

# A Model of Trust Applied to the Management of Information Technology

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**Abstract** - This work presents a model of trust as it relates to the management of information technology (IT). We comment on the definition of trust as applied to contemporary business environments, and discuss the associated risks due to the complexity of modern globalized relationships. This work focuses on IT management, emphasizing the necessity of aligning organizational strategies with a company's activities as recent studies have concluded that organizations that exhibit "business-focused" IT management are subject to less risk. In this context, our proposed model enables the evaluation of trust as it relates to IT management, by means of metrics that are related to business factors. A field application of this model demonstrates the relevance of measuring trust as a means to mitigate business risks related to IT management.

**Keywords** - Information Technology (IT) Management; Information Systems; Trust.

## 1. Introduction

The environment in which organizations find themselves is increasingly globalized and competitive. Businesses need, for optimized performance, trustworthy sources of updated information, making information technology (IT) crucial to their overall goals. Moreover, the technological development associated with globalization has created a demand for increased interaction between geographically distant people, which underscores the importance of trust when sharing information in this situation.

For efficient use of management resources, it must be remembered that what cannot be manipulated cannot be controlled. This article focuses in one specific area of information technology, the concept of trust, and attempts to evaluate its effect over several areas of IT management.

Although the concept of trust as it relates to various fields has been studied for decades, a great deal of interest remains in developing and applying empirical and theoretical models. Hereafter we propose a model that enables the evaluation of trust as it relates to IT management,

by means of metrics that are related to business factors. A field application of this model demonstrates the relevance of measuring trust as a means to mitigate business risks related to IT management.

## 2. The concept of trust

Mayer et al. (2005) list several areas in particular where trust is required: communications, leadership, goal-oriented administration, negotiation, game theory, performance recognition, work relations, and self-managed working groups. Specifically, trust is essential whenever a purchase is made or a service is rendered. While it is undeniable that trust between parties is critical, a formal definition of trust seems to be difficult. Kee et al. (1999) affirms that “trust is becoming more and more important, but no one knows yet what really it means”.

Sociologist Diego Gambetta (1988) believes that an objective standard definition of trust is almost impossible. In a relationship between two parties, there is no guarantee of reciprocity in the amount of trust, since each side may trust the other with varying degrees of certainty. The decision to initiate an interaction with another agent depends on the level of trust established, the particular context, and the level of risk involved.

As a result of these difficulties, trust is often defined only within a particular situation of interest.—Fukuyama (1996), for example, generally characterizes trust as a social virtue that contributes to prosperity in contemporary society while Luftman (1999) specifically sees trust as a factor sustaining business-IT alignment. Yet more specifically, Pillatt (2002) highlights a definition of trust to be used within the context of e-business, focusing, in a very specific manner, on topics such as authentication and ability to pay for products or services. However, this type of definition is restricted to the measurement of the trust regarding the relationship of a buyer

and a seller, and does not universally apply to the assessment of trust in other situations, such as negotiations. Manchala (1999, 2000) attempts to be more generic, quantifying trust for whole business transactions and abstracting factors tied to participants. In this case, the details regarding the entities participating in the transaction and the product or service are blurred.

When searching for a wider conception of trust based on objective—aspects related to honesty, competence, and faithfulness, we may be required to invoke terms such as authorization, authentication, and validation. In fact these terms might be used interchangeably, according to Grandison and Sloman (2000), who considered authorization to be the result of a reliable relationship. These authors propose that a delegation of access rights occurs when a transactional entity performs certain actions for a specific party when the identity of that party has been verified by an authentication process. This verification may take place using a password, digital certificates, or other methods (Grandison and Sloman, 2000).

Jones (1999) adds that trust is defined by the European Commission Joint Research Centre as being “the property of a business relationship, so that credit can be given to the business partners and to the transactions played with them.”

Thus, it is possible to say that definitions of trust at times tend to touch on interpersonal relationships, while also involving services rendered. Therefore, a proper standard will require psychological as well as objective aspects. As a result, it is beneficial to distinguish between interpersonal trust, inter-institutional trust, and trust between a person and an institution (Grassi, 2004). An interesting approach, due to Lyons and Mehta (1997), states that trust is a continuum, ranging from complete trust to its complete absence. These authors analyze the role of trust in facilitating efficient exchanges by considering socially-oriented and self-interested trust.

Socially-oriented trust considers aspects of the past when analyzing the social behaviors exhibited by individuals in a community who, intentionally or inadvertently, support trust and its consequences. Dogson (1993) calls this vision “goodwill trust,” where the recognition of good behavior in social arenas leads to a positive reputation. These social relations are governed by mutually understood group norms.

Self-interested trust arises from game theory, where the interests of agents partially conflict and partially converge. Trust is a result of careful calculation, or the intentional creation of incentives in response to a fear of betrayal. The relative costs and benefits of being trusting and/or trustworthy are measurable, and can be evaluated within the limits of the game. Therefore, self-interested trust, in contrast with the previous definition, is fundamentally “*forward-looking*”, with agents being trustful or trustworthy only up to the point where they expect such behavior to be beneficial to themselves.

Grassi (2004) comments on this dichotomy that, although “the authors, when distinguishing between the two types of trust described above, do not consider that one is universally true and the other is not, nor that there is place for only one type of trust in each relationship. They can be used to strengthen one to the other, although they are probably present in different combinations of relative importance. It would be made a mistake to consider that they are equally important. It is possible that a type is dominant in a group of firms and the other, in others”. Lyons and Mehta (1997) only affirm that it is “widely possible that the same individuals come to act with socially-oriented trust with respect to a commercial partner, but with self-interested trust with respect to another one.”

Domenico and Macri (2005) cite Couch et al. (1996) to add that a further distinction can be drawn between the trust an individual might display toward people in general, and trust based on relationships with specific trading partners. The first mode quantifies the inherent tendency

or predisposition of an person to be trusting, while the second refers to the faith he or she has in a particular relationship, which, according to Rempel, Holmes, and Zanna (1985) may be influenced by the characteristics and actions of one of the partners. Trust in general, being related to socially-oriented factors, derives from expectations based on previous experiences, and depends on how much an individual believes in human honesty, as well as his or her personal temperament.

Mayer, Davis and Schoorman (1995) emphasize that people differ significantly in their propensity to trust and their desire to believe in others. People with different experiences, personality types, and cultural backgrounds may vary in their propensity and willingness to trust.

### 3. Methodology

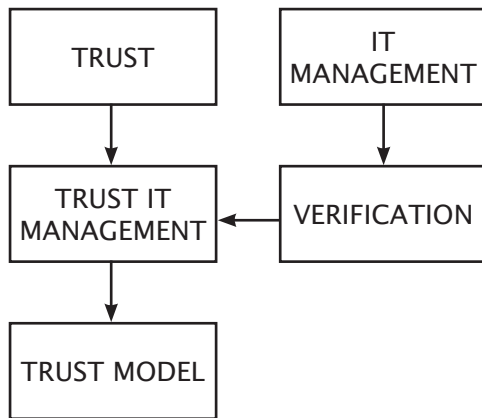
Since trust is based, at least in part, on the relationships of members within a society, the trust between peers may be very different than the trust given by an individual to an organization. Robinson and Jackson (2001) affirm that trust is related to a faith in people, and in particular, the faith that a trading partner will keep his or her word. This involves risk, since this expectation may not be fulfilled.

Bacharach and Gambetta (2000) affirm that signals exist for individuals to evaluate the trustworthiness of the others, and, moreover, the presence or the absence of these signals can often be quantified. In this way, trust and trustworthiness may be measured.

The formalization of trust as applied to IT management can be implemented using a computational model tailored to the issues specific to this type of business activity. To accomplish this task, parameters have to be established under which trust can be evaluated and quantified.

To develop such a model aspects relevant to IT management were used to build and

confirm a theoretical structure (figure 1). In addition, elements were added relating the following working definition of trust: "it is the set of activities and mindsets that allows for the designs, evaluation, and monitoring of the appropriate mechanisms to establish decision structures and processes for obtaining desired behavior" (Weill and Ross, 2004).



**Figure 1: Development of the IT trust model**

Thus, in implementing our model of trust management, the following steps were followed:

1. Selecting the parameters or aspects of trust significant to IT management.
2. Checking the result of the metrics as applied to IT management and, verifying the values allocated to each aspect of trust.
3. Assessing risk by estimating the hazards involved in a particular case.
4. Compiling a knowledge base, listing the processes that are mostly prone to risk, and finding particular areas of trust related vulnerabilities.

**3.1 Aspects of the Trust Metric**

To quantify trust as it relates to IT management, a set of metrics will be employed. These metrics are related to categories of IT components, enabling the evaluation of their relative importance and relevance. Table 1 shows some metrics among the many that could be proposed to contribute to the model.

IT CATEGORIES	METRICS
IT Architecture	<ul style="list-style-type: none"> <li>• Proportion of redundant/duplicate data elements</li> <li>• Percentage of applications not complying with the information architecture</li> <li>• Frequency of data validations</li> </ul>
IT Infrastructure	<ul style="list-style-type: none"> <li>• Number and type of deviations from the accepted technology infrastructure plan</li> <li>• Frequency of technology infrastructure plan reviews and updates</li> <li>• Number of technology platforms that are not in line with the defined IT architecture and technology standards</li> <li>• Number of critical business processes supported by obsolete (or soon to be obsolete) infrastructure</li> <li>• Number of infrastructure components that are no longer supportable (or will not be in the near future)</li> </ul>
IT Process	<ul style="list-style-type: none"> <li>• Proportion of roles with documented position and authority descriptions</li> <li>• Number of business units/processes not supported by the IT organization</li> <li>• Number of core IT activities outside of the IT organization that are not approved and/or not subject to IT organizational standards</li> </ul>
IT Changes	<ul style="list-style-type: none"> <li>• Number of disruptions or errors caused by inaccurate specifications or incomplete impact assessment</li> <li>• Cost of infrastructure changes caused by incomplete specifications</li> <li>• Percent of changes that follow formal control processes</li> </ul>

IT CATEGORIES	METRICS
IT Investment	<ul style="list-style-type: none"> <li>Percent reduction of unit costs based on IT services delivered</li> <li>Expenditure change as a fraction of the total budget</li> <li>IT return on investment expressed in terms of business value drivers (e.g., sales increase due to enhanced connectivity)</li> </ul>
IT Risks	<ul style="list-style-type: none"> <li>Percentage of critical IT objectives covered by risk assessment</li> <li>Fraction of critical IT risks identified with action plans</li> <li>Percentage of risk management action plans approved</li> </ul>
Information Systems Security	<ul style="list-style-type: none"> <li>Number of incidents damaging public reputation-</li> <li>Number of systems where security requirements are unmet</li> <li>Number of violations related to assigned duties</li> </ul>

**Table 1: Trust related metrics for IT management**

A proper model for trust in the field of IT management should incorporate the relative importance of these parameters, and will allow for a detailed evaluation of the overall IT process. This can yield a list of specific recommendations regarding points of vulnerability and inadequate management.

Among the mechanisms related to IT management, strong importance is attached to decisions that insure that the overall system aligns with the stated goals of the organization, as well as the normative aspects of corporate governance.

This model relates to the decision making process, which occurs in organizations whether the process has been formalized or not. Efficient management can be facilitated by rationalizing the way decisions are made. Existing structures can be evaluated by performance, and approaches that

do not contribute to efficiency and the achievement of overall enterprise objectives can be adjusted or abandoned.

For alignment, administrative adequacy and IT adjustment consistent with achievement of the enterprise objectives are needed. Alignment is materialized by adoption of processes involving compromises by those involved in business and IT. The processes can be evaluated for their properties and results, and can be classified according to its trustworthiness.

Given that communication is needed to diffuse policies related to efficiency, the diffusion of trust evaluations can be used by managers as a means to develop effective communication that is critical for success in a business enterprise. Besides the diffusion of the trust model, its metrics and related IT categories will influence diagnosis of trustworthiness and any consequent readjustment. In cases where there is a low level of trust, the factors underlying that low trust level will impact management.

The metrics cited will be assigned a range of values to provide greater flexibility for the implantation of the model on companies of various sizes. To avoid misinterpretation of numerical values, the values attributed to metrics variables will be classified using a rubric of (1) low, (2) medium, (3) high, or (4) very high.

### 3.2 Trust Evaluation

As the first step, a questionnaire is sent to managers allowing them to assess the level of trust associated with IT activities within an organization. Selected processes are evaluated according to the established metrics based on trust requirements. The results are evaluated using the rubric shown in table 2.

Interval	Trust Level	Risk Level
[0, 4.9]	Low	High
[5.0, 6.9]	Average	Average
[7.0, 10]	High	Low

**Table 2: Trust classification rubric**

### 3.3. Verification of Results

Responses to the proposed questionnaire are collected and summarized so as to provide the data for plotting diagrams with relevant shapes to present indicators of the IT management situation.

For such analysis, six aspects of IT management have been considered, namely: I – Planning; II – Organization; III – Implementation; IV – Availability; V – Support; and VI – Control. Each aspect has been subdivided according to its domains, being evaluated by proper metrics related to the items of the proposed questionnaire. This way the evaluated trust metrics indicate the situation of the different management areas and directly point the areas which need attention.

## 4. Field Application

A field test was conducted for the governmental organization now called DMB in the first quarter of 2008. The outcome was the first systematic description of its organizational structure in relation to its institutional information and communication technology (ICT). Oversight of DMB and its strategic outlook are determined by the Office of General Direction (ODG), while tactical decisions and practical execution is left to the Office Management Sector (ODS).

Decisions regarding ICT are under the purview of the leadership at the ODG, which deals with questions related to technology through its IT Management Body (ODTI). Officials involved in the activities of ICT exist at various levels, including electrical engineers, systems analysts, and computer scientists.

The DMB staff members who took part in the present research were grouped according to their standing in the decision making hierarchy at ICT. Of the employees who filled out the “planning” questionnaire, 12 were from the IT section of the ODG, while 8 were managers from ODTI. In addition, an “implementation”

form was completed by 25 CDS employees, while 26 members from the CIT and 14 from the CAT in Brasilia filled out a “support” version of the questionnaire. In all, the responses of 85 participants were tabulated.

Table 3 summarizes the number and rank of the participants, as well as the total number of people working in each department.

Sectors	Strategist		Execution		
	ODG Managers	ODTI Managers	CDS Analysts	CIT Analysts	CTA Analysts
Processes					
Planning Control	12/15	08/12			
Implementation Availability			25/168		
Support Organization				26/295	14/40

**Table 3: Total employee counts in each division and the number filling out the questionnaire**

The trust evaluation method outlined above was implemented and the obtained final results are summarized in the dashboard showed in figure 2.

## 5. Conclusions

In designing a model of trust applied to the management of information technology, we conclude that the broad application of trust in all aspects in this context corresponds to the general belief that, in all branches of the organization, investment in information technology is vital. The resources utilized allow for steady improvement in overall operational performance, although this requires coordinated action at all levels, and the requisite technological support.



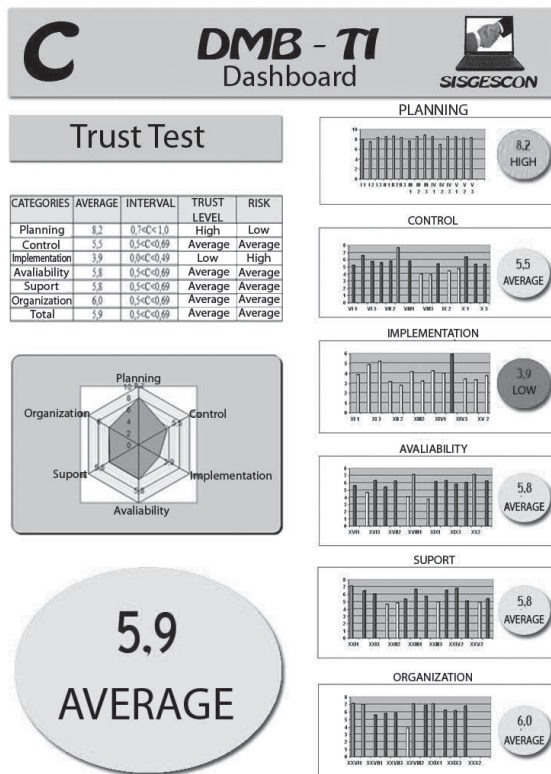


Figure 2: Trust evaluation results

It is also of prime importance that trust can be related to the alignment of decisions made at management levels with the global strategies of the organization. A purely tactical mindset, with limited vision and short-term thinking, does not add value, but rather, inhibits progress.

The market already provides tools that aim to deliver technological solutions, so that information can be disseminated and managed according to the goals of the organization. A business that has proper coordination methods in place will be poised to take advantage of new opportunities as they present themselves, and will also be better prepared to defend itself from novel threats.

In contrast, inflexible management practices and territorial battles hinder productivity. When management is overly demanding, especially regarding prompt completion of tasks that could wait, worker morale and trust are eroded. Intelligent control and implementation

strategies utilizing accurate trust metrics help to eliminate the need for course corrections, while simultaneously providing agility and promoting a reputation for trustworthiness.

The type of trust considered in this study of IT management is somewhat removed from purely interpersonal relationships. Instead, the approach to trust here involves a business-oriented conception, which can be measured and quantified.

Thus, in this context, one can infer that the optimal IT management approach is intimately tied to trust, which has the potential to provide highly desirable results for management. As a result, the creation of a formal trust model for IT management makes greater effectiveness possible, as this method allows for the alignment of management decisions with organizational strategy, and a deeper understanding of good corporate governance. Given this principle, we envision that organizational trust is also a fruitful area for future research on human interactions and game theory applied to IT management.

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### References

- [1] Bacharach, M., Gambetta, D., 2000. Trust in Signs. In: Cook, K. (ed.) Social Structure and Trust. New York, Russell Sage Foundation.
- [2] Barton T., Shenkir, W., and Walker, P., 2003. Making Enterprise Risk Management Pay Off and Enterprise Risk Management: Pulling It All Together. In: Pearson Education, The Institute of Internal Auditors.
- [3] Benzi, D., Zumba, Q., and Souza, J., 2007. O Monitoramento Estratégico Antecipativo como Mecanismo de Implantação da Identificação de Eventos do ERM. In: Anais do XXII CBBB, Brasília.
- [4] COSO, 2004. Executive Summary, Enterprise Risk Management: Integrated Framework, The Comittee of Sponsoring Organizations, Sep.
- [5] De Haes, S., and Van Grembergen, W., 2005. IT Governance Structures, Processes and Relational Mechanisms: Achieving IT/

- Business Alignment in a Major Belgian Financial Group. In: Proceedings of the 38th Hawaii International Conference on System Sciences.
- [6] Couch, L. L., Jeffrey, A. M., and Jones, W. H., 1996. Measuring the level of trust. *Journal of Personality Assessment*, 67(2), 305-323.
- [7] Dodgson, M., 1993. Learning, Trust and Interfirm Technological Linkages: Some Theoretical Associations. In: mimeo.
- [8] Domenico, S. M. R. and Macri, M., 2005. Administração geral, confiança e fidelização de clientes: um estudo em serviços aéreos. In: <http://www.ead.fea.usp.br/Semead/8semead/resultado/trabalhosPDF/267.pdf>
- [9] Gambetta, D., 1988. Trust: Making and Breaking Cooperative Relations. Oxford: Basil Blackwell.
- [10] Fukuyama, F., 1996. Confiança: As virtudes sociais e a criação da prosperidade. Rocco, Rio de Janeiro.
- [11] Grandison, T., Sloman, M., 2000. A Survey of Trust in Internet Applications. IEEE Communications Surveys.
- [12] Grassi, R. A., 2004. Em busca da noção evolucionária (neoschumpeteriana) do auto-interesse dos agentes: uma contribuição a partir da literatura sobre cooperação interfirmas. In: *Revista Análise Econômica*, 42, september, Faculdade de Ciências Econômicas, UFRGS.
- [13] Jones, S., 1999. RUST-EC: Requirements for Trust and Trust in E-Commerce. European Commission, Joint Research Centre.
- [14] Kee, P. G. W., Balance, C., Chan, S., and Schrupp, S., 1999. *Electronic Commerce Relationships: Trust by Design*. Prentice-Hall.
- [15] Luftman, J., and Brier, T., 2005. Achieving and sustaining business-IT alignment. *California Management Review*, 42(1), 109-122.
- [16] Lyons, B. and Mehta, J., 1997. Contracts, Opportunism and Trust: Self-Interest and Social Orientation. In: *Cambridge Journal of Economics*, vol. 21.
- [17] Manchala, D. W., 1998. Trust Metrics, Models and Protocols for Electronic Commerce Transactions. In: Proceedings of the 18th international conference on distributed computing systems. Amsterdam: Xerox.
- [18] Manchala, D. W., 2000. E-Commerce Trust Metrics and Models. In: *IEEE Internet Computing*, mars/april, 36-44.
- [19] Mayer, R. C., Davis, J. H., and Schoorman, F. D., 1995. An integrative model of organizational trust. *Academy of Management Review*, 20: 709-734.
- [20] Pillatt, F. R., 2002. Um Modelo para o Tratamento de Confiança sobre Transações de e-Business. Master thesis. Federal University of Campina Grande. In: <http://www.dsc.ufcg.edu.br/~copin/pessoas/alunos/htms/FabioRobertoPillatt.htm>
- [21] Robinson, R., Jackson, E., 2001. Is Trust in Others Declining in America?: An Age-Period-Cohort Analysis. *Social Science Research*, 30: 117-145.
- [22] Rodrigues, C. A. P., 2006. Governando as "Surpresas". In: *Information Week*, april. In: <http://www.informationweek.com.br>.
- [23] Sambamurthy, V., and Zmud, R. W., 1999. Arrangements for Information Technology Governance: a theory of multiple contingencies. In: *MIS Quarterly*, vol. 23, no. 2, pp. 261-290.
- [24] Van Grembergen, W., 2000. The Balanced Scorecard and IT Governance. In: *Information Systems Control Journal*, Volume 2.
- [25] Weill P., and Ross J. W., 2004. *IT Governance – How Top Performers Manage IT Decision Rights for Superior Results*. Harvard Business School Publishing.



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