent with other survey-type studies, future research should utilize alternative data collection methods, such as longitudinal and experimental designs, to address this issue. Future studies are needed to validate these results using alternative research methods. Despite these limitations, it is our hope that this research demonstrates that the "alignment" lens can be a viable and valuable approach for the study of the internal dynamics of the IT unit and will motivate other investigations of this phenomenon.

## Appendix A

| Research on information technology (IT) unit management (in two MIS journals) | Journal | Unit of analysis | Method | Shared understanding | Measurements/ standards | Gover-nance | Partner-ships | Process/ architecture | Compe-tencies | Citation |
|---|---|---|---|---|---|---|---|---|---|---|
| *More internally focused (Level 2 in Fig. 1)* | | | | | | | | | | |
| Framework of IT organization's position on a continuum ranging from closed/stable/mechanistic to open/adaptive/organic | MISQ | IT unit | Conceptual | | | | √ | | | Wetherbe and Whitehead (1977) |
| Success factors for IT management including department's role and responsibilities, basic approach, management direction, plan, and development of good people | MISQ | IT unit | Conceptual/case study | | | √ | √ | | √ | Miller (1980) |
| Explores critical success factors for IT executives | MISQ | IT unit | Interview/survey | | | √ | | | | Martin (1982) |
| Planning managerial practices including the style of senior management decision making, the volatility of the business and application portfolio, the complexity of IT organization and management, and the status and physical location of IT management | MISQ | IT unit | Comparative case study | | | √ | √ | | √ | Pyburn (1983) |
| *More externally focused (Level 1 in Fig. 1)* | | | | | | | | | | |
| Strategic IT planning includes definition of key markets (within the firm) for IT, consistency between the strategic business and IT plan, and a means to assess the planning process | MISQ | IT unit | Conceptual/case study | | | √ | | | | Henderson and Sifonis (1988) |
| Alignment, analysis, cooperation, and improvement in capabilities influence strategic IT success | MISQ | IT unit | Key informant survey | √ | √ | √ | √ | √ | √ | Segars and Grover (1998) |
| Contingencies influence the mode of IT governance to amplify, dampen, or override their mutual influences on the IT governance mode. Three scenarios are identified: reinforcing, conflicting, and dominating | MISQ | IT unit | Multiple case studies | | | √ | | | | Sambamurthy and Zmud (1999) |
| Model of the relationship between the IT department and its dynamic environment | ISR | IT unit | Structured interview | | | | | √ | | Lederer and Mendelow (1990) |
| The control of IT departments when its managers have private information about the department's costs and have objectives which may differ from those of the organization | ISR | IT unit | Analytical/simulation | | √ | √ | | | | Wang and Barron (1995) |

| | | | | | |
|---|---|---|---|---|---|
| Context for decentralized systems development governance includes organic decision-making, business unit autonomy, a differentiation competitive strategy, and an unstable industry environment. Finds with perceived deficiencies in IT capabilities and a culture that supports structural changes, a different solution may be adopted | ISR | Strategic business unit/ IT unit | Single case study | √ | Brown (1997) |

## Appendix B

| Construct/definition | Measures | Adapted from |
|---|---|---|
| IT subunit alignment – the congruence of testing strategy and development strategy | • *Alignment1*. The software testing strategy is congruent with the software development strategy in your organization<br>• *Alignment2*. The scope of the development group is tightly linked with that of the testing group<br>• *Alignment3*. The governance of the development group is in harmony with that of the testing group<br>• *Alignment4*. The resources of the development group are aligned with those of the testing group | Preston and Karahanna (2009a,b) |
| Shared understanding – effectiveness in exchange of ideas and knowledge between subunits, enabling both to understand the company's strategies, plans, environments, risks, priorities, and how to achieve them | • *SharedUnderstanding1*. There exist effective communication and liaison mechanisms between testers and developers<br>• *SharedUnderstanding2*. Testing and development members have shared understanding of the role of testing in our organization<br>• *SharedUnderstanding3*. Testing and development members have a shared view of the role of testing as a critical component in meeting the goals of the corporate IS unit<br>• *SharedUnderstanding4*. Testing and development members have a shared understanding of how testing can be used to increase the quality and productive of our software development operations | Preston and Karahanna (2009a,b) and Luftman and Kempaiah (2007) |
| Measurements/standards – uses balanced measurements to demonstrate contributions of the IT subunits in terms both the business and IT can understand and accept | • *Measurements/Standards1*. There are established development metrics to demonstrate the value of development to the organization<br>• *Measurements/Standards2*. The organization uses balanced measurements that are understood and accepted by both development and testing, to measure their relative contributions<br>• *Measurements/Standards3*. There are explicit service-level agreements in place for assessing the contribution of testing to software development<br>• *Measurements/Standards4*. There are explicit benchmarking standards available for assessing the contribution of the testing group<br>• *Measurements/Standards5*. There are formal assessments and reviews conducted for evaluating the success of testing efforts | Luftman and Kempaiah (2007) |
| Governance –who has the authority to make IT decisions and what processes are used at strategic, tactical, and operational levels to set priorities and allocate resources | • *Governance1*. The IS governance structure allows testing leadership plays a direct role in IS development planning<br>• *Governance2*. The development leadership plays a direct role in software testing planning<br>• *Governance3*. Steering committees involving testing and development personnel are used for IS governance | Luftman and Kempaiah (2007) and Henderson and Venkatraman (1993) |
| Partnerships – subunits roles in defining the business's strategies, the degree of trust between the two units and how each perceives the other's contribution. | • *Partnership1*. There is a high level of trust between testing and development<br>• *Partnership2*. Development and testing commonly partner to sponsor and champion IS initiatives | Luftman and Kempaiah (2007) |
| Process/architecture – provision of a flexible infrastructures, application of emerging technology, enabling process changes, and delivery of solutions to business and partners | • *Process/Architecture1*. The testing group uses cutting edge testing tools to provide quality assurance services<br>• *Process/Architecture2*. The testing provides leadership in relation to articulating standards for efficient and sound testing best practices<br>• *Process/Architecture3*. The testing group has put together a flexible testing infrastructure that supports the organization's software development goals<br>• *Process/Architecture4*. The testing group has a well-established process for evaluating and applying emerging technologies and best practices<br>• *Process/Architecture5*. The testing architecture is well integrated with that used for software development | Luftman and Kempaiah (2007) and Henderson and Venkatraman (1993) |
| Competencies – human resources, e.g., hiring, retention, training, performance feedback, encouraging innovation and career opportunities, developing skills, etc. Readiness for change, capability for learning, and leveraging ideas | • *Competencies1*. The cultural locus of power of the testing group is in harmony with that of the development group.<br>• *Competencies2*. There are adequate training, education and career crossover opportunities for testing personnel<br>• *Competencies3*. The testing group has hiring and retaining policies and procedures that are effective<br>• *Competencies4*. The internal environment of the testing organization fosters trust and interpersonal collaboration | Luftman and Kempaiah (2007) and Henderson and Venkatraman (1993) |

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