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Development of Measures to Assess Dimensions of IS Operation Transactions*

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Abstract / Résumé

Information Systems (IS) researchers often rely on organizational economics models to describe and explain various IS management issues. While those models are found to be useful, measures are yet to be proposed to assess the dimensions of IS transactions. In this paper, we present the results of a study that was a first effort toward this end. The focus of the study was on one type of transaction, IS operations, in a particular management context, that of outsourcing. Measures were developed for four critical dimensions of IS operation transactions: asset specificity, measurement problem, origin of the most important investment, and governance mechanism. Data from 250 large Canadian firms were used to assess the measures, using the Partial Least Squares (PLS) technique.

L'économie des organisations est souvent mise à contribution par les chercheurs en systèmes d'information (SI). Peu de travaux ont cependant proposé des instruments de mesure des dimensions transactionnelles des opérations de SI. Ce mémoire marque un pas dans cette direction. Nous proposons des instruments de mesure utiles à l'analyse de l'impartition des opérations informatiques. Quatre dimensions importantes des transactions informatiques retiennent notre attention : la spécificité des actifs, les problèmes de mesure, l'origine des investissements les plus importants et le mode de régie des transactions. Une analyse de moindres carrés partiels *(Partial Least Squares)* est effectuée à l'aide de données provenant de 250 grandes entreprises canadiennes.

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1. Introduction

For the past decade, organizational economics has been an important reference discipline for IS research. Beath (1983), for instance, used the notion of transaction costs to explain the choice of a system development strategy, and for understanding the role of users in an IS project (Beath, 1987). She proposed a model suggesting that market governance is applicable in simple cases and that a bureaucratic governance mode is more appropriate in complex situations. Malone, Yates, and Benjamin (1987) studied the impact of information technologies on the choice between the firm and the market. They found that information technologies reduce communication costs and encourage the migration of economic activities from the firm to the market. Beath and Straub (1989) used an agency model to explain why some information services are managed by their users, some are handled by the different functions of the firm, while others are centralized in an independent department. Gurbaxani and Kemerer (1989) studied agency relationships between IS departments, other departments, and the firm's top management. They emphasized the discrepancies between the respective goals of the parties, the problems of information asymmetry, and the measurement problems inherent to software development. Gurbaxani and Whang (1991) integrated agency theory and transaction costs theory in order to evaluate the impact of information technologies on two attributes of a firm: size and allocation of decision rights. They suggest that vertical integration reduces transaction costs, while increasing agency costs. On the other hand, while horizontal integration increases agency costs, it also generates economies of scale. Lacity and Hirschheim (1993) used the transaction cost framework, along with a political perspective, to understand outsourcing decisions. They found that outsourcing decisions were, to a certain extent, based on cost considerations, and that managers were concerned with the threat of opportunism when evaluating a proposition from a supplier.

These various applications of organizational economics demonstrate the explanatory power of the theory. Interestingly, however, none of the above mentioned research efforts was survey-based. This is rather surprising considering that surveys are the most frequently used research design among IS researchers (Orlikowski and Baroudi, 1991). This may be explained by the absence of valid measures to assess the dimensions of IS activities (or transactions). In view of the importance of high quality measures (Zmud and Boynton, 1991) and of the role of construct and measure development in the maturing of a knowledge area (Newsted, Munro, and Huff, 1991), in this paper, we report on the development and validation of measures of the dimensions of one type of IS transaction, that is, IS operations. We first present a brief overview of the Organizational Economics framework, then describe the development of the measures, and the assessment of their validity, using Partial Least Squares analysis (PLS).

2. Organizational Economics

As early as 1937, Coase recognized the failure of the price system, stating that the more complex a transaction, the more costly it is to negotiate, write, and enforce the contract between the parties involved. The costs of negotiating, writing, and enforcing contracts are defined as transaction costs. When these reach a certain level, the transaction is not profitable to the parties. Consequently, one of them may decide to internalize the transaction in what is known as a firm; it will then incur management costs, such as recruiting, supervision, and coordination costs. The market and the firm are then alternative governance mechanisms to manage transactions, each being more appropriate to a given situation. According to transaction costs theory, the decision to use the market or the firm to regulate a transaction depends primarily on four dimensions (Milgrom and Roberts, 1992; Williamson, 1985): (1) specificity of the assets required to produce the goods; (2) uncertainty and measurement problems surrounding the transaction; (3) origin of the most important investment; and, (4) frequency of the transaction.

2.1 Asset Specificity

Williamson (1985) defines a specific asset as an asset which cannot be redeployed without sacrificing its productive value if the contract is to be interrupted or prematurely terminated. Because the "next best use" value of the asset is much lower, the investor would loose part of its investment if the transaction was not completed. This creates a lock-in situation where the other party (not investing) could extract a quasi-rent[1] from the investor by threatening to withdraw from the transaction (Riordan and Williamson, 1985). There are three types of specific assets: human assets, which represent the learning and the knowledge parties need to acquire in order to participate in the exchange, physical assets, that consist of the apparatus required for the transaction completion, and site specificity, which is the need for a party to be physically located near the other party to participate in the transaction.

Researchers have measured asset specificity in a variety of industries and contexts such as: oil (Canes, 1976), railroad equipment (Palay, 1981), automobile industry (Monteverde and Teece, 1982; Masten, Meehan, and Snyder, 1989), coal (Joskow, 1987, 1990), client loyalty (Anderson, 1988), offsetting investments (Heide and John, 1988), aluminum and tin (Hennart, 1988), and chemical products (Lieberman, 1991). Another measure related to asset specificity is Miller and Dröge's (1986) structural liaison devices.

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[1] A quasi-rent is the difference between the value of an asset in its best use and the value it takes in its second best use (Pisano 1990, p. 159).

2.2 Uncertainty and Measurement Problems

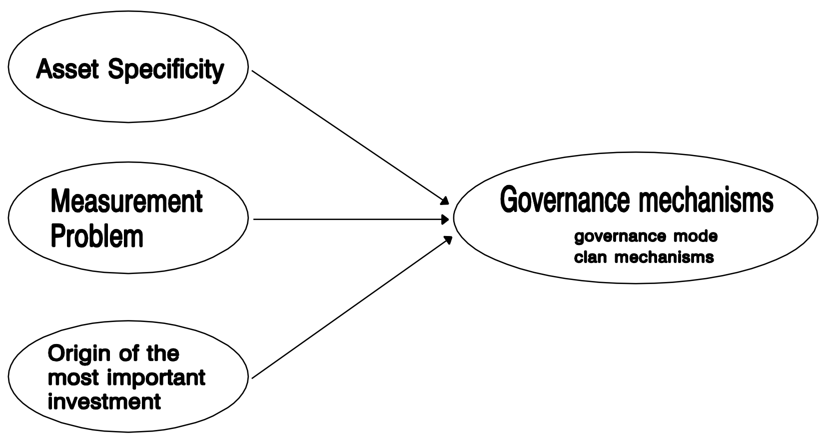
A strong assumption of classical economic theory is the availability of information and the ability of the parties to measure the value of the elements exchanged. This assumption often proves false. Transactions are conducted with a certain level of uncertainty and subject to measurement problems. Uncertainty can be defined as a lack of information. Many aspects of a transaction carry an element of uncertainty. For example it may be difficult to predict the future needs of the users in a software development project. Measurement problems are the difficulties encountered in the evaluation of an element of the exchange. For instance it may be difficult to evaluate precisely the quality of the product exchanged. Ouchi (1980) and Barney and Ouchi (1983, 1986) studied the possible coordination mechanisms when uncertainty and measurement problems were present. One way to facilitate the exchange is to base the compensation on a set of rules on which the parties agree *ex ante*. In this case, the parties do not agree in advance on the products to be exchanged, but on the behavior to adopt in different situations. This coordination mode is labelled bureaucratic coordination (Ouchi, 1980; Barney and Ouchi, 1983, 1986). It is no longer a market transaction, but a hierarchical one. Going a step further than Williamson (1981, 1985, 1989), these authors state that the hierarchical organization can also fail if transactions are so complex that it becomes impossible to establish rules of actions. In order to support the exchange in such circumstances, the parties need devices to alleviate opportunism. They need to trust each other, and to be convinced that spot inequities will even out in the long run since contributions cannot be measured. This is called the clan mechanism, and presumes a commitment from all parties (Barney and Ouchi, 1983).

Numerous studies have measured uncertainty and measurement problems is various contexts such as the automobile industry (Walker and Weber, 1984) or across industries (Jones, 1987; Caves and Bradburd, 1988). Other studies, mainly in Organization Theory, have measured various aspects of uncertainty and measurement problems, even if they did not use the transaction cost framework (Inkson, Pugh, and Hickson, 1970; Van de Ven and Ferry, 1980; Miller and Dröge, 1986; Barki, Rivard, and Talbot 1993).

2.3 Origin of the Most Important Investment

When two parties enter into a contract, each one may have to make specific investments. These investments are often of different value and the investment from one party may be significantly more important for the success of the transaction than that of the other party. The origin of the most important investment is the identity of

Figure 1 A Model of IS Operation Outsourcing



the party making the investment that is the most critical to the success of the transaction. Grossman and Hart (1986) discussed the effects of the allocation of control over a decision on the incentives parties have to invest in transaction specific assets. When it is impossible to specify *ex ante* all the contingencies needed to write a complete contract, it may be efficient to relinquish decision rights to a third party. The third party must be impartial and be recognized as such. In very complex situations, it will be difficult for the third party to know and process all the information related to the transaction and control over decisions can be allocated to one of the two contracting parties (Tirole, 1988). This allocation of control is not without side effects. Grossman and Hart (1986) indicated that there were inefficiencies associated with non-optimal investment levels made by contracting parties. Depending on the allocation of control, the parties will modify their investment level. Under-investment occurs when both parties decide independently on their actions. If the decision rights are allocated to one of the two parties, the one holding control rights will be induced to over-invest while the other will under-invest. Grossman and Hart (1986) also note that, in the best interest of the two parties, the party making the most important investment for the final output should receive the decision rights in order to move as close as possible to the optimal decision. The literature has not proposed any formal measure to evaluate the origin of the most important investment.

2.4 Frequency

Frequency is another key dimension of a transaction. Organizing a transaction within the firm implies creating a governance structure. This generates important and irreversible costs. If a transaction is known to be unique, these costs will very likely be too important to allow for the integration of the exchange within the firm. The firm will prefer to bear the cost of the risk associated with specific investments or uncertainty rather than invest in order to internalize a single transaction. Internal organization is only efficient for recurrent transactions.

3. A Model of IS Operation Outsourcing

As applied to outsourcing of IS operations, the transaction costs model remains with three critical dimensions having an impact on the choice of a governance mechanism for a given transaction (see Figure 1). Since frequency of IS operations can be regarded as infinite, because operations are performed on a continuous basis, this dimension is therefore not a factor in the decision to outsource. When applied to the IS outsourcing, the model then suggests the following relationships. When asset specificity is low, when there is no problem of measure, and when the most important investment comes from the supplier, outsourcing should be the chosen governance mode. An increase in asset specificity should bring a move of the governance mode toward the firm. Increased measurement problems should induce utilization of clan mechanisms and a move toward the firm. For the origin of the most important investment, following the Grossman and Hart argument, a transaction with an important investment coming from the firm should induce the firm to keep it under its control and conversely, a transaction with an important investment coming from an external party should induce the firm to outsource this transaction.

4. Development of the Measures

The measures presented in this paper were developed and validated in the particular context of IS operation outsourcing. Measures using the transaction costs approach, whether in economics, Marketing, or other fields, along with measures from Organization Theory, were reviewed in order to identify those that could be adapted to the context of IS operations. Data gathered during a study of IS outsourcing in ten large organizations (Aubert, Rivard, and Patry, 1993) served as another input for constructing the measures. It provided detailed descriptions of outsourcing arrangements and the corresponding activities. In order to clarify the discussion, the dimensions of the transaction cost analysis (asset specificity, uncertainty and measurement problems, origin of the most important investment, as well as the governance mode selected for a transaction) will be referred to as *constructs*. These constructs are reflected by several narrower elements called *variables*. Each of these variables is measured by several items (Figure 2).

4.1 Asset Specificity

In this section, we present the origin of the elements composing the asset specificity construct. No existing measure assessing this construct for IS operations was found. All but one variable corresponding to the construct were built for this study. From the description of the ten organizations presented in Aubert, Rivard, and Patry (1993), and from a review of practitioner literature, a list of investments that could be needed to complete an outsourcing transaction was established. These investments reflected the first two variables: clients' investments (three items) and suppliers' investments (nine items). The third variable is human asset specificity. If the conduct of specific IS operations imposes distinctive actions, it should be directly related to specific skills, therefore to human asset specificity. Employees should hence show distinctive abilities, specifically learned to operate in this environment. The human resources specificity was measured by seven items evaluating this learning. The fourth variable was the human resources replacement delay. Specific human assets should be more difficult to replace than non-specific human assets. Ten items evaluated this variable.

The other variable included in the asset specificity construct was the structural liaison devices measure proposed by Miller and Dröge (1986). It was adapted to the IS operation outsourcing context. Finally, a measure evaluating, for each IS activity presented in Appendix 1, if the activity was unique to the firm, to a few firms, to an industry, or common to several industries was included. Highly specific activities should be unique to a firm or, at least, to an industry.

4.2 Uncertainty and Measurement Problems

Several measures developed in Organization Theory assess uncertainty and measurement problems. The measures developed by Van de Ven and Ferry (1980) (job standardization, six items, and task difficulty, four items), Miller and Dröge (1986) (formalization, seven items), and Barki, Rivard, and Talbot (1993) (task complexity, twenty items) were included in the uncertainty and measurement problems construct. They were adapted and reformulated to conform with the outsourcing context.

The evidence gathered by Aubert, Rivard, and Patry (1993) indicated that the organizations described in the study were using several formal measures to control their information services, regardless of whether these services were provided by an outsourcer or by an in-house IS department. These formal measures (presented in Appendix 2) composed the last variable of the uncertainty and measurement problem construct.

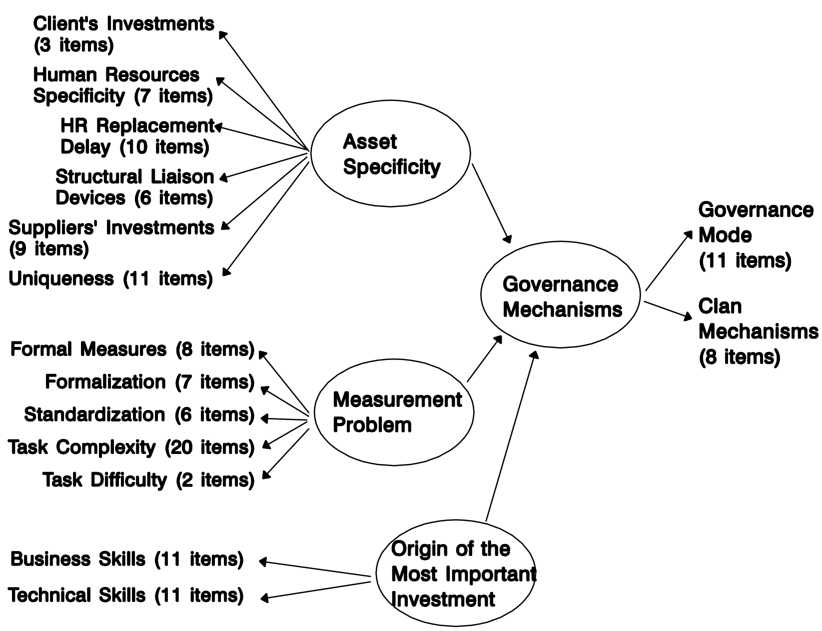
4.3 Origin of the Most Important Investment

Since the literature does not suggest measures to evaluate the origin of the most important investment, one was built for the purposes of this study. For each of the IS operations presented in Appendix 1, a question measured the relative importance of technical skills when conducting the operation, and another measured the importance of business skills when conducting the same operation. Business skills should be more developed in the firms working in their line of business and technical skills should be more widespread among the outsourcers (because IS are their line of business). These questions established the relative importance of business and technical skills for each activity, and therefore reflected the origin of the most important investment (coming from the business side or from the technical side).

4.4 Governance Mode

The governance mode evaluates the governance structure chosen for each IS operation. A fundamental dimension of the governance mode is whether the activity is performed in-house or outsourced. If there is an outsourcing arrangement, the governance mode encompasses the governance features established in the contract to ensure a smooth relationship between the client and the outsourcer. Different situations are possible, representing different levels of outsourcing.

Figure 2 IS Operation Outsourcing Model with items



A company can perform all of its operations in-house using its own employees. It can also perform operations in-house using employees from an external supplier. A further step toward total outsourcing is when a firm's equipment is hosted at a site owned and operated by its supplier. Finally, total outsourcing is encountered if all operations are performed by the supplier on its equipment and at its own location. A list of IS operations was built. For each operation, the various governance modes were presented to identify the one employed (see Appendix 1).

Clan mechanism features included in the contract, assessed by a list of questions inquiring about such possible features, were included in the instrument. The list came from a the descriptions of outsourcing arrangements provided by Aubert, Rivard, and Patry (1993) and from a literature review.

4.5 Refinement Procedures

Two refinement steps were undertaken: a classification exercise performed by judges (Moore and Benbasat, 1991), and a pre-test of the instrument with practitioners.

Following the procedure proposed by Moore and Benbasat's (1991), every item of the various measures was printed on a card, and the cards randomly numbered. A complete set of cards was submitted to each of seven judges who were either IS faculty or graduate students, along with a list of the constructs that were to be measured. Judges were asked to sort the cards according to the different constructs. The sorted cards were coded and compared to the expected "correct" classification. Perfect agreement with the "correct" classification was not expected, since we the judges were asked to note very subtle differences among variables. For example, the items of the formalization variable are very close to many items from the task complexity variable. Nevertheless, high agreement was expected for the main constructs: specificity, measurement problems, origin of the investment, and governance mode.

In order to evaluate the concordance between the judges and our intended classification, we used the Kappa coefficient (Cohen 1960). This coefficient, which varies from -1 to 1, evaluates the level of agreement between two judges; it represents the proportion of joint judgments in which there is agreement, after random agreement is excluded (Cohen 1960).

When considering the first classification, with all the detailed variables, the Kappa coefficients computed for the classifications of the different judges (compared to the questionnaire) ranged from 0.55 to 0.72 with an average of 0.64 (standard deviation: 0.05). Moore and Benbasat (1991) indicated that scores between 0.5 and 0.6 were satisfactory for exploratory work. Since our measures were either new or had been adapted from existing instruments, and had not been empirically tested, the Kappa coefficients were found to be adequate. When we grouped the different sub-classes into their larger corresponding constructs, the scores ranged from 0.68 to 0.89. The average score was 0.80, with a standard deviation of 0.07. This means that the items assigned to one of the larger constructs were different from the ones assigned to other constructs, hence that they were assessing different dimensions of transactions. This result provides some support for the convergent and discriminant validity of the measures.

In order to make sure that the items were clearly worded and would be easily understood by the target audience of IS managers, the list of items was submitted to two IS executives from two different organizations. These two assessors suggested the elimination of two items because IS executives would probably not have the information available. These items pertained to the operations of the outsourcer and that information is usually kept confidential. The items came from the task difficulty measure (Van de Ven and Ferry, 1980) and referred to problems encountered by the outsourcer. The outsourcer will put in tremendous efforts to avoid letting its client know it is encountering problems in the conduct of IS operations.

4.6 Survey procedures

Further to the first refinement procedure, a survey was conducted in order to pursue the validation of the instrument. From information published by *Canadian Business* (1992) and CanCorp - *Financial Post* (1993), a database with the names and addresses of large firms was developed, identifying who was responsible for the IS operations in each of them. The firms came from all industrial sectors. Their average assets were over $1.4 billion and they had an average of 1,680 employees. Subsequently, IS executives from 1,780 firms were contacted by phone and asked to participate in the study. The questionnaire was sent to the 1,410 executives who agreed to participate. Of these, 630 questionnaires (44%) were returned. This response rate is similar to that obtained in other studies using similar survey procedures (Chan, 1992).

5. Reliability and Validity Assessment

Partial Least Squares (PLS), a second generation multivariate method, was used to assess the reliability and the validity of the measures. The method employed and the results obtained from the analysis are presented in this section.

First generation multivariate methods, like multiple regression, factor analysis, analysis of variance and others have become extremely useful tools for researchers. First generation methods help evaluate constructs and relationships between constructs. However, such an evaluation has to be performed in subsequent steps. Other methods, called second generation methods (Fornell 1984) perform analysis of a model as a whole instead of simply evaluating each relationship separately. Instead of simply aggregating measurement error in a residual error term, these methods simultaneously evaluate both the measurement model and the theoretical model. They adjust the relationships among the variables accordingly (Rivard *et al.* 1994). Two of these newer methods, and probably the most popular ones, are covariance structure analysis (most often referred to as LISREL) and partial least squares (PLS).

PLS was selected in this study, and the procedure adopted to evaluate the measurement properties of the instruments was similar to the procedure described by Barclay, Higgins, and Thompson (forthcoming) and Rivard *et al.* (1994). In this study, PLS was preferred to LISREL for the analysis for several reasons, mainly related to data distribution and to the role of each method in the theory development ↔ theory testing continuum. Examination of the data showed that the distribution did not meet the multi-normality criterion required by LISREL. PLS presupposes no distributional form on the data. Furthermore, some of the measures were used for the first time. PLS is considered appropriate for early stages of research, when theory is untested in an application domain (Gopal, Bostrom, and Chin 1992). Therefore, a method close to the data, such as PLS, as opposed to one close to the theory, such as LISREL, was preferred.

The purpose of this validation was to further refine the measuring instrument. To do this, a subset of the questionnaires was randomly selected from the sample of completed questionnaires to perform the analysis. The remaining of the questionnaires would latter be used to test the model. The rule of thumb that prevails for the smallest sample size required to perform PLS analysis is that the sample size must be ten times the number of items present in the largest construct. Some authors even argued that five times the number of items in the largest construct may be sufficient (Gopal *et al.* 1992). In this study, the largest construct was task complexity, including 20 items[2]. Consequently, a sample of at least 200 questionnaires (100 for the less stringent requirement of five to one) was required. To perform the PLS analysis, a sub-sample of 250 questionnaires was randomly selected. This then exceeded the minimal norm

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[2] The items forming the various constructs were all reflective. Formative indicators imply that the items form, cause, or precede the construct. In this situation the construct is a summative index. Reflective items are considered a reflection, a manifestation of the construct. They can be seen as an effect of the construct. Reflective constructs will generally produce higher scores on reliability measures but lower path coefficients than formative constructs (Barclay *et al.*, forthcoming)

regarding sample size and accordingly assured a meaningful appraisal of the quality of each measure. In the following sections the evaluation process is described.

5.1 Reliability Assessment

Four criteria were used in reliability assessment. The first is Cronbach's alpha. The second is individual item reliability as evaluated with PLS. As described in Barclay *et al.* (forthcoming) and Rivard *et al.*, (1994) it is recommended to determine, using PLS, the loading of each item with its construct. These loadings should be higher than 0.5, following the criterion suggested by Rivard and Huff (1988) to indicate that significant variance is shared between each item and the construct. As mentionned by Kerlinger (1986) for the analogous factor analysis approach, there is no generally accepted standard error of factor loading. The 0.5 level is considered conservative by many researchers (Barki and Hartwick, 1994; Straub, 1989). The third indicator of the reliability of the measure is the Rho coefficient, provided by PLS. It is the sum of the explained construct variance divided by the total variance (explained construct variance plus error variance). This coefficient is analogous to Cronbach's alpha except that it is weighted by the loadings of the different items on the variable. The guidelines established by Nunnally (1978) for the interpretation of Cronbach's alpha also apply to the Rho coefficient (Rivard *et al.*, 1994). Finally, the value of average variance extracted was examined. The measures should represent a high proportion of the construct variance. The average variance extracted should be higher than 50% (Rivard *et al.*, 1994). These criteria should enable a critical evaluation of the measures and the identification of the items that should be removed from the instruments.

Table 1 presents the results of the PLS analysis. The first column indicates the variables being assessed. The rest of the table is divided into two. The first half presents the scores obtained with the initial instruments, comprised of all the items. The second half presents the results of the same tests on the instruments in which the items that did not meet these criteria were eliminated. Of the nineteen original variables, eight remained unchanged, ten had some items dropped and one was split in two. In this last case, the analysis showed that the items forming the human resources replacement delay variable were not a homogeneous group. The loading pattern revealed that these items formed two distinct groups: the hiring and the training delays. Subsequent PLS analysis showed that these two groups, when split, showed significant reliability. The clan mechanisms variable had several items removed. The mechanisms evaluated by several of these items were almost never used, by any of the surveyed companies, and therefore did not load on the variable.

5.2 Face Validity Assessment

Face validity is the extent to which an instrument looks appropriate. It is the perception of knowledgeable individuals regarding the quality of the measure (Zmud and Boynton, 1991). Our questionnaires were extensively reviewed, both by practitioners and by academics. They were evaluated in terms of appropriateness of the questions, the ability of the managers to answer them, the layout, and the apparent completeness of the instrument. From these evaluations, corrections and improvements were suggested and included in the instrument. These comments were discussed in the practitioner's validation and sorting exercise section.

5.3 Content Validity Assessment

Content validity is the extent to which the set of items comprised in a measure covers a given domain. It is the sampling adequacy of the items which form the instrument. This form of validity was ensured by a thorough literature review and by the examination of outsourcing arrangements described by Aubert, Rivard, and Patry (1993).

Table 1 Reliability Evaluation

	Initial Instrument				Final Instrument			
	# of items	alpha	rho	AVE	# of items	alpha	rho	AVE
Governance Mechanisms								
Governance Mode	11	.87	.90	.47	9	.89	.91	.54
Clan Mechanisms	8	.49	.68	.25	3	.64	.81	.57
Asset Specificity								
Clients' Investment	3	.52	.77	.53	3	.52	.77	.53
Human Resources Specificity	7	.72	.80	.37	4	.74	.82	.53
HR Replacement Delay	10	.73	.69	.27				
HR Hiring Delay					5	.93	.98	.90
HR Training Delay					5	.76	.88	.60
Structural Liaison Devices	6	.64	.85	.50	5	.80	.87	.57
Suppliers' Investments	9	.72	.80	.36	6	.63	.89	.52
Uniqueness	11	.89	.92	.52	11	.89	.92	.52
Measurement Problem								
Formal Measures (in-house)	8	.85	.89	.50	8	.85	.89	.50
Formal Measures (outsourced)	8	.84	.87	.46	6	.82	.87	.53
Formalization	7	.76	.87	.52	7	.76	.87	.52
Standardization (in-house)	6	.81	.89	.60	6	.81	.89	.60
Standardization (outsourced)	6	.79	.86	.51	6	.79	.86	.51
Task Complexity (in-house)	20	.84	.88	.28	9	.83	.87	.43
Task Complexity(outsourced)	20	.86	.89	.31	9	.85	.88	.46
Task Difficulty (in-house)	2	.67	.86	.76	2	.67	.86	.76
Task Difficulty (outsourced)	2	.71	.87	.78	2	.71	.87	.78
Origin of Investment								
Business Skills	11	.90	.92	.54	9	.91	.93	.64
Technical Skills	11	.82	.86	.37	7	.83	.88	.51

5.4 Convergent and Discriminant Validity Assessment

Discriminant validity is the extent to which a measure of a construct differs from measures of neighbouring constructs. It is the evaluation of the non-contamination of a measure. PLS was used to evaluate the unidimensionality of the higher level constructs (asset specificity, measurement problems, origin of the most important investment, and the governance mechanisms). From the reliability analysis we established a list of items composing each variable. Taking the 250 questionnaires, the items were averaged to compute a score for each of the variables. These scores were analyzed by PLS to verify the factor structure behind the various constructs. The variables that pertain to the same constructs were indicated to PLS. The loadings of all the variables within a same construct should be high on this construct, indicating high convergent validity, and low on the other ones, indicating high discriminant validity. The first characteristic shows that they share a great deal of variance with their construct, and the latter that they are independent from the other constructs.

Several runs of PLS were conducted. When all the variables were put in the analysis to produce the covariance matrix, too many missing values were present and, because of the way covariances were computed, the resulting matrix represented too small a sub-sample of the 250 questionnaires (any item missing would delete the whole case). The variables *formal measures*, *clan mechanisms*, and *investments* (clients and suppliers) had missing items and lowered the N for the correlations. Some missing values were introduced by questions omitted by some respondents but most of them were due to questions for which respondents did not have to answer, simply because not all respondents had both outsourced *and* in-house activities. Therefore, the first analysis was performed without these three variables, using all the other variables. Table 2 presents the loading structure matrix obtained with the analysis. The variables *formal measures, clan mechanisms,* and *investments* were subsequently included in the analysis.

Most of the loading structure presented in Table 2 appeared to be correct. The numbers in the columns represent the loadings of each variable on the constructs indicated at the top of the column. The underlined numbers are the loadings of the variables on their respective constructs. Therefore, we would expect the underlined loadings to be high, displaying convergent validity (high loading of the variables on their appropriate construct), and the other ones to be low, displaying discriminant validity (low loading of the constructs to which they are not related).

These results show that asset specificity had an imperfect loading structure. Uniqueness did not load on any construct and structural liaison devices loaded on both asset specificity and measurement problems constructs. All the other variables loaded adequately on their respective construct, demonstrating convergent validity, and did not load significantly on any other one, demonstrating discriminant validity. To improve the validity of the constructs, the uniqueness variable was isolated it in another PLS run. The resulting matrix is presented in Table 3.

From the results presented, it seemed that the uniqueness of the activities should be viewed separately, as a variable distinct from the other constructs. It loaded on a single factor; no other variable seem to move jointly with it.

The other puzzling variable in our loading pattern was the structural liaison devices. The rationale behind its inclusion in the specificity construct was that the more these devices are put in place, the more closely linked the IS activities are to the firm and, therefore, the more specific they are. Alternatively, these mechanisms could be an attempt to increase the visibility of these activities. When activities are difficult to evaluate, managing them through committees and joint structures help to make the efforts performed by all parties more visible. These mechanisms can be seen as facilitating structures for the management of difficult to measure activities. This could be an explanation of the double loading of this variable on the two constructs.

Table 2 PLS Loadings: Convergent and Discriminant Validity

Variables	Loadings			
	Governance Mode	Asset Specificity	Measurement Problems	Origin of the Most Important Investment
Governance mode	**1.00**	0.19	0.02	-0.21
Human res. specificity	0.11	**0.49**	0.06	-0.06
Hiring delay	0.06	**0.69**	0.13	0.00
Training delay	0.17	**0.73**	0.10	0.03
Structural liaison devices	0.14	**0.30**	0.39	-0.06
Uniqueness of activities	0.08	**-0.11**	-0.02	-0.14
Formalization	0.03	0.22	**0.60**	0.05
Job standardization	-0.03	0.22	**0.85**	0.02
Task complexity	-0.01	-0.09	**0.50**	0.00
Task difficultly	0.06	0.10	**0.70**	0.06
Business skills	-0.02	0.06	0.15	**0.74**
Technical skills	-0.29	-0.01	-0.08	**0.74**

Table 3 PLS Loadings: Convergent and Discriminant Validity After Correction

Variables	Loadings				
	Governance Mode	Asset Specificity	Uniqueness	Measurement Problems	Origin of the Most Important Investment
Governance mode	**1.00**	0.20	0.08	0.02	-0.21
Human res. specificity	0.11	**0.48**	-0.04	0.06	-0.06
Hiring delay	0.06	**0.68**	-0.05	0.13	0.00
Training delay	0.17	**0.73**	-0.02	0.10	0.03
Structural liaison devices	0.14	**0.33**	0.10	0.39	-0.06
Uniqueness of activities	0.08	-0.03	**1.00**	-0.02	-0.14
Formalization	0.03	0.23	0.00	**0.60**	0.05
Standardization	-0.03	0.22	-0.01	**0.85**	0.02
Task complexity	-0.01	-0.08	0.10	**0.50**	0.00
Task difficultly	0.06	0.10	-0.11	**0.70**	0.06
Business skills	-0.02	0.06	0.03	0.15	**0.74**
Technical skills	-0.29	-0.03	-0.24	-0.08	**0.74**

As mentionned, three additional PLS runs were performed with the *formal measures,* the *clan mechanisms,* and the *investment* variables. The runs were conducted adding each of these variables, one at the time in order to limit the missing value effect, to the other ones presented in the previous analysis.

The loading of the formal measures variable on its respective construct was not very high (0.37) but was much higher than the loadings on the other constructs, indicating that is was in its proper construct. Thus, the discriminant validity of the formal measures variable seemed sound but its convergent validity remained subject to caution. Similarly, the clan mechanisms variable did not load on any other construct than its own, indicating that it did not share much variance with the other high level constructs. The loadings indicated an appropriate level of discriminant validity. Finally, analysis of the variables related to the investments (client and supplier) was performed. The results showed that both variables had a high loading on their construct, asset specificity, and low loadings on the other constructs. This indicated appropriate degrees of convergent and discriminant validity.

To evaluate discriminant validity, Fornell and Larcker (1981) suggest a comparison between the average variance extracted (AVE) for each factor and the variance shared between the constructs. The AVE is the variance shared between a construct and its measures. The variance shared between the different constructs is the squared correlations between the constructs. To complete this evaluation, we used the correlation matrix of the constructs in which we replaced the diagonal with the square root of the AVE (underlined in Table 4). Consequently, the elements on the diagonal (underlined) should be notably higher than the elements off the diagonal.

The matrix showed such acceptable properties. The numbers on the diagonal are all much larger than the elements off-diagonal. The largest correlation between two different constructs (off-diagonal) is equal to 0.26 and the lowest AVE squared root (on-diagonal) is 0.61. Therefore, the smallest on-diagonal element is more than twice the largest off-diagonal element, confirming that the matrix corresponds to the expected pattern. Furthermore, twelve of the fifteen correlation coefficients between different constructs (off-diagonal) are under 0.20.

From this analysis, discriminant and convergent validity of the measures appeared to be satisfactory. These multiple evaluations of discriminant and convergent validity increased our confidence in the quality of the measures. The results suggested the fact that different constructs are assessed with each measure.[3]

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[3] The final instrument may be obtained from the authors.

Table 4 Variance Shared Between Constructs

Governance mode	.73					
Clan mechanisms	.23	.75				
Specificity	.12	.13	.61			
Uniqueness	.08	-.05	.02	.72		
Measurement problems	.02	.24	.26	-.01	.63	
Skills	-.18	.06	.00	-.11	.08	.74

6. Conclusion

This paper proposes measures to assess the dimensions of IS operation transactions. While more work remains to be done to improve those measures, the results obtained are encouraging. The business and the technical skills required to perform an activity were assessed for IS operations and these measures showed appropriate levels of reliability. Asset specificity, much discussed in organizational economics, was also evaluated. This first attempt to formally measure IS asset specificity lead to acceptable results. In order to evaluate measurement problems, the study used new measures tailored for IS operations. These measures correspond directly to the object of study and can be used both by researchers trying to evaluate IS operations in various contexts and by practitioners evaluating the management of their IS operations. Measures from other studies were also used (Barki, Rivard, and Talbot, 1991; Miller and Dröge, 1986; Van de Ven and Ferry, 1980). These measures had been previously tested with first generation statistical methods, such as factor analysis. The use of PLS, a second generation method, enabled further refinement and validation of these measures. Confidence in these instruments has been increased.

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Appendix 1

1. Description of the Information Systems Operations

Please consider the following list of IS operations. Please indicate, for each one, if your firm is currently executing the operation in-house, using the internal Information Systems Department, or if your firm is relying on a supplier (outsourcing). If you are relying on a supplier for an operation, please indicate the duration of the contract between you and your supplier. If one of the items listed below is not an operation of your firm, please check the N/A (Not Applicable) box for this particular operation.

	Operated in-house by firm's employees	Operated in-house by external supplier's employees	Operated on firm's own equipment on supplier's premises	Totally outsourced to an external supplier	N/A	Information unknown
a) Scheduling of operations (applications)	□	□	□	□	□	□
b) Control of operations (applications)	□	□	□	□	□	□
c) Production Support Services	□	□	□	□	□	□
d) CPU Operation	□	□	□	□	□	□
e) Operation of operating system	□	□	□	□	□	□
f) Operation of applications	□	□	□	□	□	□
g) Operating system maintenance	□	□	□	□	□	□
h) Disk space management	□	□	□	□	□	□
i) Hardware maintenance	□	□	□	□	□	□
j) Printer operation	□	□	□	□	□	□
k) Printer maintenance	□	□	□	□	□	□

Appendix 2

6. Contract Management

a) Please check all the formal measures used in your contract (between your firm and your supplier) in order to manage the information systems operations outsourced to this supplier.

- □ MIPS used
- □ MIPS available
- □ Disk space used
- □ Disk space available
- □ Response time
- □ Reliability (period without failure)
- □ Accessibility (time-span of potential utilization)
- □ Assessment of Client-Supplier relationship quality
- □ Other: ______________________________