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METRICS
Model for Eliciting Team Resources and Improving Competence Structures

A Socio-technical Treatise on Managing Customer Professionals in Software Projects for Enterprise Information Systems

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To my grandparents
Who were "doctors of life" despite having hardly received any formal instruction.

To my parents
Who nurtured in me the beauty of education.

To my brother
Who was always there to explain how things worked.

To my uncles Osvaldo and Miguel
Who inspired me in research.

And especially to Rita
Who supported me in my daily challenges.

To God
For having established the mysteries and the possibilities.

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I also want to thank the good people behind the electronic version of the *American Heritage Dictionary* and the print version of the *Random House Unabridged Dictionary*. Both dictionaries were invaluable for this non-English native.

Finally, I express my deepest gratitude to the international scientific community, for having set and for preserving – most of the time on the basis of pure self-denial – quality standards that provide society with rigorous investigations and effective solutions for the daily problems.

I apologize for any potential omission of names and facts here.

ABSTRACT

It is still not common in research on software quality to delve into non-technical issues. In the particular case of implementing customized information systems software (CISS), the field is also not completely aware of the importance of managing customers with a formal and objective set of measures that account for their responsibility in projects. CISS products – whose source code is ultimately developed according to each customer's demands on core business processes – ask developers to pay unique attention to issues like competencies, culture, strategy, and resources of the client organization, as well as to the industry' critical success factors, best practices, and prospects. The present research adds to software engineering and to organizational theory by introducing a conceptual framework (rationale) and a set of seven indicators, 27 metrics and 88 measures for improving the knowledge and the managerial practices regarding the participation of customers in CISS development. The focus is on managing the customer team (CuTe) – professionals from the client organization that contracts CISS projects, who are assigned special business and information technology (IT) roles for interacting with outsourced developers in such projects, since both customer and external (outsourced) developer teams share project authority and responsibility. Research insights and assumptions were developed throughout a six-year professional interaction with companies in a major Brazilian IT cluster; and a three-year case study within a landmark enterprise resource planning (ERP) implementation in a Brazilian university, supported by in-depth interviews with key CuTe professionals in the project, provided the research with compelling data for the assembly and validation of findings. The resultant framework – formed by the rationale and the measurement instruments – is called *Model for Eliciting Team Resources and Improving Competence Structures* (*METRICS*), and it is to be used in the industry by customers and external developers to help plan, control, assess, and make historical records of CuTe design and performance in CISS projects. Academicians also benefit from the incorporation of a new perspective with which to deal with the customer-supplier interaction in IT endeavors.

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SUMMARY

1 INTRODUCTION

A body of the literature on software development deals with highly dynamic subjects, which result from an era distinguished by frequent changes in technology (Currie & Glover, 1999; Lopes & Morais, 2002; Stump *et al.*, 2002; Levacov, 2000; Latham, 1998; Goodman & Darr, 1998). Nevertheless, similar innovation rates are not typical in the development of frames of reference for conceptualizing and managing the software process in work organizations, notwithstanding the fact that organizational change – with which software processes interrelate – is also inherent to the modern times (Paper & Simon, 2005; Nadler & Gerstein, 1992). In fact, studies on software quality and engineering, including information systems (IS) development, do not use to discuss out of the technical domain (Kotlarsky & Oshri, 2005; Glass *et al.*, 2002; Ravichandran & Rai, 1999/2000; Ravichandran & Rai, 2000; Palvia *et al.*, 2001).

However, research efforts that go beyond the general narrow perspective in software development are also fundamentally incomplete, since they almost fully ignore the importance of metrics for managing the participation of customers in projects of a particular class of software: the customized software, mainly the one that is integral to IS. Projects of *customized information systems software* (CISS) – whose source code is built or altered according to specific demands from the client company when implementing its core business processes in an IS infrastructure – require special attention to issues like business principles, organizational culture, industry knowledge, resource availability, and strategy of the contracting firm. Therefore, additionally to the excess of technical reasoning in research on software development, evidence suggests that there is also little understanding about the responsibility of customers when contracting out CISS development.

Discussions on how software development has been researched over the years are of interest for academics and practitioners alike. The academy is always interested in questioning itself, and the industry is eager to explore whatever relates to the substantial share of the world expenditures in computer software (Krishnan *et al.*, 2000); in particular, information technology (IT) outsourcing contracts – of which CISS projects are a special case – represent an attractive business opportunity (Lacity & Willcocks, 1998). Hence, our work, based on the theoretical relevance and the pragmatic contemporaneity of the subject, aims to address and fill the gap between research and practice on the participation of customers in CISS projects by developing a set of non-technical criteria to design and manage such participation. In particular, we focus on the *customer team* (*CuTe*) – professionals from the client organization of CISS projects who are assigned special business and IT roles for interacting with outsourced developers (the *X-Teams*, named after *external teams*) in such projects. Both the X-Team and CuTe developers share project authority and responsibility; thus we propose that CuTe personnel should observe performance metrics in CISS projects. In this research, a *developer* is either a programmer, a systems-business analyst, or an IS manager in both the CuTe and the X-Team.

Further motivations for this research are due to the author's professional activities in the software industry in the late 1990s as programmer and systems analyst for two Brazilian companies that developed database and Web applications. In that period, large companies from industries like mass media, air transportation, telecommunications, insurance, and education were serviced by the author and his teams in CISS projects, and it was found that the client companies would intervene in the projects only if explicitly (and sometimes repeatedly) asked to. Moreover, some companies had difficulties in eliciting the business needs for the CISS products to be developed (*inefficacy*), assessing the sequence of events in the project (*inefficiency*), anticipating future changes in business requirements (*inflexibility*) and, most importantly, understanding their very importance in the joint work with the external partners (*irresponsibility*). So, CuTe members did not seem to feel as they were needed for the effective development of CISS products; as a result, they did not follow any formal method.

As a matter of fact, the Brazilian industry does not rely on a framework for managing mutual responsibilities in software endeavors (Pereira & Bellini, 2002). Since such a framework was also not found in the international literature, expected benefits from our research cover a wide range of academic and industry interests, from which we highlight the following:

- greater transparency and accuracy in contracting the participation of CuTe professionals;

- real-time assessment of CuTe performance (a side effect would possibly be the emergence of academic interest in studying the satisfaction of X-Teams in CISS projects);
- better judgment on the actual performance of the X-Teams (by comparing their performance to that of the CuTes with which they interact, and to the overall performance of the projects they jointly execute);
- informed distribution of people (from their historical performance) in CuTes;
- anticipated knowledge of CuTe members about the performance criteria according to which they will be evaluated by employers (the client organizations) in CISS projects; and
- building the rationale that unifies areas of great interest for the IS field, including customization, quality management, seller-buyer interaction, and teamwork.

The expected benefits seem to be in line with current debates on the relevance of IS research (*e.g.*, Benbasat & Zmud, 1999, Applegate & King, 1999, Davenport & Markus, 1999, Lyytinen, 1999, Lee, 1999a, Hirschheim & Klein, 2003, and Pearson *et al.*, 2005), and the following issues provide additional support for the academic and business meaning of our intent:

- demands for customization ("make by order") are numerous in many industries (Zhu & Kraemer, 2002);
- outsourcing – a typical concern in software customization – is challenging (Lacity & Hirschheim, 1999), especially in what comes to research opportunities on how to manage IS outsourcing contracts (Ho *et al.*, 2003);
- the commitment to attracting, developing, and retaining IT professionals is among the top five IT managerial concerns reported by CIOs and other IT executives (Luftman, 2005; Luftman & McLean, 2004), implying that measures be deployed to manage and assess the effectiveness of each professional;
- most of the time, the user is credited for the benefits of technology, whereas the IT professional is accounted for its costs (Lacity & Hirschheim, 1999; Leite, 1997), thus being evident that explicit criteria need to be developed and deployed to objectively support the evaluation of the role of each stakeholder in projects;
- criteria for assessing the effective participation of customers in CISS development also convey legal meanings, given that contractors (here, the X-Teams) are already instructed to advocate that their processes and products follow generally accepted standards (Gooden, 2001);

- customarily, users do not play significant roles in system development (Clegg *et al.*, 2003), and the consequences from this should be measured;
- on the other hand, it is also unequivocal to say that system development by the end-user grows in some application domains (Von Hippel & Katz, 2002; Ravichandran & Rai, 2000; Avison & Fitzgerald, 1999), and this requires more knowledge on how effective such an activity is;
- the academic literature is somewhat "biased" in giving so much attention to users at the same time as IS professionals (contractors) are almost neglected (Feraud, 2004; Leite, 1997);
- starting from the facts that *user satisfaction* is maybe the most researched IS construct (Woodroof & Burg, 2003) and serves as a surrogate for system success (Burns & Madey, 2001; Kim *et al.*, 2002), it may be also relevant to develop something like the *contractor satisfaction* (which would be impacted by the participation of customers in projects) in order to address the success of CISS development;
- as there is little agreement on which business skills should be nurtured in programmers, systems analysts and IS managers (Todd *et al.*, 1995), such skills need to be also theoretically pioneered in the assembly of CuTes; moreover, if it is true that organizational, functional, and managerial skills are increasingly a requisite for the systems professional (Todd *et al.*, 1995), then the influence of variables from each of these dimensions on the software process should be addressed;
- vendors (here represented by the X-Teams) struggle for more impartial relations that change the long-lived dependence on buyers into interdependencies between the two parties (Stump *et al.*, 2002), and such an effort must be supported by objective, systemic criteria for assessing their relationships;
- system development teams (here, the X-Teams) usually regard themselves as the major source of knowledge to be relied upon and largely ignore the potential contribution by users (Metersky, 1993; Nambisan *et al.*, 1999), what may be related to the fact that we know but a little about learning from customers (Sivula *et al.*, 1997);
- customers and contractors search for successful partnerships (Naoum, 2003), and for this to occur criteria are needed that distinguish the actual performance of each stakeholder (Plambeck & Taylor, 2006) – in other words, they should participate within agreed-upon limits that resolve the natural conflicts of joint work (Romme & Endenburg, 2006);

- it is not clear how to promote teamwork (Leidner & Jarvenpaa, 1995);
- the outcomes of new product development mobilize individuals to increase their influence in the process (Atuahene-Gima & Evangelista, 2000), and such an influence is of interest for measurement;
- comprehensive, systematic management of software development is needed (Hosalkar & Bowonder, 2000), but little is documented on the successful implementation of metrics in improvement initiatives for the software process (Iversen & Mathiassen, 2003);
- there are great opportunities in putting together quality, measures and business (Stein, 2001a), knowledge areas that are inherent to CISS research;
- there is scant empirical evidence on the managerial function of customers in projects (Kirsch *et al.*, 2002); and
- little is known about the causes, the outcomes and the management of innovation processes (Galliers & Swan, 1999), which are key for developing CISS (Hosalkar & Bowonder, 2000); in fact, the quality of managing software influences its development (Osmundson *et al.*, 2003).

After a previous research for generating insights on how companies work together to build CISS products (described in Pereira & Bellini, 2002), the methodological steps towards developing the set of CuTe metrics included (1) the development of a conceptual model (rationale) explaining how customers participate in CISS projects, (2) the development of an 88-item instrument for in-depth interviews with CuTe professionals, and (3) a case study within a high-profile ERP implementation in a Brazilian university, which was characterized by intense interaction between customer and outsourced professionals. Such procedures intended to help us to:

- understand the fundamentals of joint work in CISS development;
- unify theoretical and pragmatic contributions for managing CuTes;
- gather perceptions about practices and needs of customers of CISS projects for managing their teams;
- identify actual practices of joint work between an X-Team and a CuTe in a representative CISS project; and
- build and validate a set of metrics for managing the participation of CuTes in CISS projects.

The research was qualitative in nature. Notwithstanding, it addressed some causalities, due to perceptions gathered from CuTe professionals having been analyzed with the help of a variant of the *revealed causal mapping* (RCM) technique (Nelson *et al.*, 2000a; Nelson *et al.*, 2000b). RCM puts together cause mapping (Laukkanen, 1994; Bastos, 2002) and content analysis (Bardin, 1977) to provide the researcher with a richer comprehension of the underlying concepts elaborated by the interviewees. Further research should now be conducted to test hypotheses on the concepts and relations that we propose, like by means of a survey within the Brazilian CISS industry.

Results indicate the need for 27 metrics, computed from 88 measures and distributed in seven indicators, to address the organizational structure and the human nature of CuTes. The other two socio-technical dimensions of work systems (technology and tasks) are not dealt with in this research, given our previous argument on the fair amount of work already done to implement them (*e.g.*, CMM models, ISO norms, and studies on the technological imperative). In contrast, structural and people-oriented metrics are not reported in the CISS literature. The complete set of indicators, metrics and measures, along with the rationale here developed, is called *Model for Eliciting Team Resources and Improving Competence Structures* (*METRICS*), which serves as a surrogate for designing and assessing the needed capabilities of CuTes in CISS projects.

2 THE MAIN THRUST OF THIS RESEARCH

This research is aimed at building the rationale and a comprehensive set of structural and people-oriented criteria by means of metrics to support client organizations in designing and managing the participation of their teams of business and information technology professionals (CuTes) that work with external teams (X-Teams) for the development of customized software that implements core organizational processes in enterprise information systems (CISS). In order to achieve that, we planned to:

(1) review the literature on organizations, management, and information systems;

(2) develop a theoretical set of structural and people-oriented metrics (formalized as semi-structured interview protocols) for the design and management of CuTes in CISS projects;

(3) empirically validate the metrics by means of observing actual practices of participation and interaction between a high-performance CuTe and an X-Team during a CISS project; and

(4) empirically validate the metrics by means of collecting CuTe members' perceptions about their personal traits, as well as about actual practices and needs for the design and management of the interaction between CuTes and X-Teams in CISS projects.

The research question to be answered is: *What are the elements of a unified measurement model accounting for the structural and people design and management of CuTes in CISS development?*

3 THE RATIONALE

The rationale for our endeavor was partially developed in this very research effort, thus representing the first component of METRICS. We investigated heterogeneous knowledge fields for building the rationale, since CISS research has roots in many scientific areas, like measurement (*e.g.*, measurement theory, data collection/analysis, and software metrics), organizational strategy (*e.g.*, business orientation), information systems (*e.g.*, technological determinism, productivity paradox, duality of technology, and business-IS alignment), organizational learning and change (*e.g.*, experiential learning, incremental change, and institutionalization), knowledge management, work systems design (*e.g.*, socio-technical systems, virtual organizations, and organizational networks), outsourcing and contracts (*e.g.*, partnerships, transaction costs economics, and innovation), software engineering (*e.g.*, methodologies, best practices, and process/product quality), engineering (*e.g.*, risks, customization, integrated product development, and collaborative development), and marketing (*e.g.*, relationship marketing, and new product development).

The concern during the literature review was to identify and build comprehensive nomological networks of constructs which could depict as fully as possible the causal connections between the concepts of interests (notwithstanding the fact that, given the subtleties involved in framing abstract ideas not directly observable, such networks are always debatable from a theoretical and epistemological perspective). It should be noted, however, that, although the knowledge fields mentioned above (as well as others) did provide invaluable information for our research, their assumptions and findings were not necessarily taken for granted in this endeavor; that is, although supplying this research with key concepts and mobilizing the development of rich insights, we critically adapted their contributions to our needs. Besides, a systematic (criteria-oriented) review of the literature was performed, leading to a true rationale-building process.

3.1 Software and Enterprise Information Systems

We focus on software in the form of a computer algorithm. We also see software as a product (Nidumolu & Knotts, 1998) due to artifacts like the source code, the documentation and the interfaces (Palvia *et al.*, 2001), notwithstanding its intangible nature (Smith & Keil, 2003) and some service-like attributes (Palvia *et al.*, 2001). Based on the software concept, we propose that an enterprise *information system* (IS) includes a software component (Stamelos *et al.*, 2003) which is central to a company's business processes (Chan *et al.*, 1997; Sabherwal & Chan, 2001). Then, when we refer to "software", we mean the software component of an IS.

The IS concept has a variety of definitions in the literature. IS are (i) systems that record, handle, transmit, retrieve and display information used in business processes (Alter, 1996); (ii) interrelated elements, based on computer technology or not, that collect, process, record and display data and information (Stair, 1998); (iii) interrelated components that collect, process, record, retrieve and distribute information needed for control and decision support in organizations (Laudon & Laudon, 2000); (iv) information technology (IT) particularly instantiated (Lee, 1999b); (v) human-activity or microsocial systems not necessarily based on computers (Clarke & Lehaney, 2000); or (vi) meaning-building systems in which people select and process data in order to connect them to contextual purpose and support human action, not involving exclusively the processing of data (Checkland, 1999). Moreover, the human factor is integral to an IS (Metersky, 1993) or at least it is closely related to the success of such systems (Marchand & Davenport, 2004), due to the complex intra and interpersonal elements involved (Bednar, 2000). Therefore, IS research is multidimensional in nature.

As a discipline, IS has sometimes been misleading or imprudent, since it not rarely rejects old-but-valid ideas to the benefit of modern trends that are not sufficiently tested (Galliers & Swan, 1999; Sharma & Rai, 2003). This is maybe related to a pandemic characteristic of the "ill-formed and conceptually confused" field of management (Checkland, 1999, p. 46), which does not have a language of its own. Indeed, the business and management worlds make use of words that provide *contact* between people, but not necessarily make sense (Correia, 2005). In particular, inadequate definitions in the IS domain constrain the accumulation of knowledge, the generalization of research findings, and, thus, making progress (Alter, 2006).

As an artifact, IS plays a vital role in the modern world (Church & Te Braake, 2001) and it is maybe the main enabling mechanism for business strategy (Ives *et al.*, 2002). The IS function should be run in accordance to the organizational goals (Dias, 2000; Sabherwal & Chan, 2001), as a result of including IS planning into business planning (Alter, 1996) and understanding that it is hard to separate business from technology (Currie & Glover, 1999) – in particular, IT, knowledge and strategy interrelate intimately (Bloodgood & Salisbury, 2001). Thus, IS planning groups IS resources (people, hardware and software) within a larger framework distinguished by setting business goals and priorities and by making actions that address them (Alter, 1996), in order to support the primary executive function: making decisions (Wetherbe, 1997).

When IS assumes strategic organizational functions, its planning should foresee and combine technical, organizational and business factors (Alter, 1996), in the search for a systemic appraisal of all relevant processes. The fit between the strategic orientation of business and the strategic orientation of IS is, however, one of the dominant challenges executives face (Brodbeck, 2001; Chan *et al.*, 1997), and more research is needed on the factors that drive such an alignment (Sabherwal & Chan, 2001). Although departments in traditional work organizations have frozen priorities and practices (Alter, 1996), IS must therefore be addressed from a multidimensional perspective in which all capable people can have a stake (Wetherbe, 1997).

The complexity of the IS field is significant. It is assumed that *IS development* or *implementation* (the initiatives to putting into effect the IT capabilities as planned – Sarker, 2000) have an impact on organizations, what supports the need for investigating how IS materializes, develops and perishes. In particular, it is of interest to understand the participation of customers in IS development; even if a system adheres to project specifications, users are free to assign arbitrary meanings to it (Checkland, 1999). It is thus reasonable that literature pays so much attention to constructs like *user competence*, *user involvement*, *user participation*, *user attitude*, *user behavior*, *user acceptance*, and *user satisfaction*.

3.2 Software and Information Systems Development

For the sake of clarity, software development is here understood as involving ingenuity (Armour, 2006). It unfolds according to a *software process*, which is defined as the set of activities, methods, practices and transformations employed in the development and maintenance of software and related products (Paulk *et al.*, 1993). Additionally, the *developer* is conceived as either the *programmer*, the *systems analyst*, or the *IS manager* in any IT-based software development team – the customer's (*CuTe*) or the contractor's (*X-Team*).

An IS department should develop products in cooperation with customers (Alter, 1996), what is in line with the following assertions from the organizational and software literatures:

- differences in frames of mind between partners are a common cause of unsuccessful outcomes (Hofstede, 1994);
- experts and customers should be mutually interested, in the search for a project's success (DiMaggio & Powell, 1983);
- the effectiveness of a given solution is related to being involved with the problematic situation (Checkland, 1985);
- when developers get users involved in building and testing the technology, it is more likely that the interpretation and its use will be more flexible, mainly when the developers are the very users (Orlikowski, 1992);
- user involvement in projects should occur from the first stage and until success is confirmed (Dvir *et al.*, 2003);
- system analysts (developers) and executives (customers) should work together, in order to effectively agree on IS project requisites (Wetherbe, 1997);
- practices that mobilize the proactivity of key stakeholders[1], like customers and developers, should be set (Ravichandran & Rai, 2000);
- cognitive differences between users, designers and developers are critical for success to be achieved (Griffith & Northcraft, 1996);

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[1] Here, *stakeholder* – people who get involved in a system's development, use and management (Sharma & Conrath, 1992) – has a broader meaning than that given by Faraj & Sproull (2000) and Guinan *et al.* (1998) – knowledgeable individuals who are *not* part of work teams, but who are affected by the outcomes of projects or who affect the performance of teams –, by the CMMI Product Team (2002) – group or individual affected by or in some way accountable for the outcome of an undertaking –, or by Landry *et al.* (1983) – people with vested interests in the problem and the solution. The reason for adopting such a broader meaning is that developers (both from CuTes and X-Teams) *do* have a stake in the outcomes of system development.

- a participatory strategy (in systems development) that delegates responsibility and authority to users represents a success factor for IS (Hunton & Beeler, 1997);
- the relationship between developers and customers, like combining multiple viewpoints, has a prominent share in product quality and the success in its use (Herbert, 1999; Baumert & McWhinney, 1992), whereas the inattentive care of such a relationship can precede the decline in customer satisfaction (Ravichandran & Rai, 2000); and
- when dealing with radically innovatory products, software developed from knowledge created during interaction with select users can reach expressive market success (Athaide & Stump, 1999).

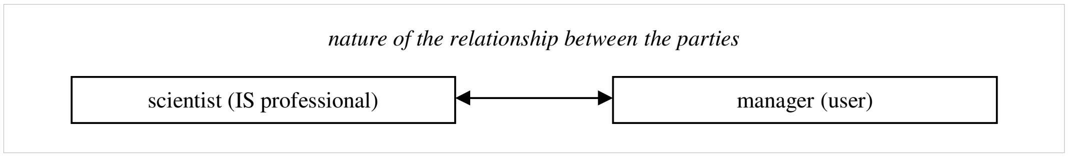
Various problems are, however, found in practice. First, we rarely adopt an interfunctional perspective in which all organizational departments potentially involved in the IS project take part (Wetherbe, 1997; Alter, 1996). In the interfunctional perspective, each individual represents the appropriate level of analysis, since the flow of information and resources between individuals in different departments constitutes the primary link between departments (Atuahene-Gima & Evangelista, 2000). Project management should, however, organize the relationship between specific, complementary expertise, and not try to mobilize individual, multidisciplinary expertise (Garel, 2003).

Second, executives are routinely interviewed (for modeling system specifications) separately (Wetherbe, 1997), as opposed to in group – when multiple visions could be shared and questioned. Third, most IS professionals are not skillful in social analysis, sometimes championing technologies not completely useful – if at all – and cost ineffective (Kling mentioned in Rodrigues Filho *et al.*, 1999); this is contrary to the fact that soft capabilities (*e.g.*, writing, teamwork, project management, and interpersonal relationship) are increasingly asked for (Noll & Wilkins, 2002; Todd *et al.*, 1995). Fourth, organizations are inconsistent in managing IS personnel, since they recognize the need for certain capabilities (like the ones just mentioned) but do not incorporate them as professional prerequisites when contracting (Todd *et al.*, 1995; Scarbrough, 1999). Fifth, the customer imposes obstacles to the software process when he/she does not know exactly what information is needed, but the developer is not usually aware of this (Wetherbe, 1997); problems in communicating with customers are indeed chronic, and Mann (2002) recommends nine issues to be addressed in relationships.

In spite of the abundant literature on software development (Pressman, 2001), most publications could be more sophisticated when dealing with IS development. Fundamentally, attention is given almost entirely to technical (technology- and task-related) issues of projects, as argued in studies on software engineering and IS development (*e.g.*, Kotlarsky & Oshri, 2005; Glass *et al.*, 2002, Ravichandran & Rai, 1999/2000, Ravichandran & Rai, 2000, and Palvia *et al.*, 2001). As a matter of fact, a far-reaching literature exists on the technical capability of software development team members as anteceding product quality and team productivity (Krishnan *et al.*, 2000), but additional dimensions – like the individual personality and behavioral traits of developers, and the structural organization of developer teams – should also be of interest when addressing the effectiveness of the software process. Nonetheless, the importance of technology should not be neglected: IT plays an increasingly active role in product development (Terwiesch & Loch, 1999), and mastering the technology is critical for IS professionals (Todd *et al.*, 1995).

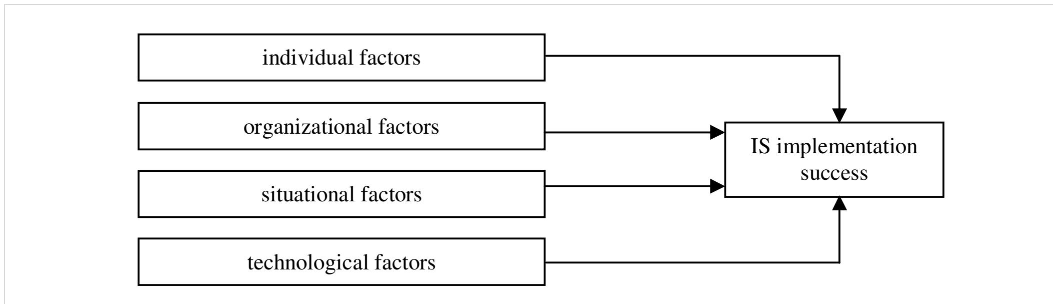
IS development should be systematic, independently repeatable, aimed at quality (Osmundson *et al.*, 2003; Maldonado *et al.*, 2001), and it may be conceptualized as unfolding through the following general steps: pre-development investigation, conceptual design, design and product engineering, systems test, development, and manufacturing (Terwiesch & Loch, 1999). Checkland (mentioned in Avison & Fitzgerald, 1999) suggests additionally that IS development is to be understood as involving (i) an intellectual framework comprised of ethical principles and ontological and epistemological issues, (ii) a methodology to put into action the intellectual framework, and (iii) an application area represented by a problematic situation to be solved. Despite the presence of the intellectual framework, which *a priori* confers to the IS professional reasonable freedom for action, IS development has been characterized in practice by the functional perspective (in line with the classification of sociological paradigms by Burrel & Morgan, 1979), and this is moreover the general pattern in systems analysis, systems engineering, and even in modern approaches to projects – like joint and rapid application design (Clarke & Lehaney, 2000).

Sarker (2000) describes four perspectives on IS implementation (Figures 1.1, 1.2, 1.3, 1.4), of which the socio-technical view seems to be currently the most appropriate for framing relevant variables in the process. The socio-technical perspective is discussed in more detail in a subsequent section.



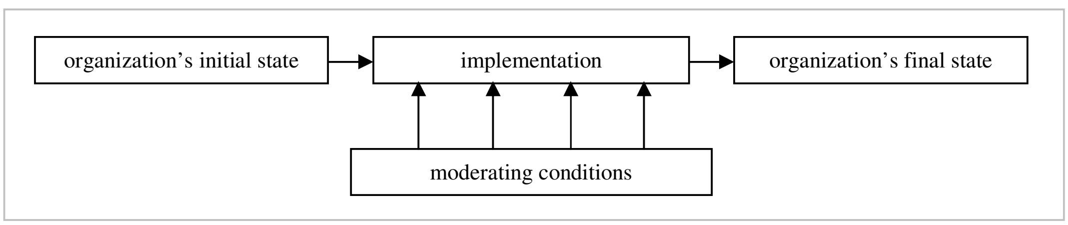
Source: (Sarker, 2000, p. 196).

Figure 1.1. Philosophical perspective on IS implementation.



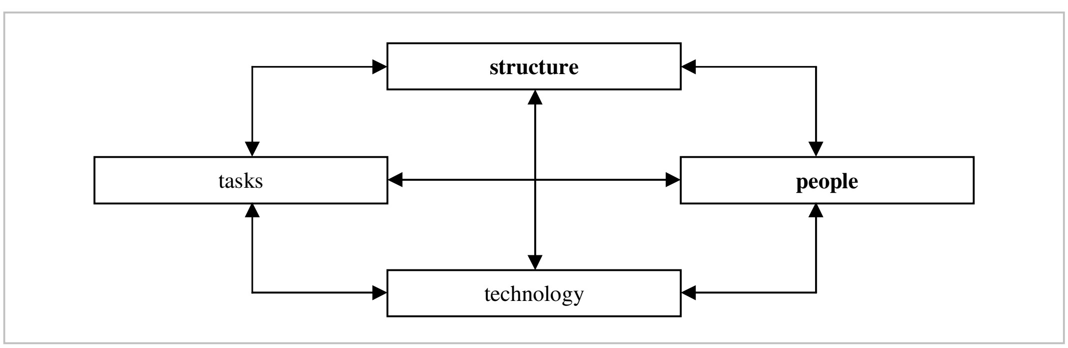
Source: (Sarker, 2000, p. 196).

Figure 1.2. Factors perspective on IS implementation.



Source: (Sarker, 2000, p. 196).

Figure 1.3. Process perspective on IS implementation.



Legend: boldface items represent the focus of our research, as explained later.
Source: (Sarker, 2000, p. 196).

Figure 1.4. Socio-technical perspective on IS implementation.

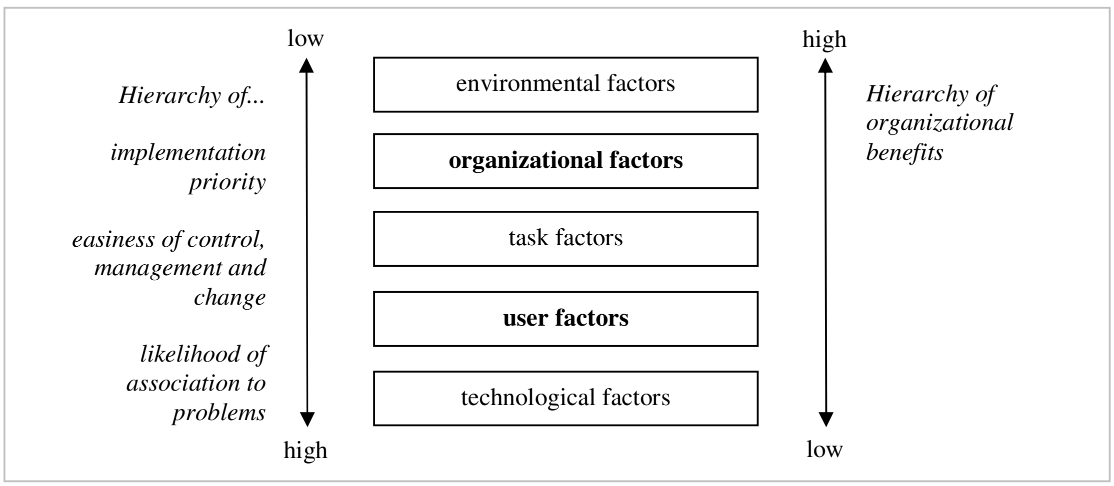
Process quality is a requisite (Osmundson *et al.*, 2003; Silva, 1995; Tsukumo *et al.*, 1997), truly setting the scene for product quality (Sherman, 1984; Tsukumo *et al.*, 1997; Pessôa, 2002a). But process quality does not represent a source of competitiveness anymore (Da Rocha *et al.*, 2001c) possibly due to practices being institutionalized in the industry (Galliers & Swan, 1999; Bellini, 2002). Such a reality is not new, given that since the mid-1990s quality changed from an advantage into a need (Kaplan & Norton, 1997).

But problems arise soon in the software process (Burchill & Fine, 1997). Theoretical gaps in software management (Ravichandran & Rai, 2000), like in assessing project management quality (Osmundson *et al.*, 2003), constrain our understanding and improvement of the whole process. Even software engineering, which should be quality driven (Avison & Fitzgerald, 1999; Da Rocha *et al.*, 2001b), is clearly shortsighted due to the aforementioned focus on technical issues, and such a bias is present in the whole software development field (Ravichandran & Rai, 2000; Palvia *et al.*, 2001). Consequently, there is no surprise in the amount of research reporting problems in software development (*e.g.*, Jiang *et al.*, 2006, Ågerfalk & Fitzgerald, 2006, Stamelos *et al.*, 2003, Osmundson *et al.*, 2003, Smith & Keil, 2003, Hoving, 2003, Shaw, 2003, Clegg *et al.*, 2003, Sharma & Rai, 2003, Pich *et al.*, 2002, Ropponen & Lyytinen, 2000, Ravichandran & Rai, 2000, Faraj & Sproull, 2000, Krishnan *et al.*, 2000, Keil *et al.*, 2000, Guinan *et al.*, 1998, Chatzoglou & Macaulay, 1997, and Clark, 1997), most of them relating to issues on productivity, schedule, budget, functionality, and customer satisfaction[2]. If we agree that most problems have been routinely reported in the software field during the last decades, then instead of a crisis the field faces a chronic problem (Parnas, 2006). Nevertheless, risk management is a relatively new trend (Sauer, 1999; Ropponen & Lyytinen, 2000), and, with the growing complexity of systems (Avison & Fitzgerald, 1999; Church & Te Braake, 2001) and the fast pace of technology change (Currie & Glover, 1999; Lopes & Morais, 2002; Stump *et al.*, 2002; Levacov, 2000; Latham, 1998; Goodman & Darr, 1998), rethinking the software process is always needed. The *Guide to the Software Engineering Body of Knowledge* (Abran *et al.*, 2001) is an endeavor to address problems like the ones mentioned and set best practices in knowledge areas for the software engineering domain – requirements, design, construction, testing, maintenance, configuration

[2] In what comes to scheduling, evidence is found that the need to systematically recalculate deadlines due to aggressive development strategies can be part of a managerial decision to reduce shortcut-taking by software developers, thus improving output quality and distinguishing the organization from the "better-managed" counterparts (Austin, 2001).

management, engineering management, engineering process, engineering tools and methods, and quality.

In order to find the underlying causes for the challenges facing the software field, Shaw (2003) proposes that perceived and actual problems may differ. Figure 2, based on Maslow's hierarchy of needs, shows that factors influencing the software process are in reverse order to their implementation priority in practice. This means that the most important factors (higher in the hierarchy) are seldom implemented, which is an explanation for why most projects fail, as well as for why technological issues (appearing at the bottom) are the first – and sometimes the only – concern in projects. Sarker (2000) conceived a similar model with the factors perspective mentioned earlier, but with no hierarchical assumptions.



Legend: boldface items represent the focus of our research, as explained later.
Source: adapted from Shaw (2003), reproduced from Bellini *et al.* (2004, p. 18).

Figure 2. Hierarchy of factors affecting IS implementation.

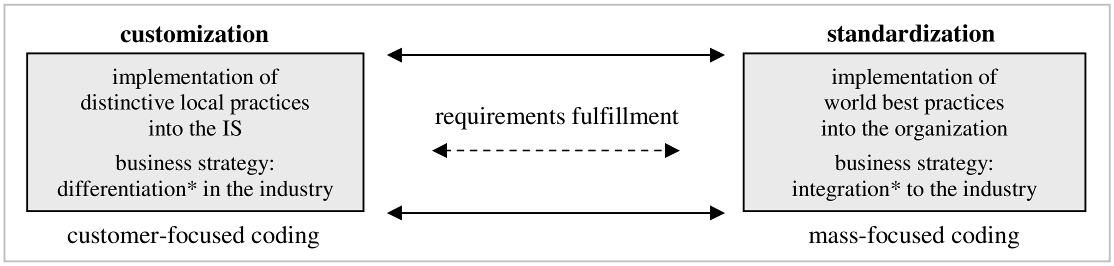
Figure 2 is rich in insights for understanding why so much attention is given to technical attributes in software projects (and, therefore, to technology-oriented metrics). First, since Shaw's (2003) hierarchy is based on Maslow's hierarchy of needs, in which higher-level needs are only addressed when lower-level needs are satisfied, the fact that technology is the dominant preoccupation in IS projects may mean that the implementation of technology is currently ineffective (be it due to the technology itself or to its application), thus preventing attention to be paid to higher needs. Second, technology being the most desirable dimension for effortless management may have an influence in developers not being incited to take care of other dimensions of the solution. Third, the natural tendency of connecting deficiencies in implementation to the likelihood of lower-level needs not being fully satisfied perhaps favors an approach whereby excessive attention is devoted to perfecting – maybe endlessly – the fulfillment of the more fundamental needs. Other explanations not stemming from Shaw's (2003) reasoning may relate to IT professionals not being prone to change, to the institutionalization of practices in the profession and the industry (DiMaggio & Powell, 1983), and also to particular preferences of developers.

As a consequence of the recurring problems in software, the organizational top layer turned out to be cautious in what comes to committing resources to system development (Wallace, 1989). IS designed based on traditional perspectives do not benefit the users nor meet competitive needs anymore (Jackson, 1999), possibly due to omitting "people" costs (Trist, 1993), overlooking key social and political factors and patronizing an excessively technical view in projects (Avison & Fitzgerald, 1999). We thus propose that the management of IS development requires fresh approaches and innovative research.

3.3 Outsourcing and Software Customization

The particular employment relation in a project generally affects its performance as measured by profitability (Mayer & Nickerson, 2005). In this sense, outsourcing is a means to developing software rooted in the efficiency imperative (Anderson, 2002), since external expertise from partners is contracted in a cost-effective manner. In fact, even software organizations may outsource the development process, given that no single company has all the requisite market capabilities (Leite, 1997).

Outsourced software projects *may* involve (but not necessarily do) building one-of-a-kind products, and customized products *may* be (but not necessarily are) developed under an outsourcing contract as well. This research focuses on outsourcing agreements for developing customized IS software (CISS), *customization* here understood as the degree to which software development can be tailored to individual project needs (Nidumolu & Knotts, 1998; Stamelos *et al.*, 2003; Leite, 1997). Ultimately, CISS contains a significant software component individually developed for each situation in order to implement at least one core business process (Figure 3). CISS development, however, faces the challenge of counteracting the fact that most approaches to software development take for granted that software is a standard product (Hosalkar & Bowonder, 2000).



* An extension of Lawrence & Lorsch's (1973) work on the organizational structure.
Source: adapted from Bellini *et al.* (2004, p. 19).

Figure 3. Implementation *continuum* for IS software requirements.

Key concepts to be extensively used in this CISS rationale are found in Table 1.

buyer (customer, client, contracting agent)
Organization that sponsors development efforts (Majchrzak *et al.*, 2005), adopts and uses innovations (Athaide & Stump, 1999), or accepts a product and authorizes payment (CMMI Product Team, 2002). In our research, there are no implications in distinguishing between the *user* and the *customer* (see Kirsch *et al.*, 2002, and Yourdon, 1997), although we also warn that this should not always be the case (see Metersky, 1993); a review on the user's nature can be found in Lamb & Kling (2003). The buyer may be also referred to in situations by its *insourced/internal system developers* (*CuTe professionals*).

seller (vendor, supplier, contractor)
Organization that develops and transacts technological innovations (Athaide & Stump, 1999). The seller may be also referred to in situations by its *outsourced/external system developers* (*X-Team professionals*).

partner
Organization that is committed to an enduring relationship with another organization in order to attain business goals from the perspective of maximizing each partner's effectiveness (NEDC mentioned in Naoum, 2003). We here deem individuals as partners as well.

joint development
Degree to which vendors and buyers develop products together (Stump *et al.*, 2002).

customization (personalization)
Strategic decision of vendors in regard to the degree to which their products incorporate a customer's individual needs (Stump *et al.*, 2002). In our research, *personalization* has the same meaning (see Cheung *et al.*, 2003, Zhu & Kraemer, 2002, and Anderson, 2002).

user participation
Behaviors, assignments, and activities that the user or his/her representative[3] performs during system development (Hartwick & Barki, 1994).

Table 1. Key concepts for CISS research.

[3] The notion of a representative is crucial, since CuTes may represent the user in some situations. In fact, our empirical research involved a CuTe that played this role mainly through the presence of lead users in the team.

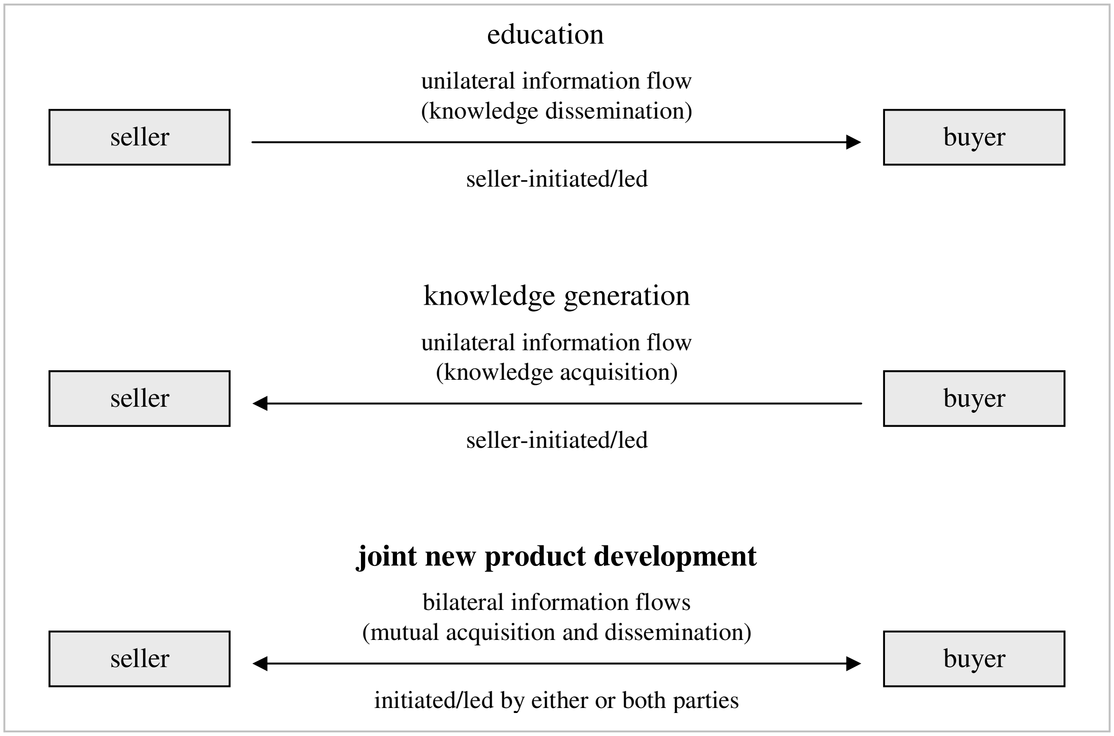
Customized IS products are aimed at matching IS to an organization's business processes, although we recognize that a perfect match is virtually impossible. Such an alignment is assumed to be key for the company's successful performance – that is one reason why an organization is unlikely to perceive benefits when imitating competitors (Sabherwal & Chan, 2001). A specific benefit of developing customized software is that it has a significant positive effect on the process' perceived performance, and, paradoxically, it improves flexibility and predictability (Nidumolu & Knotts, 1998). Moreover, it is well recognized that customized products benefit both the customer and the supplier (Stump *et al.*, 2002), supporting a much desirable win-win business perspective (Blackstone Jr. *et al.*, 1997). There is no surprise that software integration and customization are expected to increase (Avison & Fitzgerald, 1999).

Collaborative work is the starting point for developing customized IS, and partnerships, which are increasingly implemented (Lacity & Hirschheim, 1999; Powell, 1998), represent the governance design to be adopted (Anderson, 2002). Following Naoum (2003), their origin can be traced back to the care with customers and with the complexity of systems, providing the means to setting mutual goals between developers and to searching for continuous improvement and the resolution of conflicts. Partnerships presume trust, cooperation and teamwork (Naoum, 2003); trust, as a matter of fact, enables cooperation (Blanchard & Horan, 1998), truly being necessary that a trustworthy relationship be established between the customer and the IS professional in system projects (Kirsch *et al.*, 2002). In the case of collaborative development of new products – a partnership-like arrangement based on active roles performed by both the seller and the buyer (Athaide & Stump, 1999) –, sellers and buyers are interdependent, minimizing the opportunism of the latter as well as market and technological uncertainties relative to commercializing innovations (Stump *et al.*, 2002). Factors like motivation and capability, though, need to be present when integrating the customer in product development (Tollin, 2002).

Due to environmental idiosyncrasies, an organization can face nontrivial challenges to penetrate the social context of its customers (Sivula *et al.*, 1997) and create enough knowledge on the required business processes (Allen, 2002; Lacity & Hirschheim, 1999), what is, nevertheless, mandatory for IS implementation (Bednar, 2000). Among the challenges, we highlight the inability of developers to grasp the informational needs of users (Griffith & Northcraft, 1996), largely because the demands of the latter change over time (Swanson & Dans, 2000; Wallace, 1989). User involvement and participation are, thus, unavoidable in IS projects (Jiang *et al.*, 2002). This is in line with the fact that the partaking of internal and external actors in a problematic situation amplifies the analysis of solutions (Bednar, 2000), as well as with the assumption that the most efficient partner in a given task should perform it (Anderson, 2002).

For the vendor, the proximity with the customer represents a competitive advantage in the specific context of each problem (Sivula *et al.*, 1997). Therefore, developers should conceptualize their customer base as a managed set of relationships for new product development (Athaide & Stump, 1999) – and it is this very management that interests mostly our research. On the other side, the clientele of customized solutions also experience ample benefits, as exemplified by the fact that joint work with external experts enables the contracting organization to pay exactly for what it needs and gets (Avison & Fitzgerald, 1999) while keeping the eyes on the strategic processes (Melian *et al.*, 2002). The contracting organization, however, is asked to develop skills for selecting the most appropriate vendor (Avison & Fitzgerald, 1999).

Figure 4 shows three behavioral dimensions implied by the relation between sellers and buyers when developing new products – *education*, *knowledge generation*, and *joint new product development* (Athaide & Stump, 1999). Our research focuses on the joint new product development, mainly in what comes to investigating how to make more proactive and deliberate in terms of project responsibilities the organization that acquires CISS. Indeed, bilateral approaches govern product customization, while unilateral perspectives prevail in the development of standard products (Athaide & Stump, 1999).



Legend: the boldface item represents the focus of our research.
Source: Athaide & Stump (1999, p. 472).

Figure 4. Behavioral dimensions in new product development.

As a result, the relationship between a company and its customers typically perseveres along time (Sharma mentioned in Sivula *et al.*, 1997), and this is to be reinforced by the development of customized products (Stump *et al.*, 2002). In fact, customers and manufacturers are closer than ever (Zhu & Kraemer, 2002) and many tasks requiring business skills are even transferred to end-users or performed by mixed teams (Feraud, 2004; Todd *et al.*, 1995). In the particular case of software projects, intense customer participation not only leads to a possible better fit between problems and solutions, but also makes it more likely that the user will assess positively the system produced (a causal mapping involving customer participation in projects, willingness to participate, system evaluation, and satisfaction can be built from Burns & Madey, 2001, Kim *et al.*, 2002, Hunton & Beeler, 1997, and Galliers & Swan, 1999).

In spite of the over-optimism of the outsourcing literature (Lacity & Hirschheim, 1999), drawbacks are naturally present, particularly when involving customization. Among the most critical aspects, outsourcing strategic routines is not at all desirable, since an organization must protect its core business and competence; indeed, privileged organizational information may be critical to performance (Wetherbe, 1997). Second, the technological knowledge gap between customer and supplier may impose important risks to the former (Lacity & Hirschheim, 1999); therefore, formal and detailed agreements between customer and supplier are essential in such a governance design (Ho *et al.*, 2003; Lacity & Hirschheim, 1999; Avison & Fitzgerald, 1999). Other problems concern organizational strategies about innovation and customer relationship management (Tollin, 2002) and vendors incurring in high investments for customizing products, disputes around patent ownership, exclusivity clauses, buyer opportunism and information asymmetry (Stump *et al.*, 2002; Lacity & Hirschheim, 1999).

Customers are, therefore, learning to negotiate better contracts (Lacity & Willcocks, 1998), sometimes writing up one-sided agreements in order to benefit from the excessive self-confidence of developers (Kovitz, 2003), while suppliers search for more impartial – interdependent – relations with customers (Stump *et al.*, 2002). Effectively, the equilibrium in partnerships involves much debate (Lacity & Hirschheim, 1999). This state of affairs is part of a broader perspective – that of new product development – which is concerned with risks, ambiguities, uncertainties and functional conflicts emerging from differences in perceptions and interests between the agents (Frost & Egri mentioned in Atuahene-Gima & Evangelista, 2000). Our research contributes for the field particularly in helping to build more detailed contracts by improving the knowledge about actual performance criteria to be observed by CuTes, as well as on how to measure them, judge the measurements and apply results in future projects involving the same client organization or its CuTe professionals. In sum, *process visibility* – the assessment of who is at fault – is on target, what is argued to be directly related to improved system performance (Plambeck & Taylor, 2006).

Table 2 presents the critical success factors (CSF), or the minimum required for success (Rockart, 1979), for certain classes of software projects – among which, customization. The *innovation* attribute deserves some interpretation. *Product innovativeness* refers to breaking established standards (Mintzberg, 1983) or the degree to which a product is new for an organization or market (Atuahene-Gima & Evangelista, 2000); but innovations are not easy to frame nor imitate, they are subjective and dependent on context (Galliers & Swan, 1999), and the active participation of users in the innovation process should be reinforced (Sivula *et al.*, 1997). Nonetheless these challenges, the centrality of innovation in the organizational studies (after all, enhancing without innovating from time to time may drive an organization to a loss in competitiveness – Blaschek, 2001) is not ignored in the software customization arena, specially in IS implementation (Galliers & Swan, 1999). Indeed, IT innovation may result in high customization (Anderson, 2002).

	PROJECT CLASS			
FACTOR	Conv	**Cust**	Pack	**ERP**
customer requirements analysis		x		
software configuration design				x
validation	x			
ability to meet competitors' offerings	x			
cycle time estimation	x	x		
software customization		x		
innovation		x		
cross-functional interaction		x		x
alignment with multiple user requirements			x	
ability to configure multiple users			x	x
customizable submodules				x
analysis of interaction between submodules				x

Legend: "Conv" = conversion projects, "Cust" = customization projects, "Pack" = packages, "ERP" = enterprise-wide projects; boldface items represent the focus of our research.
Source: Hosalkar & Bowonder (2000).

Table 2. Critical success factors according to software project class.

Table 3 introduces an update for CSF and best practices in ERP implementation. It should be noted, however, that there is a lack of rigorous research on the actual drivers of successful implementation of ERP packages (Correa & Cruz, 2005). ERP implementation is the special interest of our empirical research, as discussed later.

CRITICAL SUCCESS FACTORS Colmenares (2005)	BEST PRACTICES Ferratt *et al.* (2006)
top management support	IS participation
presence of a champion in the project	project planning
project management	top management support
full-time availability of the best workers	participation of team members
effective communications	composition of the project's team
interdepartmental communication and cooperation	training of the project's team and end-users
management of expectancies	software selection
users' technical and business knowledge	primary consultant's capability
end-user participation	primary consultant's support
standardization and commitment to the implementation procedures	
judicious selection of suppliers	
user training	
implementation strategy	
transparency in the definition and the achievement of project goals	
use of external consultants	
parsimony in changing the system	
integration between the customer and the supplier	
assembly of a management committee for the project	
process reengineering	
computer support	

META-ANALYSIS OF CRITICAL SUCCESS FACTORS Correa & Cruz (2005)
Factor (citations in ISI journals)
top management support (16)
training (16)
project management (14)
business process reengineering (12)
change management (10)
business plan (10)
implementation team (9)
external consultancy (9)
effective communications (8)
accurate data (8)
presence of a champion (7)
software testing (7)
system integration (6)
selection of supplier (5)
parsimony in changing the system (5)
culture (5)
(other factors) (less than five citations)

Table 3. Critical success factors and best practices for ERP implementation.

In what comes to success factors for IS outsourcing, Leite (1997) organizes them according to Table 4. Of special note here is the presence (with top priority) of customization in the list, what suggests an intimate relation between the two development strategies (customization and outsourcing). In addition, some factors in Table 2 are mirrored in Table 4.

FACTORS	IMPORTANCE
customization; service quality	1
technical competence of the team; implementation monitoring	2
customer relationship; service scope; technological updates; knowledge flexibility of the team; international experience; infrastructure and physical facilities; deployment of methodologies; previous successes	3
innovation capacity; ability to make technological investments; focus on a specific market segment; technological independence; assertive marketing; stability of the in-house personnel; partnerships with other organizations; breadth of the telecommunications network	4

Source: Leite (1997).

Table 4. Critical success factors for IS outsourcing.

Albertin (2001) adds that the following CSF are due to any IT project: top management support, quality technical processes, monitoring and control, plans and schedule, and definition and transparency.

3.4 Software Quality and Best Practices

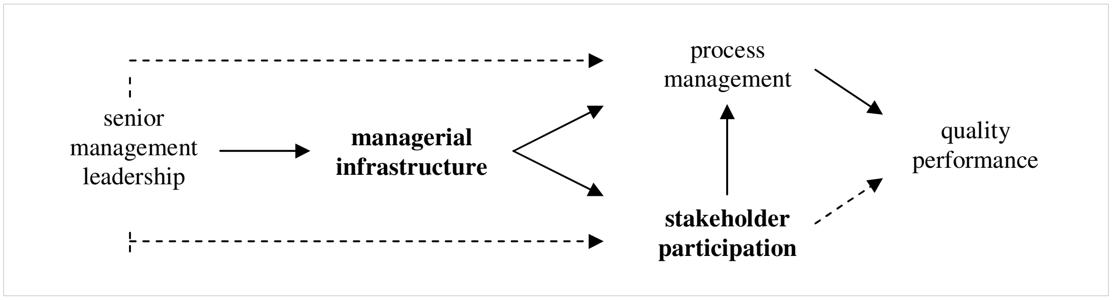
The importance of discussing quality is put in evidence by the facts that improvements are needed in qualifying the management of software development (Hosalkar & Bowonder, 2000) and that there is a green field to be explored in connecting quality, measures and business (Stein, 2001a). A satisfactory application of total quality management (TQM) to systems development and a theory on managing software quality emerged only recently (see Ravichandran & Rai, 1999/2000, and Ravichandran & Rai, 2000), but the authors do not differentiate stakeholder types in software development nor take into account a project's nature (customized or not, outsourced or not, for instance).

Hoyer and Hoyer (2001) compile several definitions for *quality*, as contributed by the authoritative works of Deming, Crosby, Feigenbaum, Ishikawa, Pirsig, Shewhart, and Taguchi. In our research, however, the definition from the International Organization for Standardization (ISO) is adopted, according to which quality is the totality of characteristics of a product or service that rests on the ability to satisfy explicit or implicit needs (Sharma & Conrath, 1992; Palvia *et al.*, 2001); it is straightforward from this that each individual has his/her own perception about the quality of any product or service.

During the mid-1990s, quality changed from a distinctive into a compulsory organizational attribute (Kaplan & Norton, 1997; Da Rocha *et al.*, 2001c), possibly due to the institutionalization of practices (Galliers & Swan, 1999; Bellini, 2002). The management of quality cannot be evaded by an organization that wishes to stay in business and flourish (Bialowas & Tabaszewska, 2001). For instance, improvements in cycle time and productivity are related to efforts on quality (Harter *et al.*, 2000). Notwithstanding the contemporary organization must cope with such a contingency (the permanent eye on quality), TQM – whose principles should be extended to the software process (Huq, 2000; Palvia *et al.*, 2001) – is applicable to any situation (Bialowas & Tabaszewska, 2001), and this provides the theoretical cornerstone for starting the initiative. In systems development, TQM favors user requirements to be addressed on functionality and budget constraints by means of project management and the involvement of users, senior managers and system developers (Aggarwal & Rezzae, 1996); there is, however, the need for a better understanding of the causal bonds between some TQM components (Ahire & Ravichandran, 2001).

According to Ravichandran & Rai (2000), the key components of an organizational system driven by software development quality (*product quality* and *process efficiency*) are (Figure 5):

- *senior management leadership* – degree to which senior IS management sponsors improvements on quality and theorizes on quality initiatives for the systems development organization;
- *managerial infrastructure* – structural property of the IS organization related to creating an organizational setting oriented towards quality for the central processes and work practices;
- *process management* – degree to which the key project and development processes get defined, controlled and systemically improved; and
- *stakeholder participation* – degree to which the work practices are set in a way that each group contributes with complementary knowledge to the other groups involved in CISS development.



Legend: continuous arrows indicate direct, positive effect; dashed arrows indicate indirect, positive effect; boldface items represent the focus of our research.
Source: Ravichandran & Rai (2000).

Figure 5. Software management quality.

Senior management does not affect directly the actual participation of each stakeholder group, but instead it sets the overall conditions for the process to flow smoothly and successfully. This is in accordance with an assumption of the socio-technical design of work systems stating that teamwork should operate in a relatively autonomous fashion (Trist & Murray, 1993b). The focus of the CISS research is on the antecedents and consequents of stakeholder participation.

Improvements in the field of software quality are, however, only slowly changing the realm of software development and application; in fact, unsuccessful improvement programs in the software industry exceed in number the success reports, while improvement rates seem also to be less than desired (Halloran, 1999). As already mentioned, this may be related to the technological bias present in most projects (Ravichandran & Rai, 2000; Palvia *et al.*, 2001), but a more intriguing – and potentially harmful – subject is the trend of "best practices" in the software industry. There is no doubt that CMM- and ISO-like models provide powerful directions for improving the software process and the overall organization for quality; after all, learning from high-performance projects is axiomatic (Stensrud & Myrtveit, 2003). But the overconfidence on such models notwithstanding the lack of publicized, scientific empirical validation of their effects on company performance (Gefen *et al.*, 2006; Krishnan *et al.*, 2000; Ravichandran & Rai, 2000) and user satisfaction (Gotzamani & Tsiotras, 2002) may be misleading and, worse, become institutionalized (Galliers & Swan, 1999) due to, for instance, external pressures for certification and advertising (Gotzamani & Tsiotras, 2002). Careful examination of such models and the specific application context is nevertheless necessary in order to prevent that benefits are only perceived by the models' vendors. The following excerpts illustrate the reasoning:

- many proposals on improving the software process do not make explicit claims on organizational factors (Ravichandran & Rai, 2000); however, it is widely known that productivity – important factor in software development – can only be achieved systemically (Blackstone Jr. *et al.*, 1997);
- quality standards do not keep track of development and product maintenance costs (Krishnan *et al.*, 2000);
- in some domains, it seems that the manufacturing process is the actual motive for the organizational synergy, rather than system (product) quality (Avison & Fitzgerald, 1999; Baiman *et al.*, 2000); as a matter of fact, quality and customer satisfaction are not addressed by ISO9000 norms as direct outcomes for the long run (Gotzamani & Tsiotras, 2002);
- shortcomings in managing knowledge workers, like the IS professionals, are not of a psychological or cultural nature, but reflect deep conflicts, and this demands that prudence be the guide for arguing about "best practices" for standardizing the work of such individuals (Scarbrough, 1999); in particular, software development teams bears problematic issues for management (Faraj & Sproull, 2000);
- the validity of quality models should be investigated in greater depth (Ravichandran & Rai, 2000); for instance, regarding how to mature process capabilities, the definition of "process management", the development of measurement instruments, and the integration between an organizational perspective and TQM's customer-oriented process improvement;
- organizations that adopt, say, ISO9000 standards are not asked to demonstrate the extension of economic, operational or market improvements after deploying the norms (Gotzamani & Tsiotras, 2002); and
- besides the norms reporting best practices not necessarily valid in the industry, their dissemination (*e.g.*, in academic events or professional meetings) by a large number of unproficient *ad hoc* groups (like some committees of ABNT, the Brazilian association for technical normalization) encourages serious doubts on the exhortations' efficacy.

Comparisons between some software quality models were discussed in depth by Argollo Jr. (2002), Balduíno (2002), Machado (2002a & 2002b), Pessôa (2002a & 2002b), Reinehr (2002), Spínola (2002) and Tsukumo *et al.* (1997).

Recalling the literature on product development (software included), it is noticeable that it draws attention on setting criteria to be complied with only by contractors. For instance, Baiman *et al.* (2000) talk about profits for buyers and penalties for suppliers; the literature on *satisfaction* is consistent in its customer focus (*e.g.*, Burns & Madey, 2001; Kim *et al.*, 2002);

Avison & Fitzgerald (1999) ask customers to build skills for choosing vendors, but they do not make similar claims on vendors selecting customers with, say, good reputation in collaborative software development; Burchill and Fine (1997) focus on the need of product developers to understand the customer's use context, while they bypass the supporting role played by the latter for successful project outcomes; Bialowas and Tabaszewska (2001) propose a ranking system with which customers assess suppliers, saying nothing, though, about a possible similar framework to proceed in the reverse way; Hwang *et al.* (2006) and Gooden (2001) present us to the issue of customers asking suppliers to be certified in quality management standards, although no similar demand for certifying customers of technology seems to exist; and, accordingly, Jiang *et al.* (2002) warn that little has been done to prevent user risks before developing systems.

Nonetheless, when assuming that quality standards are to be exclusively applied to contractors, an essential ingredient for the success of customized projects – the effective participation of customers – is inadvertently neglected. Realizing that little is researched on the customer responsibility for software quality is even more disturbing when confronted with the already mentioned fact that the alignment between strategic business and IS issues is key for the executive function (Brodbeck, 2001; Chan *et al.*, 1997). The customer plays an invaluable role in this, since IT benefits can only be devised when emerging from adapting the technology to the organizational context during implementation (Lassila & Brancheau, 1999), what is in line with the assertion that technology is created, used and modified by people (the *duality of technology* – Orlikowski, 1992). In practice, this means that espoused (*officially* adopted) technologies may eventually not equate to in-use (*effectively* adopted) technologies (Orlikowski, 2004).

Why, then, not to involve the customer in adhering to quality standards when interacting with external developers during CISS development? Our work conceives this as a potentially harmful perspective (although we subscribe to the legitimate precedence of customers in the industry) and supports a thorough debate to improve arguments and practices. Customer performance should, however, be assessed with different methods as compared to contractor performance, given the very nature and roles of each party in projects.

3.5 Work Systems and CISS Projects

CISS development takes place within organizations, and it is usual that at least two organizations get involved: the client organization and the outsourced company responsible for the best global practices in technology and business processes. A third organization is found in most projects as well – a consultant firm responsible for implementing the project. Our research is interested in a peculiar group within the client organization – the customer team (CuTe), already defined as a team of professionals from the client organization of CISS projects who are assigned special business and IT roles for interacting with external developers (the X-Team) in such projects.

From a theoretical perspective, the work within a CuTe is here framed as a socio-technical system (Trist & Murray, 1993a). Although abundant in IS research, socio-technical evidences are scant in the management of software quality (Ravichandran & Rai, 2000) – and this confers a seminal contour to our research intents. Recently, the socio-technical approach to IS development has received great attention with the publication of a special issue of the *European Journal of Information Systems* devoted to the subject (the reader is invited to browse Chae & Poole, 2005, Davidson & Chiasson, 2005, Doherty & King, 2005, Hatzakis *et al.*, 2005, Kotlarsky & Oshri, 2005, Lee & Xia, 2005, Lin & Silva, 2005, and Luna-Reyes *et al.*, 2005).

The importance of arguing about the structure of work systems in this research is due to the fact that, as pointed out by Clegg *et al.* (2003), organizations have not been successful in addressing non-technological issues of technology – like the human and structural properties –, and that the human component is the most challenging and the key determinant of system architecture (Metersky, 1993); in reality, computer systems are immersed in human systems, and the effective project of such systems should understand and anticipate the implications of this (Douglas, 1983).

The following subsections discuss the links between CISS research and the socio-technical approach to framing the work system.

3.5.1 Teams

In this section we comment on why teams are the appropriate design for bringing together IS professionals in customization efforts, especially why we focus on customer *teams* as the unit of analysis.

So, starting from the *human group* as a number of people in touch with each other (Hofstede, 1994) or as people who intercommunicate during some time and who are few enough to be able to communicate directly one with the other (Homans mentioned in Jones, 1997), a *team* would be a group of people whose complementary skills and common goals and thinking enable them to carry out tasks on which each member is equally responsible (Church & Te Braake, 2001). By engaging in a team perspective, painful relationships between line and staff personnel can be mitigated (Scarbrough, 1999), an entrepreneurial attitude is leveraged (Richards & Gupta, 1985), and knowledge creation is nurtured (Leidner & Jarvenpaa, 1995).

Table 5 contrasts teams against committees and workgroups, and from it we can argue about the former as the most effective layout for the IT-business workforce in CISS development:

- the fact that teams are generally small adheres to the assumption that size reduction is necessary for people to be in contact with each other for work coordination (Semler, 1989), as needed in CISS development;
- the technical competence of team members – although multifunctionality is also needed (Cowley-Durst, 1999; Rezende, 1999; Lind & Seigerroth, 2003) – is in line with our premises that CuTes are also responsible for the success of CISS development and that they should meet performance levels;
- the high levels of team autonomy espouse the selection of a socio-technical framework for designing the work system in CISS development;
- the fact that teams work as compact units make them able to satisfy demands in which task complexity exceeds the individual cognitive ability of their members (Osmundson *et al.*, 2003; Simon, 1979);
- the vendor-client nature of the relation of teams with other entities in projects is of particular importance for addressing the role of the IT-business people (both from the customer and the developer companies) involved in CISS development; and

- the aforementioned arguments can be also deployed for advocating the team design as the structural option for the outsourced professionals (the X-Team) that will interact with a CuTe.

Rezende (1999) posits that an IS should be developed by teams populated by the following individuals: the *sponsor* (user/customer executive, typically from the largest company division involved in the project, with extensive decision power, and who sets goals and deadlines and negotiates the planning), the *manager* (user/customer professional assigned to operational and systemic processes, with decision power and responsible for ensuring that the planning is executed), the *customer/user team* (business professionals executing operational processes) and the *technical team* (computer technicians, system analysts and software engineers executing operational processes). CuTes match the capabilities of both customer/user teams and technical teams.

	committee	**workgroup**	**TEAM**
unit size	large	medium	**small**
composition	mostly senior management	seasoned managers and frontline employees	**mostly young, frontline employees**
members' competence	mainly non-technical	technical and non-technical	**mostly technical**
level of independence	low	medium	**high**
internal organization	divided into subgroups	works mostly as a single group	**works exclusively as a single unit**
relationship with other units	subservient	competitive	**vendor-client**
relationship with external contractors	delegates technology	delegates parts of technology	**builds/integrates most technology**
members' attitude to projects	supervision	management	**ownership**
culture and spirit	none	unique language and work culture	**independent work ethics and performance standards**

Source: Peled (2000, p. 11).

Table 5. Organizing the work in human groups.

3.5.2 Socio-technical Design

According to Nadler and Gerstein (1992), the bureaucratic organizational structures were successful for a long time whereby organizations rested on a categorical system of hierarchical relations with direct effects on decision making and coordination processes. Organizations should be governed by a transparent and consistent set of principles and procedures for each function; at the same time, the incumbents should objectively qualify for the tasks with a level of technical competence that affirmed the professional legitimateness and the likelihood of personal evolution within the hierarchy.

Nevertheless, some flaws in the bureaucratic model impelled the advent of alternative governance structures for work design. For instance, bureaucracy relates to managing somewhat stable and predictable situations, and it assumes that the workforce is primarily motivated by pecuniary factors; but such organizations will eventually experience complexity, no mastery in reacting to external pressures, and an inward behavior. Hence, bureaucracy does not address properly the demands from the turbulent exterior; after all, there is no correspondence between an organization's internal variety and the environmental requisite variety[4].

A London-based institute started studies that would radically contend the bureaucratic sovereignty. Trist and Murray (1993b) comment that the Tavistock Institute of Human Relations was built in 1946 as an independent, nonprofit organization aimed at studying the relation between society and the social and psychological sciences. According to Nadler and Gerstein (1992), it was then proposed that a superior organizational performance implied that social and technical needs deserved to be taken as equally important and be simultaneously satisfied in the project of any work system. The Institute's researchers argued that a set of principles different from the traditional "one man, one function" should be employed; as an alternative to fitting people and structures to an optimum technical system, joint optimization of the technical and the social systems should be sought instead. The socio-technical approach advocates the following principles (Trist, 1993; Nadler & Gerstein, 1992):

- the work system as a whole constitutes the unit of analysis – instead of the job positions into which it decomposes;
- the internal supervision by the group replaces the individual supervision;

- although work principles and processes for achieving success need to be set, nothing more than the indisputable essential is defined (*minimum critical specification*);
- each member is required to be skilled in more than one function (*redundancy of functions*, not parts), for the work system to be flexible and adjustable (*holography* and *requisite variety*);
- interdependent functions are allocated within the same departmental boundaries;
- information systems provide information directly to where it is needed for decision making and action;
- deviations from the ideal process are controlled at the source; and
- people complement the machine – they are not part of it.

These principles are intimately related to an important belief of Eric Trist, one of the founding fathers of the socio-technical approach: that of people being able to effect substantial changes when offered alternatives (Pasmore & Khalsa, 1993). Assumptions like this, allied to robust methodology and a reported successful history, confer creditability to the socio-technical exhortations (Mumford, 1999).

3.5.3 High-performance Work Systems and Teams

As an extension of the socio-technical approach, Nadler & Gerstein (1992) talk about high-performance work systems (HPWS) for the design of human organizations, integrating people, technology and information towards a more effective fulfillment of customer needs and other environmental demands and opportunities. Basically, HPWS try to counterbalance the fact that the socio-technical framework is strongly oriented to the organizations' interior. Such systems observe project principles applied to specific situations, and they can be synthesized as follows:

- any project starts with attention being given to the customer and to the external environment, moving gradually towards the organization's interior;

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[4] *Variety* is the number of possible states of a system (Beer, 1983; Flood & Carson, 1988). Any system struggles for equilibrium between its internal and external variances (Morgan, 1996; Flood & Carson, 1988).

- the organizational units are designed around complete work pieces, maximizing interdependencies within units and minimizing interdependencies between units (teams, instead of individuals, are the "building blocks");
- procedures are defined and clear;
- error control takes place at the source, with work units being equipped with tools and information to detect and prevent them;
- the technical and the social systems are inexorably interrelated, none being able to uniquely define the other;
- there is a flow of information, not data;
- people are trained in multiple functions;
- people cherishing is practiced;
- the managerial structure, culture and processes are reinforced; and
- the work units are adept in rapid reconfiguration.

From this, *high-performance teams* (HPT) are defined as elite units comprised of a small number of professionals with complementary skills and who are devoted to shared objectives and performance goals, as well as to a system of beliefs upon which everyone is responsible (Peled, 2000). Key for the HPT concept is, according to Dawson and Newman (2002), *empowerment*: the development of (1) skills for learning from available information, (2) trust in experimentation with new things and learning from experience, (3) skills for finding solutions, (4) trust in the ability to select and pursue reasonable paths of action, (5) skills for explaining what is done, and (6) skills for working in teams. For Morley and Heraty (1995), HPT members report, among other benefits, an increase in work variety, autonomy, and satisfaction with feedback on performance (in fact, feedback encourages self-management – Blackstone Jr. *et al.*, 1997). Such teams are vital for the success of mission-critical IT projects (Peled, 2000).

Nadler and Gerstein (1992) conclude that HPWS are among the most effective work designs available, being aligned to initiatives in total quality. TQM, for instance, should be implemented from a socio-technical perspective, according to Ahire and Ravichandran (2001). The affinity between HPWS and quality, and, in particular, between HPT and IT projects makes explicit reference to the appropriateness of our research framework for dealing with the work organization of CuTes. At the same time, the lack of studies on the links between participatory approaches and process improvement, and the influence of contextual factors on current practices (Ravichandran & Rai, 2000) suggest the relevance of our endeavor.

3.5.4 Socio-technical CISS Development

In this section we compile contributions from the literature to put in evidence the importance of taking into account the four socio-technical dimensions – technology, tasks, people, and structure – and the principles that govern their application in CISS development. The ultimate intent is to support the argument that the participation of customers in IS projects must be measured (among other reasons, in order to enable fair rewards and deviation analysis and correction) based on variables and relations of a socio-technical nature. This is in line with the fact that socio-technical design is consolidated in IS research (Ravichandran & Rai, 2000).

First, theoretical contributions suggest that not only the technology should be deployed in customizing IS software:

- individual, organizational and product-related factors impact new product development (Atuahene-Gima & Evangelista, 2000);
- IT development involves technical and managerial issues (Latham, 1998);
- the success of IS implementation is multidimensional (Palvia *et al.*, 2001);
- any system should be technically and organizationally validated (Ravichandran & Rai, 2000);
- IS curriculum needs to address organizational issues at least at the same extent as technical issues (Lopes & Morais, 2002);
- numerous social variables are related to IT effectiveness (Ryan & Harrison, 2000);
- improvements in the social process of software development is a promising field (Basili & Musa mentioned in Faraj & Sproull, 2000);
- computer systems are inserted in human systems, whose peculiarities must be addressed in designing the former (Douglas, 1983);
- the structuration perspective (social process involving the interaction between human actors and structural features of organizations – Orlikowski, 1992) highlights the intrinsic ties between the individual action and the institutional processes, which is not always deemed of interest in IS research (Jones, 1999);

- in structuration terms, technology is a minor aspect of social practice (Jones, 1999);
- emphasis on only one (socio-technical) dimension does not lead to success (Lee, 1999b), since all components of the organizational system should be developed in order to quality to be achieved (Ravichandran & Rai, 2000); and
- it is mandatory that the technical, the social and the knowledge systems of a company be integrated (Scarbrough, 1999).

Second, the literature on IS development and on work in general discusses the flexibility of relations between managers and subordinates, as illustrated by the following excerpts:

- IS professionals should be granted with autonomy of actions in order to meet performance levels (Ravichandran & Rai, 2000), leaving for the managers the task of leading and motivating them (Blaschek, 2001) – the autonomy of teams working in parallel, however, should not put at risk the implementation level between interdependent subsystems (Gerwin & Barrowman, 2002);
- managers should design the processes and empower the workers to define the specific procedures (Drucker mentioned in Blackstone Jr. *et al.*, 1997);
- many people, including the technical experts, perform tasks with manifest managerial components (Currie & Glover, 1999), what supports the idea that teams can operate in a relatively autonomous fashion;
- the traditional structures of control and command are to be discarded in favor of managerial approaches based on teams and projects (Scarbrough, 1999); in fact, current literature as a great interest on *coordination* – team interactions for managing expertise and resources (Faraj & Sproull, 2000), or simply the management of dependencies among tasks (Wagstrom & Herbsleb, 2006);
- cybernetics celebrates non-hierarchical managerial processes (Beer, 1983);
- in organizations, there should be only a few hierarchical levels, decentralization (for decision making) and group autonomy (Pels & Wortmann, 1992);
- managing win-win relations does not require that close supervision be effected; it creates an adequate environment for personal achievement, and impels the individuals to cultivate initiative and responsibility (Blackstone Jr. *et al.*, 1997);
- the worker is asked to get involved and participate in the definition and the effort of producing with quality (Fleury, 1993).

Third, something that is also evident in the literature is the interfunctional and multidisciplinary aspect of the work teams. Such a premise is maybe rooted on the same socio-technical imperatives guiding the need for a systemic wisdom (from the social and technical perspectives), intent that shall drive the convergence of multiple visions (functions or disciplines). This is, indeed, of a systemic nature, given the concept of variety; it can be thus argued that the multiple functions of a work team are aimed at counterbalancing, as much as possible, the functional diversity that is experienced in the world of business. Below one can find examples of what was just put forth:

- multifunctionality is required (Cowley-Durst, 1999; Rezende, 1999);
- system development teams are multidisciplinary (Boardman, 1995);
- HPT consist of professionals with complementary skills (Peled, 2000);
- regarding customized software, high levels of interfunctional interaction are critical (Hosalkar & Bowonder, 2000), while the industry of software packages also employs, for improving the software process, interfunctional teams coupled with an approach to parallel development (Dube, 1998);
- in order to set strict objectives for product development and performance, development teams should be interfunctional (Ellekjaer & Bisgaard, 1998);
- three dimensions of expertise are commonly related to software development (Faraj & Sproull, 2000): *technical* (the technical area), *design* (software design principles and architecture), and *domain* expertise (the application domain and customer operations);
- Yoon *et al.* (1995), in a discussion about expert systems, argue that developers should master in interpersonal skills, in framing business problems, and in deploying systems thinking when dealing with problematic situations; and
- Todd *et al.* (1995) organize what is required from IS professionals (managers, system analysts, and programmers), as illustrated in Table 6.

Class	Category	Examples	ACM* Category
technical knowledge	*hardware*	*mainframe*, mini and personal computers; storage devices, controllers, printers, networks	computers
	software	applications, operating systems, packages, networking softwares, languages.	
business knowledge	business	functional (finance, marketing) and industry (retail, mining) expertise	organizations
	management	general management skills (leadership, project management, planning, controlling, training, organization)	
	social	interpersonally and communication skills, personal motivation, ability to work independently	people society
systemic knowledge	problem solving	creative solutions, quantitative skills, analytical modeling, logical capabilities, deductive/inductive reasoning, innovation	models
	development methodology	systems development methodologies and approaches, issues on implementation, operations and maintenance, documentation, analysis/design tools/techniques	systems

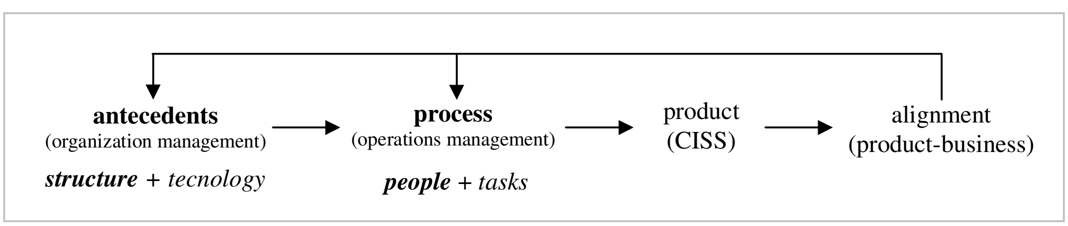
* Association for Computing Machinery
Source: Todd *et al.* (1995, p. 6).

Table 6. Knowledge/skills for the IS professional.

Finally, socio-technical systems are appropriate for dealing with problems in systemic and *unitary* contexts, that is, when problems are complex and decision makers share frames of reference (Jackson & Keys, 1984). In our research, which deals with setting criteria for the participation of CuTe professionals in CISS development, there is no doubt on the inherent complexity of managing the human factor (in CuTes), mostly when interacting with many other people (like the X-Team members). On the other hand, the unitary character is also eminent in regard to the shared vision about the benefits that researchers and entrepreneurs (the managers) perceive with such management – for the sake of clarity, at least for understanding and assessing CuTe performance. The unity, however, should be reflected also in the instruments deployed to manage CuTes – and helping in this is an important achievement of our effort.

The main aim of this section was to provide evidence for why the socio-technical perspective is adopted as the reference for framing CuTes, as inserted in the field of organizational studies. Such a theoretical approach is also responsible for providing the dimensions of interest from which to assess CuTe performance. The dimensions of interest in our research are the organizational structure and the individual members of CuTes, due to two main reasons: first, it was extensively argued in the previous sections that the technical subsystem (composed of technology and task factors) in a work design has received most attention in theoretical research and industry practices, what makes this a less interesting and relevant subject for scrutiny; and second, we posit that each factor of the social and the technical subsystems plays a prominent role depending on the stage of CISS development (Figure 6), given that two factors are here proposed to be more static (structure and technology) and the other two more dynamic (people and tasks) during the timeframe of a given project – therefore enabling us to investigate static and dynamic attributes, as well as different stages of CISS development. Two assumptions deserve further explanation:

- The "static" factors are not really static, or at least not static forever, regarding the values designed for their attributes. Given the temporary nature of any project (CMMI Product Team, 2002; Turner & Müller, 2003), such factors will likely change values less times or more subtly than the "dynamic" factors during a project's life cycle, thus looking as if they were immutable (mainly when the project is short enough). But if a project lasts for too long, a fixed design will be clearly undesirable for the technology and the tasks, since there would be an increase in the probability that natural updates are needed (due to, for instance, technological innovations or new reported best practices in processes). One should define contingent actions for implementing the required flexibility in technology and tasks as a response to preparing for future environmental demands.
- Although the four socio-technical factors are interdependent and should be simultaneously designed (Nadler & Gerstein, 1992), each factor clearly plays a unique role in CISS development, given the heterogeneous nature of attributes across factors. This permits us to assume that CISS development is driven by a specific design of the four factors according to a project's stage, since factors whose attributes are more in line with the demands of a given stage will be more likely to define that stage. Figure 6 depicts a high-level relation between the socio-technical factors and CISS projects. Such an assumption is a major theoretical development in our research.



Legend: boldface items represent the focus of our research.
Source: Bellini *et al.* (2004, p. 24).

Figure 6. Socio-technical framework for CISS development.

3.5.4.1 CuTe Structure

Organizations can be described according to relatively stable configurations of their attributes, notwithstanding no configuration is able to represent perfectly – and with no need for updates along the timeline – any particular organization (Mintzberg *et al.*, 2000). Such configurations enable one to differentiate between work systems, for the purpose of, for instance, studying the appropriateness of organizational attributes to contingencies imposed by the internal and the external environments.

Among the drivers of configuration development, one finds *organizational structure*, which can be conceived as the set of relations between individuals, tasks and corresponding authority and responsibility levels, as well as work principles and norms (Mülbert *et al.*, 2002; Donaldson, 1996). Lin *et al.* (2006) add that the structure also includes the levels of access to the organizational resources. In line with the fact that organizations exist for people to transcend their individual limits regarding information appraisal and processing due to the complexity and the uncertainty of the work environment (Simon, 1979), the organizational structure impacts work and shapes the behavior of individuals, thus being intimately related to organizational performance (Mülbert *et al.*, 2002; Ghezzi *et al.*, 2001).

The literature reports the theoretical and actual occurrence of many structural configurations between and within organizations, as well as assorted reasons for the diversity of directions provided. Currently, though, maybe the most adopted view is that the organizational structures are not more than enabling mechanisms (Mülbert *et al.*, 2002) or arbitrary choices for action (Motta, 2000b), choices that are at some degree molded by environmental contingencies (Donaldson, 1996). If this is true, changes in external configurations should lead to new corresponding internal configurations (Clegg & Hardy, 1999), and, as people and organizations build their own repertoires of actions (March & Simon, 1963; Nelson & Winter, 1982), structures should be set to support those repertoires, specially following changes in the technical and social subsystems in organizations (Motta, 2000b). All this relates to building, as much as possible, a one-to-one relationship between environmental attributes (*e.g.*, critical success factors) and organizational attributes (*e.g.*, core competencies) if the organization wants to effectively qualify for the requisite-variety criterion.

Researching on structures is a tradition in organizational science (Sinha & Van de Ven, 2005). This resulted in typologies and taxonomies of sound theoretical and pragmatic implications, like the landmark studies on bureaucracies (Weber, 1982), on the relation between the environmental dynamics and the mechanistic/organic nature of organizations (Burns & Stalker, 1961), on the relation between technologies and production systems (Woodward, 1965), on the differentiation and integration in organizations (Lawrence & Lorsch, 1973), on the socio-technical axes of work systems (Trist & Murray, 1993), on the virtualization of organizations (Mowshowitz, 1994), on organizational configurations (Mintzberg, 1983) and on organizational metaphors (Morgan, 1996).

A common interest in studies that try to classify organizations according to their structure seems to be that of grounding research findings in degrees between the extremes of the bureaucracy and the organicity – which are also key for understanding Burrell and Morgan's (1979) insightful sociological and organizational paradigms. In fact, most debates on the structural alternatives for designing or explaining the place of work systems in current industries and markets consist of seizing implications of the mechanistic bureaucracy and the organic adhocracy as drivers of human action and business performance. Among the various alternatives available, our research assumes Mintzberg's (1983) *organizational configurations* for classifying the structures, given the number and conceptual diversity of the variables employed in such a ranking system, as well as the fact that the variables address important structural issues for CuTes; additionally, Mintzberg's (1983) configurations are among the most discussed and deployed in the literature.

Table 7 contrasts Mintzberg's (1983) framework of five main organizational configurations – the *simple structure*, the *machine bureaucracy*, the *professional bureaucracy*, the *divisionalized form*, and the *adhocracy*.

	simple structure	machine bureaucracy	professional bureaucracy	divisionalized form	ADHOCRACY
coordination mechanism	direct supervision	standardization of work processes	standardization of individual skills	standardization of task interfaces	**mutual adjustment**
key component	strategic apex	technostructure	operations	intermediary line	**support staff**
decision making	vertical and horizontal centralization	limited horizontal decentralization	vertical and horizontal decentralization	limited vertical decentralization	**selective decentralization**
decision flow	top-down	top-down	bottom-up	differentiated between HQ and divisions	**mixed**
informal communication	intense	discouraged	significant at the management level	some between HQ and divisions	**intense**
training and indoctrination	little	little	much	some (division managers)	**much**
organization	organic	bureaucratic	bureaucratic	bureaucratic	**organic**
clustering and size	functional; large	functional; large at the bottom	functional and market oriented; large at the bottom	market oriented; large at the top	**functional and market oriented; small**
staff and liaison mechanisms	few	few	at the management level	few	**many**
environment	simple and dynamic, sometimes hostile	simple and stable	complex and stable	relatively simple and stable; diversified market	**complex and dynamic**
power	chiefship	technocratic or external	professional	intermediary management	**experts**
function of the strategic apex	all the administrative work	fine-tuning, coordination of functions, conflict resolution	external contacts, conflict resolution	strategic portfolio, performance control	**external contacts, conflict resolution, work balance, project monitoring**
function of the operational division	informal, with little autonomy	formal and routine, with little autonomy	standard and specialized, with much individual autonomy	tendency to formalization	**truncated or mixed with management for the informal work**

Legend: boldface items represent the focus of our research.
Source: Mintzberg (1983, 2001a, 2001b).

Table 7. Main organizational configurations.

The Structure of the Client Organization

The structural configuration of client organizations is not to be taken as either a barrier or a lever for the effectiveness of CuTes. That is, when designing a metrics plan for managing CuTes in CISS development, it should not be of importance whether the whole company conforms to one or to another structural configuration. The reason for this is that possibly the relation is reverse: the structure of the client organization does not prescribe the metrics' contents; but the metrics, as soon as they are designed, require the whole organization to adhere to a given structural configuration in order to effectively manage CuTe work. After all, literature in the last three decades shows that structure is contingent to several factors (Donaldson, 1996); in fact, structure is a decision made by individuals with organizational power (Motta, 2000b) to serve merely as an enabler for action (Mülbert *et al.*, 2002).

Provocative enough, it is verily because the primacy of the contingency over the structure is not fully understood – thus giving rise to a situation where an *a priori* structural configuration supports the screening of environmental variables that will be part of the organization's internal variety – that many organizations take inflated risks in the long run (Motta, 2000b). Structural changes in response to external contingencies should, though, be framed as a way to continuously rationalize the organization, more than to reconstruct it from time to time (Motta, 2000a)[5].

Adding to the above, the metrics in our research are dedicated for application by a limited, well-defined group of employees – the CuTe professionals –, meaning that the key concern here is with that group's structure, and not with the mother organization's structure (structural change is to be implemented only in the limits of CuTes). It is surely true that client companies with bureaucracy-like structural configurations provide better means to support CuTes in their struggle for performance indices, given the clear-cut work design and professional relations; indeed, bureaucracies are not oriented towards solving problems, mainly new ones, but achieving performance (Mintzberg, 1983). But there are no serious reasons to exclude other companies (say, from the adhocratic breed) from effectively managing their teams with design and performance metrics. After all, most team management takes place in the domain of each project, thus freeing client organizations from compulsorily changing their whole managerial character in favor of a specific project's needs. Moreover, an organization is capable of harmonizing very different structures if under effective leadership (Motta, 2000a).

That said, customer companies that wish to make use of CuTe metrics should, by means of superior leadership (Ravichandran & Rai, 2000), nurture work environments where professional assessment for reward, improvement, and quality of working life is conceived but a necessity for all. There is, then, reason to believe that any organization/configuration can decide on implementing a CuTe metrics plan for CISS development, for this just being asked to proceed to structural changes in CuTe design. Something similar takes place currently during the institutionalization of ISO and CMM practices, when not necessarily the whole organization should undertake profound changes in its business character.

[5] The argument exposes a paradox inherent to the contingency approach: although developed within the systems school of thought (thus requiring factor interdependence), the contingency approach prioritizes the environmental influence over the organizational structure.

For the sake of conclusion, given that the effectiveness of a metrics plan for CuTes depends on the organizational structure (after all, structure and performance are intimately related – Mülbert, 2002; Ravichandran & Rai, 2000), it is management's responsibility of the client organization in CISS projects to decide for a structure that *facilitates* CuTe work and the deployment of metrics for designing and evaluating the teams. That is, CuTe structure should be formerly adapted to enabling the proposed metrics plan – and this will eventually lead to better performance. Thus, the customer company being a simple structure, a machine bureaucracy, a professional bureaucracy, a divisionalized endeavor, or an adhocracy does not influence substantially the development of the metrics' *contents*, nor does it prevents decision makers from prescribing the desired structural configuration to its teams – to the contrary, it is their very duty to do so.

The Structure of CuTes

CuTes, on the other hand, are not to determine their structure, but to adhere to an imposed configuration deemed most effective for the nature of IT-business work. As part of a socio-technical design of the work system, CuTe structure should be deliberately planned by the mother organization along with the technological infrastructure. The contingency is the nature of the meaningful external environment, and, as it will be soon shown, an *administrative adhocracy* design is the one option – although no design guarantees sustainable success (Lin *et al.*, 2006). For building the argument, let us briefly characterize the context of CISS development.

CISS development occurs in a myriad of contexts, since all industries are currently investing in IS implementation. Therefore, CISS projects can be brought about in environments either static or dynamic (in reference to accurately anticipating the events) and simple or complex (in reference to enabling a readily understanding). An important implication is that IT-business professionals in CuTes should innovate (Anderson, 2002; Galliers & Swan, 1999; Hosalkar & Bowonder, 2000), be multifunctional (Cowley-Durst, 1999; Todd *et al.*, 1995) and possibly work with other experts in outsourcing agreements (Currie & Glover, 1999; Lacity & Hirschheim, 1999; Lacity & Willcocks, 1998) due to the strategic options (Anderson, 2002) and the organizational competencies (Leite, 1997). This is one reason why IT-business personnel represent a challenge for group design and management (Boardman, 1995; Faraj & Sproull, 2000), as well as why there is such an intense company shift of those professionals in the industry (Hosalkar & Bowonder, 2000; Scarbrough, 1999). In the special case of programmers, adds to adversity the fact that, unlike physicians and engineers, they are not tied to norms of professional conduct (Pavur *et al.*, 1999), thus hardening the deployment of management approaches. More broadly, knowledge workers are said to hardly adhere to externally taught practices (Scarbrough, 1999).

Given the characteristics of the adhocracy in Table 7, the context of CISS development and the general aspect of CuTe professionals, it is natural to propose an adhocratic configuration for organizing CuTes in their joint work with X-Teams. Let us see why on the basis of Mintzberg's (1983) argument.

The adhocracy is the only structural configuration able to promote sophisticated innovation – a primary attribute of CISS. Innovation in such a structure is facilitated by a more flexible and informal information and decision flow, which, when necessary, takes precedence over the established formal authority. Innovation is in fact representative of dynamic and complex environments, arguably typical in CISS endeavors. Whenever innovation in processes, products and services is envisioned, tasks exhibit increased uncertainty, and, if more uncertain, less subject to programming and more to adhering to *ad hoc* structures (Donaldson, 1996).

Putting together multidisciplinary expertise in *ad hoc* project teams – a requisite in complex environments – is also made simple in the adhocracy, since in it experts hold proper power, liaison mechanisms are widely available, and training is institutionalized. Multidisciplinarity addresses the systemic principle of requisite variety, according to which CuTes should incorporate enough skills to promptly adapt to the presumably large range of possible IT-business projects contracted by their companies; moreover, multidisciplinarity promotes redundancy of functions, the key holographic principle that pushes a group into operating as a coherent and flexible whole.

Professionals should be assigned to specific projects and organized according to a matrix structure (in which functional and project skills are put together), in such a way that each team is able to fully satisfy the greatest possible number of demands. Matrices, frequently regarded as intrinsic to the adhocracy, combine the bureaucratic structure of functions and departments with the organic structure of market-oriented project teams (Kuprenas, 2003; Morgan, 1996). Additionally, managers, staff and line personnel should act in concert, sharing project authority and responsibility. This plays a direct and positive effect on a team's ability to solve conflicts (Scarbrough, 1999), but also requires top management to work skillfully in managing human relations; after all, the professional expertise puts at risk control systems like those found in the hierarchies (Donaldson, 1996), and it is already known that IT-business people do not easily welcome managerial interference in the profession (Scarbrough, 1999).

In what comes to coordination within and between project teams, once again the expert autonomy, the liaison mechanisms with the internal and the external environments, and the mutual adjustment imperative favor the adhocracy. Given that teams are generally small human groups, the adhocracy consists of a fairly large number of managers with multiple assignments – functional, integrative, market-oriented, etc. As already mentioned, management does not include the traditional control mechanisms; but this should not lead to the conclusion that the adhocracy is chaotic, since an important managerial role is to monitor project performance.

Mintzberg's (1983) adhocratic configuration can be divided into two categories: the *operating adhocracy* and the *administrative adhocracy*. The former deals with searching for customers' solutions, operating under contract with these, and reacting to assorted contingencies like when adapting to whatever project comes about. Operational and administrative personnel do not differentiate within projects in the operating adhocracy, which usually involve product customization. The administrative adhocracy, on the other hand, focuses the organization's internal problems (and not the customers'), exhibits a technically sophisticated work system, and relies on reduced operational workforce (operations are frequently outsourced). This last attribute is possibly explained by the fact that the administrative adhocracy, due to being deeply involved in solving internal problems and possibly not exhibiting all the required technical expertise[6] or having deliberately decided to exploit only the organization's core competencies, may decide to search externally the complementary skills and focus attention on managing the project – to which the metrics in our research are believed to contribute.

So, the administrative adhocracy seems to better describe the nature of CuTe work, while the operating adhocracy would describe the X-Teams. According to Mintzberg (1983), both adhocracies have in common the ability to work with complex, ill-defined problems, particularly those involving sophisticated innovation and customization.

Adhocracy Shortcomings

There are natural problems in designing CuTes according to the adhocratic configuration. Perhaps the most obvious and provocative is the little expected formalization of professional behavior in the adhocracy (Motta, 2000b), what may hinder the institutionalization of performance metrics and the adhesion to them. The innovative organization is barely based on coordination, thus deviating from classic bureaucratic tenets such as the sharp definition of tasks, the standardization of behavior and the deep commitment to planning and control. This is motivated by the understanding that formatting one's actions weakens his/her flexibility to react to the environment (Mintzberg, 1983). Furthermore, standardizing human behavior (like our research is trying to do to some extent) usually leads to undesirable side effects (Motta, 2000b) like inhibiting learning (Powell, 1998), and best practices for IT-business professionals are usually questionable (Scarbrough, 1999). Nevertheless, since any activity entails the division of work in tasks and coordination (Mintzberg, 2001a), it is mandatory that a certain degree of control be implemented; the solution is maybe to focus attention on the interfaces between tasks more than on the individuals' behavior (Morgan, 1996). Other forms of control are available in Kirsch *et al.* (2002).

The adhocracy also relies excessively on intense communication, temporariness, lack of formalization and unpredictable workload, leading to a model that is efficacious, but inefficient (Mintzberg, 1983). Moreover, the matrix structure typical of the *ad hoc* practice collides against the functional divisions, thus giving rise to centralization effects (Motta, 2000b), while paying loyalty to double seniority in matrices (by function and by project) lowers the team's morale (Morgan, 1996).

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[6] After all, as already commented, the company that pays for IS customization may be from any industry and sell to any market, thus not being expected to master all the required IT capabilities.

3.5.4.2 CuTe People

The human nature of CuTes, in its turn, cannot be statically designed like its structure. Conflicting evidences and directions are sometimes found in the literature, as well as research findings that are due to strict cases. For instance, we cannot tell in advance whether a thoughtful technology savant would perform better than an extraverted ingenious novice in a CISS project that typically involves much negotiation of technological restraints, current processes versus best practices, money shortages, deadlines, and knowledge sharing for preventing discontinuities in the future. On the other hand, that same youngster, who is maybe also risk-taking, driven by self-interests in the short run, and who takes his/her current job as a stairway to making a rocket career, will be a challenge for management. Another burdensome case is that of defining and establishing the business ethics for the team: would it be correct that an employee endures in an opportunistic behavior for the sake of protecting the company's commercial position? And finally, how do individuals (conceivably different in many traits) interrelate to produce the team's response and performance in a project?

That being said, we can anticipate how complex is the web linking variables quite different in nature and with a range of values in part innate, in part contingent. Therefore, other than discussing every possible alternative for hiring applicants according to their personal traits, we opted to learn from an exemplary CuTe working in a benchmark CISS project. What we did expect, however, was to measure cognitive and behavioral traits grouped as follows:

- traits of the structural identity of the individual – with issues related to personality, trustworthiness, innovativeness, entrepreneurship, expertise, and transactive memory;
- traits of how the individual conceives the current professional endeavor – with issues related to understanding the meaning of and links between the company's strategy, the personal role in it, and the end product's (the system's) expected attributes;
- traits of how the individual interacts with the current business partner on the basis of personal effectiveness – with issues related to facilitating and effecting learning processes, communicating clearly, and being proactive in regard to the others' duties in order to speed up production;
- traits of how the individual transacts with the current business partner on the basis of functional effectiveness – with issues related to conceptualizing the partnership, monitoring it, and using it for one-sided benefits;

- traits of how the individual justifies his/her behaviors in the current professional endeavor – with issues related to adjusting the priority of personal goals, making use of psychological and social self-justification mechanisms, assigning value to past investments, and continuously appraising the value of project goals; and
- traits of how the individual frames the historical perspective of the relationship with his/her current business partner – with feelings about interdependence and continuity.

3.6 Systems Engineering and Team Management

Systems engineering plays a key role in our research. Systems engineering started to be developed in the 1950s (Jackson & Keys, 1984; Checkland, 1983) as an approach to be deployed along with customers in solving problems (Sage, 1980) and satisfying needs (Bahill & Dean, 2002). It is concerned with the total project of complex systems aimed at assuring that subsystems are designed, integrated, verified and operated in an efficient, future-oriented way (Checkland, 1983). According to Bahill and Dean (2002), systems engineering is interdisciplinary and composed of seven tasks – problem definition, investigation of alternatives, systems modeling, systems integration, systems launching, performance estimates, and reassessment – and, although considered a *hard* approach to problem solving (Checkland, 1983; Flood & Carson, 1988), there are evidences of its suitability for complex and nonunitary contexts (Jackson & Keys, 1984).

Systems engineering is used here to complement the socio-technical perspective; after all, different systemic approaches do not exclude one another when the researcher is granted the possibility to be simultaneously systemic and systematic (Müller-Merbach, 1983). Further challenges in managing CuTes are discussed below to make the point of applying systems engineering to our research.

3.6.1 CuTe Management

Historically, companies devote little attention to performance criteria for projects and product development processes (Kaplan & Norton, 1997), and it was not but recently that organizational research has put an eye on metrics (Straub *et al.*, 2002). Nevertheless, only through the continuous identification and correction of detours can an organization stand on the competitive edge (Blackstone Jr. *et al.*, 1997), which is more and more conspicuous (Bharadwaj *et al.*, 1999). In fact, what is correctly measured is correctly managed (Feigenbaum, 2001); on the other hand, without constant measurement there is no process management, and, with no process management, there are no improvements (Gardner, 2001; Avison & Fitzgerald, 1999). That is, management needs measurement for being rigorous, but measurement needs management for conveying purpose (Bourque *et al.*, 1999). Additionally, managing and improving relate to two broad processes (Jackson & Keys, 1984): *planning* (the *effective* path towards a goal) and *controlling* (the *efficient* path to it). Planning may also be defined as a continuous activity aimed at stimulating creativity and assuring adaptation in highly dynamic and uncertain environments in a participative and interactive process (Richards & Gupta, 1985). Just planning, however, does not necessarily lead to project success, but its absence augments the probability of project failure (Dvir *et al.*, 2003). Control, in turn, may be viewed as knowledge about the distance between the current and the desired state of a system, as well as about who is responsible for adjusting the deviations (Blackstone Jr. *et al.*, 1997). In order to achieve that, a *sensor* (measuring mechanism) and a *governor* (decision mechanism) are needed (Douglas, 1983).

Additionally, a commitment to learning should also take place when targeting continuous improvement (Garvin, 1993) or product development (Ellekjaer & Bisgaard, 1998). Towards that, opportunities for assessments are invaluable to enlarge the knowledge base on the impact of individual and group decisions (Bednar, 2000).

However, projects with unstable requirements are hard to manage (Keil *et al.*, 2000). In particular, software teams are usually assembled afresh for each new project, hindering the development of a shared work history by its members (Faraj & Sproull, 2000). Moreover, programmers – unlike physicians and engineers, for example – do not have professional standards to follow (Pavur *et al.*, 1999), and this is likely to be a major source of negative influence over the teams. Software teams indeed constitute a challenge for management (Scarbrough, 1999; Boardman, 1995), especially in managing their knowledge (Faraj & Sproull, 2000), and a typical effect is late intervention in problematic projects (Keil *et al.*, 2000). As a matter of fact, the software industry deploys only a few metrics from the many available for controlling the development process and predicting product features (Sommerville, 2001; Münch & Heidrich, 2004).

Due to reasons like the ones above, the most important cost factor in CISS development is represented by people (Pfleeger mentioned in Stamelos *et al.*, 2003). In two recent surveys, the commitment to attracting, developing, and retaining IT professionals ranked fourth (Luftman & McLean, 2004) and second (Luftman, 2005) among the top five IT managerial concerns reported by CIOs and other IT executives. Nevertheless, it is not clear how to promote teamwork (Leidner & Jarvenpaa, 1995) and there are questionable models to be deployed for coordinating the fragmented expertise (Barley mentioned in Scarbrough, 1999), while it is also known that teams that master how knowledge is distributed among their members perform better (Faraj & Sproull, 2000).

Adding depth to such a complex scenery, management is a social construction in organizations (Currie & Glover, 1999), naturally delineated by subjectivities of many orders. In this sense, and even though the managerial function is to make the work productive and the worker achieving (Drucker mentioned in Blackstone Jr. *et al.*, 1997), it is hard to understand what really is *to manage* (Motta, 2000). Broadly, management is conceived as dealing with uncertainty (Miller *et al.*, 1996; Morgan, 1996), as making decisions on imponderable matters (Simon, 1979), as combating a chaotic organizational reality (Motta, 2000; Cohen mentioned in Miller *et al.*, 1996), and as trying to elucidate how the obscure causal relations with the organizational performance take place (Motta, 2000). But alternatives for mitigating uncertainty still constitute a challenge for research (Terwiesch & Loch, 1999) and little is known, in particular, about the causes, the consequences and the management of innovation (Galliers & Swan, 1999). As a result, among the most important ventures is to timely decide on resuming or getting rid of problematic projects (Keil *et al.*, 2000). IS project managers are, anyway, required (Pavur *et al.*, 1999).

Notwithstanding the challenges, what is plain is the need for practices to managing work with a set of objective, clear criteria causally linked to organizational performance. Such a need is put in evidence in the particular case of CISS development when we understand that the relationship between service organizations (like the ones that develop CISS) and customers are, in general, durable (Sharma mentioned in Sivula *et al.*, 1997), and that customized products are likely to strengthen the ties (Stump *et al.*, 2002). Poor management, thus, may compromise such a natural, mutual commitment.

Our research is particularly interested in setting parameters for the customer activity in CISS projects. The goal is aligned with the fact that inaccuracies in assessing *user risks* (the degree to which prospective IS users take part of the development, their likelihood in accepting the system, their attitude towards the system, and their experience in developing projects – Jiang *et al.*, 2002) may be related to unsuccessful outcomes. Besides that, if the critical issue of user participation in systems development is general responsibility (Hartwick & Barki, 1994), then there should be methods to measure and enlist such responsibility. One benefit implied by effectively measuring customer activity in software projects is that, if putting down in contract a customer's assessments of acquired products, the supplier is assured that products will be rejected only if (accurately) assessed by the customer and deemed actually defective (Baiman *et al.*, 2000). Another benefit of setting criteria for the participation of customers in projects lies in trials that may be faced by organizations that do not institutionalize and follow quality practices (Gooden, 2001). In general, it is more profitable to prevent flaws prior to running projects, like by making partnerships for institutionalizing joint-work practices between customers and external developers (Jiang *et al.*, 2002), what is also true for any outsourcing contract (Lacity & Hirschheim, 1999).

3.7 Software Measurement and Management

Software measurement arguably lies behind software management – and this includes the management of technology, tasks, people, and organizational structures involved in the business of software development. Software measurement has roots in debates on the efficiency of computer programs and the productivity of programmers, but in recent years the field is heading steadily towards more managerial issues. Such a trend – that can be framed as departing from a concern about hard issues such as the complexity of software algorithms, and moving towards softer issues like managing projects involving multidisciplinary professional teams – mirrors influences the field has experienced from knowledge areas previously considered unrelated, like human resources management, marketing, organizational theories, and research methods.

3.7.1 Measurement in Software Engineering

Measurement is essential for science (DeVellis, 1991), and in organizations it serves to help manage by fact, not by feeling (Dekkers & McQuaid, 2002). In software engineering, it still lacks consolidated terminology, principles and methods (Ruiz *et al.*, 2003; Abran *et al.*, 2003), but it is said to address processes, products and resources (Bush & Fenton, 1990). It is useful for (1) nourishing visibility and understanding, (2) establishing the grounds for improvements, and (3) planning, monitoring, and controlling processes, products and resources (Pfleeger, 1995). It is also well accepted that software measurement activities include direct and indirect assessments, as well as predictions (Sommerville, 2001; Fenton & Neil, 1999; Jørgensen, 1999; Bush & Fenton, 1990). Table 8 illustrates software measurement interests.

ENTITY	ATTRIBUTES	
Product	**Internal**	**External**
specification	size, reuse, modularity, redundancy, functionality, syntactic correctness	understandability, maintainability
design	size, reuse, modularity, coupling, adherence, inheritance, functionality	quality, complexity, maintainability
coding	size, reuse, modularity, coupling, functionality, algorithm complexity, flow of control	reliability, usability, maintainability, reusability
test data	size, range	quality, reusability
Process	**Internal**	**External**
development specification	time, effort, number of changes in requirements	quality, cost, stability
detailed design	time, effort, number of defects found in specifications	cost, cost effectiveness
test	time, effort, number of defects found in coding	cost, cost effectiveness, stability
Resource	**Internal**	**External**
personnel	age, cost	productivity, experience, intelligence
teams	size, level of communication, structure	productivity, quality
organizations	size, ISO certification, CMM level	maturity, profitability
software	price, size	usability, reliability
hardware	price, speed, memory size	reliability
offices	size, temperature, light	comfort, quality

Source: Fenton and Neil (2000).

Table 8. Examples of software measurement interests.

Measuring software involves knowing how to deploy *measurement theory*. In fact, this theory, a branch of applied mathematics (Sarle, 1995) rooted in developments made during the 19th century but that truly matured in the last five decades or so (Díez, 1997), is consistently developing in software engineering (Kirk & Jenkins, 2004; Briand *et al.*, 1996). It is closely related to Stevens' *theory of scales* (Mari, 2003; Jørgensen, 1999) and basically involves setting unequivocal relations between an empirical measurement object and a symbolic system representing some attribute of it that is of interest for measurement (Mari, 2003; Rossi, 2003; Briand *et al.*, 1995; Briand *et al.*, 1996; Sarle, 1995; Bush & Fenton, 1990). The purpose is to access the "real world" object by means of processing symbols equated to its attributes (Mari, 2003) and reducing biases introduced by measurement error (Schmidt & Hunter, 1999). Nevertheless, errors of a statistical nature – like the random measurement error – are not of concern to measurement theory, and it is also taken for granted that measurements are always discrete – that is, they exhibit limited precision (Sarle, 1995). According to Jørgensen (1999), Díez (1997), Briand *et al.* (1995), Briand *et al.* (1996), and Sarle (1995), the following concepts are essential for framing the theory (without claiming to be exhaustive):

- *empirical relational system* (ERS) – qualitative description of objects, relations and operations representing the portion of reality where measurement takes place, as well as the extant empirical knowledge about attributes of the objects one wants to measure;
- *formal/symbolic relational system* (SRS) – description of the domains for the measures on the objects' attributes, as well as the relations of interest between measures; systems ERS and SRS are linked by means of measures and scales (discussed below);
- *measure* – formal mapping between the two systems, matching ERS elements with SRS numbers/symbols and observing the equivalence of relations between the systems;
- *admissible transformation* – transformation that preserves the equivalence between empirical and symbolic relations;
- *nominal scale* – strictly one-to-one admissible transformations allowing exclusively the empirical relation "equality";
- *ordinal scale* – admissible transformations strictly on an increasing monotonous function allowing exclusively the empirical relations "equality" and "order";
- *interval scale* – positive linear admissible transformations ($f(x) = ax + b, a > 0$) allowing exclusively the empirical relations "equality", "order" and "difference";
- *ratio scale* – positive similar transformations ($f(x) = ax, a > 0$) allowing the empirical relations "equality", "order", "difference" and "relative difference"; and
- *absolute scale* – no transformation is meaningful except the identity ($f(x) = x$).

With the rigorous approach provided by theory (Bush & Fenton, 1990), measurement in software engineering is made easier to frame and manage. In particular, there is the need to deepen and systematize our comprehension about the attributes of the objects of interest, what will then give rise to a theoretical and formal system with which an object and its attributes would be subsequently dealt with. This leads one to address the more fundamental issue of understanding the concept behind the object and the attributes, adopting a particular perspective for working with them and standardizing it (for a case in software quality, *see* Jørgensen, 1999).

Although measurement issues seem trivial at first, each concept may convey a great deal of reflection and heated debate (*e.g.*, Mari, 2003, Segars, 1997, and Mari, 1996). The most fundamental discussion is whether the object under empirical examination has attributes that are conceptualized by current theories and that can be measured by available methods (that is, whether the values produced by measuring the object's attributes are within known ranges and really reflect the nature of the object). This exerts direct impacts on the purpose and on the use of measures.

Our perspective is similar to that of Mari (2003) and assumes that measures do not relate to "actual" (intrinsic) attribute values (or *true scores* – DeVellis, 1991), but to outcomes of procedures currently deemed appropriate for getting purposeful information about real-world objects. In other words, given the likely endless philosophical debate on an object's ontology, interpretation and subjectivity are in fact the very intrinsic ingredients of every measurement attempt, and this helps explain why there should be a sound conceptual framework underlying the software measurement endeavor.

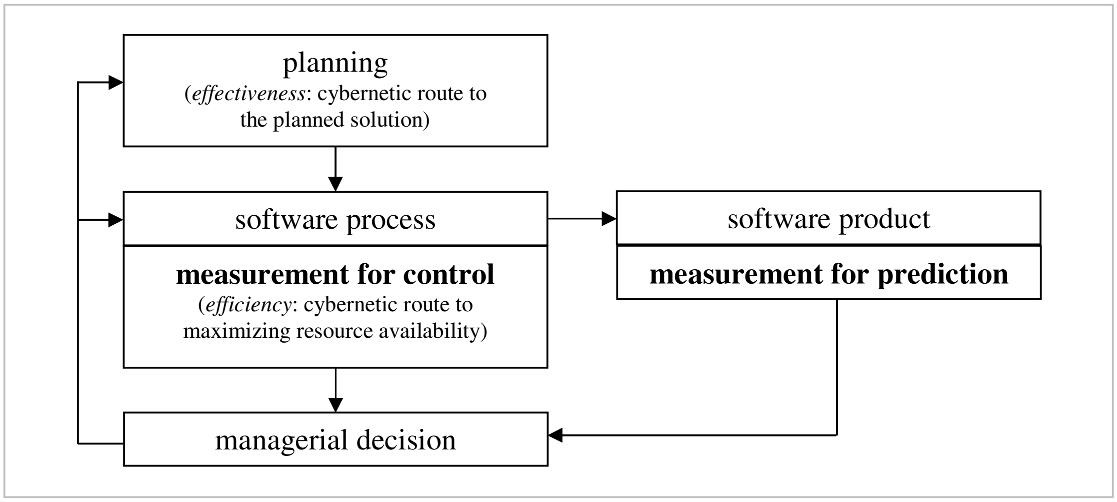
Recent advances in measurement theory indicate the need for a probabilistic version of it (Rossi, 2003). Another current concern is the discussion around a more pragmatic and flexible deployment of scales and corresponding statistical procedures (Jørgensen, 1999; Briand *et al.*, 1995; Briand *et al.*, 1996), like in what can be called a *weak measurement theory* (Morasca, 2003); in some cases, like in studies on the relation between IT and organizational dimensions, less rigid scale transformations have been frequently performed – admissible transformations are indeed more of a mandatory (rather than exclusive) nature (Sarle, 1995). Finally, bold developments are expected in the field of quality with respect to specific deployments of measurement theory to software engineering (Jørgensen, 1999).

Abran *et al.* (2003), however, unveiled critiques to applying measurement theory to software engineering, since the theory would only provide the means for handling a set of classic measurement issues. The broader field of *metrology*, which covers theoretical and practice-oriented issues alike, should in their view be considered when setting the basis for developing and applying measurement instruments and processes. Metrology would look after defining measurement principles, which in turn would help negotiate methods and procedures for measuring. Symptomatically, current initiatives in software engineering would be lacking a consistent approach to effectively address the instrumentation for measurement.

Irrespective of how one frames the deployment of measurement theory to software engineering, its application should provide the means for developing measures independently of whom is in charge of the process, as well as measures that address solely the empirical object of interest (Mari, 2003). Furthermore, the outcomes of measurement must adhere to assessing and predicting the quality of products, processes and resources.

3.7.2 Software Metrics

Software engineering and metrics are bound together (Kirk & Jenkins, 2004; Gopal *et al.*, 2002; Fenton & Neil, 1999). In fact, metrics constitute the dominant approach to measurement in software engineering (Abran *et al.*, 2003). Sommerville (2001) and Pavur *et al.* (1999) state that metrics relate to process control – like the average effort and time demanded when fixing defects – and to the prediction of product features – like the number of operations associated to an object. More broadly, metrics are key for vigorous research (Straub *et al.*, 2002), serving as feedback and measurement tools for assessing whether one is proceeding correctly (Corbin, 1991), as well as drivers for engineering and management processes (Gopal *et al.*, 2002). They are organic to the software process (Gopal *et al.*, 2002; Eisner, 1997) in the sense that they support IS managers in estimates, technical tasks, project control, and process improvement (Pressman, 2001). In particular, metrics are the only factor currently available for contrasting companies in terms of process maturity (Rainer & Hall, 2003). Figure 7 synthesizes how metrics apply to software development.



Source: adapted from Bellini *et al.* (2004, p. 23), Sommerville (2001), Pavur *et al.* (1999), Blackstone Jr. *et al.* (1997), Richards and Gupta (1985), and Jackson and Keys (1984).

Figure 7. Measurement for software control and prediction.

Key for the effectiveness of metrics is, according to Pfleeger (1995), the development of a metrics plan describing *who/how* (tools, techniques, and personnel), *what* (is to be measured), *where/when* (in the measurement process) and *why* metrics (after all, they must be useful – Leung, 2001). At the same time, the abstraction level of measures should be addressed for building any metric, since not always – or almost never – it is possible to measure software quality attributes directly; building unidimensional measures is truly the outcome of robust theoretical and statistical modeling (Segars, 1997; Churchill Jr., 1979). Likewise, the aggregation level of the work system of a software organization (*e.g.*, business unit, project, or component) should also be taken into account when making the metrics plan (Leung, 2001). The result is that the surrounding context of measurement must be carefully assessed, given that software projects usually involve variables of a highly dynamic, complex nature and presenting fuzzy relationships with other variables (Barros *et al.*, 2004).

Committing oneself to a metrics agenda means to be prone to change towards a culture in which decisions are made based on relevant, accurate, practice-oriented data (Iversen & Mathiassen, 2003). This is in line with the assumption that the only rational way for improving any process is by measuring specific attributes of it, developing a set of metrics appropriate for the attributes and applying the metrics to provide signals of improvement (Pressman, 2001). Moreover, choosing metrics, collecting data, discussing the results of measurement and taking due action take time as well as other nontrivial resources, and this only makes sense if such activities address specific improvement goals (Pfleeger, 1995).

Nevertheless, little is said about the successful implementation of metrics in the realm of software process improvement (Iversen & Mathiassen, 2003; Fenton & Neil, 1999).

There is, however, some inadvertent use of terms like "measure" and "metric" in the literature (Wallace & Reeker, 2001), reason why we here adopt Pressman's (2001) conceptualization:

- *measures* result from computing data from a software project, process or product, and indicate in quantitative terms the magnitude of an attribute;
- *metrics* result from computing measures, and indicate in quantitative terms the degree to which a system, component or process exhibits some attribute; and
- *indicators* result from computing metrics, and help us with insights on software projects, processes and products.

Bahill and Dean (2002) add that metrics are particularly important for managing processes (like CISS development), not products. They finally recommend that during performance estimation in systems engineering one should also build *figures of merit*, which give clues on how much a system satisfies stated requirements.

A number of software metrics have been proposed over the years for a myriad of interests, but sometimes complementary or conflicting rationales and empirical evidences were assumed between works. The field of metrics is indeed large and complex, and here we present but a general picture of some illustrative cases. For instance, source-code metrics are among the most popular in some scientific communications and industry practices (Fenton & Neil, 1999), like metrics for algorithm complexity and size; nevertheless, no current complexity metric addresses completely what is needed for controlling, managing, and maintaining software (Chhabra *et al.*, 2003), and metrics of this kind exhibit obscure relationships with software quality (Sommerville, 2001) and programmer productivity (Ghezzi *et al.*, 1991). On the other hand, attention is increasingly being paid to multidimensional metrics addressing the whole software endeavor, like those on process and project management (*e.g.*, Osmundson *et al.*, 2003). In fact, Shaw (2003) already demonstrated that, during IS implementation, heterogeneous factors play a role.

According to Fenton and Neil (1999), among the key trends and needs of the metrics field, one can find a deeper approach to uncertainty and to combining heterogeneous subjective evidences, as well as some disregard to the traditional regression analyses – which may obstruct a fuller understanding about causality. They also write about advancements in meta-analyses, mainly on (1) the mechanics of metric implementation programs, (2) the deployment of metrics in empirical software engineering, and (3) theoretical foundations of software metrics. There is also room for discussing further challenges, listed below:

- maybe most academic research is not relevant in substance nor in scope for the industry;
- little is known about the effectiveness of metrics (Gopal *et al.*, 2002 provide sound improvements in this sense); and
- little is known about the true reasons why, notwithstanding current critiques, metrics like lines of code, defect counts, cyclomatic numbers and function points still have their place among the most popular standards.

Another arresting theme in software metrics is subjecting to measurement the very context in which measurement occurs (Briand *et al.*, 2002). In this sense, it is in increasing obsolescence assessing software with no explicit regard to the environment in which the software is handled. After all, choosing a particular project design gives rise to inevitably circumscribing the quality attributes for the software (Bosch & Lundberg, 2003). There is indeed some exhortation that the technical validation of a system should be performed only after the validation of its very context (McDaniel, 2002), but this seems not trivial to understand nor to effect. What is clear, though, is that a comprehensive, quality-oriented, metrics-based management of the software endeavor is needed, and the key components of an organizational system oriented towards such a goal (product quality and process efficiency) are those given in Figure 5 from Ravichandran and Rai (2000).

3.7.3 Identification of Metrics

Measuring software should head steadily towards appropriate metrics for each application context and directions on how to apply them (Fuggetta *et al.*, 1998), in order not to give rise to unintended side effects (Dekkers & McQuaid, 2002; Stein, 2001b). This challenges interpretations that some measurement is better than none (as in Ghezzi *et al.*, 1991).

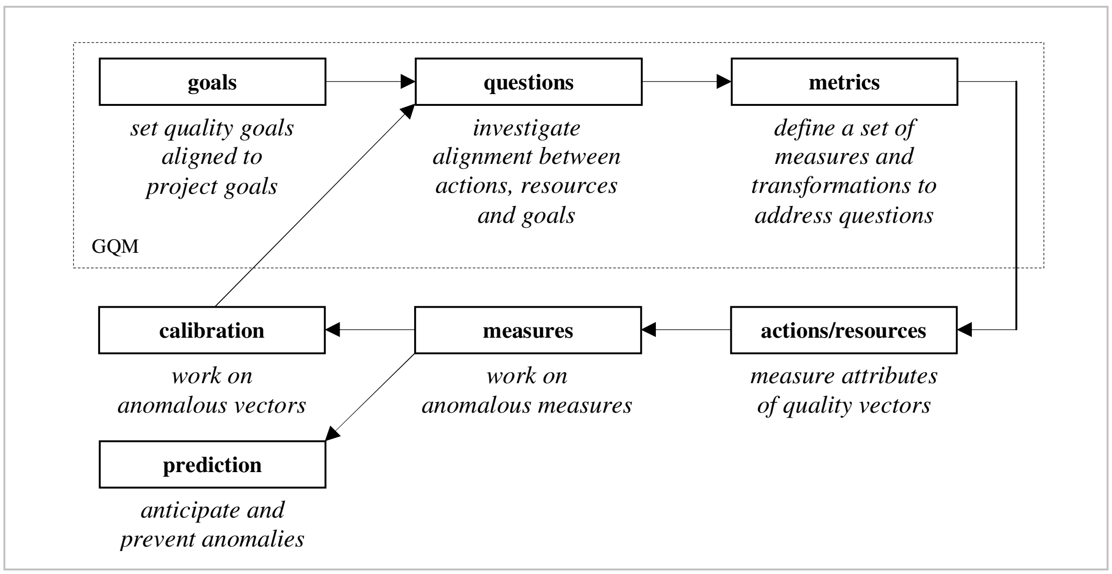
The first and perhaps most important procedure is to choose the measures that should be effected; after all, the outcome of this decision propagates throughout the sequence of activities and is intrinsically related to the very goals of the measurement system. From Hetzel (1997) and Wallace and Reeker (2001), one organizes the following components for any measure:

- the *handle* – an appropriate name for the measure;
- the *description* – what the measure is and what are the goals of collecting it;
- the *relationship* – how will the measure be related to the software process;
- the *history* – what we know about the measure from previous experiences;
- the *expectation* – what is expected from the measure in the future;
- the *source* – where the measure is to be collected;
- the *tools* – technology available for measurement support;
- the *observation* – how will the measure be collected;
- the *frequency* – when will the measure be collected;
- the *stakeholders* – who will be involved with measurement;
- the *scale* – measurement units;
- the *range* – maximum and minimum values to be observed;
- the *threshold* – control and triggering values for measurement;
- the *validation* – data for validating relationship strength and accuracy;
- the *interpretation* – how will the measure be screened;
- the *report* – measurement documentation; and
- the *actions* – events triggered by the measure.

Therefore, systematizing the selection of measures is crucial for the success of metrics, and, according to mainstream, leading publications in software engineering, one can safely conclude that the Goal-Question-Metric (GQM) approach (Basili & Rombach, 1988) is the dominant alternative for metric development. In fact, GQM is frequently deployed in its original or adapted formulation, or even combined with other models (*e.g.*, Berander & Jönsson, 2006, Lindvall *et al.*, 2003, Briand *et al.*, 2002, Leung, 2001, Pfleeger, 1995, Briand *et al.*, 1995, and Bush & Fenton, 1990). GQM defines, institutionalizes and systematically addresses measurement programs that support the quantitative assessment of software products and processes (Fuggetta *et al.*, 1998). GQM involves the following:

- the design of corporate, division or project goals usually targeted at productivity and quality issues and always tied to the organization's ultimate goals;
- the development of questions that sharpen the goals, in order to make visible whether they were fulfilled or not, by means of identifying uncertainty points related to the goals – the underlying assumption is that reaching any goal involves answering specific questions; and
- the identification of metrics related to measures to be collected which answer the questions (deriving measures from questions which in turn are rooted in superior goals gives GQM its top-down character).

Figure 8 shows how GQM can be the cornerstone for a measurement program.



Source: adapted from Sommerville (2001) and Basili and Rombach (1988).

Figure 8. Integrating GQM to measurement.

Among the GQM variants, it is worth mentioning Briand *et al.*'s (2002) work, which was supported by one of GQM's fathers and extends the original framework. They developed the GQM/MEDEA (GQM/MEtric DEfinition Approach) model, which combines GQM to empirical hypotheses (empiricism is in fact present in many recent developments and aspirations in software engineering – Fenton & Neil, 1999; Fenton & Neil, 2000; Fuggetta *et al.*, 1998; Gopal *et al.*, 2002); empirical hypotheses then undergo experimental verification based on expected mathematical properties of the theoretical measures from the attributes of interest. The most important contribution of GQM/MEDEA to the original framework would be establishing a systematic process to defining software product measures from GQM goals.

Moreover, the model makes explicit all the decisions involved in planning the measurement activity for building a predictive model; in fact, this recent model emphasizes making directions – maybe in reaction to previous critiques from the literature (*e.g.*, Hetzel, 1997). The experimental-empirical character is also made apparent when the authors name the mandatory traits of an effective software measurement process (which would be integral to GQM/MEDEA): the process must be disciplined, rigorous and based on goals, with properties and experimental assumptions accurately defined, and the process must also include comprehensive, experimental validation. Synthetically, the new model addresses:

- a detailed description of the activities involved in defining the measures and informational flows between activities;
- the integration of the definition of measures, the corporate goals and the development context;
- the fact that measures should not be defined *per se*, but according to the theoretical context;
- the support for the rationale, interpretation and reuse of measures;
- the support for identifying problems that may occur during the definition of measures, taking into account that the process is "human" intensive; and
- a conceptual model to be deployed in the implementation of a repository of relevant knowledge for measurement.

GQM is not free from critiques. First, top-down methods are not easily espoused by those who are assigned to implement it. While it is relatively straightforward to set goals and develop the questions, it is extremely hard to measure them effectively, and conflicts between developers and managers may then be easily brought into existence (Hetzel, 1997). According to Pfleeger (1995), the model also lacks an approach to connecting metrics that answer the same question, as well as to guiding one through implementing the measures. Finally, Hetzel (1997) claims that GQM's top-down character bypasses the actual measurement needs that are known only at the bottom.

Bottom-up models for identifying metrics are also available, starting from measurable items and then building management goals based on the measures. Such models build a database of measures to be collected on each product according to the following (Hetzel, 1997):

- *input measures* – information about resources (personnel, computers, tools, etc.), processes and activities performed;
- *output measures* – information about the production outcomes; and
- *result measures* – information about the use and the effectiveness (perceived and actual) of the production outcomes in fulfilling requirements and satisfying people.

What is behind the bottom-up approach is that the primary function of measurement is to support the engineering tasks by raising questions and helping rich insights to develop.

3.7.4 Measuring

Collecting and analyzing measures are two fundamental processes of software measurement intrinsically related to the previous discussion on measurement theory – which provides the means to formalize such processes, a requisite for an effective metrics plan. Given the intensive human involvement with software processes and products, the instrumentation for collecting and analyzing measures in software engineering owes much to methodological advances in the social sciences (Briand *et al.*, 1996; Briand *et al.*, 2002; Fuggetta *et al.*, 1998); as a matter of fact, software development is socio-technical in nature (Duvall, 1995).

3.7.4.1 Assembling the Evidences

Collecting the measures, or what we here call the process of assembling the evidences, is the way to efficiently gather data that provide the highest predictive power for a set of stated goals (MacDonell & Gray, 2001). According to Hetzel (1997), the collection of measures should follow the principles of (1) not being obtrusive, (2) being automated whenever possible, (3) being based on public, explicit, unambiguous definitions, (4) validating measures as soon as they are collected (and as close to the source as possible), and (5) integrating the collected measures to a repository for future validation. A robust collection of measures is vital for the empirical software engineering field, since this field aims to build a reliable base of measures for professionals and researchers (Votta *et al.* mentioned in Fuggetta *et al.*, 1998). It is important, however, that the set of measures be valid (represents what it is intended to represent – El Emam, 2001), inasmuch as no amount of data neutralizes a poor isomorphism between theoretical *constructs* or *latent variables* and the methods used to measure them (DeVellis, 1991). For this, the largely neglected discipline of instrumentation for measurement in software engineering demands greater care (Abran *et al.*, 2003).

The process of collecting measures should be adapted to each organization (Wieczorek, 2002) and the subsequent implementation may take different forms – it depends on the nature of the measures (in regard to an object's attributes), on the researcher's knowledge about what is to be measured, on the purpose of collecting, and on the appropriateness of the instruments. Thus, measurement may be direct or indirect (Jørgensen, 1999), objective or subjective (Pfleeger, 1995; Hetzel, 1997), based on theory or not (DeVellis, 1991), applied to people or objects, and consist of different sorts and quantities of data (Briand *et al.*, 1995). It should not be left out of sight, though, that measurement ought to be focused as much as possible; that is, collect exclusively the intended data that answer purpose-driven questions (Wallace & Reeker, 2001).

All this leads to the variety of methodological procedures available. A comprehensive review of collection techniques is not, however, within the scope of this investigation; thus, we next make reference to current literature discussions on measure collection with some emphasis on directions from the *Guide to the Software Engineering Body of Knowledge* (Abran *et al.*, 2001). Another decision made here in order for the discussion to be more straightforward and focused on current developments was to exclude collection methods like automatic algorithm analysis (for measuring size, coupling, etc.) or computational mechanisms for knowledge discovery in databases. Such a decision took into account the fact that software engineering is steadily incorporating methodological developments from the social sciences (Briand *et al.*, 1996; Briand *et al.*, 2002; Fuggetta *et al.*, 1998) and that, for software process improvement, organizational factors – measured with the support of corresponding methods – are at least as important (Dybå, 2002). Finally, we opted not to comment specific software packages developed for particular collection procedures, like the increasingly available tools for automatically assembling measurement instruments or performing Web-based data collection.

A current debate deals with the measurement instruments themselves. Notwithstanding the wealth of measures available and their potential applications, Abran *et al.* (2003) warn that little discussion is effected on measurement instrumentation for software engineering; moreover, directions found in the literature or in practice are often misleading. In fact, Briand *et al.* (1995) and Briand *et al.* (1996) criticize usual directions for being inflexible when constraining *a priori* measures to particular scales (like nominal, ordinal, or ratio), since there would be only a few cases where a given measure would be unequivocally tied to one specific scale. As previously stated, scales and admissible transformations (data analysis procedures) are closely related; but, due to the rigid direction of scales being univocally assigned to each measure *a priori*, data collection (and subsequent data analysis) is forced to operate in strict, narrow limits that may subsequently prove to be conservative in excess. A handy argument for advocating the contrary is that it is always possible to move from a stronger to a weaker level of measurement (Sarle, 1995); that is, if a stronger scale (say, ratio) is found incompatible with an object's attributes, it is possible to convert measurements to a weaker scale (say, ordinal). Therefore, it is suggested that instruments for data collection do not follow inexorably early scale assignments to measures.

Another subject of growing interest is the deployment of methods to collect qualitative data (Basili, 2006). Hetzel (1997) mentions that data collection may rely on gathering individual perceptions, for instance by means of *surveys* (with structured questionnaires applied to statistically significant samples) or *in-depth interviews* (with semi-structured interview protocols applied to select individuals). Techniques for group discussion such as *focus groups* (small groups of peers assembled for lively debate of subjects) are also of interest for qualitative measurements (Beecham *et al.*, 2003). And the *expert estimation* (Grimstad & Jørgensen, 2006; Jørgensen, 2004; Jørgensen *et al.*, 2004; Wieczorek, 2002; Wohlin & Andrews, 2003; Beecham *et al.*, 2005; Faraj & Sproull, 2000) is of special concern; in what comes to estimating the effort in software development, the qualitative expert estimation is indeed the dominant approach (Jørgensen, 2004).

The instrumentation for data collection is decisive in these cases – similarly to what was previously said about selecting appropriate scales for measurement. For instance, when using open-ended instruments for in-depth interviews, face and content validation are of need (Boudreau *et al.*, 2001; Hussey & Hussey, 1997; Churchill Jr., 1979) before and after pre-tests (Straub, 1989). Notwithstanding the collection of measures in such a case having no statistical meaning, the collection only ends when the answers of a number of individuals converge to the same constructs (when *theoretical saturation* comes about – Jones, 2005). In surveys – like for collecting statistically significant information about customer satisfaction with a specific software package –, instrument (questionnaire) development also requires expediency in validation procedures (Babbie, 1999). Surveys require rigorous statistical analysis for defining the appropriate samples and, additionally to the aforementioned face and content validation and pre-tests, pilot tests and construct validation (convergent, discriminant, and nomological validation – Bagozzi *et al.*, 1991; Boudreau *et al.*, 2001; Churchill Jr., 1979) need to be fulfilled. Construct validation, however, may depend on the purpose and stage of the research.

Data collection for developing metrics may also be done with direct searches in databases (Evanco & Lacovara, 1994; Hetzel, 1997; Wieczorek, 2002; Zhu & Kraemer, 2002), what is best known as the *collection of secondary data* (Palvia *et al.*, 2003). Moreover, building and maintaining a *metrics repository* (Harrison, 2004) or *experience base* (Münch & Heidrich, 2004) is an important decision for future projects (Khoshgoftaar *et al.*, 1997; Sommerville, 2001), mainly when the organization is committed to learning from previous enterprises (Zack, 1999). Nevertheless, keeping the database relevant through continuous assessments is also needed (El Emam, 2001). Lastly, Hetzel (1997) suggests the deployment of unusual methods in software engineering, like case studies.

Table 9 adapts the categories in Palvia *et al.* (2003) for research methods in the IS field, indicating which could be used for measure collection in software engineering.

Method	Proposition in Software Engineering
library research	Review on the history, the state of the art, and the state of the practice of measures and measurement procedures, as well as on the changing knowledge about the measurement objects.
literature analysis	Meta-analyses for consolidating terms, methods in particular applications, and objects of interest for measurement.
case study	Qualitative, longitudinal analysis of the behavior of an object's attributes.
in-depth interviews	Semi-structured interviews for capturing the perception of select experts about the nature of an object's attributes.
survey	Structured interviews for capturing the perception of a sample of practitioners about the behavior of an object's attributes.
laboratory experiment	Experimental control over an object's attributes being measured during simulation.
field experiment	Quasi-experimental control over an object's attributes being measured in real life.
secondary data	Search in databases of measures collected by previous purpose-driven, comparable processes, in order to understand the behavior of an object's attributes and the correlation with other measures.

Source: adapted from Palvia *et al.* (2003, p. 291).

Table 9. Methods for collecting measures in software engineering.

3.7.4.2 Producing the Evidences

Analyzing the measures, or what we here call the process of producing the evidences, comes straightforward from their collection. Exhibiting the stigma of hard work (Sommerville, 2001), it is nevertheless usually handled with insufficient care (Harrison, 2004; Hetzel, 1997) notwithstanding the sound benefit to be perceived if performed within efficient feedback mechanisms that leverage organizational processes (Gopal *et al.*, 2002). Before the actual analysis, collected measures sometimes must follow a "purifying" path. Although the collection of measures should be ideally based on a deliberate process supported by appropriate techniques, the measures may not be ready for analysis. In fact, formatting the data into a friendlier, scale-adherent design should precede measure interpretation (Hetzel, 1997). For instance, after fulfilling audio recordings during in-depth interviews (as for measuring initial perceptions on the performance of changes effected to the software process), the discourses should be formatted into appropriate media for particular content analysis procedures (Bardin, 1977) to be later deployed. One alternative is to reproduce the measures into a word processing application or codify them into a package for semantic, quantitative analysis (Ford *et al.*, 2000). In either case, the transcription must adhere to the interface with the target medium and – more importantly – follow some relation prescribed by measurement theory governing the equivalence between the recorded items in audio format and the text being built. From this, we should observe that moving measures between media for analytical purposes also conveys a collection process that must comply with all the previously addressed assumptions from measurement theory – since an accurate transcription of items between representation systems is envisioned, with no interference resulting from deploying the instrument for data "collection".

Developments made in the field of statistics are incorporated by software engineering whenever appropriate (Briand *et al.*, 1996), and as such a laborious process is also expected when preparing the measures for multivariate analysis. Before choosing and applying the most appropriate methods available (*see* Hair Jr. *et al.*, 1998 for a comprehensive review), tests like the ones for sample adequacy and adherence to particular probability distributions should be performed. Such procedures are here not regarded as of a genuine analytical nature (although they truly support the analyses), since *per se* they do not add information to the knowledge nor to the decision making based on the measures effected – the ultimate purpose of software metrics (Hetzel, 1997). Those procedures are more oriented towards supporting simulations, exploring scale attributes, or indicating the need for changing the set of measures (*e.g.*, excluding values or fitting the data to certain statistical procedures in subsamples), thus guiding the analyst throughout the mathematical maneuvers and conceptual reasoning. In this dissertation, what truly distinguishes the analysis is not the deployment of one mathematical method or another, but the incorporation of theory and subjective interpretation to what is measured – which is then ready for the scientific scrutiny.

Like it happens for the collection process, formatting the measures and analyzing them rely on numerous factors, among which the type of data collected and the purpose/nature of the analyses (Briand *et al.*, 2002; Evanco & Lacovara, 1994). Nevertheless, in all cases measurement theory is helpful for accuracy, conceptual consistency, and process objectiveness (Briand *et al.*, 1996). Methodological rigor and pragmatic usefulness thus resultant will root the effective application of metrics for the purposes in mind (Gopal *et al.*, 2002).

An important discussion regarding the analysis of measures concerns the very deployment of measurement theory and the various types of scales (*e.g.*, Briand *et al.*, 1995, Briand *et al.*, 1996, Bush & Fenton, 1990, and Jørgensen, 1999). As mentioned before, the theory predicts particular relationships between scale types and measures, according to the nature of the latter, and each type includes admissible and non-admissible transformations. Naturally, if we assume that one can hardly seize *impromptu* the nature (and the scale type) of a measure, then it is also true that an arbitrary decision made before the analyses (during the collection of measures) will block a whole set of transformations potentially suitable for the measures (Table 10 reproduces some scale types and corresponding directions). Nevertheless, Briand *et al.* (1995) champion a more pragmatic standpoint that reckons the chronic doubt on the nature of some measures and allows – not without explicit and meticulous speculations about possible side effects – greater freedom for the analyst to handle them. Such a flexible stance, although clearly not being the mainstream perspective in software engineering, is widely espoused or at least accepted for producing minor hurdles in other knowledge areas – one frequently finds, for instance, the computation of arithmetic means for Likert scales. In fact, Sarle (1995) puts that “there is no need to restrict the transformations in a statistical analysis to those that are permissible”, but also “an appropriate statistical analysis must yield invariant or equivariant results for all permissible transformations”.

Scale Type	Appropriate Statistics (examples)	Type of Appropriate Statistics
nominal	mode frequency contingency coefficient	nonparametric
ordinal	median Kendall's tau Spearman's rho	
interval	mean Pearson's correlation	nonparametric and parametric
ratio	geometric mean coefficient of variation	

Source: Briand *et al.* (1995, p. 12).

Table 10. Examples of relating scales to statistics.

Another debate deals with how causes and effects are investigated. Fenton and Neil (1999) alert that correlations between measures (which, once detected, enable one to perform a whole set of statistical procedures and conceptual inferences) merely suggest the simultaneous occurrence of those measures – and *nothing* about antecedents and consequents. Therefore, studies in which nomological networks of constructs are not exhaustively investigated with advanced methods like *structural equations modeling* (Gefen *et al.*, 2000) are not able to postulate genuine causal reasoning.

Fenton and Neil (1999), with their developments on Bayesian belief networks, claim to have made progress on this regard (causes and effects) and other delicate subjects like the role of uncertainty and lack of information (measures). The authors' model was implemented as a graphic tool which makes transparent to the user the complex Bayesian mathematics behind the intrinsic propagations of probability. The tool takes as input values the outcomes of measurement and depicts the effects from the measures in the complex relationships between components (previously modeled). Summarily, the benefits from using such a model include: (1) the explicit modeling of "ignorance" and uncertainty in estimates, as well as cause-and-effect relationships; (2) the unveiling of assumptions originally hidden; (3) reasonable predictions even with the lack of important data; (4) *what-if* analyses; (5) the deployment of probability distributions objectively or subjectively derived; and (6) rigorous mathematical semantics. Several other studies make comparisons or devote critiques to particular statistical methods, usually those which can be applied to multiple variables simultaneously (*e.g.*, Wieczorek, 2002, Khoshgoftaar & Seliya, 2003, Hanebutte *et al.*, 2003, Briand *et al.*, 2002, and Beecham *et al.*, 2003); but since no clear alignment between those studies was unveiled in the literature review, our research does not delve into them.

Finally, regardless of the method, the outcomes from the analyses must be fed back to the organization and especially to the point where measures were collected (Hetzel, 1997). Such a feedback should be understood as *lessons learned* to integrate the repositories of metrics (Harrison, 2004) and project knowledge (Zack, 1999), in order to serve as a source for future processes of measure collection and analysis.

3.7.4.3 The Crossroads in the Future of Software Engineering

Software engineering faces a critical decision in what comes to its role in the collection and the analysis of measures: in spite of the steady incorporation of methods from other knowledge areas like the social sciences, we find but a few publications (mainly targeted at the IS audience) where instrument validation is of real concern. If the field aims to understand, apply, and become *the* reference in the canons of software measurement, much more than current exegeses are needed; academic practice should be improved or at least communicated in detail.

Additionally, it is unclear whether software engineering and information systems will remain separate or merge into a single domain in the near future, not only in what comes to measurement issues (concepts, objects of interest, procedures, and so on), but also in terms of the required expertise for its professionals in academy and industry. Take, for instance, new development approaches like the *agile method* of *eXtreme Programming*: its assumptions on informality, prototyping, and pair programming (Ramesh *et al.*, 2006; Wagstrom & Herbsleb, 2006; Flor, 2006) have been typical in research on human-computer interaction, IT-business alignment, and inter-rater validity; the assumption that the agile practices should be implemented as an indivisible whole is not in line with the needed operational flexibility in industry (Ågerfalk & Fitzgerald, 2006), which is a design rule at least since the contingency approach to management came about in the late 1960s (Donaldson, 1996); and the espoused practice of avoiding documentation is clearly against good project principles (Parnas, 2006). The reader is referred to a recent work by Basili (2006) on further challenges in the field (like performing meta-analyses, promoting the need for empirical studies, and setting the principles for experimental replication).

3.7.5 Sources of Metrics for CuTe Performance

A key development in this research was to gather theoretical metrics for gauging the effective performance of CuTes. This was done based on an extensive literature review, which was subsequently validated in empirical investigation (as discussed later). It should be observed that no metric is self-contained; that is, besides being useful only in regard to a given objective and being technically dependent on the measurement instruments, different individuals will likely make different assumptions about the subject of measurement as well as how any value is to be interpreted. Thus, identifying the mindset and interests of different stakeholders is part of an effective metrics agenda (Palvia *et al.*, 2001; Chan *et al.*, 1997).

3.8 Software Development and Organizational Issues

This section stresses the argument on the merge between software development and organizational issues, particularly from a strategic viewpoint.

3.8.1 Organizational Strategy and Cognition

Fonseca and Machado-da-Silva (2001) say that research on strategy evolves from the prevalent perspective of the *strategic choice*, which assumes that the organizational action takes place in a rational and instrumental way targeted at maximum results and deliberately set procedures. The authors also put that this view has many flaws, reason why the alternative perspectives of *cognition* and *institutionalization* propose some improvements: the former frames the organization as a set of knowledge and symbols created and transformed by collective intersubjectivity, in order to negotiate satisfactory results; and the latter is concerned with a system of standard activities expressing values, beliefs and social norms, in order to come to legitimation in the environment (adhering to social norms would also enable the organization to survive and to grasp opportunities for innovation).

The cognitive approach to strategy suggests including *interpretation* in between the extremes of *stimulus* and *response* of the mainstream deterministic frames of reference. In line with Simon (1979) and Elster (1994), Machado-da-Silva *et al.* (2000) remind us that imponderabilities and the very subjectivity of decision makers may govern the walk on strategic routes different from those previously planned. Therefore, complete rationality is not believed to be possible, and *cognitive maps* (Laukkanen, 1994; Bastos, 2002) are among the evidences of this: as descriptive models of concepts and relations that an individual uses to understand the contexts in which he/she is inserted, cognitive maps show that (1) decision makers do not deal with objective events, (2) mental models drive one's attention to particular information, (3) the current mental model lies behind the interpretation of any stimuli, and (4) mental models coordinate action.

Along with cognitive maps, the *interpretive schemes* – ideas, values and beliefs that organize and give meaning to structures and systems (Hinings & Greenwood mentioned in Machado-da-Silva *et al.*, 2000) – support the organization in the sense of providing it with an operational scope, principles, and internal criteria for estimates on performance. That is, the organizational variety in the environment is assured, regardless of how isomorphic the contextual dynamics may be. It is worth reminding that the variety needed in any organization to effectively answer to the environmental demands, which adds to the systemic fact that structures, functions and behaviors of social organizations depend on complex interactions (Morgan, 1996), supports the presence of different organizations in the same environment and experimenting similar isomorphic pressures. The concept of a shared environment, though, is debatable, as this is maybe the result of how one conceives it (Machado-da-Silva *et al.*, 1999).

3.8.2 Organizational Change

Grounded as they are on values and beliefs, and given that change is inherent to any system, the interpretive schemes may disagree with the external environment. When this happens, two classes of organizational change in terms of structure, culture, goals, program or the mission (DiMaggio & Powell, 1983) should take place in order to align organizational and contextual inputs and outputs: *incremental change* and *strategic change*. These two classes respectively echo Argyris' (1992) *single-loop* and *double-loop learning*. Incremental change has long been said to provide good explanations for the organizational dynamics (*e.g.*, Lindblom, 1959), although not everyone agrees with that due to the issue of instant, radical changes (Miller *et al.*, 1996). In fact, organizations seem to be naturally prone to preserving the routines, instead of changing them (Nelson & Winter, 1982; Andrews, 2001; Tolbert & Zucker, 1999; Sartor, 2002; Fleury & Fleury, 1997). A reason for this could be because it is harder to dissolve knowledge in order to learn something new than to learn for the very first time (Hofstede, 1994), as when seeing the future first and unusually (Hamel & Prahalad mentioned in Parker, 1999). A good exercise would be to counterbalance such an assertion – that organizational matters tend to routine – with the systemic principle of *entropy*, according to which systems evolve towards states of greater disorder (Flood & Carson, 1988).

Machado-da-Silva and Fernandes (1998) put that successful organizations usually postpone new strategic orientations when confronted with environmental turbulence mainly due to (1) psychological and financial reserves, (2) the stability of structures and interpretive schemes, (3) learning difficulties (such as connecting causes to effects) and attribution mechanisms (with which managers guard themselves against responsibilities in what comes to performance), and (4) the institutional contexts of reference. When, however, they decide to change (possibly encouraged by crisis), the opportunity may not be at hand anymore.

Organizational change aimed at addressing the surrounding contextual variables can evolve beyond the struggles for customers and production inputs: it may occur as a response to the search for *institutional legitimacy*, which takes place by means of *coercive*, *mimetic* or *normative isomorphism* and may have far deeper consequences than the technical performance of the organization (DiMaggio & Powell, 1983). For instance, the conformity to quality standards may be regarded by the environment as more important than the performance of a product's specific features, like the very functionality of it. Simultaneous pressures from the *technical environment* (where products and services are exchanged) and the *institutional environment* (where business practices are negotiated and shared) will drive the change (Machado-da-Silva & Fonseca, 1999). The organization, though, may not be fully prepared to interpret and act correspondingly, due to a *collective programming of the mind* (Hofstede, 1994) or to the key individuals' interpretive schemes (Machado-da-Silva *et al.*, 1999; Machado-da-Silva & Fernandes, 1998).

3.8.3 Organizational Learning

In organizations, change and learning are interrelated concepts. Guarido Filho and Machado-da-Silva (2001) classify studies in learning in the organizations field as pertaining to one of two main streams: the *organizational learning* literature, which is more interested in theoretical issues (*e.g.*, Argyris, 1992, and Nelson & Winter, 1982), and the *learning* *organization* literature, which is the industry counterpart (*e.g.*, Garvin, 1993, and Senge, 1998). Some say that the terms above are inadequate, since the verbs "to organize" and "to learn" would be mutually exclusive (Weick & Westley, 1996), but in any case we will take as granted that learning in organizations demands live experience (Ruas, 2001) and change in behavior (Sweringa & Wierdsma, 1995).

Garvin (1993) and Argyris (1992), representatives of the aforementioned schools of thought, help us in understanding the above assumptions. The first author posits that a learning organization masters five self-explanatory abilities: systematic problem solving, experimentation, learning from experience, learning from the experience of others, and efficiently disseminating knowledge within the organizational structure. The second author puts forth *theories of action*, which are brought into existence by means of two models for the individual action: the *espoused theory*, which describes the manifest, official action; and the *in-use theory*, which describes the action actually effected. Learning at the organizational level is, after all, a matter of patronizing the convergence between the organization's mechanics and that of the environment.

3.8.4 Software Customization and Organizational Issues

For CISS research, it seems that the organizational issues of strategy, cognition, change and learning contribute to an understanding of the factors governing the implementation of CuTe metrics. From those issues we derived the following contributions:

- the influence of the financial and psychological reserves, the stability of structures and interpretive schemes, the learning problems and attribution mechanisms, and the institutional contexts of reference over changes in action strategies;
- the different perspectives on strategy (traditional, cognitive, and institutional); and
- the convergence of organizational and environmental values as an evidence of learning.

In fact, the development and transformation of analytical perspectives in software projects should be targeted. If committing to quality demands organizational change (Fleury, 1993), then developing quality metrics for CuTes is expected to be a multidimensional venture. Not only the frames of reference currently in use – which were already depicted as privileging technical over social factors – should undergo profound changes, but also questioning the *status quo* demands changing individual and social structures vigorously sponsored in contemporary academy and industry. That is, for new practices to be effective in project units, they face the challenge of counteracting dominant values (Machado-da-Silva *et al.*, 1999). Another sound implication comes from the fact that the interpretive schemes give shape to the operational scope, the principles and the criteria for estimates on performance; regarding such criteria, they relate intimately to our endeavor in planning and assessing the participation of CuTes in CISS projects.

In terms of strategy, the assumptions that organizations are not autonomous and that the technical performance is sometimes less important than the conformity to the environment enable one to devise a situation in which a change in the whole software industry can occur in order to effect a new *praxis*. Hence, as soon as organizations with more institutional power champion new practices, the others are likely to exhibit isomorphism at some degree, and that is why DiMaggio and Powell (1983) warrant that organizations are rewarded by similarity with others. In the specific case of our research, new practices in industry would mean to match the effective – although sometimes neglected – responsibility of CuTes in CISS projects to socio-technical performance metrics. Interestingly, the institutionalization of such metrics would lead to a situation where the technical *and* the institutional performances of any company are expected to be high, given that the institutionalized metrics are aimed at improving the social and the technical performance of CuTes.

Finally, organizational learning is a much needed attribute of CuTes, whereby CuTes institutionalize industry standards (like best practices in socio-technical metrics) and incorporate knowledge from their own past experiences. Nurturing the development of IT clusters, for example, is a healthy initiative in this sense, since they introduce the companies to an atmosphere of technical and business information exchange (Porter, 1998; Porter, 1999).

3.9 Indicators, Metrics and Measures for Managing CISS Development

This section is devoted to compiling the theoretical review into two third-order social constructs (*CuTe Structure* and *CuTe People*) that help organizations design, manage and evaluate CuTes. Such a set – subsequently validated in a real CISS project – is expected to constitute the major contribution of our research to theory and practice.

From the analysis on the structural attributes of CuTe work, we developed the semi-structured interview protocol *On CuTe Structure* (Appendix A-1) for letting CuTe workers assess how far the structural design of their team is from the desired adhocratic design. And, from the discussion on the human nature of CuTe individuals, we developed the semi-structured interview protocol *On CuTe People* (Appendix B-1) for guiding CuTe workers reveal the innermost personal characteristics that are needed for CISS implementation. Both instruments are primarily designed as self-assessment tools, but with minor changes (especially to the *On CuTe People* instrument) they can be used by project leaders to assess the social architecture of their teams.

3.9.1 Team Structure – CuTe Adhocratic/Organic Design

The *On CuTe Structure* instrument is composed of one indicator (labeled *CuTe Adhocratic/Organic Design*), which in turn is the outcome of computing six metrics and 21 measures in total. The reason for having just one structural indicator is due to the previous argument on the appropriateness of designing and managing CuTes with the adhocracy paradigm in mind. Therefore, the instrument is intended to measure the structural design of CuTes and match the result against the adhocracy standard. Given that adhocracy owes much to the socio-technical design of work systems, it is also expected that we find the implementation of socio-technical principles in CuTe work. In Tables 11.1 to 11.6, one can find the theoretical sources for each measure (some exceptions are due to insights developed in conducting this research).

The *Organizational Fit* metric (Table 11.1) describes how fit the individual is for working in the project, that is, which part of the environmental variety (professional function) is due to each member and to the team as a whole. It is measured by the level of ongoing training and indoctrination for the role (*Fit1*), the likelihood of people changing roles during the project (*Fit2*), and the design of the workplace where tasks are intended to be fulfilled (*Fit3*).

Measure	Theory Deployed	Original Construct/Measure	Source
Fit1	social psychology	management support for social integration (training)	Aladwani (2002)
		education	Palvia *et al.* (2001)
		education & training	Garvin (1993)
		team training	Kim & Peterson (2003)
		commitment to skill development	Ravichandran & Rai (1999/2000)
Fit2		personnel rotation	Garvin (1993)
Fit3		structure of team interaction (team workplace)	Jones (2005)
		managerial leadership & infrastructure	Ravichandran & Rai (2000)
		commitment to skill development	Ravichandran & Rai (1999/2000)
			Corbin (1991)

Table 11.1. Measures for metric Organizational Fit.

The *Task Interdependence* metric (Table 11.2) describes how integrated and purposeful each role in the project is. It consists of the likelihood of assigned tasks serving as input for someone else' tasks (*Interdep1*), and the likelihood of assigned tasks being served by someone else' tasks (*Interdep2*).

Measure	Theory Deployed	Original Construct/Measure	Source
Interdep1 Interdep2		outcome control	Kirsch *et al.* (2002)
		task interdependence	Andres & Zmud (2001/2002)

Table 11.2. Measures for metric Task Interdependence.

The *Goal Conflict* metric (Table 11.3) describes how self-governed and effective each individual is expected to be in the project. It consists of criteria for delivering completed tasks (*Conflict1*), and criteria for asking someone else to deliver tasks (*Conflict2*).

Measure	Theory Deployed	Original Construct/Measure	Source
Conflict1 Conflict2		outcome control	Kirsch *et al.* (2002)
		time pressure (concern for career & concern for quality)	Austin (2001)
		speed & accuracy	Förster *et al.* (2003)
		goal conflict	Andres & Zmud (2001/2002)
		IS management commitment to quality & quality policy and goals	Ravichandran & Rai (1999/2000)

Table 11.3. Measures for metric Goal Conflict.

The *Formality & Knowledge Sharing* metric (Table 11.4) describes how flexible and committed each role in the project is, that is, how able the team is to respond to complex demands from the environment. It consists of the frequency of free information exchanges (*Formal1*), the atmosphere of spreading the word about one's perceptions and insights (*Formal2*), the level of informality between the parties (*Formal3*), the alternatives available for professional self-improvement in the project (*Formal4*), and the degree of contract-attached individual behavior (*Formal5*).

Measure	Theory Deployed	Original Construct/Measure	Source
Formal1		relationalism (information exchange)	Grover *et al.* (2002)
		team atmosphere	Jones (2005)
		organic/mechanistic coordination	Andres & Zmud (2001/2002)
Formal2		team atmosphere	Jones (2005)
		safe space	Gallivan & Keil (2003)
		programmer/analyst empowerment	Ravichandran & Rai (1999/2000)
Formal3		relationalism (information exchange)	Grover *et al.* (2002)
		expertise coordination (bring expertise to bear)	Faraj & Sproull (2000)
		organic/mechanistic coordination	Andres & Zmud (2001/2002)
		team atmosphere	Jones (2005)
		(informal information)	Gallivan & Keil (2003)
Formal4		team atmosphere	Jones (2005)
Formal5	transaction cost analysis	monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		relationalism (flexibility & information exchange)	
		team atmosphere	Jones (2005)
		behavior & outcome control	Kirsch *et al.* (2002)

Table 11.4. Measures for metric Formality & Knowledge Sharing.

The *Cooperativeness* metric (Table 11.5) describes how power is managed and used for the benefit of cooperative work. It consists of top management's concern for each role (*Coop1*), the autonomy for doing joint work (*Coop2*), the outcomes of organizational power (*Coop3*), the integrity of cooperative work (*Coop4*), and conflict resolution (*Coop5*).

Measure	Theory Deployed	Original Construct/Measure	Source
Coop1		inclusion	Palvia *et al.* (2001)
		top management support	Kim & Peterson (2003)
		programmer/analyst empowerment	Ravichandran & Rai (1999/2000)
Coop2		relationalism (information exchange)	Grover *et al.* (2002)
		organic/mechanistic coordination	Andres & Zmud (2001/2002)
Coop3		relationalism (power)	Grover *et al.* (2002)
		(user influence/power)	Gallivan & Keil (2003)
Coop4		behavioral factors (team skills)	Guinan *et al.* (1998)
Coop5		(divergent thinking)	Gallivan & Keil (2003)

Table 11.5. Measures for metric Cooperativeness.

The *Genuine Participation & Autonomy* metric (Table 11.6) describes how authoritative each individual is in his/her role, that is, how control and operational information is expected to flow within the project. It consists of the likelihood of point-of-action decision (*PartControl1*), the likelihood of point-of-decision action (*PartControl2*), the share of decision making due to each professional (*PartControl3*), and the share of work due to each professional (*PartControl4*).

Measure	Theory Deployed	Original Construct/Measure	Source
PartControl1 PartControl2 PartControl3	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		relationalism (shared problem solving)	Grover *et al.* (2002)
		organic/mechanistic coordination	Andres & Zmud (2001/2002)
		outcome control	Kirsch *et al.* (2002)
		self-control	Kim & Peterson (2003)
		decentralized control	Ghezzi *et al.* (1991)
		programmer/analyst empowerment	Ravichandran & Rai (1999/2000)
PartControl4		user-related risk	Jiang *et al.* (2002)
		genuine participation	Andres & Zmud (2001/2002)
		stimulation	Palvia *et al.* (2001)
		joint new product development	Athaide & Stump (1999) Stump *et al.* (2002)
		self-control	Kim & Peterson (2003)
		(user influence/power)	Gallivan & Keil (2003)

Table 11.6. Measures for metric Genuine Participation & Autonomy.

3.9.2 Human Nature

The *On CuTe People* instrument is composed of six indicators, which are the outcome of computing 21 metrics and 82 measures in total. The instrument is intended to measure the human design in CuTes, and the benchmark against which particular measurements should be contrasted is represented by levels attained by high-performance teams in corresponding CISS projects. In the following chapter we illustrate suggested values, as collected from one such team in a real-life setting. In Tables 12.1 to 12.21, one can find the theoretical sources for each measure (some exceptions are due to insights developed in conducting this research). Many measures are based on stable scales from the literature.

3.9.2.1 CuTe Eligibility

The first people-oriented indicator is called *CuTe Eligibility* and serves as a pre-screening mechanism for building the set of CuTe individuals, based on more stable personal traits. It is formed by four metrics: Personality, Trustworthiness, Innovativeness & Entrepreneurship, and Expertise & Transactive Memory.

The *Personality* metric (Table 12.1) describes the most rudimentary framework of the individual. It consists of attributes relating to extraversion (*Person1*), goal orientation and conscientiousness (*Person2*), tolerance (*Person3*), emotional influence (*Person4*), and content orientation (*Person5*).

Measure	Theory Deployed	Original Construct/Measure	Reference
Person1		personality (extraversion)	Clark *et al.* (2003)
Person2		personality (conscientiousness)	Clark *et al.* (2003)
		business competence (leadership)	Basselier & Benbasat (2004)
		self-control	Kirsch *et al.* (2002)
Person3 Person4 Person5		personality (agreeableness)	Clark *et al.* (2003)
		personality (emotional instability)	
		personality (openness)	

Table 12.1. Measures for metric Personality.

The *Trustworthiness* metric (Table 12.2) describes how trustworthy the individual is, that is, the distance between what he/she says and what he/she perceives or thinks, or how he/she behaves. It consists of the need for external supervision to meeting effectiveness and mutual benefits (*Trust1*), the abilities to protect group information from external threats (*Trust2*) and guide fellows (*Trust3*), and transparency (*Trust4*).

Measure	Theory Deployed	Original Construct/Measure	Reference
Trust1	agency theory	shortcuts (concern for career)	Austin (2001)
	transaction cost analysis	opportunism	Williamson (1985)
		monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		social ties (trust)	Kotlarsky & Oshri (2005)
		trust	Wilson & Vlosky (1997)
		behavior control & self-control	Kirsch *et al.* (2002)
Trust 2		trust	Wilson & Vlosky (1997)
		external group processes (guard)	Guinan *et al.* (1998)
Trust3		social ties (trust)	Kotlarsky & Oshri (2005)
		trust	Wilson & Vlosky (1997)
Trust 4	agency theory	(observation difficulty)	Austin (2001)
	transaction cost analysis	information asymmetry	Williamson (1985)
		relationalism (information exchange)	Grover *et al.* (2002)
		trust	Wilson & Vlosky (1997)

Table 12.2. Measures for metric Trustworthiness.

The *Innovativeness & Entrepreneurship* metric (Table 12.3) describes how able the individual is to promote actual innovations in products and processes, in order to accomplish this much-needed attribute of CISS. It consists of the general aspect of his/her ideas as compared to known alternatives (*Innov1*), the preoccupation with the economic aspects of production (*Innov2*), the personal inclination of following the environmental dynamics (*Innov3*), and the usefulness of ideas (*Innov4*).

Measure	Theory Deployed	Original Construct/Measure	Source
Innov1	adaption-innovation theory	innovativeness (originality)	Gallivan (2003)
Innov2	adaption-innovation theory	innovativeness (efficiency & rule-conformity)	Gallivan (2003)
		speed & accuracy	Förster *et al.* (2003)
Innov3	adaption-innovation theory	innovativeness (preference for change or stability)	Gallivan (2003)
		relationalism (flexibility)	Grover *et al.* (2002)
Innov4			

Table 12.3. Measures for metric Innovativeness & Entrepreneurship.

The *Expertise & Transactive Memory* metric (Table 12.4) describes the individual's requisite competence for the project. It consists of the actual social and technical competencies one possesses before and during the project (*Expert1*), the ability to foresee effective and critical paths to a solution (*Expert2*), the ability to manage human knowledge resources (*Expert3*), and the amount of requisite variety added by one's knowledge to the team (*Expert4*).

Measure	Theory Deployed	Original Construct/Measure	Source
Expert1		presence of expertise	Faraj & Sproull (2000)
		behavioral factors (experience spread & team skills)	Guinan *et al.* (1998)
		technical, business & interpersonal knowledge & skills	Byrd *et al.* (2004)
		business competence	Basselier & Benbasat (2004)
		integration skills & expertise	Lam (2004)
		team members' attitude (experience & knowledge)	Chatzoglou & Macaulay (1996)
		experience	Kim & Peterson (2003)
		client understanding of the IS process	Kirsch *et al.* (2002)
		user-related risk	Jiang *et al.* (2002)
		technical, business & systems knowledge/skills	Todd *et al.* (1995)
		(technical) expertise	Schultz (2001) Ghezzi *et al.* (1991)
Expert2		presence of expertise	Faraj & Sproull (2000)
		behavioral factors (experience spread & team skills)	Guinan *et al.* (1998)
		technical, business & interpersonal knowledge & skills	Byrd *et al.* (2004)
		business competence	Basselier & Benbasat (2004)
		integration skills & expertise	Lam (2004)
		team members' attitude (experience & knowledge)	Chatzoglou & Macaulay (1996)
		experience	Kim & Peterson (2003)
		client understanding of the IS process	Kirsch *et al.* (2002)
		user-related risk	Jiang *et al.* (2002)
		(technical) expertise	Schultz (2001) Ghezzi *et al.* (1991)
Expert3		team atmosphere	Jones (2005)
		expertise coordination (expertise location)	Faraj & Sproull (2000)
		business competence (knowledge networking)	Basselier & Benbasat (2004)
		knowledge sharing (transactive memory)	Kotlarsky & Oshri (2005)
Expert4		team atmosphere	Jones (2005)
		expertise coordination (expertise needed)	Faraj & Sproull (2000)
		business competence (knowledge networking)	Basselier & Benbasat (2004)
		knowledge sharing (transactive memory)	Kotlarsky & Oshri (2005)
		technical, business & systems knowledge/skills	Todd *et al.* (1995)

Table 12.4. Measures for metric Expertise & Transactive Memory.

3.9.2.2 CuTe Risk-averse Attitude & Social Integration

The second people-oriented indicator is called *CuTe Risk-averse Attitude & Social Integration* and addresses how the individual aligns with the company's present needs. It is formed by three metrics: Strategic Enrollment, Role Cherishing, and System Championing.

The *Strategic Enrollment* metric (Table 12.5) describes the far-reaching perspective the individual has about the impact of the project on the company's long-term presence in the environment – be it in terms of market, industry, community, or any other interacting system. It consists of a general understanding about how the project relates to the company's strategy (*RiskStrat1*), how much is the individual committed to the strategic issues (*RiskStrat2*), which stake of the organizational change can be expected from the individual (*RiskStrat3*), and how true it is that both partners share the goal of putting the client's strategy to work (*RiskStrat4*).

Measure	Theory Deployed	Original Construct/Measure	Source
RiskStrat1		business knowledge & skills	Byrd *et al.* (2004)
		business vision & business requirements	Lam (2004)
		business competence (organizational overview)	Basselier & Benbasat (2004)
RiskStrat2	theory of reasoned action theory of planned behavior	user attitude	Hartwick & Barki (1994)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		user-related risk	Jiang *et al.* (2002)
		stakeholder buy-in	Lam (2004)
		team members' attitude (commitment)	Chatzoglou & Macaulay (1996)
		genuine participation	Andres & Zmud (2001/2002)
			Kotlarsky & Oshri (2005)
RiskStrat3	theory of reasoned action theory of planned behavior	user involvement	Hartwick & Barki (1994)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		user-related risk	Jiang *et al.* (2002)
		business competence (organizational units)	Basselier & Benbasat (2004)
		(routine-led behavior)	Nelson & Winter (1982)
RiskStrat4	social psychology	social integration	Aladwani (2002)
	contingency theory	user-related risk (partnering)	Jiang *et al.* (2006)
		vendor/consultant participation	Ravichandran & Rai (1999/2000)

Table 12.5. Measures for metric Strategic Enrollment.

The *Role Cherishing* metric (Table 12.6) describes the importance the individual attaches to his/her participation in the project. It consists of the stream of causality perceived by the professional between his/her assigned tasks in the project and the project's expected outcomes (*RiskRole1*), the reward and punishment system arguably to be deployed (*RiskRole2*), and the interplay between the individual's job responsibility (*RiskRole3*) and authority (*RiskRole4*).

Measure	Theory Deployed	Original Construct/Measure	Source
RiskRole1	theory of reasoned action theory of planned behavior	user participation	Hartwick & Barki (1994)
		business knowledge & skills	Byrd *et al.* (2004)
		business competence (organizational overview)	Basselier & Benbasat (2004)
		client understanding of the IS process	Kirsch *et al.* (2002)
			Kotlarsky & Oshri (2005)
RiskRole2	social psychology	management support for social integration (rewards)	Aladwani (2002)
		stimulation	Palvia *et al.* (2001)
		stakeholder buy-in	Lam (2004)
		job security	Reimers (2003)
		rewards	Blackstone Jr. *et al.* (1997) Kirsch *et al.* (2002) Osmundson *et al.* (2003) Pich *et al.* (2002) Corbin (1991) Ravichandran & Rai (1999/2000)
		security	Bednar (2000)
RiskRole3	social psychology	management support for social integration (rewards)	Aladwani (2002)
	theory of reasoned action theory of planned behavior	user participation	Hartwick & Barki (1994)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		relationalism (shared problem solving)	Grover *et al.* (2002)
		business competence (organizational responsibility)	Basselier & Benbasat (2004)
		genuine participation	Andres & Zmud (2001/2002)
RiskRole4		decentralized control	Ghezzi *et al.* (1991)
		business competence (organizational responsibility)	Basselier & Benbasat (2004)
		programmer/analyst empowerment	Ravichandran & Rai (1999/2000)

Table 12.6. Measures for metric Role Cherishing.

The *System Championing* metric (Table 12.7) describes the meaning for the individual of implementing the system. It consists of the full appraisal of the system's functionality (*RiskSyst1*), the degree of system support by the worker (*RiskSyst2*), as well as how distant such a support is from his/her team's (*RiskSyst3*) and the external partner's (*RiskSyst4*), the impact of the workload on the individual (*RiskSyst5*), and the time needed to produce technological outcomes in a joint effort with the external partner (*RiskSyst6*).

Measure	Theory Deployed	Original Construct/Measure	Source
RiskSyst1		commitment	Kim & Peterson (2003)
		organizational impact & business requirements	Lam (2004)
		buyer knowledge	Stump *et al.* (2002)
			Athaide & Stump (1999)
		business competence (organizational units)	Basselier & Benbasat (2004)
RiskSyst2	theory of reasoned action theory of planned behavior	user attitude	Hartwick & Barki (1994)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		user-related risk	Jiang *et al.* (2002)
		commitment	Kim & Peterson (2003)
		stakeholder buy-in	Lam (2004)
		team members' attitude (commitment)	Chatzoglou & Macaulay (1996)
		genuine participation	Andres & Zmud (2001/2002)
RiskSyst3 RiskSyst4	agency theory	goal incongruence	Keil *et al.* (2000)
	theory of reasoned action theory of planned behavior	user attitude	Hartwick & Barki (1994)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		user-related risk	Jiang *et al.* (2002)
		commitment	Kim & Peterson (2003)
		stakeholder buy-in	Lam (2004)
		goal conflict	Andres & Zmud (2001/2002)
		team members' attitude (commitment)	Chatzoglou & Macaulay (1996)
			Kotlarsky & Oshri (2005)
RiskSyst5		relief, non-threatening	Palvia *et al.* (2001)
		team members' attitude (anxiety)	Chatzoglou & Macaulay (1996)
RiskSyst6		time pressure (concern for career & concern for quality)	Austin (2001)
		speed & accuracy	Förster *et al.* (2003)

Table 12.7. Measures for metric System Championing.

3.9.2.3 CuTe Self-preservation

The third people-oriented indicator is called *CuTe Self-preservation* and addresses the expedients used by the individuals to justify their pro- or anti-project behaviors. It is formed by five metrics: Goal Incongruence, Psychological Self-Justification, Social Self-Justification, Sunk Cost Effect, and Completion Effect.

The *Goal Incongruence* metric (Table 12.8) describes the bridges one wants to build between his/her current organizational status and his/her expected personal achievements by means of the project. It consists of the stake of group cohesion each member feels responsible for and anonymously implements (*GoalInc1*), and what is the role of project success in the individual's mindset (*GoalInc2*).

Measure	Theory Deployed	Original Construct/Measure	Source
GoalInc1	agency theory	goal incongruence	Keil *et al.* (2000)
		(observation difficulty)	Austin (2001)
	transaction cost analysis	monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		relationalism (power)	
		goal conflict	Andres & Zmud (2001/2002)
GoalInc2	agency theory	goal incongruence	Keil *et al.* (2000)

Table 12.8. Measures for metric Goal Incongruence.

The *Psychological Self-justification* metric (Table 12.9) describes one's psychological structures that put together the self and the project. It consists of the individual's deliberate and unconscious, formal and informal support that he/she manifests to other people through actions like in conversations or decisions in daily life (*NfPsycho1*), the amount of involvement with the project as compared to other personal and professional needs (*NfPsycho2*), and the emotional bonds between the worker and the project (*NfPsycho3*).

Measure	Theory Deployed	Original Construct/Measure	Source
NfPsycho1	self-justification theory	need for psychological self-justification	Keil *et al.* (2000)
		external group processes (visionary)	Guinan *et al.* (1998)
NfPsycho2	self-justification theory	need for psychological self-justification	Keil *et al.* (2000)
	theory of reasoned action theory of planned behavior	user involvement	Hartwick & Barki (1994)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		team members' attitude (commitment)	Chatzoglou & Macaulay (1996)
			Kotlarsky & Oshri (2005)
NfPsycho3	self-justification theory	need for psychological self-justification	Keil *et al.* (2000)
	theory of reasoned action theory of planned behavior	user attitude	Hartwick & Barki (1994)
			Kotlarsky & Oshri (2005)

Table 12.9. Measures for metric Psychological Self-justification.

The *Social Self-justification* metric (Table 12.10) describes how the individual feels about the public image he/she has to espouse and protect in what comes to linking individual responsibility and project success. It consists of the sense of being accountable for failure (*NfSocial1*), and the sense of playing a unique, recognized role in the project (*NfSocial2*).

Measure	Theory Deployed	Original Construct/Measure	Source
NfSocial1	self-justification theory	need for social self-justification	Keil *et al.* (2000)
		job security	Reimers (2003)
		security	Bednar (2000)
NfSocial2	self-justification theory	need for social self-justification	Keil *et al.* (2000)

Table 12.10. Measures for metric Social Self-justification.

The *Sunk Cost Effect* metric (Table 12.11) describes one's affection to the resources already invested in the project and that cannot be rolled back, that is, resources highly specific to the transactions already performed. It consists of feelings about personal investments (*SCostEff1*), and feelings about the company's investments (*SCostEff2*).

Measure	Theory Deployed	Original Construct/Measure	Source
SCostEff1	transaction cost analysis	asset specificity	Williamson (1985)
	prospect theory	sunk cost effect	Keil *et al.* (2000)
		relationship investments	Wilson & Vlosky (1997)
SCostEff2	transaction cost analysis	asset specificity	Williamson (1985)
	prospect theory	sunk cost effect	Keil *et al.* (2000)
		relationship investments	Wilson & Vlosky (1997)
		external group processes (visionary)	Guinan *et al.* (1998)

Table 12.11. Measures for metric Sunk Cost Effect.

The *Completion Effect* metric (Table 12.12) describes the effect of advancing over the project plan on the individual worker. It consists of senses of accomplishing a mission (*ComplEff1*), and the eagerness for hitting a visible target (*ComplEff2*).

Measure	Theory Deployed	Original Construct/Measure	Source
ComplEff1 ComplEff2	approach avoidance theory	completion effect	Keil *et al.* (2000)
		external group processes (visionary)	Guinan *et al.* (1998)

Table 12.12. Measures for metric Completion Effect.

3.9.2.4 CuTe Transaction Costs Management

The fourth people-oriented indicator is called *CuTe Transaction Costs Management* and basically addresses issues developed in transaction cost analysis, which relates to human behavior in business transactions. It is formed by three metrics: Contractual Relationship, Relationship Monitoring, and Opportunism & Information Asymmetry.

The *Contractual Relationship* metric (Table 12.13) describes how bounded rationality mediates the definition of the joint work between the partners. It consists of conceptualizing the nature of the professional relation (*Contract1*), understanding the criteria that help assess the partnership as successful or not (*Contract2*), and the way partners manage situations that do not involve previously formatted information in the project (*Contract3*).

Measure	Theory Deployed	Original Construct/Measure	Source
Contract1	transaction cost analysis	association with supplier	Grover *et al.* (2002)
		relationalism (shared problem solving)	
		vendor/consultant participation	Ravichandran & Rai (1999/2000)
Contract2		outcome control	Kirsch *et al.* (2002)
		vendor/consultant participation	Ravichandran & Rai (1999/2000)
Contract3		business competence (interpersonal communication)	Basselier & Benbasat (2004)
		bring expertise to bear	Faraj & Sproull (2000)
		relationalism (information exchange)	Grover *et al.* (2002)
		(informal information)	Gallivan & Keil (2003)

Table 12.13. Measures for metric Contractual Relationship.

The *Relationship Monitoring* metric (Table 12.14) describes how bounded rationality mediates the tracking of the joint work between the partners. It consists of appropriately framing how current tasks and outcomes of joint work impact project performance (*Monitor1*), the technical and emotional efforts needed to monitor the transactions (*Monitor2*, *Monitor3*), and the perception of how distant the current course of action is from the efficient and harmonious path (*Monitor4*).

Measure	Theory Deployed	Original Construct/Measure	Source
Monitor1	agency theory	(observation difficulty)	Austin (2001)
	transaction cost analysis	association with & monitoring the supplier	Grover *et al.* (2002)
		bounded rationality	Simon (1979)
		business competence (leadership)	Basselier & Benbasat (2004)
		behavior & outcome control	Kirsch *et al.* (2002)
Monitor2 Monitor3	transaction cost analysis	association with & monitoring the supplier	Grover *et al.* (2002)
		team members' attitude (anxiety)	Chatzoglou & Macaulay (1996)
		internal group processes (relationship)	Guinan *et al.* (1998)
		(user-developer conflict)	Gallivan & Keil (2003)
Monitor4		synchronization & timing	Lam (2004)

Table 12.14. Measures for metric Relationship Monitoring.

The *Opportunism & Information Asymmetry* metric (Table 12.15) describes the much common behavior of the stakeholder not truly engaging in partnership in order to accomplish private interests. It consists of impeding the flow of potentially harmful, negative information (*OppAsym1*) or simply changing its nature (*OppAsym2*), taking part of the project with a personal, hidden agenda in mind (*OppAsym3*), and only reactively (as contrasted with proactively) serving as an information provider, thus acting like a bottleneck in the production process and preventing the project to take full advantage of business opportunities (*OppAsym4*).

Measure	Theory Deployed	Original Construct/Measure	Source
OppAsym1 OppAsym2	agency theory	(observation difficulty)	Austin (2001)
	agency theory	information asymmetry	Keil *et al.* (2000)
	transaction cost analysis		Williamson (1985)
		monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		external group processes (guard & visionary)	Guinan *et al.* (1998)
OppAsym3	transaction cost analysis	opportunism	Williamson (1985)
		monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		relationalism (power)	
OppAsym4	transaction cost analysis	information asymmetry & opportunism	Williamson (1985)
		monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		relationalism (information exchange)	
	cooperative learning theory/ educational psychology	collaborative elaboration	Majchrzak *et al.* (2005)
		expertise coordination (expertise needed)	Faraj & Sproull (2000)

Table 12.15. Measures for metric Opportunism & Information Asymmetry.

3.9.2.5 CuTe Interpersonal Effectiveness

The fifth people-oriented indicator is called *CuTe Interpersonal Effectiveness* and addresses the effectiveness with which the individual reports to its external partner. It is formed by four metrics: Organizational Proxy, Collaborative Elaboration, Customer Learning, and Customer Communication & Leadership.

The *Organizational Proxy* metric (Table 12.16) describes the ability of the individual to help his/her partner in learning about the client organization, that is, the ability to manifest the organizational variety and the strategic competence needs, thus enabling the X-Team to improve its performance as a virtual organizational member. It consists of facilitating an understanding about the customer's current business (*Proxy1*), business needs (*Proxy2*) and technology needs (*Proxy3*), and the ability to fine-tune expertise deployment in the project (*Proxy4*).

Measure	Theory Deployed	Original Construct/Measure	Source
Proxy1 Proxy2 Proxy3		interpersonal knowledge & skills	Byrd *et al.* (2004)
		seller-initiated/led knowledge generation	Athaide & Stump (1999) Stump *et al.* (2002)
		relationalism (information exchange)	Grover *et al.* (2002)
		business competence (IT-business integration)	Basselier & Benbasat (2004)
Proxy4		interpersonal knowledge & skills	Byrd *et al.* (2004)
		expertise coordination (expertise needed)	Faraj & Sproull (2000)
		knowledge sharing (decision to contribute)	Goodman & Darr (1998)

Table 12.16. Measures for metric Organizational Proxy.

The *Collaborative Elaboration* metric (Table 12.17) describes the interplay between the individual and his/her partner's knowledge domain. It consists of being in need to know the partner's unstated reactions to ideas (*CollElab1*), being prone to use multiple means to express an idea (*CollElab2*), being sensitive to unnoticeable situations (*CollElab3*), being sympathetic to working out the partner's goals without loosing from track the personal responsibilities (*CollElab4*), being able to address shared goals as a result of decision making (*CollElab5*), and being able to compare alternatives to fallback positions (*CollElab6*).

Measure	Theory Deployed	Original Construct/Measure	Source
CollElab1	cooperative learning theory/ educational psychology	collaborative elaboration	Majchrzak *et al.* (2005)
		seller-initiated/led knowledge generation	Athaide & Stump (1999) Stump *et al.* (2002)
		clan control	Kirsch *et al.* (2002)
CollElab2	cooperative learning theory/ educational psychology	collaborative elaboration	Majchrzak *et al.* (2005)
		seller-initiated/led knowledge generation	Athaide & Stump (1999) Stump *et al.* (2002)
CollElab3	cooperative learning theory/ educational psychology	collaborative elaboration	Majchrzak *et al.* (2005)
CollElab4	cooperative learning theory/ educational psychology	collaborative elaboration	Majchrzak *et al.* (2005)
		relationalism (information exchange)	Grover *et al.* (2002)
		seller-initiated/led knowledge generation	Athaide & Stump (1999) Stump *et al.* (2002)
		clan control	Kirsch *et al.* (2002)
CollElab5	cooperative learning theory/ educational psychology	collaborative elaboration	Majchrzak *et al.* (2005)
		relationalism (power)	Grover *et al.* (2002)
		expertise coordination (expertise needed)	Faraj & Sproull (2000)
CollElab6	cooperative learning theory/ educational psychology	collaborative elaboration	Majchrzak *et al.* (2005)
		relationalism (flexibility)	Grover *et al.* (2002)

Table 12.17. Measures for metric Collaborative Elaboration.

The *Customer Learning* metric (Table 12.18) describes how sensitive the individual is to professional interaction when building a shared business reality, that is, how target-oriented (inflexible) or error-avoiding (flexible) the CuTe member is. It consists of being prone to questioning the current perspective on requirements (*CustLearn1*, *CustLearn2*, *CustLearn3*), and translating such a change into appropriate action (*CustLearn4*).

Measure	Theory Deployed	Original Construct/Measure	Source
CustLearn1 CustLearn2 CustLearn3	cooperative learning theory/ educational psychology	client learning	Majchrzak *et al.* (2005)
		seller-initiated/led education	Athaide & Stump (1999) Stump *et al.* (2002)
		relationalism (flexibility)	Grover *et al.* (2002)
		knowledge sharing (decision to adopt)	Goodman & Darr (1998)
		business competence (organizational responsibility)	Basselier & Benbasat (2004)
		user participation	Ravichandran & Rai (1999/2000)
		(divergent thinking)	Gallivan & Keil (2003)
CustLearn4		knowledge sharing (decision to adopt)	Goodman & Darr (1998)
		relationalism (flexibility)	Grover *et al.* (2002)
		user participation	Ravichandran & Rai (1999/2000)
		(change in behavior)	Argyris (1992) Sweringa & Wierdsma (1995)

Table 12.18. Measures for metric Customer Learning.

The *Customer Communication & Leadership* metric (Table 12.19) describes the individual's communications toolset employed during joint work with the partner. It consists of the ability to communicate clearly, accurately and timely (*CustComm1*, *CustComm6*), being sensitive to the partner's professional needs (*CustComm2*), conceiving a business meeting as an opportunity from which to derive important project information (*CustComm3*, *CustComm5*), and dealing effectively with the partner, in terms of protecting the company's interests together with doing no harm to the other systems in the environment (*CustComm4*).

Measure	Theory Deployed	Original Construct/Measure	Source
CustComm1	cooperative learning theory/ educational psychology	developer communication quality	Majchrzak *et al.* (2005)
		interpersonal knowledge & skills	Byrd *et al.* (2004)
		communication between team members and users	Chatzoglou & Macaulay (1996)
		business competence (interpersonal communication)	Basselier & Benbasat (2004)
		user-developer communication	Gallivan & Keil (2003)
CustComm2	cooperative learning theory/ educational psychology	developer communication quality	Majchrzak *et al.* (2005)
		relationalism (information exchange)	Grover *et al.* (2002)
CustComm3	cooperative learning theory/ educational psychology	developer communication quality	Majchrzak *et al.* (2005)
		team atmosphere	Jones (2005)
CustComm4	cooperative learning theory/ educational psychology	developer communication quality	Majchrzak *et al.* (2005)
	transaction cost analysis	monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		interpersonal knowledge & skills	Byrd *et al.* (2004)
		business competence (leadership)	Basselier & Benbasat (2004)
		external group processes (guard & visionary)	Guinan *et al.* (1998)
CustComm5	cooperative learning theory/ educational psychology	developer communication quality	Majchrzak *et al.* (2005)
		team atmosphere	Jones (2005)
CustComm6	cooperative learning theory/ educational psychology	developer communication quality	Majchrzak *et al.* (2005)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
		business competence (interpersonal communication)	Basselier & Benbasat (2004)
		user-developer communication	Gallivan & Keil (2003)
		speed & accuracy	Förster *et al.* (2003)

Table 12.19. Measures for metric Customer Communication & Leadership.

3.9.2.6 CuTe Prospect

The sixth people-oriented indicator is called *CuTe Prospect* and addresses the likelihood that the CuTe member will be included in future CISS efforts. It is formed by two metrics: Cooperative Interdependence, and Partnership Propensity.

The *Cooperative Interdependence* metric (Table 12.20) describes how much of the collective learning and implementation effort is due to the individual alone. It consists of the perception about how effective the professional is in working as an open, processing system responsible for contributing to the team's functional redundancy, or for handling and servicing a unique organizational variety (*Balance1*), and how attached he/she is to the uniqueness of the project as a whole (*Balance2*).

Measure	Theory Deployed	Original Construct/Measure	Source
Balance1	cooperative learning theory/ educational psychology	cooperative interdependence	Majchrzak *et al.* (2005)
	contingency theory	user-related risk (nonsupport)	Jiang *et al.* (2006)
	transaction cost analysis	monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		relationalism (shared problem solving)	
		user-related risk	Jiang *et al.* (2002)
		joint new product development	Athaide & Stump (1999) Stump *et al.* (2002)
		interpersonal knowledge & skills	Byrd *et al.* (2004)
Balance2		joint new product development	Athaide & Stump (1999) Stump *et al.* (2002)
		genuine participation	Andres & Zmud (2001/2002)

Table 12.20. Measures for metric Cooperative Interdependence.

Finally, the *Partnership Propensity* metric (Table 12.21) describes a general picture of the individual as a source of social facts in CISS projects. It consists of an overall appraisal of the interpersonal performance in the project (*ProPart1*), the perception about how much of a partner the CuTe member was (*ProPart2*), the perception about friendship playing a role in the partnership (*ProPart3*), as well as the role of quality of working life in it (*ProPart4*), the individual's proneness to working for the benefit of all stakeholders (*ProPart5*), and the likelihood that, upon being asked to in future CISS enterprises, the CuTe member would choose to work again, under similar partnership agreements, with his/her current partner (*ProPart6*), and vice-versa (*ProPart7*).

Measure	Theory Deployed	Original Construct/Measure	Source
ProPart1		social ties (rapport)	Kotlarsky & Oshri (2005)
		relationship satisfaction	Stump *et al.* (2002)
		internal group processes (relationship)	Guinan *et al.* (1998)
ProPart2	social psychology	social integration	Aladwani (2002)
	contingency theory	user-related risk (partnering & nonsupport)	Jiang *et al.* (2006)
		interpersonal knowledge & skills	Byrd *et al.* (2004)
		business competence (interpersonal communication)	Basselier & Benbasat (2004)
		social ties (rapport)	Kotlarsky & Oshri (2005)
		commitment	Wilson & Vlosky (1997)
ProPart3	social psychology	social integration (friendliness of work environment)	Aladwani (2002)
		social ties (rapport)	Kotlarsky & Oshri (2005)
ProPart4		social ties (rapport)	Kotlarsky & Oshri (2005)
		internal group processes (relationship)	Guinan *et al.* (1998)
		(user-developer conflict)	Gallivan & Keil (2003)
ProPart5	contingency theory	user-related risk (partnering)	Jiang *et al.* (2006)
	transaction cost analysis	monitoring the supplier & supplier opportunism	Grover *et al.* (2002)
		interpersonal knowledge & skills	Byrd *et al.* (2004)
		intentions for partnership	Basselier & Benbasat (2004)
		social ties (trust)	Kotlarsky & Oshri (2005)
		commitment	Wilson & Vlosky (1997)
		goal conflict	Andres & Zmud (2001/2002)
		vendor/consultant participation	Ravichandran & Rai (1999/2000)
ProPart6 ProPart7		intentions for partnership	Basselier & Benbasat (2004)
		prior relationship history & expectations of continuity	Stump *et al.* (2002)

Table 12.21. Measures for metric Partnership Propensity.

It is a critical assumption in our research that the causalities in Figures 9.1 to 9.8 hold, within more or less flexible ranges for particular cases, for any high-performance CuTe in CISS projects. With the exception of self-preservation, all other indicators generally have a positive effect on CuTe performance. However, some metrics within each indicator may attenuate its effect; for instance, trait *psychological self-justification* may positively impact performance (contrary to what is expected from the other self-justification traits), and trait *opportunism & information asymmetry* may negatively impact performance (contrary to what is expected from the other traits on transaction costs management). Accordingly, some measures may also attenuate the role played by the aggregate metrics in explaining CuTe performance. Nonetheless, the expected causalities – between measures and metrics, metrics and indicators, and indicators and CuTe performance – are not to be taken unavoidably, given that (1) our research does not have the explanatory power/design that would be required otherwise, and (2) the instruments for data collection, as given in the Appendices and applied to the respondents in our empirical investigation (discussed later), do not necessarily convey useful information for making *a priori* causal claims (as an example, see the wording for the measures in metric *goal conflict*).

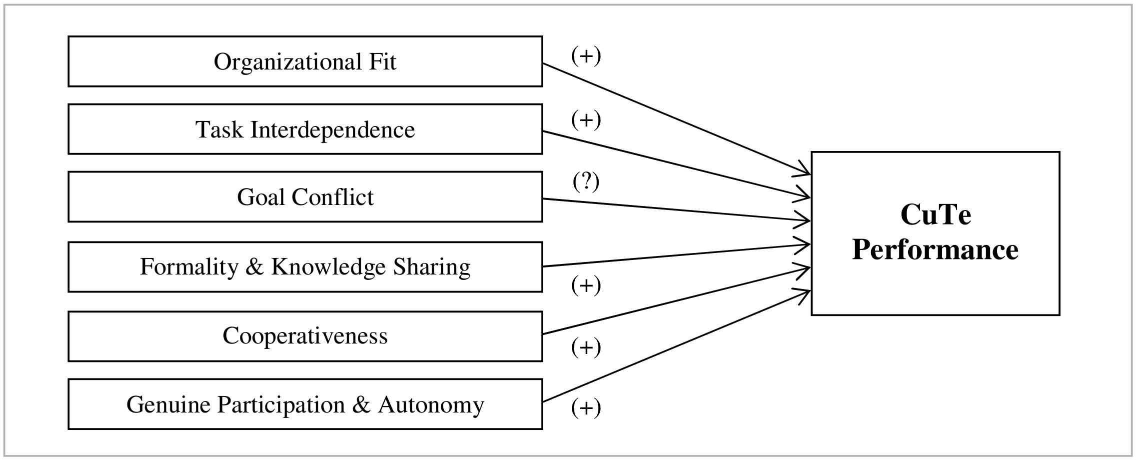


Figure 9.1. Causalities assumed between adhocratic design and CuTe performance.

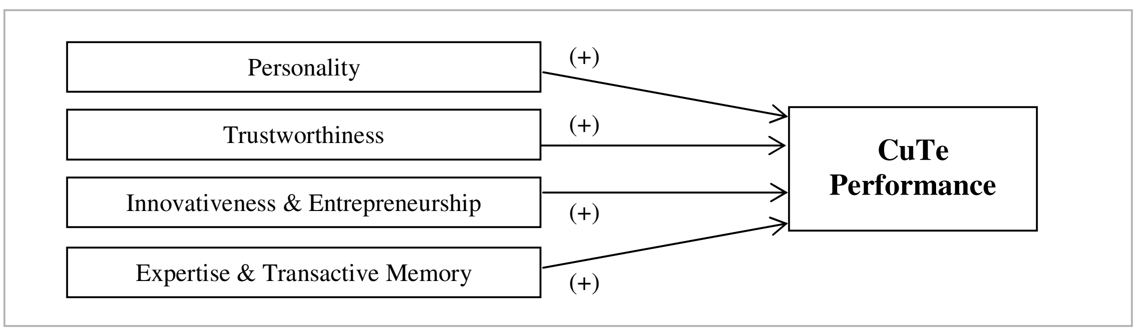


Figure 9.2. Causalities assumed between eligibility and CuTe performance.

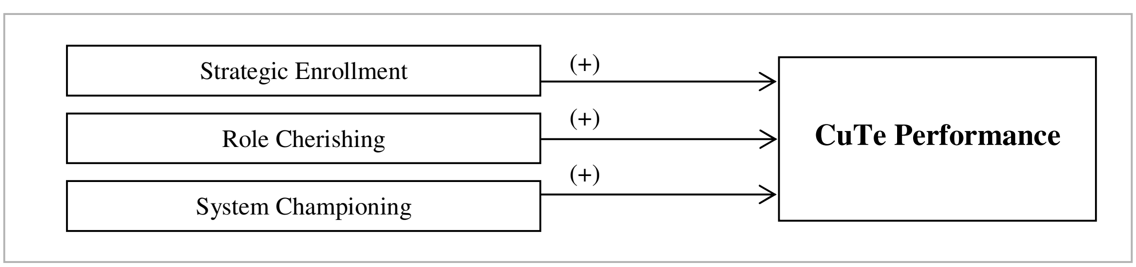


Figure 9.3. Causalities assumed between risk-averse attitude & social integration and CuTe performance.

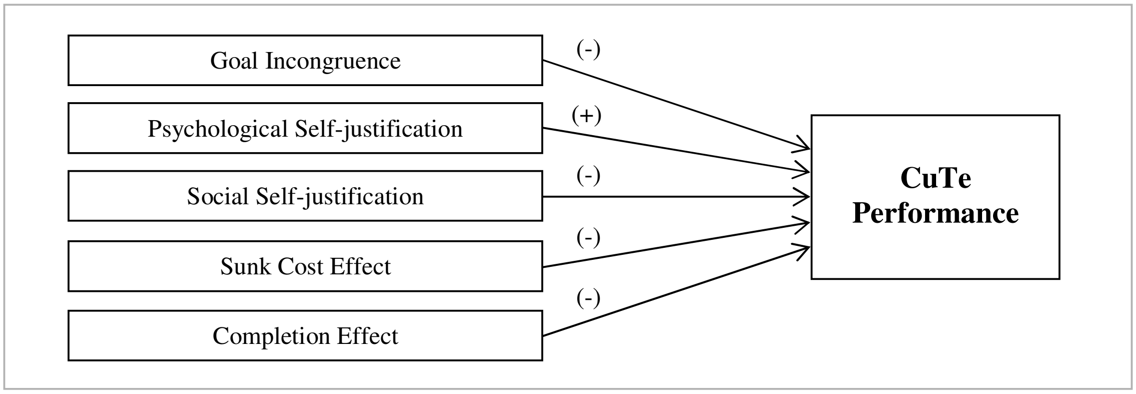


Figure 9.4. Causalities assumed between self-preservation and CuTe performance.

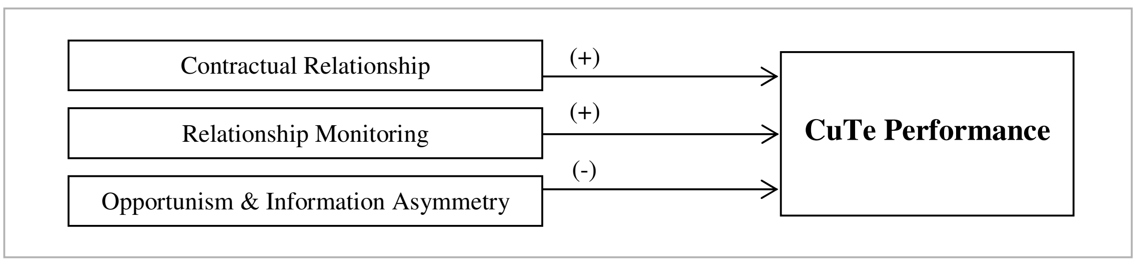


Figure 9.5. Causalities assumed between transaction costs management and CuTe performance.

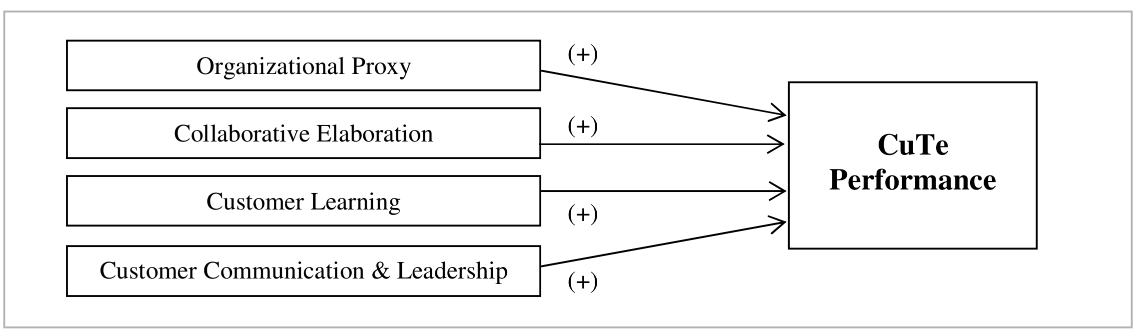


Figure 9.6. Causalities assumed between interpersonal effectiveness and CuTe performance.

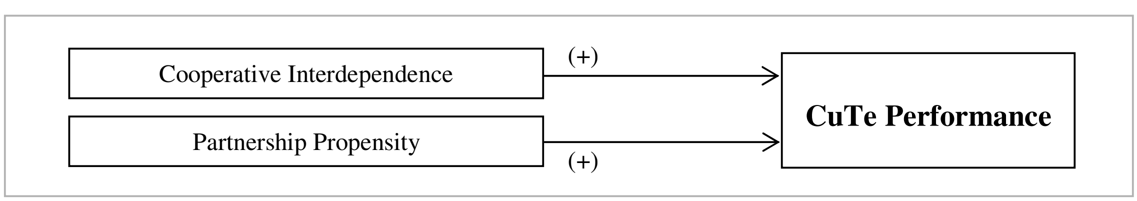


Figure 9.7. Causalities assumed between prospect and CuTe performance.

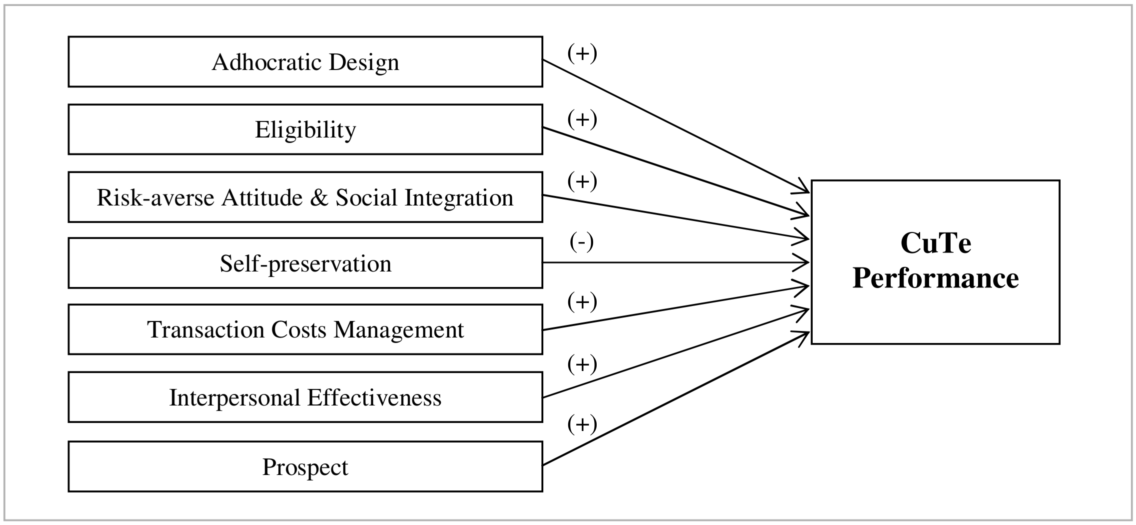


Figure 9.8. Causalities assumed between the indicators and CuTe performance.

3.10 Further Comments

Due to issues like the ones discussed in the previous sections, our research seeks improvements in knowledge and managerial practices about the participation of CuTes in CISS projects, in order to lead the teams towards high levels of performance (Peled, 2000). Such an intervention is aligned with the facts that there should be some motivation for the buyer to employ its knowledge when interacting with sellers (Athaide & Stump, 1999), and that, following Chatman and Barsade (1995) and the main thrust of the *theory of reciprocal action*, people behave according to expectations on the action of others (in this case, the assessment). In other words, the relationship with customers, particularly when aimed at transparency, asks for some sort of external coordination (Sivula *et al.*, 1997), and an effective management of relationships during new product development antecedes the success in industrial, technology-based markets (Athaide & Stump, 1999).

We do *not* aim, however, to achieve unconditional power over the routines of CuTe individuals through performance metrics, due to efficacy, efficiency, and ethical reasons, as evidenced by the following excerpts:

- some professional knowledge is best for the organization if kept tacit (Bloodgood & Salisbury, 2001);
- for people to take healthy organizational initiatives, they need to feel secure in the work environment (Bednar, 2000), and therefore metrics cannot serve as tools for punishment – just the opposite, metrics play a key role in acknowledging good performance, since appropriate rewards are also needed (Blackstone Jr. *et al.*, 1997; Kirsch *et al.*, 2002; Osmundson *et al.*, 2003; Pich *et al.*, 2002; Corbin, 1991); and
- systems for production control often institutionalize the manufacturing of defective products, since people realize that they have a "fault quota" and that it is not their role the identification of such faults (Morgan, 1996).

After all, the critical approach to software development posits that a problem cannot be reduced to an engineering solution (Clarke & Lehaney, 2000); in the specific case of the present research, the metrics implementation should be seen as a rational engineering process supported by an evolutionary process in which organizational interests and values are challenged and changed (Iversen & Mathiassen, 2003).

From these and other admonishments on controlling and measuring performance in organizations, some organizational thinkers have developed arguments on using *ad hoc* management for the knowledge work (Scarbrough, 1999), and even on improvising in business and IT (Ciborra, 1999). Our effort, notwithstanding, does not engage in such radical perspectives; to the contrary, we believe that some objective performance criteria should be applied to CuTes – what is in line with Goldratt's *theory of restrictions*, according to which business has only a few restrictions (Blackstone Jr. *et al.*, 1997) that *are* to be observed.

4 METHODOLOGY

The research unfolded as follows:

- we informally developed insights on how companies interact to develop CISS products, mainly through case studies and informal interactions with companies in a leading Brazilian IT cluster;
- we designed the research's rationale and the instruments for data collection by means of a thorough literature review;
- we argued on the available methods to answer the research question;
- we developed a case study within an important ERP project, in which it was possible to (1) informally interact with CuTe and X-Team professionals, (2) carry out in-depth interviews with select CuTe professionals, during which they performed self-assessments about personal traits and performance in the project, and (3) carry out an in-depth interview with the manager of those CuTe professionals for assessing them on the basis of personal traits and performance in the project, as well as for assessing the structural configurations that were designed for or emerged from their professional interactions; and
- we validated the findings with the help of three external judges.

The methodological procedures provided as much as possible (1) an understanding about the fundamentals of software customization and the participation of CuTe professionals in it, (2) insights into practices and needs of customers and developers of CISS projects for managing their teams, (3) the identification of actual practices of joint work between CuTes and X-Teams in CISS projects, and (4) a set of metrics for managing the participation of CuTes in such projects.

The empirical research was developed within the Brazilian software industry. The author has worked in it since de mid-1990s in the roles of designing, developing and managing database, Internet and enterprise-wide applications. In order to draw a richer picture about the industry practices, pressing needs and foreseeable trends, we also continuously cooperate in several research fronts with companies from Pólo de Informática de São Leopoldo (a leading Brazilian IT cluster) and other companies. Some findings from those researches are available in Bellini and Pedrozo (2001a; 2001b), Pereira and Bellini (2002; 2006), Pereira *et al.* (2008), Franzen and Bellini (2003), Bervian and Bellini (2005; 2006), Strauss and Bellini (2006), and Tosetto and Bellini (2007).

Following guidelines in Rossi and Slongo (1997) and in Checkland (1985), and with the support of our successful experience in a large research endeavor (Bellini, 2001), all methodological procedures were implemented by this researcher – from the collection to the analysis of data, with *no* exception other than the external validation by three experts.

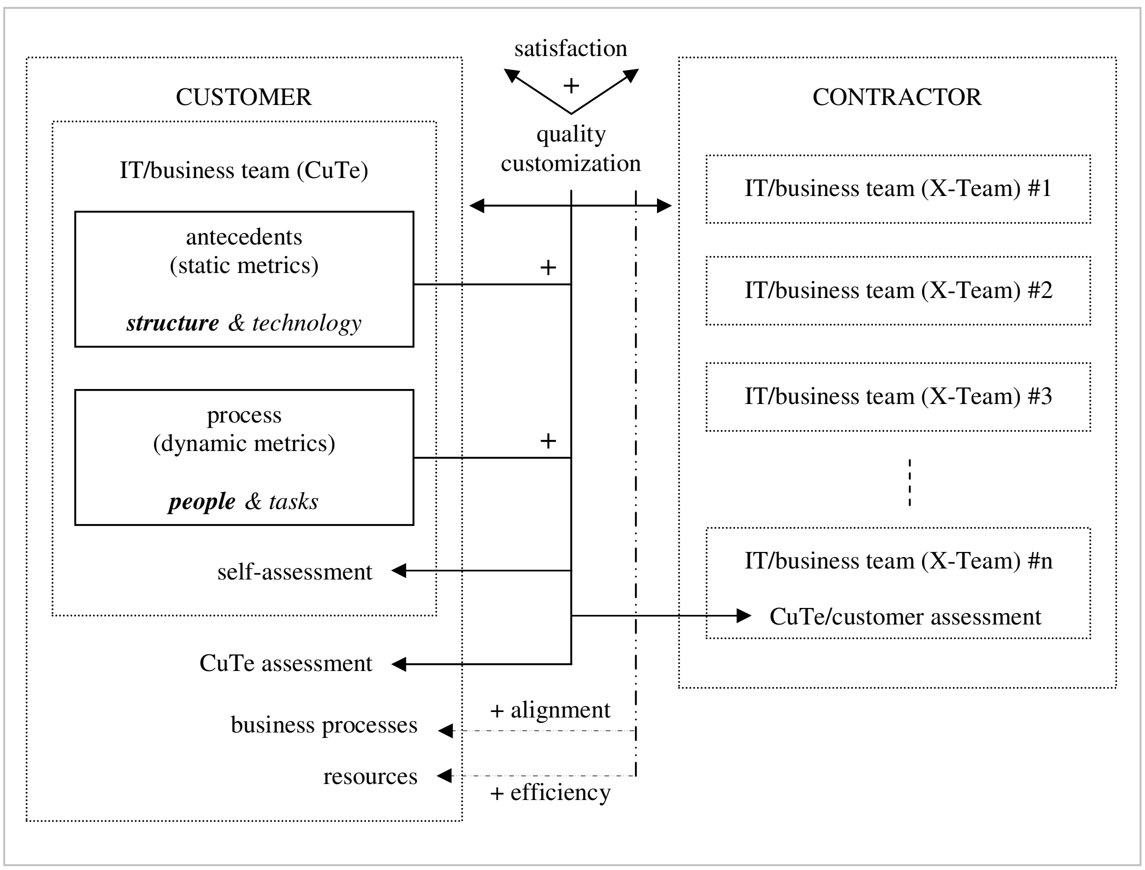
4.1 Research Model

Figure 10 synthetically depicts the distinguishing elements and assumptions of our conceptual model:

- the two types of actors (customer and external developer) involved in CISS projects, as well as their interacting teams (CuTe and X-Team);
- the key (socio-technical) dimensions that describe the metrics we look for;
- the presumable positive impact the metrics cause on the customer (better assessment of CuTe performance, alignment of the CISS product with the organization's business processes, and efficiency in deploying the organizational resources) and on the external developer (better assessment of the actual participation of CuTes in CISS projects); and
- the ultimate purpose of developing the metrics (the satisfaction of both the customer and the external developer with the customization).

According to the large tradition of organizational theory, the structure of an organization is likely to adapt to contingency factors. Although influencing the work performance and shaping people behavior, the structure would be nothing more than a means to an end, or arbitrary decisions to facilitate the organizational repertoire of actions (Nelson & Winter, 1982). Technology, in turn, is usually seen as a contingency factor (Donaldson, 1996) that influences the organizational structure. But although the changing nature of technology, it is evident from the literature (*e.g.*, Zack, 1999) that there are some common elements in most technology prescriptions for enabling the knowledge work like that of IS professionals.

So, we take relatively for granted both the structure and the technology (see again Figure 6 and the corresponding explanation), although attention must be paid to the possible mutual contingencies as the causality between structure and technology is not completely known – Dolci (2005) offers an interesting discussion on this subject. Such an assumption (that of setting relatively stable structural and technological configurations for CISS development) is supported by Ravichandran and Rai's (2000) model in Figure 5, according to which an organizational infrastructure should be set prior to running process management and involving different stakeholders.



Legend: boldface items represent the focus of our research.

Figure 10. Research model.

4.2 Generation of Insights

Insights for the research were continuously generated from 2000 to 2006 in studies within a cluster of IT companies in Southern Brazil (described in detail in Bellini & Pedrozo, 2001a, 2001b, Pereira & Bellini, 2002, and Franzen & Bellini, 2006) and within an ERP implementation project (described in detail in Bervian & Bellini, 2005, 2006, and Strauss & Bellini, 2006). The main purpose was to gather evidence about the practical relevance of our research for the industry, as well as to deepen our knowledge on actual practices and compelling needs in managing CuTe work. Below, we tersely describe the settings that provided most insights.

4.2.1 Clusters of Companies

Patronizing cooperation in a competitive environment, clusters of companies nourish local actions that may have world impact. The Silicon Valley in the USA is a case in point, since it dictates the main moves of the powerful computer industry. Clusters put together in the same geographical region several types of organizations, including direct competitors. Basically, they can be framed as groups of organizations bound together by common and complementary attributes in a competitive-cooperative behavior (Porter, 1999). This way, companies selling and companies buying share a common space, as they also share area with educational institutions (which prepare workforce for the cluster), with state and private agencies ruling the cluster's activities, and with many other organizations looking for the progress of the local industry. The boundaries of a cluster, however, are completely arbitrary, but they should include all organizations with strong vertical, horizontal or institutional links (Porter, 1998; Haddad, 1998).

The clusters approach is interesting due to the fact that even rival companies decide to build an environment of mutual cooperation in order to better answer to the market dynamics. This is similar to networks theory, which states that the social contacts of an organization modify its behavior (De Graaf & Uitermark, 1998). Thus, organizations in a cluster are immersed in an environment which detains a vast amount of strategic information for their businesses (after all, all partner organizations actuate in related market segments), making it easier for any one organization to scan the environment in search of opportunities for innovation while keeping an eye on the other players' movements. This is similar to the free exchange of information in supply chains (Corbett *et al.*, 1999). Therefore, a significant change occurs to the competitiveness of companies in a cluster, in terms of productivity, capacity for innovation and possibility of starting new business (Table 13). Table 14 shows the relation between clusters and some elements involved in their study.

Productivity	
Access to inputs and employees	Lower costs are achieved when the local production and workforce are used, and the growth of a cluster multiplies the offer of specialized workforce in its region. But forging alliances between companies in a cluster and other companies may be home to flexibility risks for the former.
Access to information	Clusters hold strategic information, which is valuable for a company's business intelligence processes.
Complementarities	Companies in a cluster are often mutually dependent. Local buyers benefit from having access to multiple sources for business transaction.
Access to institutions and public goods	Companies share many structures in a cluster. Additionally to the physical ones (buildings, communication systems, etc.), they also organize themselves in groups of power for the sake of having a stake in industry decisions.
Incentives, and performance measurement	The continuous comparison to rivals, the similar experiences in the market, and the need to acting close to the local communities push the companies towards performing well.
Innovation	
Companies in a cluster anticipate their clients' needs and are expedite in introducing new technologies.	
New Business	
Entry barriers are the lowest possible – and maybe the barriers for leaving the cluster as well.	

Source: adapted from Porter (1998).

Table 13. Clusters and competitiveness.

clusters and...	description
… the socioeconomy	Economic activities take place in a social context. The progress of a cluster depends on the construction of healthy relations among all the participants.
… the economic geography	The major source of a region's economic prosperity in the long run is its clusters driven towards the external environment. The growth of all clusters (as well as decentralizing the production) is a condition for a superior economy.
… the government	Government must promote political and macroeconomical stability, microeconomical abilities (on education, infrastructure, etc.), rules to be observed by competitors, and a general plan for the long run. It must also stimulate the development of all clusters, must not give birth to new ones, and must not distort the market by benefiting individual firms or industries.
… other clusters	Clusters may influence each other.
… the industrial policy	While the industrial policy states that strategic industries should be the focus, Porter talks about not differentiating between clusters.

Source: adapted from Porter (1998).

Table 14. Clusters and analytical elements.

The rising of a cluster in a region is due to a series of possible conditions, among others Porter (1998) highlights the uncommon local demands, the previous existence of groups acting in related segments, the innovation promoted by local companies, and even casual opportunities. But as clusters emerge they also disappear, what is most common when their internal rigidity reaches a critical point, generally when governments intervene dramatically in the competition. External threats, like the technological discontinuities and changes in the preferences of customers, may also weaken the integrity of a cluster. So, it is important to monitor risk indicators by means of an effective environmental scanning (Choudhury & Sampler, 1997), what is made easier by the presence of similar companies in the same geographical region.

The disadvantages of clusters are as follows (Porter, 1998):

- the more successful the cluster, the more expensive it is to maintain the local workforce in it, and the more scarce this workforce and the raw materials become;
- companies in a cluster infrequently lead markets for a long time; and
- groupthinking may constrain new business plans originated in the cluster.

The Southernmost Brazilian State (Rio Grande do Sul) hosts some IT clusters, of which the one located in São Leopoldo (hereafter referred to as *PISL*, or simply *the cluster*) provided us with important data for generating insights and assumptions for the research. A brief description of the cluster is found in the next section.

4.2.2 Softex, Softsul, and the IT Cluster at São Leopoldo

With headquarters in Campinas, Brazil, Softex is a nonprofit organization with administrative and financial autonomy to promote the development and the exportation of Brazilian software, as well as to place Brazil among the five leaders in this market. This is to be achieved by stimulating companies to reach at international quality and productivity standards. Softex's institutional statements are given in Table 15.

Mission	Help Brazil excel in software development and exportation.
Values	creativity, innovation, quality
Permanent Objectives	- Put Brazil among the five most important nations in software development and exportation. - Reach at international standards in software quality and productivity. - Improve continually the managerial, market and technical abilities of the Brazilian software companies. - Institutionalize internationally the image of Brazil as a developer and exporter of software. - Offer financial support to companies for the development and the exportation of software, with resources similar to those found in the USA and Europe. - Reduce the costs in developing and exporting software.
Vision	- The Brazilian software will mature in the international market. - The Brazilian software companies will establish plants in the US, European and Asian markets, among others, and they will make strategic alliances and businesses. - The "Brazilian Software" trademark will be known all over the world as a certification for creativity, innovation, and quality. - The Brazilian software companies will generate thousands of quality job opportunities and high salary levels.

Table 15. Softex's institutional policy.

In 1997, Softex launched *Softex 2000*, an effort for exporting the Brazilian software, with the following structure: 20 regional centers over the country to support more than 800 companies in the exportation of software, six international offices to find opportunities for the Brazilian software, and 20 other centers over the country to enable new endeavors in software development.

Softsul is Softex's regional center for Southern Brazil, with activities dating back to 1993. Its mission is to promote the overall progress, the financial health, and technological and managerial abilities of the software industry settled in the State of Rio Grande do Sul, through the articulation of cooperation among universities, companies and government, thus consolidating a technological cluster able to generate software with high levels of quality as required by the international market. As a derivative, it aims to make Rio Grande do Sul the second most important Brazilian software developer and exporter.

Finally, PISL, whose design started in 1996, puts together new and experienced IT companies that want to invest heavily in qualifying their activities. By attracting and maintaining entrepreneurs and researchers in the same place, the cluster aims to become an international reference in what comes to IT products and services, as well as to promote all sorts of benefits for the local communities. Softex is a key partner of the cluster. Nevertheless, this IT cluster is not an isolated initiative in Southern Brazil, in fact being part of a series of local and foreign investments that have long consolidated the IT infrastructure in that region.

Initially, the following organizations participated in designing the cluster: the Commercial, Industrial, and Services Association of São Leopoldo (ACIS/SL), the Association of Brazilian Companies of Software and IT Services (Assespro/RS), the Union of IT Companies of Rio Grande do Sul (Seprors), Softsul, the Municipality of São Leopoldo, and the local university. Decisive support was given by a local regulation from 1997 stating that the IT companies established in São Leopoldo would not pay some municipal taxes until 2003, and small, fixed taxes from that year on. But the benefit was restricted to companies operating in the development and the maintenance of systems, hardware support, IT training and consultancy, data communication, automation, micromechanics, or microelectronics. The regulation was valid for all IT businesses settled in the city of São Leopoldo.

The next step was to implement the project. For the physical area of reference, the local university offered 5.5 hectares, where, in 1998, the Incubator and the Condominium of companies started to be built to give birth to the Unit for Technological Development (Unitec), launched on June 30, 1999. The Municipality also offered 36,589.29 squared meters of an area contiguous to Unitec for the construction of the Technological Park, which would keep together solid IT companies (raised within the cluster or not). The State of Rio Grande do Sul invested in infrastructure for the cluster as well.

The Incubator hosts micro and small IT companies and supports their endeavors on innovation in processes and services. In it, each company has its own physical space, but also shares resources with other companies (like a room for meetings and an area for displaying products). Assorted services are offered to the companies in the Incubator, like telecommunications, security, and cleaning, and the local university is also responsible for the scientific and technological support, the ethical and social orientation, the judicial, financial, market, and managerial assistance, and the access to laboratories and the library.

The Condominium, on the other hand, was designed to host companies capable to share the market with big players. The main criterion for a company to be part of the Condominium is the technical and the commercial attributes of the company’s project, that must be ethical and legal as well. After maturing and consolidating its market share, the company in the Condominium may choose to move its facilities to the Technological Park, or to another location. If deciding towards the Technological Park, it will find support for preserving its market positions through working in an atmosphere of high technology and in close interaction with other technology suppliers.

4.2.3 The IT Cluster as an Actual Cluster of Companies

PISL is the outcome of an IT culture well established in the State of Rio Grande do Sul; as a result, Rio Grande do Sul is a great place for the IT industry to design and develop new products. Indeed, massive investments from companies searching for qualified workforce and solid markets are under way in the State.

The cluster's workforce is highly specialized due to the many educational institutions present in the region, and it moves almost freely from one company to the other. This is due to the current IT labor-market model, whose dynamics and notable growth make organizations to be always looking for talented and hard-working people, especially experts in new technologies. Thus, IT professionals are obliged to update on a continuous base their technical skills for the coming challenges – and the new challenges may come, with a better paycheck, from another company. So, companies in the cluster have to be prepared for an escalation in salaries (Porter, 1998).

Another aspect for analysis deals with the competitive advantage of the cluster's companies. Mata *et al.* (1995) suggest that the competitive advantage of an IT company is less dependent on the technology itself and more on managing it. One way the authors suggest to promote competitive advantage in the market is to ask IT managers to develop professional relations with their counterparts in other companies, mainly with rivals, and exchange valuable business information. This is a particular case of Rademakers' (1998) exhortation that cooperation in business generally fosters competitive advantage. Therefore, the companies in the IT cluster at São Leopoldo should engage in mutual strategic support as much as possible, instead of just focusing on the operational excellence.

Although by now there are not really detailed, published data on some strategic issues for the cluster (as its stake in the total amount of job opportunities in the region, quality-of-life indicators, estimates for segmented international transactions in the next years, etc.) nor about the vertical and the horizontal power and business relations between any two companies in the cluster, it is reasonable to say that its companies are highly competitive, and that regional development for the local communities is fact. If competitive advantage is grounded on cooperation (Rademakers, 1998) and innovation (Porter, 1999), the presence of complementary and rival companies at the same place promotes multiple IT business opportunities for the whole region. The reason is that complementary companies cooperate with each other, and rival companies constantly search for innovating in the market. So, as put before, formal and informal professional interactions are highly desirable for the companies to read the business signals from the market, the industry, the society, and the government.

Another strategic issue is the cluster's geographical location at the middle of Mercosul, the common market in South America. The cluster is also benefited for its nearness to an international airport and several regional airports, as well as for being serviced by an efficient transport system for the local workforce, the raw materials and the production outcomes.

Finally, the support from state agencies at all stages of the cluster's evolution is fundamental while ruling, stimulating, financing, and promoting the entrepreneurial activities. In fact, Rademakers (1998) talks about the role of social institutions in the cooperation between companies, especially about how the government may induce a decrease in business risks for the industry, and how it may not turn out to be, by itself, a source of instability. Accordingly, governments should not interfere in the competition (Porter, 1998). In this way, it seems that the state agencies are playing their positive influence on the IT cluster at São Leopoldo, since it was not reported any undesirable fact on this subject.

In general, the specialization of the cluster (IT products and services), its geographical location given by clear boundaries (the municipality of São Leopoldo), its foreseeable substantive participation in the national IT production and exportation, the high quality of its workforce, and the interaction between the companies, local schools and government permit us to frame this as an actual cluster.

4.3 Building the Rationale

The research's rationale – presented in the previous chapter – was formally developed during a long timeframe between 2001 and 2006, when we were able to consolidate the insights and the theoretical understanding about the research's subject (the actual participation of CuTes in CISS development). It was not but by May 2006 that we realized that the rationale was consistent and apt to being published. The long validation process comprised discussions with three experts in the field, workshops and speeches performed by the author in local universities and conferences (*e.g.*, Bellini, 2002, 2004d, 2005a, 2005b, and 2006), and the research model was also discussed in the doctoral symposium of the leading Brazilian conference on management (Bellini, 2003) and in three US doctoral symposiums on information systems (Bellini, 2004a, 2004b, 2004c). An introduction to the rationale and to the alternative methods available to answer the research question was subsequently published (Bellini *et al.*, 2004), and the particular discussion on measurement is scheduled to appear in a leading software engineering journal (Bellini *et al.*, 2008).

4.4 On Action Research as an Alternative Method

An action research within a high-profile software project (the development of an information system for the Brazilian Presidential Office) was initially designed in order to help us validate and extend the set of metrics that were developed for designing and managing CuTe participation in CISS projects. Although time and confidentiality restraints prevented us from taking part of the project (whose control was transferred to a state organization), below we briefly describe the original methodological plan (which is then left for future research).

In the action research, the researcher is also an actor, meaning that in our initial plan we would engage in ordinary activities of CISS development – like project management, system analysis, and coding. The point here is that the researcher experiences a unique perspective when fully committed to the situation under surveillance – in the particular case of this research, the daily routine of CuTe and X-Team interaction. Other procedures that were to be accomplished during the action research included in-depth interviews with project stakeholders, and the use of software tools for gauging project performance. The question to be answered was: Is the model (rationale and metrics) for managing CuTes appropriate for the needs of the client organizations and the external developers?

The proposal was anchored in the general beliefs that (1) action researches adapt well to the socio-technical view of software development (Benbasat *et al.*, 1987); (2) they enable a fuller appraisal of the power relations between customers and consultants (Eden & Huxham, 1996; Hussey & Hussey, 1997); (3) they contribute to both the academic and the pragmatic knowledge (Grant & Ngwenyama, 2003), as well as to understanding the social context (Palvia *et al.*, 2003); and (4) superior studies are accomplished by the very actors of a problematic situation (Checkland, 1985).

It is worth noting that a possible intervening variable in the action research (as well as in the case study described below) could be the performance of the CuTe and the X-Team with which we would interact. Thus, it would be necessary to carefully identify the source (CuTe or X-Team) of project faults and accomplishments, in order to accurately credit performance levels to the teams. The socio-technical perspective of the software process, providing systemic and rich variables for analysis, was likely to account for such a need.

4.5 On Survey as an Alternative Method

We also deliberated on performing the most popular method in the applied social sciences (Palvia *et al.*, 2003): the survey. If carried out, the survey would be applied to at least 150 respondents[7] in the Brazilian software sector (75 CuTe members, and 75 fellow X-Team members in CISS projects), in order to enable convergent, discriminant, and nomological validation for the support of inferences on construct validity (Boudreau *et al.*, 2001; Churchill Jr., 1979) and external validity (Palvia *et al.*, 2003; Churchill Jr., 1999) for the measures, which would then be codified as structured questions in a questionnaire (say, according to a five-point Likert scale). Additionally, if combined with qualitative methods such as action research or case study, the findings would be sensibly improved (Kaplan & Duchon, 1988).

However, exhortations from experts in the field regarding both the need for longitudinal, in-depth studies on the CISS phenomenon, as well as the challenges involved in getting back full responses from 75 pairs of software partners, made us abandon the survey. In fact, surveys are not effective in providing rich descriptions of an immature subject (Pinsonneault & Kraemer, 1993), they pose internal validity problems (Palvia *et al.*, 2003), and their cross-sectional nature constrains the development of causal reasoning.

[7] Such a number is the lower limit for structural equations modeling (Gefen *et al.*, 2000).

4.6 Case Study – The entERPrise at UnivERP

We chose a case study in this research. Beyond being far the most deployed method for studying ERP implementation (Correa & Cruz, 2005), we had four other reasons for performing a case study: it helps deepen our knowledge about reality (Palvia *et al.*, 2003; Hussey & Hussey, 1997), it does not require all major variables to be known in advance (Boudreau *et al.*, 2001; Benbasat *et al.*, 1987), it frames complex elements for future investigation (Stake, 2000; Isaac & Michael, 1979), and it achieves high levels of internal validity (Palvia *et al.*, 2003). These methodological issues relate to our main argument – that since the customer is usually seen as the "unsuspected" part in software development when it comes to quality assurance and partnership performance, there is a tradition that must be examined from the very beginning of a new perspective.

The case study was aimed at providing insights into current practices and needs of CISS customers for managing their teams, as well as at validating the research's rationale and measures. Towards this, and for contrasting team reports with actual practices, in-depth interviews with key CuTe members in a major IS project (commented below) and direct observations of that project were carried out. That was done in the sense of investigating Argyris's (1992) *espoused/in-use theories of action*. Two questions were raised:

- How do CuTe members conceive their interaction with X-Team members in a CISS project?
- What are the measures currently used by customers of CISS development to design, control and assess the participation of their CuTes?

4.6.1 Unit of Analysis

The unit of analysis for the case study was the set of formal and informal, declared and hidden, voluntary and mandatory, deliberate and unconscious, work-oriented CuTe practices during the joint work of one CuTe with one X-Team in a CISS project.

4.6.2 Research Site

The company where the research's rationale and measurement instruments were empirically validated is here called *UnivERP*. UnivERP is a private university in Southern Brazil[8] that is prominent in IT capabilities and initiatives – *e.g.*, it is the university partner of the cluster previously described, and it hosts an ESICenter[9] to service companies in achieving high-maturity software capabilities. As part of a comprehensive redesign of its business processes and market orientation, UnivERP contracted out a R$15 mi (some U$7 mi) project to implement an ERP-II package from PeopleSoft[10], giving birth to a socio-technical endeavor hereafter referred to as the *entERPrise*. *Enterprise resource planning* (ERP) systems are information systems that support the organizational business processes with timely, accurate enterprise-wide information for decision making (Vemuri & Palvia, 2005) in a cost-effective, best-in-the-industry manner that trades-off between software customization and organizational change (Pollock & Cornford, 2004); and ERP-II systems open the technological infrastructure to the company's partners. To the best of our knowledge, only two Brazilian universities have so far implemented and customized at some degree their ERP academic solutions.

The entERPrise, as contracted with PeopleSoft, is officially accomplished. It started in August 2003 and extended through December 2005, in a partnership that included business and IT professionals from the client organization (UnivERP), the world-leader vendor (PeopleSoft), and a local consultant firm experienced with ERP implementations (hereafter referred to as the *PartnERP*). The implementation followed a two-year mapping of the company's operational processes and selection of the most appropriate ERP package from several solution providers. The chosen package was expected to reduce inefficiencies in the operational processes, speed up and make less complex the managerial processes, and also provide transparency and improved effectiveness to the organizational decisions.

The implementation occurred in cycles: the first cycle consisted of migrating the company's legacy information systems and departmental routines into the new (ERP)

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[8] Some facts: 32 years of existence, undergraduate and graduate programs in all major areas of research and practice, more than 25,000 students, 800 faculty members, and 900 clerical workers. It currently struggles against persistent financial shortcomings and a declining institutional prestige, probably due to the fierce commercial orientation and the obscure practices in human resource management made known to the public during the last few years (SINPRO, 2006).

[9] Granted by the European Software Institute and managed by IEEE board member Juliana S. Herbert, Ph.D.

[10] If UnivERP decided not to implement that ERP, costs for ordinary solutions would be at R$10 mi (U$4.7 mi).

solution; the second cycle added new features to the basic solution and addressed the adaptation and the training of users; and upcoming cycles will open the system to institutional partners (schools at different Brazilian cities) and implement customer relationship management, among other functionalities. In January 2005, the system went live with the solutions for managing human resources, finances, inventory, and education, as well as the Web portal. The entERPrise is deemed successful, and UnivERP's IT-business team is now responsible for keeping the ERP running and providing support for particular processes – finances, human resources, education, management information, projects, and the Internet. The entERPrise is among the most successful international cases in PeopleSoft's history, having implemented almost all UnivERP processes in record time.

With 145 employees and 15 teams, the entERPrise can be defined as a large organization (MCT, 2005), and as such it challenged the managerial practices. It is also easily conceived as a *virtual organization*, assembled for the specific purpose of managing the entERPrise and dismantled thereafter (Mowshowitz, 1994; 1997), as well as a *death march* project, in which typical project parameters (like budget, functionality, required performance, and the size of the team) "exceed the norm by at least 50 percent" (Yourdon, 1997, p. 2), thus leading to a situation where the likelihood of failure was greater than that of success. Indeed, entERPrise professionals were hired upon compliance with a major requirement: to contribute to a team that was expected to learn fast and go live with a fully functional system within a tight schedule – and that system was nearly the complete PeopleSoft ERP solution. This is to say that the entERPrise would define a new world benchmark for PeopleSoft[11]. Common challenges included such things as managing very different people, building a cohesive team, making planned or fortuitous replacements, maintaining high levels of motivation, struggling against fatigue, and negotiating politics (Yourdon, 1997). Nonetheless, plain it was for everybody that the project should be fade to success.

The entERPrise implementation seems to be in line with the principles of business process re-engineering (BPR), which is the prevalent academic approach to organizational change in the IS field (Paper & Simon, 2005) but also a long-time criticized means to efficiency – due to possibly having been poorly understood by practitioners or intentionally used against the workforce (Galliers & Swan, 1999). Paper and Simon (2005) offer a slightly different definition of BPR, which aligns change with the organizational goals; in essence,

[11] The implementation of 35 modules took 18 months, sensibly shorter than the usual 36 months reported by PeopleSoft for international cases. Ten other modules are to be implemented in the near future.

their definition replaces the original *radical* redesign of the work processes by *meaningful* and *incremental* redesign – but this last attribute was not observed in the entERPrise, given that the project was aimed from the beginning at breaking world records. Maybe this notion of meaningfulness could be further matched with the critical social theorists' exhortation that the scientific inquiry (and, by natural analogy, the enterprise endeavors like the organizational change) should not only address the methodological rigor, but foremost the historical perspective and the value for society of each particular research (Lee, 1999b); that is, a BPR-like undertaking is inexorably tied to the organization's history and the future effects on the socio-technical dimensions of the work system – the tasks, the structure, the technology, and the people.

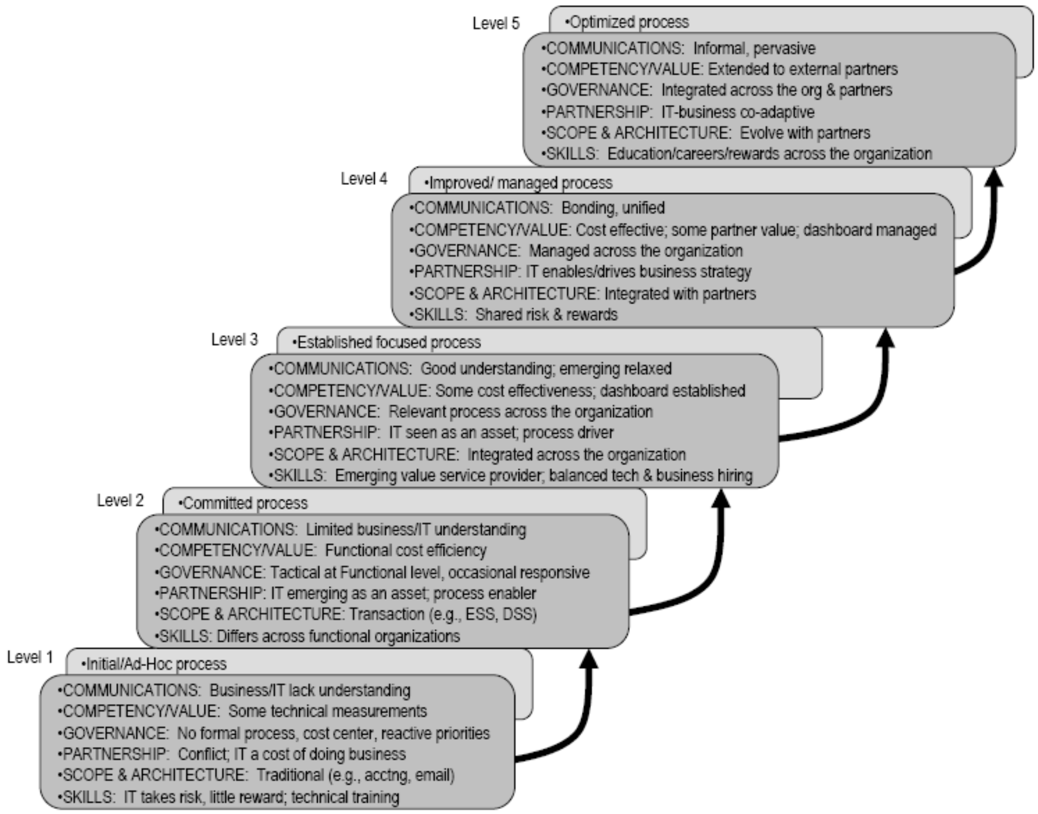
Notwithstanding the pandemic benefits reported by UnivERP as resulting from this ERP implementation[12], we agree with Vemuri & Palvia (2005) that many may be just hype, like the widespread belief that any company record would be fully and easily accessible; to the contrary, this very author, for example, is on the wait since May 2006 for the retrieval from the system of his full professional records at UnivERP. We also believe that the entERPrise was intentionally – but naively – used by senior management at UnivERP to support strategic decisions on replacing people that were not aligned with the company's mindset, as well as imprinting the company's commercial orientation into the campus routine of students, faculty members, and staff.

4.6.3 The High-performance CuTe

The whole implementation team – formed by the CuTe and the X-Team – is conceptualized as a high-performance unit. For instance, it was designed according to such design principles as (1) hiring professionals with superior learning skills (and not only experts in current technologies), (2) meeting functional/expertise redundancy (and not redundancy of parts/professionals), (3) promoting teamwork for the effective interaction of technology experts, business analysts, and lead users, (4) assigning high levels of autonomy to the professionals for the identification and correction of detours, and (5) leveraging the spirit of genuine group cohesiveness for achieving group goals. Additionally, the whole team can be

[12] Like: annual savings of R$500 thousand (some U$160 thousand), the same as starting 10 undergraduate technological programs; the elimination of redundancies in processes; the objectiveness and transparency of all company processes and decisions; and others.

straightforwardly conceived as a Level-4 or Level-5 unit (a mature unit) in terms of its strategic business practices (Figure 11).



Partnership maturity
To what extent have business and IT departments truly collaborated? Is this collaboration based on mutual trust and sharing of both risks and rewards?
Communications maturity
How well do the IT and business folks converse and understand each other? Do business and IT staff connect easily and frequently? Does the IT organization communicate effectively with external consultants, vendors, and partners? Does IT disseminate organizational learning internally?
Competency/value measurement maturity
How well does the organization measure its own performance and the value of the projects it invests in? After projects are completed, does the organization evaluate what went right and wrong? Does the post-implementation evaluation improve internal processes to make the next project better?
Governance maturity
How well does the organization connect its business strategy to IT priorities, technical planning, and resource allocation? Do IT projects undertake flow from an understanding of the business strategy? Do they support/drive the business strategy?
Scope and architecture maturity
To what extent has the IT organization evolved to be more than simply back-office business support? How has it helped the business grow, compete, and thrive?
Skills maturity
Does the IT staff have the competence and skills to be effective? How well does this staff understand business drivers and speak the language of the business? How well does the business staff understand and explain relevant IT concepts? How well does everyone understand user-centered design principles and their importance?

Source: Luftman (2005).

Figure 11. Levels of strategic alignment maturity.

The researcher was assistant professor of information systems at UnivERP from March 2002 to February 2006, where he interacted on a weekly basis with most professionals of the entERPrise's implementation team. All respondents in the in-depth interviews (Tables 16.1 and 16.2), except for the manager, attended at least one course taught by the researcher at UnivERP. At class, theoretical issues on ERP implementation were frequently raised, and discussions invariably ended up addressing the entERPrise, since classes had on average three students who also worked in the project. Thus, besides getting information directly from project leaders and experiencing the "winds of change" at UnivERP, the researcher was also provided with fresh, up-to-date facts from the shop floor reported by the student workers.

Three respondents worked in the entERPrise since its very beginning (approximately 34 months), and the other five respondents took part of at least 53% of the 18-month implementation. At the end of the project, two respondents (*Developer2* and *Analyst5*) were hired by different companies for playing the role of PeopleSoft consultants to work with customers in CISS projects, as a consequence of their outstanding performance in the entERPrise.

CuTe Member	Roles in the Project	Prior IS Experience	In the Company	In the Project	In the Role
Developer1	webmaster	90 months	108 months	last 18 months (53%)	18 months
Developer2	webmaster	36 months	36 months	last 20 months (59%)	20 months
Analyst1	developer systems analyst	36 months	68 months	last 21 months (62%)	10 months
Analyst2	network administrator	-	45 months	from the beginning	from the beginning
Analyst3	webmaster systems analyst	222 months	120 months	from the beginning	from the beginning
Analyst4	network administrator	30 months	30 months	last 25 months (74%)	25 months
Analyst5	lead user business analyst	-	84 months	last 18 months (53%)	18 months
Manager	manager	10 years	120 months	from the beginning	from the beginning

CuTe Member	CuTe Partners	X-Team Partners	Main Interaction with the X-Team	Duration of Interview
Developer1	15	2	face to face	103 minutes
Developer2	8	3	instant messenger	124 minutes
Analyst1	10	8	face to face	58 minutes
Analyst2	10	8	face to face	50 minutes
Analyst3	13	5	face to face	125 minutes
Analyst4	10	8	face to face	164 minutes
Analyst5	8	3	instant messenger	(by e-mail)
Manager	90	35	face to face	214 minutes

Table 16. The respondents.

4.6.4 Revealed Causal Mapping

Our choice for the particular technique that would help us to extract relevant conceptual categories from the interviews was a variant of the *revealed causal mapping* (RCM) approach (Nelson *et al.*, 2000a; 2000b), which introduces managerial *cognitive maps* (Laukkanen, 1994; Clarke & Mackaness, 2004; Bastos, 2002) into content analysis (Bardin, 1977) in order to reveal the causalities hidden in people's minds regarding the concepts under investigation. An illustration of RCM procedures is given in Appendix D.

Our technique, however, was not fully operational at building the causal maps – and accordingly it also did not address the validation of the maps by the very respondents in a second round of interviews. The main reason for not performing deep causal inferences from the respondents' discourses was that we were not primarily searching for strict paths between constructs, but the existence or not of some personal and team attributes in the entERPrise's CuTe. And second, the main causality of interest was already available – that, as expected, the high-performance CuTe mediated the success of the entERPrise.

As it happens with any methodological choice, RCM is not free from criticisms. The first critique can be traced back to the Scottish philosopher David Hume (1711-1776), for whom words like "because" have no causal meaning given that they cannot be tested; such words would only draw an artificial line between two facts separated by time, and not by verifiable causality (Monteiro, 2004). The validity of the maps is also a critical issue, since they are largely based on explicit, individual assumptions (from the respondents) that are not compared against external parameters (Bastos, 2002) nor to unspoken concepts. Finally, it is widely known from the 18th century manuscripts of Immanuel Kant on the intrinsically personal construction of reality, as well as from the great scientific progress made during the last century on the social behavior and the human cognition, that an individual's statements are populated with incomplete perspectives, bounded rationality, latent intentions, efficiency-driven simplifications of reality, and communication skills, such as when reporting perceptions on project risk (Keil *et al.*, 2002) and project success (Procaccino *et al.*, 2005).

The systematic procedure for assembling the basic analytical categories for content analysis included the following criteria adapted from Lima Filho (mentioned in Borges, 2000):

- *mergence* of terms with different spelling/pronunciation but shared conceptual meaning;
- *separation* of terms with identical spelling/pronunciation but different conceptual meaning;
- *determinateness*, or screening the concepts of interest *for the interviewer* (this is the *conceptual* relevance); and
- *representation*, or screening the concepts of interest *for the interviewee* (this is the *empirical* relevance).

The researcher assembled all categories (49 for structure, 202 for human nature) with the help of an MS-Excel™ spreadsheet, after going through the 132-page literal transcriptions of the interviews.

5 RESULTS

We believe to have a positive answer for the main research question, given that a unified measurement model accounting for the structural and people design and management of CuTes in CISS development was established. Such a model is called *METRICS – Model for Eliciting Team Resources and Improving Competence Structures* and puts together descriptive and prescriptive frameworks developed in heterogeneous knowledge fields, as well as two instruments for collecting perceptions on two-sided teamwork.

Figures 12 and 13 epitomize the ultimate purpose of CuTe design and management – to leverage and make accessible the potential contribution of each professional to CuTe endeavors in CISS development. Basically, a CuTe resembles a *community of practice* (Thompson, 2005), in the sense that its members are in general self-made technology experts who autonomously explore the knowledge available in the shared realm of the members' interaction (the "sea of knowledge" in Figure 12). Putting it simple, communities of practice develop a primary outcome: knowledge (Wenger & Snyder, 2000), which is to be as categorical as possible (Figure 13). But similarities between such communities and CuTes stop here, since the assumptions on the "communitarian" behavior[13] would also imply that *voluntary* participation takes place, which is only partially true in most CuTe tasks – and mandatory in the particular case of ERP implementation.

[13] For a review on community attributes and assumptions, see Bellini and Vargas (2003; 2005).

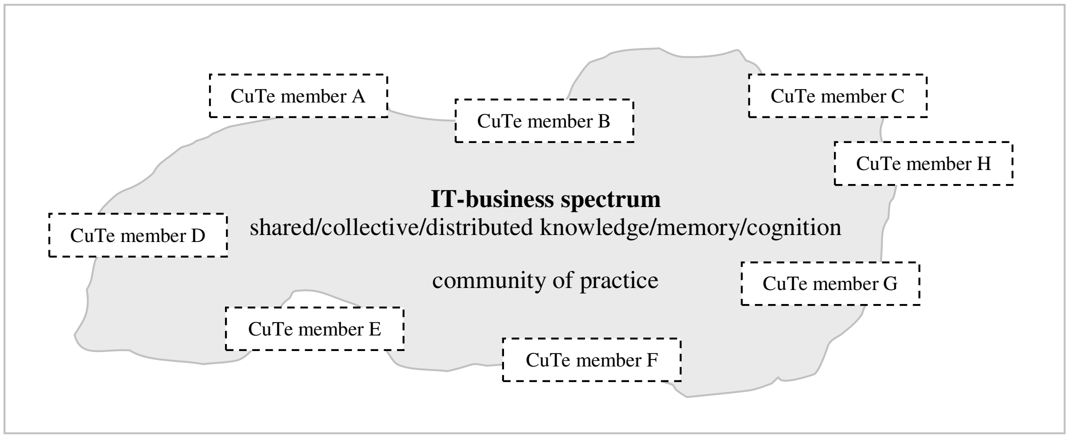
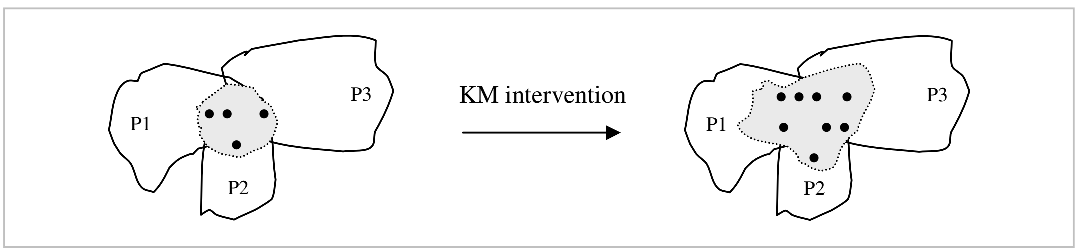


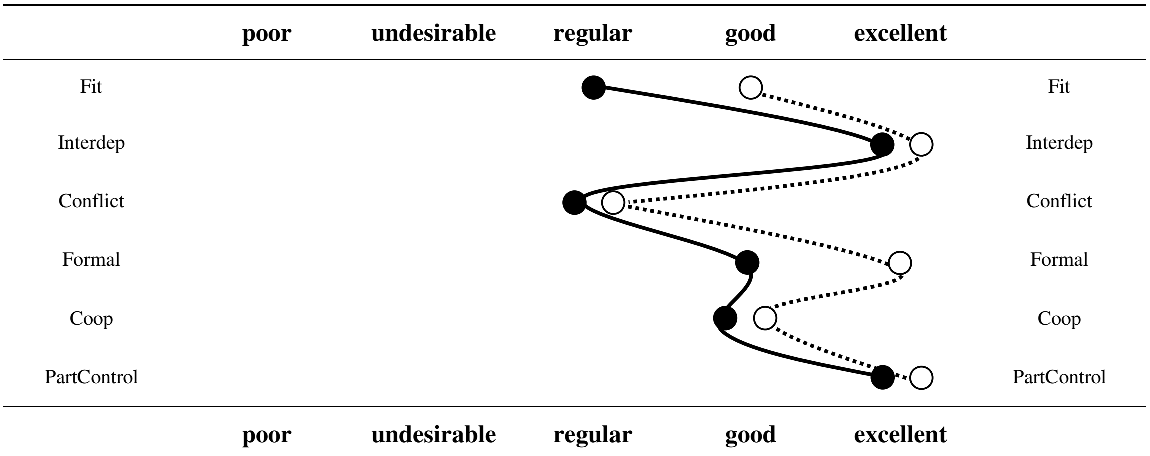
Figure 12. CuTe as professional community of practice.



Legend: the dashed encircled areas represent a CuTe's shared knowledge that results from deliberate organizational learning prior and after some knowledge management intervention; shared knowledge is knowledge in both explicit/codified form (the full spots) and implicit/tacit form (the shaded areas).
Source: adapted from Lind and Seigerroth (2003).

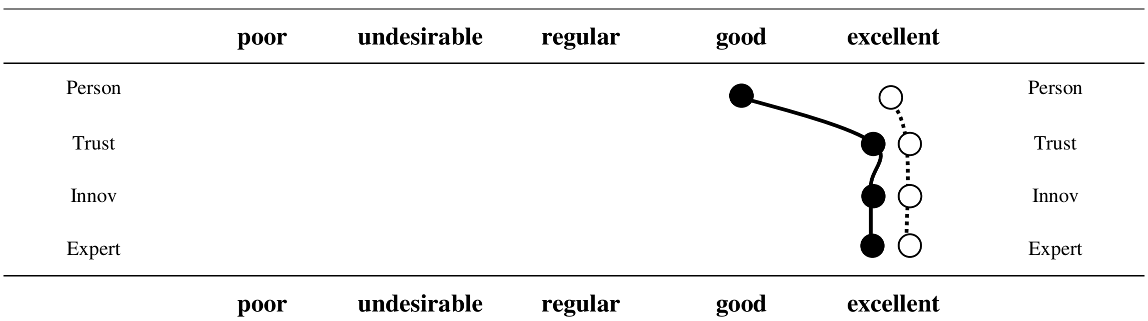
Figure 13. Expanding CuTe knowledge.

Tables 17.1 to 17.7 plot the structural and personal architecture of the entERPrise's CuTe as reported in the interviews (after categorization and normalization according to the researcher's discretion). It is relatively straightforward to conclude from the "competence maps" that the entERPrise's CuTe performed really well, having scored high in most metrics. This enables us to suggest that the levels achieved by this CuTe in each indicator can serve as a first benchmark for high-performance CuTe work in ERP implementations.



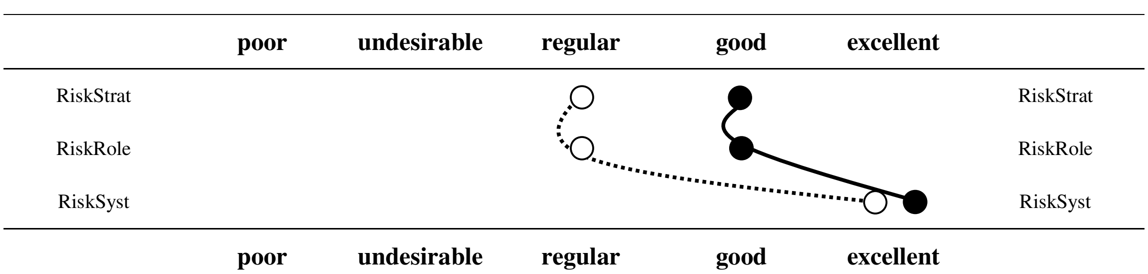
Legend: the full circles plot CuTe members' perceptions; the empty circles plot the manager's perceptions.

Table 17.1. Perception map on CuTe structure – adhocratic/organic design.



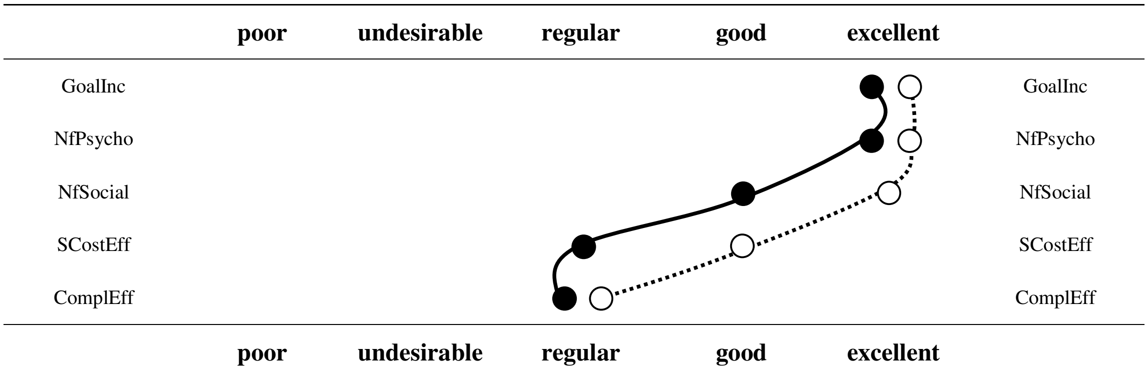
Legend: the full circles plot CuTe members' perceptions; the empty circles plot the manager's perceptions.

Table 17.2. Perception map on CuTe human nature – eligibility.



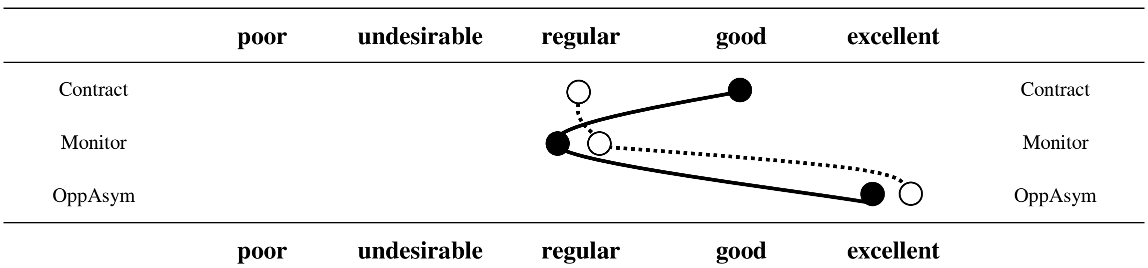
Legend: the full circles plot CuTe members' perceptions; the empty circles plot the manager's perceptions.

Table 17.3. Perception map on CuTe human nature –
risk-averse attitude & social integration.



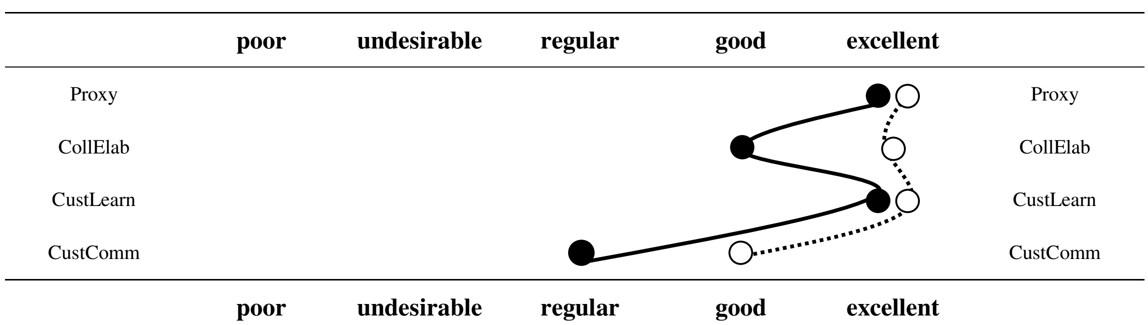
Legend: the full circles plot CuTe members' perceptions; the empty circles plot the manager's perceptions.

Table 17.4. Perception map on CuTe human nature – self-preservation.



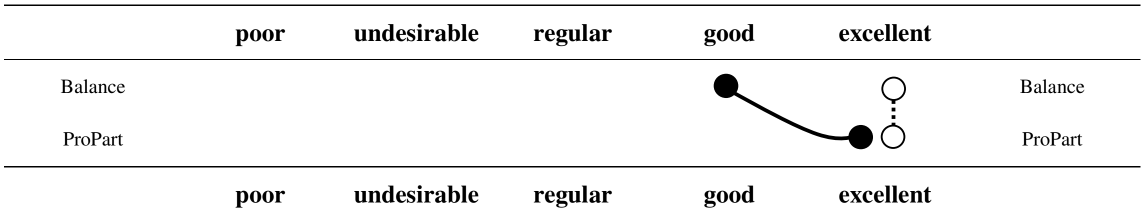
Legend: the full circles plot CuTe members' perceptions; the empty circles plot the manager's perceptions.

Table 17.5. Perception map on CuTe human nature – transaction costs management.



Legend: the full circles plot CuTe members' perceptions; the empty circles plot the manager's perceptions.

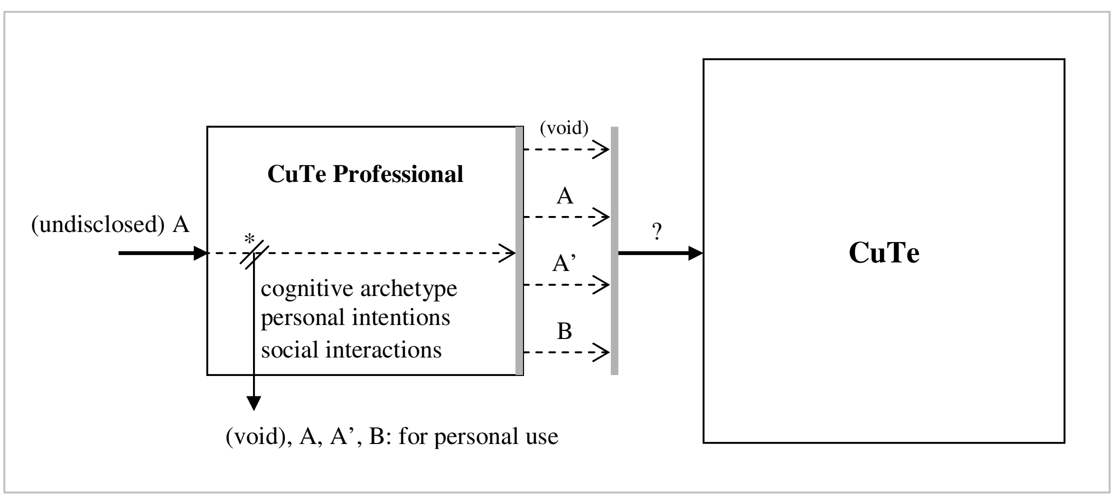
Table 17.6. Perception map on CuTe human nature – interpersonal effectiveness.



Legend: the full circles plot CuTe members' perceptions; the empty circles plot the manager's perceptions.

Table 17.7. Perception map on CuTe human nature – prospect.

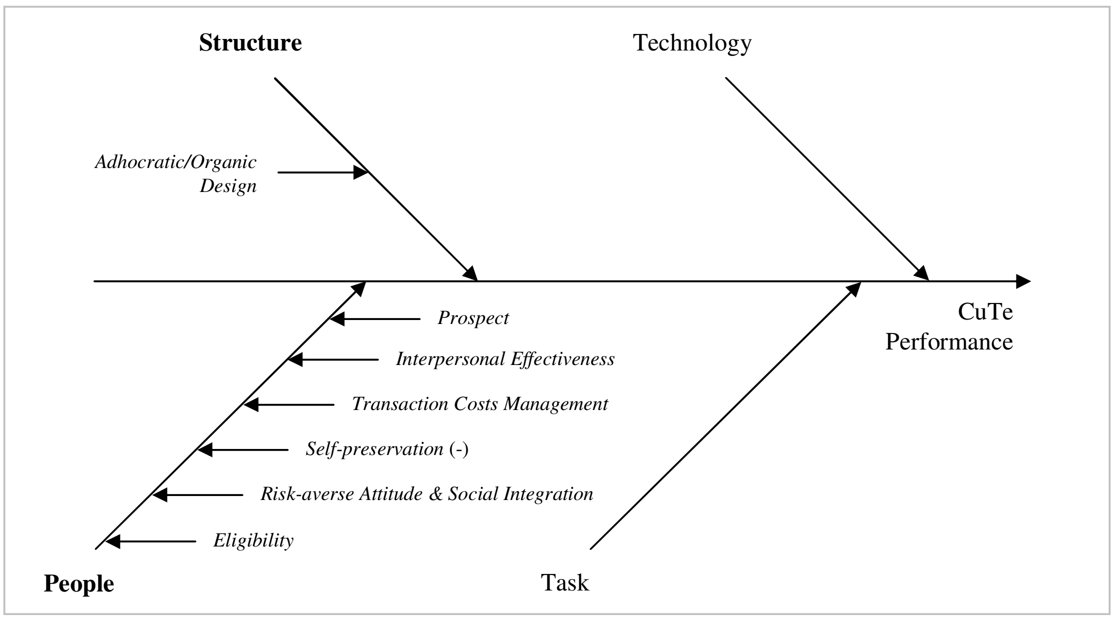
An important finding is that CuTe professionals participate in CISS projects for both meeting a personal, hidden agenda, and for playing categorical organizational roles, with clear precedence of the former over the latter – and this is even true in high-performance CuTes like the one we studied. As an illustration, in the case of deciding on whether to provide the project with potentially useful, privately held inputs, the screening process will first peruse the personal interests (Figure 14). So, and if we add to such a puzzling managerial problem the facts that (1) bounded rationality rules human cognition (what is *per se* a limiting factor for the informational effectiveness in projects), and that (2) customers are not usually held accountable for project failures (what restricts the voluntary and mandatory provision of information about this important stakeholder), the complexity of the situation demands that an effective, balanced performance system be put to work by both the customer and the outsourced developer in CISS endeavors.



** Incompletely rational, deliberate or unconscious decision mediated by the individual's cognitive archetype, personal intentions and his/her social interactions about providing the project with unaltered input A, altered input A', alternative input B, or no input at all.*

Figure 14. Precedence of personal concerns over organizational roles.

This does not seem to contradict any theoretical assumption on the interplay between personal and group interests, but reassures that CuTe performance follows not only from an up-to-date technological infrastructure and the definition and standardization of efficient work processes, but also from the cognitive archetype and personal interests of CuTe members and the social interactions that emerge and are nurtured among them as a result of human nature and the organizational structure. In particular, CuTe structure should adhere to an adhocratic design, and CuTe members should exhibit a proper combination of eligibility, risk-averse attitude and social integration, self-preservation, transaction costs management, interpersonal effectiveness, and prospect behavior in CISS projects (Figure 15).



Note: boldface items represent the scope of the findings.

Figure 15. Ishikawa diagram for CuTe performance.

As thoroughly discussed in the literature (*e.g.*, Ferratt *et al.*, 2006, and Ravichandran & Rai, 2000) and confirmed in the entERPrise, an effective and supportive management is among the most important factors accounting for high-performance teamwork. This finding contributes to our intent of discussing in greater depth the participation of customers in CISS projects. Moreover, it adds to the long-lived debate on the role of management as an actual determinant of production outcomes. Interestingly, the entERPrise manager makes extensive use of analogies to describe his ideas, what may suggest an abstractive skill far from usual, and, thus, the ability to conceive organizational actions in different layers according to each situation. We further believe that the influence of abstraction on the effectiveness of management may be a profitable theme for future research on IS development.

After the empirical validation within the entERPrise, seven measures were removed from the *On CuTe People* instrument (*Innov2*, *CollElab3*, *CollElab5*, *CollElab6*, *CustComm3*, *CustComm5*, *CustComm6*), 10 measures were codified into four new measures in the *On CuTe People* instrument (*Contract1_Contract2*, *OppAsym1_OppAsym2*, *Proxy1_Proxy2_Proxy3*, and *CustLearn1_CustLearn2_CustLearn3*), and three measures were codified into a new measure in the *On CuTe Structure* instrument (*PartControl1_PartControl2_PartControl3*), leading to a final set of 88 measures, 27 metrics, and seven indicators.

The findings support the belief that the entERPrise was actually carried out by a high-performance CuTe. Although only CuTe members could be directly interviewed in this research, the long, ongoing professional interaction between the researcher and the respondents enabled a whole set of social rules to be relaxed, thus granting the researcher access to private facts about one's actual behavior and perceptions in the project. Therefore, by means of applying the research's rationale to the entERPrise (a world benchmark for PeopleSoft ERP projects), and especially to some of its brilliant professionals, we believe to have cast aside undesired sources of influence over the inferences that we made; we thus also believe to have reached at a valid set of measures with which to design and manage CuTe participation in CISS development. Nevertheless, it is always safe to state that generalization from organizational change projects is hard to seize (Paper & Simon, 2005), and also that, due to our methodological choice (a qualitative, although longitudinal, case study), the measures developed may be only *necessary* – but not *sufficient* – to tell the whole story of CuTe design and performance in CISS development.

Only a few measures (possibly *RiskStrat3*, *GoalInc2*, *SCostEff2*, *Proxy1*, *Proxy2*, and *Proxy3*) are exclusive to CuTe nature – but this is not how the research should be interpreted in face of originality and contribution to the field. In fact, the major contribution of the present effort was to undertake a comprehensive search in the literature towards social measures (human nature and structural configuration) to address the effectiveness of CISS implementation and validate the measures for the *particular use* with CuTe members. In this sense, we believe that our research is coherent to its purpose, original for science, and useful for practice.

5.1 Lessons Learned

The respondents enabled a rich set of lessons learned to be developed from the interviews, of which we translate and transcribe some in the following pages.

"[For the individual morale to be high][14] we decided that lead users [from UnivERP's business units] who were allocated to the entERPrise would not be replaced by their [business units'] managers."

"For hiring the team members, I collected information on how they related to their groups."

"I was concerned with hiring individuals who were [enthusiastic about] change. Our group was an 'outlier' if compared to the rest of the company."

"For the technical people, [we hired on the basis of] behavior and ability to learn fast. For the business people, [the requisite was] to know the unit's business processes."

"It is faster to learn the technology than the business."

"The IT people have learned to work at a higher level of decisions – that of the business processes."

"We took advantage [of the competition between the teams] for the benefit of learning."

"Participative leadership [mediates] the feeling of group authority."

"The [sense of] accountability for project faults is related to [the sense of] ownership, [and this is mediated by participative-versus-traditional development.]"

"We had to delegate much [authority] in order to accomplish the tasks. For the sake of speed, we trusted."

"There is room for faster, quality decisions that include all stakeholders."

"Some executives asked me for private meetings, but I answered: 'You and I will solve nothing, we need to talk with those who live the process – and that included the blue-collar workers."

"We were chiefly proactive [in solving problems.]"

"The bureaucratic authority wasn't necessarily the actual authority."

"Responsibilities were not [inflexibly] defined, [so] we had to calibrate the expectancies."

"[Developers'] proactivity poses the risk of users becoming dependent."

"Just one thing is not allowed: staying quiet [when an idea comes to mind.] We believed that those people used to have good ideas."

"People were encouraged not to repress [their emotions.]"

"Promoting the strategy is not trivial. You [must gradually] translate it into project premises."

"In order to build a cohesive team, we moved from the beginning to a large room with no walls nor symbols of hierarchy [as expressed in furniture and protocols.]"

"Managers should put hands on [operational activities], in order to know what is practicable."

"[In my daily "pilgrimage" through the employees' desks] I wasn't capable of helping them technically in 99% of the cases – but this wasn't important for the workers [since they primarily wanted to be heard.]"

"Technical people are more 'binary': if they don't believe that [the plan] is feasible, they don't buy it."

"The team performed as a whole: [when confronted with a technological impediment for the integration] 'If necessary, we'll move the data by hand from one side to the other!'"

Manager

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[14] Brackets mean that the words are inferred from the respondent's discourse.

"I don't believe that we developed a new methodology, but we 'ignored' some PMBOK paragraphs."

"The wall [against which the team is pushed] is fixed at the deadline."

"The 90%-complete syndrome is real, since [we don't realize that] we overestimate what is actually done."

"Minimize customization."

Manager

"[The general character of] the system is standard, but the solutions [we] devised are not."

"Being at the same room [is] really important for knowledge sharing."

"For the developers' self-esteem, [that] separation wasn't good at all [the business/user personnel worked in the building where the institutional focus was on, while the developers worked in another building]."

"The developers' amalgam was the sensation of isolation."

"Being [naturally] extraverted doesn't mean that you'll always be extraverted."

"There are those who are driven by detail, but don't advance an inch."

"[The practice of] mere [bureaucratic] authority doesn't convince me."

"The 'invisible' hierarchy inhibits behavior."

"You don't [work proactively] when credits [for performance] aren't as expected."

"Life isn't made of just 'thank you', [but also of] financial and status benefits."

"Each individual demands unique attention."

"Sport activities [in the campus] served to unite the team."

"I was uneasy with the lack of information [on the organizational change.]"

"The changes [at UnivERP] are inhumane."

Developer1

"Project is exactly this: you must work hard."

"[There shouldn't be this] large gap between the IT and the business people."

"One has to ask for clues whenever needed – but not 'please, do it for me.'"

"Overtime payment is a motivational factor."

"I developed greatly when I changed my seat in the room [I sat near a more experienced fellow.]"

"[Being] honest and competent – that's all."

Developer2

"Ask me responsibility, give me authority."

Analyst2

"Some people contend about minor issues… [but] we should engage in better communication."

"[Changes in professional routines are healthy,] but not all the time; otherwise, nobody works effectively."

"Rotation [between tasks] may make me stay in the team."

"I must [learn to] distinguish between quality and my expectations [about the performance of others.]"

"I was part of it, thus we cross our fingers for it!"

Analyst3

"Our [first] manager used to protect us [from some hard activities.] The second manager imposed the tasks [although unsympathetic, that was effective.]"

"Upon requests from colleagues, [it is sometimes important to] delay the answer, in order to make it clear that [you're also] busy."

"That shirt [labeled with the project's name] demanded us responsibility."

"If trained, we could have been 100% more efficient and have reduced overtime to a third."

"[Team] commitment was a critical success factor."

Analyst4

"My participation in the project was important for me."

Analyst5

It is especially significant that almost all respondents assured that:

- the entERPrise was worth of every Herculean effort and persistent abnegation along the 18 months of implementation, although the financial and status rewards were deemed insufficient; this is related to the general sense that IT professionals are used to "hard but fulfilling work" (Developer2) and "doing some nightshifts" (Manager);
- improving the personal organization is a permanent need, but this is not as important as accomplishing the tasks and observing the deadlines; this is related to an old behavioral dilemma, that of being effective and expeditious at the same time;
- prior technological knowledge is not as important as learning capability; this is related to the flexibility needed in face of the technological changes and the pressures for designing creative solutions;
- the team was indeed effective, that is, we found that the professionals in this CuTe were mutually supportive in reckoning the others' performance at work; this is related to the autonomy-with-responsibility design of socio-technical work systems, which also implies corresponding rewards (like the acknowledgment from peers);
- culture is mostly attached to technological knowledge; this is related to the general feeling that IT workers lack a systemic understanding of business;
- at the beginning of the partnership (between UnivERP and PartnERP), the entERPrise's CuTe and X-Team interacted stressfully; this is intriguing, since stress in relationships is expected to develop through time;

- training was ineffective; this is contrary to good project principles, but the team proved to have outstanding learning capabilities to perform the tasks and even break world records; and
- the contract between UnivERP and PartnERP was a black box for non-managers; this leads to shortfalls in productivity, since controversies between the partners are not promptly solved and similar tasks may be superimposed.

It is also true that not all reported and informal discourses were positive or light regarding the entERPrise's *raison d'être* and the performance of its CuTe professionals. In addition to the fact that human endeavors are axiomatically imperfect, the entERPrise suffered from occasional and recurrent critiques from individuals and groups concerned with UnivERP's downsizing and commercial orientation. Some technical attributes of the ERP implementation also asked a high price from the CuTe professionals – like the large number of people to be managed, their different competencies and conflicting interests, the tight deadline, the shortage of rewards, the limited help from the X-Team, and the high turnover rates typical in the software industry. And finally, since the entERPrise's CuTe was, by definition, composed only of UnivERP's personnel, it is natural to conclude that the adverse organizational climate[15] had a prevailing negative effect over the individuals – and this is expected to have moderated their performance.

[15] In 2005, UnivERP surveyed a random sample of its professionals on a set of organizational climate drivers, but results were not made public – contrary to what was informed prior to the survey. This researcher was one of the respondents to the questionnaire.

6 CONCLUSIONS

Our thesis is that the client organization, and especially its CuTe professionals, *should* be unavoidably held accountable for the outcomes of developing customized information systems software (CISS), and accordingly be managed in reference to performance metrics built from the measurement theory imperative. Moreover, CuTe accountability and metrics should arguably differ from those in X-Teams, given the very nature of each team – the technology-driven, “selling” X-Team, and the business-driven, “buying” CuTe. Our research considered these assumptions and empirically verified their suitability in a three-year case study within a landmark enterprise resource planning (ERP) project (here called “entERPrise”) carried out in a Brazilian university (here called “UnivERP”) with the help of an IT-business consultancy (here called “PartnERP”) that represented the technology vendor (PeopleSoft).

Another goal in this research was to delve into non-technical issues, which were traditionally neglected by research and practice in software development, whereas they do account for most idiosyncrasies that drive project performance. In this sense, we started from the socio-technical design of work systems to propose that the structural configuration and the human nature (the social subsystem) of CuTe work demand operationalization, especially in what comes to a comprehensive set of definitions and managerial principles. Both issues were hopefully addressed in our research by means of what we believe to be the rationale for CISS development, as well as two instruments for collecting perceptual data on CuTe performance (instruments *On CuTe Structure* and *On CuTe People*). The resultant framework is called *METRICS – Model for Eliciting Team Resources and Improving Competence Structures.*

The empirical investigation showed that the entERPrise was actually carried out by a high-performance CuTe, what enabled us to validate 103 social measures (then reduced to 88) developed from the thorough literature review, as well as propose a first set of performance levels to be achieved by CuTe professionals in large ERP implementations. Although only CuTe members (and not also the X-Team) could be directly interviewed in this research (what accounts for one of its limitations), the intense and long professional interaction between the researcher and the respondents enabled a whole set of social rules to be relaxed, and thus granted the researcher access to private facts about one's actual behavior in the project. Therefore, by means of applying the research's rationale to the entERPrise (a world benchmark for PeopleSoft ERP projects) and especially to select CuTe professionals in it, we believe to have cast aside undesirable sources of influence over the inferences we made. We then also believe to have reached at a valid set of measures with which to design and manage CuTe participation in CISS development. Nevertheless, we are aware of the fact that generalization from organizational change projects is hard to seize (Paper & Simon, 2005), and also that, due to the methodological choice (a qualitative, longitudinal case study), the measures that were developed may be only *necessary*, but not *sufficient*, to tell the whole story of CuTe design and performance in CISS development.

The social measures were grouped in metrics and indicators that include:

- principles of adhocratic teamwork;
- traits of the structural identity of the individual – with issues related to personality, trustworthiness, innovativeness, entrepreneurship, expertise, and transactive memory;
- traits of how the individual conceives his/her current professional endeavor – with issues related to understanding the meaning of and links between the company's strategy, his/her personal role in it, and the end product's (the system's) expected attributes;
- traits of how the individual interacts with the current business partner on the basis of personal effectiveness – with issues related to facilitating and effecting the learning processes, communicating clearly, and being proactive in regard to the other's duties in order to speed up production;
- traits of how the individual transacts with the current business partner on the basis of functional effectiveness – with issues related to conceptualizing the partnership, monitoring it, and using it for two-sided benefits;
- traits of how the individual justifies his/her behaviors in the professional endeavor – with issues related to adjusting the priority of personal goals, making use of psychological and social self-justification mechanisms, assigning value to past investments, and continuously appraising the value of project goals; and
- traits of how the individual frames the historical (past and future) perspective of the relationship with his/her current business partner – with issues related to interdependence and continuity.

The metrics contain only a few measures that are exclusive to CuTe nature, but this is not how the research should be interpreted in face of originality and contribution to the field. The major contribution of the present dissertation was to undertake a comprehensive search in the literature for social (structural and people-oriented) measures that could frame the effectiveness of CISS implementation, and to validate the resulting measures for the *particular use* with CuTe members. In this regard, we believe that our research is coherent to its purpose, original in results, and useful for practice.

An important finding that confirms previous research is that an effective management is integral to high-performance teamwork. As thoroughly discussed in the literature and confirmed in the entERPrise, management is the single most important factor accounting for effective teamwork. This finding does not contradict the autonomy principle of socio-technical design (which does not preclude management's authority), and supports our original intent to discuss in greater depth how to manage the participation of customer professionals in CISS projects.

From a practice viewpoint, important directions for the development and the application of instruments for collecting the measures were derived. First, practice-oriented measures should be developed consistently, that is, based on a robust, agreed-upon belief on the effective relation between the empirical and the symbolic relational systems. The measures must also address exclusively the empirical object of interest and be as independent as possible from the measurer. And second, professionals should not feel inhibited to deploy scale transformations for the purpose of supporting the analysis of measures whenever the nature of an object's attributes is not clear enough and once such transformations seem to purify one's comprehension. This is not to say that freewill rules, but that real-time business demands (like from customers, employees, partners, or the technology) must correspond to, if not optimal, at least discretion-led satisfactory reactions from production and management. Summing up, and since cultural change is integral to the implementation of metrics (Iversen & Mathiassen, 2003), positive instrumentation should support the client organization and the contractor in CISS projects.

It is clear that our research's findings need to be further examined in the software industry in order to see whether there is a match between the art and the practice of software development, as well as whether one (art or practice) should incorporate the other's premises. Gaps between academy and industry in the software engineering and IS fields have been reported as common (see Todd *et al.*, 1995, and Franzen & Bellini, 2005); it is thus prudent not to misjudge one based on any assumption of *what should be*. As technology develops and changes fast (Lopes & Morais, 2002; Currie & Glover, 1999), and given that IS research has long followed, with a natural delay, developments made in the industry (Benbasat *et al.*, 1987) and that practitioners do not use to read or reflect on academic research (Pearson *et al.*, 2005), the occurrence of such gaps is not surprisingly new. Indeed, the rigor-*versus*-relevance debate is familiar (*e.g.*, Benbasat & Zmud, 1999, Applegate & King, 1999, Davenport & Markus, 1999, Lyytinen, 1999, Lee, 1999a, Hirschheim & Klein, 2003, and Pearson *et al.*, 2005). In particular, empirical research can investigate the very implementation of metrics in software process improvement initiatives (as identified by Iversen & Mathiassen, 2003), since metrics are essential for contrasting companies on process maturity (Rainer & Hall, 2003).

6.1 Limitations

We believe that the potential limitations of our research concern the validation of findings. First, and contrary to what was originally planned, PartnERP's professionals (the X-Team) were not available for assessing UnivERP's professionals (the entERPrise's CuTe), thus preventing us to measure from another perspective the actual traits and performance of the latter; in fact, the more neutral assessments were supposedly made by the entERPrise's manager and by this researcher when assembling the evidences. And second, time and professional restraints impeded us to discuss with the interviewees the outcomes from our content analysis; if accomplished, this desirable validation procedure would approximate us to the full application of RCM's rationale, which tries to develop insights as rich as possible from the discourses during in-depth interviews.

The normalization procedure for enabling the comparison of measures (within each metric) and metrics (within each indicator) relied almost exclusively on the researcher's discretion, thus posing threats to the internal validity of the instruments and subsequent comparison of results. On the other hand, the psychometric tradition, based on its historical databases of research findings, usually takes for granted that some established measures (say, operationalized as items in a structured questionnaire) share a common scale (say, five-point Likert), what is *per se* a questionable normalization decision. In this case, the only difference to our research is that we did not define a scale for each measure, given that we searched for a richer understanding of the subject's perceptions during the interviews, and also because some measures were borrowed from extant instruments with different scales, or were simply developed from scratch.

Another limitation is due to the company where the ERP was implemented. Universities are a special type of organization (Pollock & Cornford, 2005), and as such, solutions that are good for them are not necessarily effective in other industries. This leads to the conclusion that our findings may not be fully observable in or applicable to other companies.

Finally, the very success of the entERPrise – as defined from UnivERP's desire to implement an enterprise-wide system, reduce costs, promote an institutional image of technological vanguardism, and displace professionals – may have produced an overconfident groupthinking effect among the entERPrise's CuTe members, thus blurring the role played by less desirable individual traits and performance factors.

6.2 Future Research

In what comes to future theoretical research, the primary need is doubtlessly to consolidate terminology, principles and methods for measurement in software engineering, as denounced by Ruiz *et al.* (2003) and Abran *et al.* (2003), and subsequently continue to unify previous research outcomes by means of, for instance, meta-analyses. Our study did some improvements in this sense. Even though subjectivity is still endemic to measurement (not only regarding the epistemological base, but also due to the generous current involvement with qualitative measures), one cannot ignore that it is of pressing need that the software community once and for all agrees on the core assumptions. Current disagreements have theoretical and practical implications, as productivity problems will continue to happen.

Another theoretical issue that should be investigated in depth concerns the cultural components that are to influence or to be changed by the implementation of a metrics plan. Software teams already work in a performance-oriented way (Peled, 2000), but enforcing the development of certain personal characteristics or the adoption of best practices is not to be without objections by knowledge workers (Scarbrough, 1999). Moreover, organizations are regarded as routine-preserving structures (Nelson & Winter, 1982; Tolbert & Zucker, 1996), maybe because it is harder to dissolve knowledge in order to learn something new (in this case, moving to a metrics culture) than to learn for the very first time (Hofstede, 1994).

Scale development is always an important concern for the applied social sciences and for practice. Therefore, we also propose that the instruments *On CuTe Structure* and *On CuTe People* be used in surveys to test whether there is a normalized scale (say, five-point Likert) that can be used in the whole software industry by pairs of CISS customers and contractors to assess CuTe performance.

Finally, we see that, by extending our rationale and measures to other CISS development cases and incorporating the results into the myriad of process and technology practices already developed in the academy and industry, a fully socio-technical perspective on CISS development may be achieved – for the benefit of all stakeholders.

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APPENDIX A-1

INSTRUMENT *ON CUTE STRUCTURE* FOR IN-DEPTH INTERVIEWS WITH THE CUSTOMER

(The following instrument was applied in its Portuguese version to CuTe professionals. Although most questions are here not worded in "neutral" form, they were not necessarily verbalized to the interviewee in the exact spelling below, thus preventing possible biases of guiding the answers towards specific meanings. This is an interview protocol, not a questionnaire.)

This is part of a research aimed at improving the customer-vendor interaction and the effectiveness of software development during IS customized implementation. Please answer the questions taking into account your specific role and experience in the project mentioned by the researcher. Be as deep and clear as possible, and do not hesitate to add any comments you freely judge pertinent. Additional guidelines:

- whenever asked about "the project", consider the project mentioned by the researcher;
- whenever asked about "your partner", consider your counterpart at the contractor's team in the project; and
- whenever asked about "your team", consider your colleagues at your company's team in the project.

Similar interviews can be also performed with business managers, IS/IT managers, system analysts and programmers from both sides (customer and vendor) in this project.

Indicator	adhocratic/organic design

Metric: **organizational fit** (Fit)

Fit1) Is the level of training (technical and social) and indoctrination adequate for your role in the project?

Fit2) Is it likely that you change between (meaningful) roles in the project?

Fit3) Does the workplace enable you to perform and learn about your role?

Metric: **task interdependence** (Interdep)

Interdep1) To which extent are you assigned tasks that serve as input to your partner's and your team's tasks?

Interdep2) To which extent are you assigned tasks that need input from your partner's and your team's tasks?

Metric: **goal conflict** (Conflict)

Conflict1) Are you requested to deliver tasks on the basis of celerity, or of user-friendliness, accuracy, and expediency?

Conflict2) Do you request your team and partner to deliver tasks on the basis of celerity, or of user-friendliness, accuracy, and expediency?

Metric: **formality & knowledge sharing** (Formal)

Formal1) Are you free to exchange information with your partner and your team?

Formal2) Are you encouraged to express your ideas, even if not fully developed yet?

Formal3) Do informal gatherings and information have a place in the project?

Formal4) How do you learn about your role in the project?

Formal5) How frequently do you refer to contractual information when interacting with your partner?

Metric: **cooperativeness** (Coop)

Coop1) How frequently are your participation and that of your team in the project elicited by senior management?

Coop2) Are you free do meet with your partner and your team to discuss project information?

Coop3) Is power used for the benefit of the project, or mostly for personal/team interests?

Coop4) What about the mix of expertise in the project?

Coop5) Is conflict of ideas seen as an impediment for work?

Metric: **genuine participation & autonomy** (PartControl)

PartControl1) To which extent is it likely that problems will be immediately reported to you if they pertain to your expertise domain?

PartControl2) To which extent is it likely that problem solving will be immediately requested from you if it pertains to your assigned task?

PartControl3) To which extent does other decision making issues on your task reflect your input?

PartControl4) To which extent does the final system reflect your input?

Additional Comments

Interviewee's Profile

Age:

Gender:

Company:

Role in the company:

Role in the project:

Months of IT/IS professional experience (before the project):

Months in the company (before the project):

Months in the project:

Months in the role (during the project):

Size of your team (CuTe):

APPENDIX A-2
PORTUGUESE VERSION OF
INSTRUMENT *ON CUTE STRUCTURE* FOR
IN-DEPTH INTERVIEWS WITH THE CUSTOMER

(O instrumento a seguir foi aplicado a profissionais da equipe-cliente. Embora a maioria das questões não esteja em formato "neutro", elas não necessariamente foram verbalizadas ao entrevistado exatamente como transcrito abaixo, de modo a minimizar a influência sobre as respostas. Este é um protocolo para entrevistas, não um questionário. Também se faz notar que algumas questões do instrumento original foram excluídas, dado que não se mostraram relevantes após a realização das primeiras entrevistas.)

Isto é parte de uma pesquisa que tem o objetivo de melhorar a interação entre cliente e parceiro terceirizado, bem como a efetividade do desenvolvimento de *software* durante a personalização de sistemas de informação. Por favor, responda as questões levando em consideração a <u>sua</u> experiência no projeto. <u>Não</u> restrinja suas respostas à interação com os parceiros terceirizados. Seja tão detalhista quanto possível e não hesite em adicionar comentários relevantes livremente.

Entrevistas similares poderão ser também realizadas com gestores de negócio, gestores de tecnologia, analistas de sistemas e programadores de ambas as empresas envolvidas no projeto.

Indicador	projeto orgânico/adhocrático

Métrica: **ajuste organizacional** (Fit)

Fit1) O nível de treinamento (técnico e social) é adequado para a sua função no projeto?

Fit2) É provável que você exerça diferentes funções no projeto?

Fit3) O ambiente de trabalho permite a você desempenhar e aprender sobre sua função?

Métrica: **interdependência de tarefas** (Interdep)

Interdep1) Em que medida o resultado das suas atividades no projeto serve de entrada para as atividades de outras pessoas?

Interdep2) Em que medida o resultado das atividades de outras pessoas no projeto serve de entrada para as suas atividades?

Métrica: **conflito de objetivos** (Conflict)

Conflict1) Você deve executar suas tarefas com base em rapidez e outros critérios econômicos, ou com base em atributos de qualidade?

Conflict2) Você pede que os outros executem as tarefas com base em rapidez e outros critérios econômicos, ou com base em atributos de qualidade?

Métrica: **formalidade e compartilhamento de conhecimentos** (Formal)

Formal1) Você é livre para trocar informações com as outras pessoas no projeto?

Formal2) Você é encorajado(a) a expressar suas idéias no projeto, mesmo que elas ainda não estejam plenamente desenvolvidas?

Formal3) Atividades informais entre colegas são estimuladas e freqüentes no projeto?

Formal4) Exemplifique como você faz para aprender/atualizar-se sobre sua função no projeto.

Formal5) Com que freqüência você recorre a informações expressas em contrato durante a interação com as outras pessoas no projeto?

Métrica: **espírito de cooperação** (Coop)

Coop1) Seus superiores no projeto estimulam sua participação ativa?

Coop2) Você é livre para se encontrar com as outras pessoas do projeto para discutir informações?

Coop3) O exercício do poder acontece para benefício do projeto, ou principalmente para beneficiar pessoas específicas?

Coop4) O que você acha do conjunto de conhecimentos e habilidades da sua equipe de trabalho?

Coop5) No projeto, o conflito de idéias é visto como impedimento para o trabalho?

Métrica: **participação genuína e autonomia** (PartControl)

PartControl1) Em que medida é provável que problemas sejam imediatamente reportados a você caso pertinentes ao seu domínio de perícia?

PartControl2) Em que medida é provável que a solução de problemas seja imediatamente requisitada de você caso pertinente à sua função?

PartControl3) Em que medida outras questões de tomada de decisão na sua função refletem a sua contribuição?

PartControl4) Em que medida o sistema final desenvolvido reflete a sua contribuição no projeto?

Comentários Adicionais:

Questões Demográficas

Idade:

Sexo:

Função na empresa:

Função no projeto:

Meses de experiência profissional em projetos de sistemas de informação (antes do projeto):

Meses na empresa (antes do projeto):

Meses no projeto:

Meses na função (durante o projeto):

Tamanho da sua equipe de trabalho:

Tamanho da equipe terceirizada:

Principal forma de interação com os colegas terceirizados:

Meses interagindo com os colegas terceirizados:

Freqüência de interação com os colegas terceirizados:

APPENDIX B-1
INSTRUMENT *ON CUTE PEOPLE* FOR
IN-DEPTH INTERVIEWS WITH THE CUSTOMER

(The following instrument was applied in its Portuguese version to CuTe professionals. Although most questions are here not worded in "neutral" form, they were not necessarily verbalized to the interviewee in the exact spelling below, thus preventing possible biases of guiding the answers towards specific meanings. This is an interview protocol, not a questionnaire.)

This is part of a research aimed at improving the customer-vendor interaction and the effectiveness of software development during IS customized implementation. Please answer the questions taking into account your specific role and experience in the project mentioned by the researcher. Be as deep and clear as possible, and do not hesitate to add any comments you freely judge pertinent. Additional guidelines:

- whenever asked about "the project", consider the project mentioned by the researcher;
- whenever asked about "your partner", consider your counterpart at the contractor's team in the project; and
- whenever asked about "your team", consider your colleagues at your company's team in the project.

Similar interviews may be also performed with business managers, IS/IT managers, system analysts and programmers from both sides (customer and vendor) in this project.

Indicator	eligibility

Metric: **personality** (Person)
Person1) Are you generally talkative and gregarious?
Person2) Are you generally organized, conscientious and persistent?
Person3) Are you generally friendly, tolerant and forgiving?
Person4) Are you generally secure, enthusiastic and stable?
Person5) Are you generally cultured, curious and imaginative?

Metric: **trustworthiness** (Trust)
Trust1) Should transactions with you be supervised closely?
Trust2) Do you respect confidentiality of project information?
Trust3) Are project information received from you trustworthy and relevant?
Trust4) Do you withhold important project information?

Metric: **innovativeness & entrepreneurship** (Innov)
Innov1) To which extent do your ideas, solutions and decisions generally reflect team, company or industry standards or frames of reference?
Innov2) To which extent are you driven by detail, efficiency and conformity to rules in the work environment?
Innov3) Are you more prone to change or stability in the work environment?
Innov4) To which extent are your ideas, solutions and decisions generally implemented?

Metric: **expertise & transactive memory** (Expert)
Expert1) Do you have the requisite expertise for the project?
Expert2) To which extent can you distinguish between effective and ineffective actions for the project?
Expert3) Do you have a good mental map of your team's expertise?
Expert4) Does your expertise mix efficiently with your team's and your partner's?

Indicator	risk-averse attitude & social integration

Metric: **strategic enrollment** (RiskStrat)
RiskStrat1) Do you understand the strategic meaning of the project for your company?
RiskStrat2) Do you enthusiastically adhere to the project's strategic intent?
RiskStrat3) Are you ready to undertake the organizational change (if) required?
RiskStrat4) Do you feel like working in a true team with your partner?

Metric: **role cherishing** (RiskRole)
RiskRole1) Can you see the links between the strategic meaning of the project and your role in it?
RiskRole2) Do you anticipate personal benefits/drawbacks in fulfilling your role in the project?
RiskRole3) Do you feel responsible for the project's outcomes?
RiskRole4) Do you feel authoritative in the project?

Metric: **system championing** (RiskSyst)
RiskSyst1) Do you understand what the system is expected to do?
RiskSyst2) Do you have a positive attitude towards the system?
RiskSyst3) Is your attitude towards the system aligned with your team's presumable attitude towards it?
RiskSyst4) Is your attitude towards the system aligned with your partner's presumable attitude towards it?
RiskSyst5) Is the workload expected from you humane and technically reasonable?
RiskSyst6) Is the time available to working with your partner enough for meeting quality and deadlines?

Indicator	self-preservation

Metric: **goal incongruence** (GoalInc)
GoalInc1) Do you act out of self-interest when working in the project?
GoalInc2) Would association with failure in the project have an adverse effect on your chance to advance in the company?

Metric: **psychological self-justification** (NfPsycho)
NfPsycho1) Do you repeatedly express support for the project?
NfPsycho2) Are you extensively involved with the project?
NfPsycho3) Are you emotionally attached to the project?

Metric: **social self-justification** (NfSocial)
NfSocial1) Would abandonment of the project make you “look bad” to others?
NfSocial2) Do people inside or outside the company view the project as your “baby”?

Metric: **sunk cost effect** (SCostEff)
SCostEff1) Do you make reference to your own past investments in the project as a reason to continue in/with it?
SCostEff2) Do you feel that a great deal of time, money and other resources was already invested in the project, and that this would be a reason to continue in/with it?

Metric: **completion effect** (ComplEff)
ComplEff1) Do you argue that you have gone too far to quit the project?
ComplEff2) Do you argue that you are too close to the end to quit the project?

Indicator	transaction costs management

Metric: **contractual relationship** (Contract)
Contract1) Do you understand what the relationship with your partner is all about?
Contract2) Do you understand what the specific outcomes expected from the relationship with your partner are?
Contract3) Does informal information have a place in the professional relationship with your partner?

Metric: **relationship monitoring** (Monitor)
Monitor1) Do you have a clear picture on the ongoing relationship with your partner?
Monitor2) Is it easy and pleasurable to work and monitor the relationship with your partner?
Monitor3) Is it likely easy and pleasurable to work and monitor the relationship with you?
Monitor4) Does work with your partner flow smoothly along the timeline?

Metric: **opportunism & information asymmetry** (OppAsym)
OppAsym1) Do you conceal negative information from your partner or from top layers in the project/company?
OppAsym2) Do you distort negative information when reporting to your partner or to upper management?
OppAsym3) Do you take personal advantage of information in the project?
OppAsym4) Do you withhold potentially useful information that is not explicitly asked for in the project?

Indicator	interpersonal effectiveness

Metric: **organizational proxy** (Proxy)
Proxy1) Do you facilitate your partner's learning about your company's business?
Proxy2) Do you facilitate your partner's learning about your company's business needs?
Proxy3) Do you facilitate your partner's learning about your company's technology needs?
Proxy4) Are you prone to contributing (proactively and reactively) with your expertise in the project?

Metric: **collaborative elaboration** (CollElab)
CollElab1) To which extent do you ask about the others' unstated reactions to ideas?
CollElab2) To which extent do you use multiple ways to describe an idea?
CollElab3) To which extent do you identify differences that are not obvious to the others?
CollElab4) To which extent do you focus on understanding or achieving the others' personal goals?
CollElab5) To which extent do you generate alternatives that accomplish shared goals between your team and your partner's?
CollElab6) To which extent do you compare alternatives to fallback positions?

Metric: **customer learning** (CustLearn)
CustLearn1) To which extent does a business dialogue reorient your thinking about requirements?
CustLearn2) To which extent does a business dialogue question your preconceptions about requirements?
CustLearn3) To which extent does a business dialogue expand your scope of thinking about requirements?
CustLearn4) To which extent can a business dialogue change your attitude and behavior in the project?

Metric: **customer communication & leadership** (CustComm)
CustComm1) Do you communicate clearly, accurately and in appropriate time with your partner?
CustComm2) Are you sensitive to your partner's present needs?
CustComm3) Do you pay attention to what your partner say?
CustComm4) Do you deal effectively with your partner?
CustComm5) Are you a good listener to your partner?
CustComm6) Do you generally say the right thing at the right time to your partner?

Indicator	prospect

Metric: **cooperative interdependence** (Balance)
Balance1) To which extent do you meet project obligations that directly relate to others?
Balance2) What is the stake of the total customization effort that you feel responsible for?

Metric: **partnership propensity** (ProPart)
ProPart1) Are you satisfied with your interpersonal performance in the project?
ProPart2) Do you repute your action towards your partner as of genuine business partnership?
ProPart3) To which extent friendship is an attribute of the relationship with your partner?
ProPart4) To which extent quality of working life is an attribute of the relationship with your partner?
ProPart5) Are you prone to building a mutually beneficial (win-win) professional history with your partner?
ProPart6) Is it likely that you will choose to work with your partner again in a similar customer-developer contract?
ProPart7) Is it likely that your partner will choose to work with you again in a similar customer-developer contract?

Additional Comments

Interviewee's Profile

Age:

Gender:

Company:

Role in the company:

Role in the project:

Months of IT/IS professional experience (before the project):

Months in the company (before the project):

Months in the project:

Months in the role (during the project):

Size of your team (CuTe):

Size of your partner's team (X-Team):

Main form of interaction with X-Team professionals:

Months interacting with X-Team professionals:

Frequency of interaction with X-Team professionals:

APPENDIX B-2
PORTUGUESE VERSION OF
INSTRUMENT *ON CUTE PEOPLE* FOR
IN-DEPTH INTERVIEWS WITH THE CUSTOMER

(O instrumento a seguir foi aplicado a profissionais da equipe-cliente. Embora a maioria das questões não esteja em formato "neutro", elas não necessariamente foram verbalizadas ao entrevistado exatamente como transcrito abaixo, de modo a minimizar a influência sobre as respostas. Este é um protocolo para entrevistas, não um questionário. Também se faz notar que algumas questões do instrumento original foram excluídas, dado que não se mostraram relevantes após a realização das primeiras entrevistas.)

Isto é parte de uma pesquisa que tem o objetivo de melhorar a interação entre cliente e parceiro terceirizado, bem como a efetividade do desenvolvimento de *software* durante a personalização de sistemas de informação. Por favor, responda as questões levando em consideração a <u>sua</u> função específica no projeto. Seja tão detalhista quanto possível e não hesite em adicionar comentários relevantes livremente.

Entrevistas similares poderão ser também realizadas com gestores de negócio, gestores de tecnologia, analistas de sistemas e programadores de ambas as empresas envolvidas no projeto.

Indicador	aptidão/qualificação

Métrica: **personalidade** (Person)

Person1) Você se considera falante, agregador(a), sociável?

Person2) Você se considera organizado(a), consciente, persistente?

Person3) Você se considera amigável, tolerante, perdoador(a)?

Person4) Você se considera seguro(a), entusiasmado(a), emocionalmente estável?

Person5) Você se considera culto(a), curioso(a), imaginativo(a)?

Métrica: **confiabilidade** (Trust)

Trust1) Acordos/negócios feitos com você precisam ser supervisionados de perto?

Trust2) Você respeita a confidencialidade de informações de projeto?

Trust3) Informações de projeto que você divulga são confiáveis e relevantes?

Trust4) Você esconde/segura informações de projeto que talvez sejam importantes?

Métrica: **inovação e empreendedorismo** (Innov)

Innov1) Suas decisões, idéias e soluções costumam refletir padrões da indústria, da sua empresa ou da sua equipe, ou desviam-se deles?

Innov2) Você é guiado(a) pelo detalhe, eficiência e conformidade a regras no ambiente de trabalho?

Innov3) Você prefere as mudanças ou a estabilidade no ambiente de trabalho?

Innov4) Em que medida suas idéias são, em geral, colocadas em prática por você ou colegas?

Métrica: **perícia e memória transacional** (Expert)

Expert1) Você tem o conhecimento requerido pelo projeto?

Expert2) Você costuma conseguir distinguir entre ações que darão resultado no projeto e outras que não darão?

Expert3) Você tem um bom mapa mental de como o conhecimento está distribuído na sua equipe?

Expert4) Seu conhecimento complementa bem o conhecimento do seu colega terceirizado?

Indicador	aversão a riscos e integração social

Métrica: **imersão estratégica** (RiskStrat)

RiskStrat1) Você compreende o significado estratégico do projeto para a sua empresa?

RiskStrat2) Você adere entusiasticamente ao objetivo estratégico do projeto?

RiskStrat3) Você está pronto(a) para encarar a mudança organizacional resultante do projeto?

RiskStrat4) Você se sente trabalhando em uma verdadeira equipe com seu colega terceirizado?

Métrica: **estima pela função** (RiskRole)

RiskRole1) Você consegue ver a ligação entre o significado estratégico do projeto e a sua função no mesmo?

RiskRole2) Você prevê ganhos ou prejuízos pessoais/profissionais em função da sua participação no projeto?

RiskRole3) Você se sente responsável pelos resultados do projeto?

RiskRole4) Você se sente com autoridade no projeto?

Métrica: **apoio ao sistema** (RiskSyst)

RiskSyst1) Você compreende o que o sistema deve fazer?

RiskSyst2) Você tem uma atitude positiva em relação ao sistema?

RiskSyst3) Sua atitude em relação ao sistema está alinhada à atitude demonstrada por sua equipe?

RiskSyst4) Sua atitude em relação ao sistema está alinhada à atitude demonstrada por seu colega terceirizado?

RiskSyst5) A carga de trabalho esperada de você é humana e tecnicamente viável?

RiskSyst6) O tempo disponibilizado para você trabalhar com seu colega terceirizado é suficiente para contemplar a qualidade da tarefa e a observação de prazo de entrega?

Indicador	autopreservação

Métrica: **incongruência de objetivos** (GoalInc)

GoalInc1) Você age por auto-interesse no projeto?

GoalInc2) Associação a falhas no projeto teria efeito negativo em suas chances de progredir na empresa?

Métrica: **autojustificativa psicológica** (NfPsycho)

NfPsycho1) Você freqüentemente manifesta (verbalmente, por escrito, etc.) apoio ao projeto?

NfPsycho2) Você se sente bastante envolvido(a) com o projeto?

NfPsycho3) Você se sente emocionalmente envolvido(a) com o projeto?

Métrica: **autojustificativa social** (NfSocial)

NfSocial1) O abandono do projeto faria você ser "mal visto(a)" pelas outras pessoas?

NfSocial2) Pessoas de dentro e de fora da sua empresa vêem o projeto como o "seu filho"?

Métrica: **efeito do custo submerso** (SCostEff)

SCostEff1) Você faz referência a seus investimentos pessoais no projeto como motivo para continuar nele?

SCostEff2) Você pensa que muito dinheiro, tempo e outros recursos já foram investidos no projeto, e que isto seria motivo para continuar nele?

Métrica: **efeito da finalização** (ComplEff)

ComplEff1) Você costuma dizer que vocês já foram muito longe para simplesmente deixarem de lado o projeto?

ComplEff2) Você costuma dizer que vocês estão muito próximos do fim para simplesmente deixarem de lado o projeto?

Indicador	administração de custos de transação

Métrica: **relacionamento contratual** (Contract)

Contract1) Você compreende o significado do seu trabalho com o colega terceirizado?

Contract2) Você compreende o que se espera do seu trabalho com o colega terceirizado?

Contract3) A troca de informações informais tem espaço na sua relação profissional com seu colega terceirizado?

Métrica: **monitoração do relacionamento** (Monitor)

Monitor1) Você tem uma idéia clara do andamento do seu trabalho com o colega terceirizado?

Monitor2) É fácil e prazeroso trabalhar com seu colega terceirizado?

Monitor3) Você acha que é fácil e prazeroso trabalhar com você?

Monitor4) Trabalhar com seu colega terceirizado flui tranqüilamente ao longo do tempo?

Métrica: **oportunismo e assimetria de informações** (OppAsym)

OppAsym1) Você esconde informações negativas a respeito do projeto (problemas, críticas, etc.) quando reportando a seu colega terceirizado ou superiores?

OppAsym2) Você distorce informações negativas a respeito do projeto (problemas, críticas, etc.) quando reportando a seu colega terceirizado ou superiores?

OppAsym3) Você tira vantagens pessoais de informações do projeto?

OppAsym4) Você esconde/segura informações potencialmente úteis mas que não são explicitamente solicitadas?

Indicador	efetividade interpessoal

Métrica: **representação organizacional** (Proxy)

Proxy1) Você facilita o aprendizado do seu colega terceirizado a respeito dos negócios da sua empresa?

Proxy2) Você facilita o aprendizado do seu colega terceirizado a respeito das necessidades da sua empresa?

Proxy3) Você facilita o aprendizado do seu colega terceirizado a respeito das necessidades de tecnologia da sua empresa?

Proxy4) Você se sente disposto(a) a contribuir (proativamente e reativamente) com seus conhecimentos no projeto?

Métrica: **elaboração colaborativa** (CollElab)

CollElab1) Em que medida você costuma procurar entender a reação dos outros às suas idéias?

CollElab2) Em que medida você costuma tentar se fazer entender por múltiplos meios?

CollElab3) Em que medida você costuma identificar diferenças que não são óbvias para os outros?

CollElab4) Em que medida você costuma tentar entender ou mesmo tentar solucionar objetivos dos outros?

CollElab5) Em que medida você costuma gerar alternativas que abordem objetivos comuns entre sua equipe e a equipe terceirizada?

CollElab6) Em que medida você compara alternativas para posições anteriores?

Métrica: **aprendizado do cliente** (CustLearn)

CustLearn1) Em que medida uma conversa de trabalho com seu colega terceirizado pode reorientar o seu pensamento, ou você é do tipo irredutível?

CustLearn2) Em que medida uma conversa de trabalho com seu colega terceirizado pode questionar seus conceitos sobre requisitos?

CustLearn3) Em que medida uma conversa de trabalho com seu colega terceirizado pode expandir o seu pensamento sobre requisitos?

CustLearn4) Em que medida uma conversa de trabalho com seu colega terceirizado pode mudar sua disposição e comportamento no projeto?

Métrica: **comunicação e liderança do cliente** (CustComm)

CustComm1) Você se comunica com clareza, precisão e no tempo apropriado com seu colega terceirizado?

CustComm2) Você é sensível às necessidades profissionais do seu colega terceirizado?

CustComm3) Você presta atenção às necessidades profissionais do seu colega terceirizado?

CustComm4) Você sabe negociar questões profissionais com seu colega terceirizado?

CustComm5) Você é um bom ouvinte de seu colega terceirizado?

CustComm6) Você geralmente diz a coisa certa no tempo certo para seu colega terceirizado?

Indicador	prospecto

Métrica: **interdependência cooperativa** (Balance)

Balance1) Em que medida você cumpre obrigações de projeto que tenham a ver com outras pessoas?

Balance2) Por quanto da personalização envolvida no projeto você se sente responsável?

Métrica: **propensão à parceria** (ProPart)

ProPart1) Você está satisfeito(a) com o seu desempenho interpessoal no projeto?

ProPart2) Você acha que o seu trabalho com seu colega terceirizado caracteriza uma verdadeira parceria profissional?

ProPart3) Amizade é um atributo do trabalho com seu colega terceirizado?

ProPart4) Em que medida a qualidade de vida no trabalho é um atributo do trabalho com seu colega terceirizado?

ProPart5) Você está disposto(a) a construir uma história profissional mutuamente benéfica com seu colega terceirizado?

ProPart6) É provável que você escolha trabalhar em projetos futuros com esse mesmo colega terceirizado?

ProPart7) É provável que esse mesmo colega terceirizado escolha trabalhar com você em projetos futuros?

Comentários Adicionais:

Questões Demográficas

Idade:

Sexo:

Função na empresa:

Função no projeto:

Meses de experiência profissional em projetos de sistemas de informação (antes do projeto):

Meses na empresa (antes do projeto):

Meses no projeto:

Meses na função (durante o projeto):

Tamanho da sua equipe de trabalho:

Tamanho da equipe terceirizada:

Principal forma de interação com os colegas terceirizados:

Meses interagindo com os colegas terceirizados:

Freqüência de interação com os colegas terceirizados:

APPENDIX C-1
INFORMATION PRIVACY STATEMENT

São Leopoldo, April 2006.

By this letter, I inform *[respondent's full name]* that I will not disclose any personal information of your interview for the research *METRICS – Model for Eliciting Team Resources and Improving Competence Structures*, including the name of the project you took part of and the companies involved in it. I take full responsibility of the unauthorized use of any information provided by you for the research. The interview, recorded in digital media (voice recorder) with no identification of the interviewee, will be permanently deleted after codification of answers into the conceptual categories of interest for the research, performed by this researcher within a timeframe of 24 hours. The publication of the research's findings, including the codified answers to this interview, will take place solely in scientific media, in accordance to the anonymous process here established.

For the participation as interviewee, *[respondent's full name]* will receive one complete copy of the research as soon as it is published, one R$20-value coupon readily available at Livraria Cultural at Universidade do Vale do Rio dos Sinos, and can request a one-day consultancy for you or your company, performed by this researcher on METRICS subjects and not tied to any future contractual obligations.

Thank you for the interview,

Carlo Gabriel Porto Bellini

bellini@ccsa.ufpb.br

APPENDIX C-2
PORTUGUESE VERSION OF THE
INFORMATION PRIVACY STATEMENT

São Leopoldo, abril de 2006.

Por este instrumento, informo *[nome completo do entrevistado]* que não divulgarei informações pessoais de sua entrevista para o projeto *METRICS – Model for Eliciting Team Resources and Improving Competence Structures*, inclusive no que diz respeito ao nome do projeto e das empresas envolvidas. Assumo responsabilidade pelo uso desautorizado de quaisquer informações da entrevista. A entrevista, gravada em mídia digital (gravador de voz) sem identificação do entrevistado, será apagada permanentemente após ser codificada nas categorias de interesse da pesquisa por este pesquisador, o que acontecerá no prazo máximo de 24 (vinte e quatro) horas. A divulgação dos resultados de pesquisa, incluindo a codificação das entrevistas, acontecerá somente em veículos de comunicação científica, mantendo-se os referidos anonimatos.

Pela entrevista, *[nome completo do entrevistado]* receberá 1 (uma) cópia integral da pesquisa, 1 (um) cheque-presente no valor de R$20,00 (vinte reais) a ser utilizado na Livraria Cultural da Universidade do Vale do Rio dos Sinos, e poderá solicitar 1 (um) dia de consultoria gratuita para si ou sua empresa, executada por este pesquisador e não vinculada a necessidades futuras de consultoria, em assuntos que digam respeito à aplicação dos resultados da pesquisa METRICS.

Obrigado por sua participação,

Carlo Gabriel Porto Bellini

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APPENDIX D
ILLUSTRATION OF REVEALED CAUSAL MAPPING

The following illustration of revealed causal mapping (RCM) procedures was extracted from Nelson *et al.* (2000a, pp. 504-505).

STEP 1	**Examples**
Identification of causal statements.	1. "If a person has logical reasoning skills and experience in different environments, then I will consider him/her an expert." 2. "Personal employee growth can lead to development of support personnel expertise."

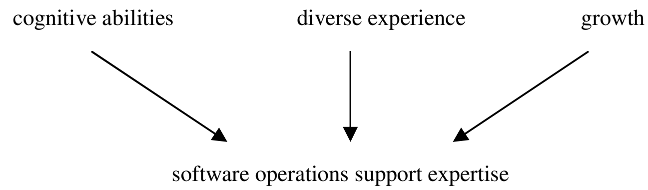
	Cause	**Connector**	**Effect**
STEP 2 Construction of raw causal maps.			
	If a person has logical reasoning skills	IF-THEN	then I will consider him/her an expert.
	If a person has diverse experience	IF-THEN	then I will consider him/her an expert.
	Personal employee growth	CAN LEAD TO	can lead to expertise of support personnel.

	Raw Phase	**Coded Concept**
STEP 3 Codification scheme.	1. Person has logical reasoning skills	Cognitive abilities
	2. Person has diverse experience	Diverse experience
	3. Consider him/her a support expert	Software operations support
	4. Personal employee growth	Growth
	5. Expertise of support personnel	Software operations support expertise

STEP 4

Recast of raw causal maps
into concept-level revealed causal maps.

concept-level revealed causal map



STEP 5

Recast of concept-level revealed causal map
into construct-level revealed causal map.

construct-level revealed causal map