INVESTMENT ASSESSMENT ON OUTSOURCING PRACTICES AND SOFTWARE DEVELOPMENT ENGINEER'S PERFORMANCE ANALYSIS

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SUMMARY

This research aims to analyze the impact of the variables: outsourcing investment (Y_1) and performance of the software developer (Y_2), from the perspective of an organization that hires software outsourcing services, through a structural model. To perform this analysis, a multivariate model was designed and populated with data from a sample of 290 organizations that contracted this service, measured using a Likert scale. The results align with the model fit, although they do not demonstrate cause–effect relationships among the analyzed variables; however, quantifying the relationship is still possible.

Introduction

Companies and organizations of various types and sizes are always searching for new ways to reach their goals and become more competitive, mainly driven by the costs of the products and services they offer. Recently, one business strategy that has helped companies achieve their objectives is outsourcing, as it allows organizations to reduce costs by delegating certain activities to external service providers. This is particularly relevant since many of these activities normally require personnel with specific knowledge and expertise that many organizations do not possess. Therefore, it is often more practical to rely on external providers rather than investing in selecting and hiring workers with specialized skills and training. One of the most common areas within organizations that has been extensively working with outsourcing practices is the IT department, because, as mentioned earlier, many companies are not willing to invest in resources outside their main production lines (Arora *et al*., 1999).

As technological advances continue to emerge at a faster rate in the field of information systems development, the number of cases in which organizations depend on outsourcing companies is also growing rapidly. For instance, in the late 80s, Kodak decided to hire an external company to manage all their information systems in order to save significant amounts of money on activities that were clearly outside their primary line of business. However, despite the success and high acceptance of outsourcing practices, several key issues should be analyzed carefully to ensure a successful experience for both client and provider organizations. In particular, software development outsourcing efforts involve many aspects that should be considered before any specific work begins. We believe some of the main aspects in most software development outsourcing projects are cost management (McIvor, 2000), innovation (Mierau, 2007), and software developer performance (Abraham and Taylor, 1993). The main objective of this work is to analyze how developer performance relates to the cost paid by client companies for these kinds of services, as well as the level of satisfaction achieved.

Background

Evidently, IT is a continuously growing area that plays a significant role in the efficiency, productivity, and competitiveness of all types of organizations due to their heavy dependence on information technologies and communications. As mentioned, companies and organizations that are not considered technologically oriented based on the products and services they offer often rely on outsourcing service providers to satisfy their information technology needs. Outsourcing can be defined as any business process that is developed and maintained by an external group on behalf of a given company. However, any outsourcing process between client and provider companies is not an easy task and usually requires, among other things, adequate planning and coordination from both parties to thoroughly understand the requirements or needs at hand, as well as to manage costs efficiently (McIvor, 2000; Aydin and Bakker, 2008).

According to OECD and EUROSTAT (Organization for Economic Co-operation and Development, 2005), innovation is the process by which products and services, whether new or enhanced, are introduced to satisfy their

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EVALUACIÓN DE LA INVERSIÓN EN PRÁCTICAS DE *OUTSOURCING* Y ANÁLISIS DEL DESEMPEÑO DE LOS INGENIEROS DE DESARROLLO DE SOFTWARE

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RESUMEN

Esta investigación tiene como objetivo analizar el impacto de las variables: inversión en outsourcing *(Y_1) y el rendimiento del desarrollador de software (Y_2), desde la perspectiva de una organización que contrata servicios de outsourcing de software, a través de un modelo estructural. Para realizar este análisis, se diseñó un modelo multivariante y se incorporaron datos de una muestra de 290 organizaciones que contrataron este servicio, medido mediante una escala de Likert. Los resultados se alinean con el ajuste del modelo, aunque no demuestran relaciones causa-efecto entre las variables analizadas; sin embargo, aún es posible cuantificar la relación.*

AVALIAÇÃO DE INVESTIMENTOS EM PRÁTICAS DE TERCEIRIZAÇÃO E ANÁLISE DE DESEMPENHO DE ENGENHEIROS DE DESENVOLVIMENTO DE SOFTWARE

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RESUMO

Este estudo tem como objetivo analisar o impacto das variáveis: investimento em terceirização (Y_1) e desempenho do desenvolvedor de software (Y_2), sob a perspectiva de uma organização que contrata serviços de terceirização de software, por meio de um modelo estrutural. Para realizar essa análise, foi desenvolvido um modelo multivariado e preenchido com dados de uma amostra de 290 organizações que contrataram esse serviço, medidos por meio de uma escala Likert. Os resultados estão alinhados com o ajuste do modelo, embora não demonstrem relações de causa e efeito entre as variáveis analisadas; no entanto, quantificar a relação ainda é possível.

respective demands and uses. In this sense, outsourcing is a continuously growing practice responsible for executing specific processes that many companies may not only be capable of performing but also obtain the desired end results in a shorter time frame (Mierau, 2007; Ainin *et al*., 2012), especially in recent times when the life cycle of new products is getting shorter due to constant innovation and intense competition.

On the other hand, software developer performance has been a relevant subject in the outcome of outsourcing projects because it can show whether a set of goals and objectives were successfully achieved on time. In fact, outsourcing providers encompass a set of human and technological resources that, together, can bring value to client companies (Bani-Hani and Alhawary, 2009). Some of the main reasons companies rely on outsourcing providers are (Modi and Shah, 2013): a) Lack of skilled professionals, b) Lack of internal resources, c) Difficulty in managing operating processes.

Meanwhile, outsourcing providers also face several challenges and specific needs, among which one of the most important is hiring personnel with certain technical skills and advanced training that would enable them to perform adequately and make significant contributions. Other important attributes include: a) Experience, leadership and creative thinking (Booneka and Kiattikomol, 2008), b) Risk management and teamwork (Grover, 2013), c) Complex problem-solving skills.

Method

Table I shows the set of case study variables in this work. Below, we present the set of hypothesis tests that were defined based on the proposed variables and the data that were collected and analyzed.

H_1: Cost management (X_1) is significant for outsourcing investment (Y_1)

H_2: Innovation (X_2) is significant for outsourcing investment (Y_1)

H_3: Leadership (X_3) is significant for outsourcing investment (Y_1)

H_4: Problem-solving (X_4) is significant for outsourcing investment (Y_1)

H_5: Work experience (X_5) is significant for outsourcing investment (Y_1)

H_6: Software developer performance (Y_2) is significant for outsourcing investment (Y_1)

H_7: Cost management (X_1) is significant for software developer performance (Y_2)

H8: Innovation (X_2) is significant for software developer performance (Y_2)

H_9: Leadership (X_3) is significant for software developer performance (Y_2)

H_{10}: Problem-solving (X_4) is significant for software developer performance (Y_2)

H_{11}: Work experience (X_5) is significant for software developer performance (Y_2).

In this work, the nature of our study is descriptive and correlational-causal, based on a quantitative approach with a non-experimental cross-sectional design, with data collected at one point in time (Hernández Sampieri *et al*., 2010). The sample for this survey-based study was selected from companies acquiring software development services. Moreover, we developed and applied a multiple-choice questionnaire to 290 organizations that participate in different sectors, for instance, 33.45% in industry, 23.45% in commercial, and 43.10% in services. Since we wanted to collect project-related data from experienced people, the majority of respondents were either high-level executives or technical managers. The gender distribution is 59.31% male, 39.31% female, and 1.38% didn't answer. All participants rated each question using a

TABLE I
CASE STUDY VARIABLES

Variables	Definition	Indicators
X_1	Processes that establish cost planning and control of products and services	V_2. The proposed cost complies with the budget intended for hiring information services. V_3. In case the service cost increases, is there an economic error margin to finish the project.
X_2	Processes that create or enhance products and services	V_4. Outsourcing contracting makes possible to launch new products or services more often.
X_3	Set of skills and abilities to persuade other individuals to perform certain activities	V_5. Project personnel have the ability to interact with other individuals and teams. V_6. Project personnel can develop their functions adequately. V_7. Project personnel are capable of taking necessary risks to perform their functions adequately.
X_4	Ability to solve any difficulties that may prevent from reaching specific goals	V_8. Project personnel showed a long term vision for the usability of the final product. V_9. Project personnel have the ability to solve any problems that may occur during project development. V_{10}. The decision criterion related to the usability of the product was adequate.
X_5	Knowledge acquired based on work assignments	V_{11}. Project personnel showed an adequate use of technological tools required for project development. V_{12}. Project personnel showed adequate knowledge to reach the proposed objectives. V_{13}. Project personnel trained the client on how to use the final product.
Y_1	Economic resources for acquiring products and services	V_1. Outsourcing investments meet the expectations.
Y_2	Level of accomplishment on the activities each individual performs	V_{14}. Project personnel reached the objectives within the stipulated timeframe. showed an adequate use of technological tools required for project development. V_{15}. The final product was delivered on time.

X_1: Cost management, X_2: Innovation, X_3: Leadership, X_4: Problem solving, X_5: Work experience, Y_1: Outsourcing investment, and Y_2: Software developer performance. Source: Authors.

five-point Likert scale, from 1 to 5, according to their knowledge and experience.

Structural Model

The data were analyzed using exploratory factor analysis and the statistical tool SMART-PLS. In particular, the use of SMART-PLS and structural equations helps separate the relationships among variables for each group of dependent variables. Figure 1 shows the structural model used to perform the analysis of the dependent variables: outsourcing investment (Y_1) and software developer performance (Y_2).

Results

In order to complement our multivariate analysis, the following two questions were included in our study, and participants were asked to respond to them:

1. How often do you hold meetings to discuss software outsourcing projects?
   a. Once every two years
   b. Once a year
   c. Twice a year
   d. Three times a year
   e. Four times a year

Based on the obtained results, 3.45% indicated that they meet once every two years, compared to 2.76% who meet once a year, 13.10% meet twice a year, 23.79% meet three times a year, and 56.90% meet four times a year.

2. How much impact have outsourcing investments had on internal production costs?
   a. Drastically decrease
   b. Slightly decrease
   c. No change
   d. Slightly increase
   e. Drastically increase

For this question, about 2.41% of the participants responded that their costs drastically decreased, compared to 2.41% with a slight decrease, 10.34% with no change, 24.83% who noticed a slight increase, and finally, 60% observed drastic increases.

Afterwards, we performed a Spearman analysis to prove the correlation level between planning and the impact produced by outsourcing investments, in which we obtained a result of 0.630 with a significance level of 0.000. This result shows that planning within companies tends to increase the number of outsourcing investment projects. Moreover, such increases consequently generate economic losses for those organizations. Therefore, as expected, a lack of planning increases costs for such companies.

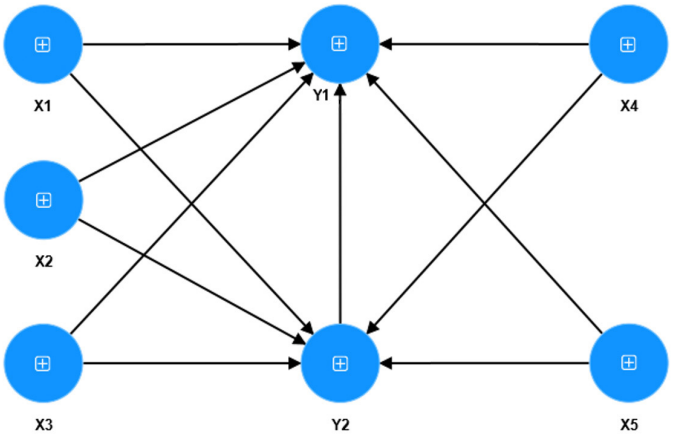

Figure 1. Graphical view of the model. Source: Analysis of results using SMART-PLS.

Structural Model Validation

In order to prove the validity of our structural model, the following analyses were also performed:

Multicollinearity. Tables II and III show the values corresponding to the Variance Inflation Factor (VIF) for each latent and dependent variable, where all values are less than four. Therefore, from the results, we can conclude that there is no collinearity among these latent variables.

Meanwhile, Table IV shows the results obtained for the quality criteria in which we evaluated the following aspects:

Convergent Validity (CV). This evaluates whether a set of indicators measures a particular construct and not some

TABLE II
COLLINEARITY STATISTICS Y_1

Variable	VIF
X_1	2.557
X_2	3.220
X_3	3.657
X_4	1.999
X_5	3.528
Y_2	1.651

Source: Analysis of results using SPSS.

TABLE III
COLLINEARITY STATISTICS Y_2

Variable	VIF
X_1	2.556
X_2	3.178
X_3	3.529
X_4	1.947
X_5	3.296

Source: Analysis of results using SPSS.

other concept (Fornell and Larcker, 1981). Moreover, the Average Variance Extracted (AVE) represents the average variation that a latent variable exerts over the observable variables (Farrell, 2010). It can be shown that values above 0.5 are acceptable (Hair *et al*., 2011), and as Table IV shows, all AVE values are above 0.5, and their average value is 0.778, which satisfies the CV criterion (Hair *et al*., 2011; Farrell, 2010).

Composite Reliability (CR). This refers to the internal consistency of a latent variable without assuming that the indicators are reliable, but instead assigning them priorities. Any values between 0.6 and 0.7 are considered appropriate as the lower limit (Hair *et al*., 2011). As shown in Table IV, all CR values are above 0.8.

Discriminant Validity. This proves that a construct measures a concept distinct from other constructs. This type of validity was performed in two parts. The first part consists of the Fornell-Larcker method, which involves obtaining the square root of the AVE and comparing the value per construct with the value of the correlations between each variable. When making this comparison, it is verified that the square root of the AVE is higher, as shown in Table V. In the second part, we obtained the average cross-loading values for each latent variable, which were then compared against the composite reliability values (Fornell and Larcker, 1981). It is noted that for each latent variable, the composite reliability values are higher than the average cross-loading values, as shown in Table IV.

R^2. The R^2 results for dependent variables Y_1 (0.430) and Y_2 (0.394) are shown in the fifth column of Table IV. Since these values are below 0.500, they are considered weak (Hair *et al*., 2011).

Cronbach's Alpha. This represents the internal correlation or reliability of a set of indicators that measure either a non-observable or directly measured variable. In this case, each of the proposed variables X_1, X_3, X_4, X_5, and Y_2 has been measured with its corresponding indicators, and the results are acceptable based on the fact that they all satisfy the lower limit of 0.6 (Hair *et al*., 2011). On the other hand, X_2 and Y_1 are measured with just one indicator, which explains the high value obtained (1.000), as shown in Table IV.

Content Validity. This evaluates each of the latent variables and verifies their association. This analysis is also carried out in two parts. In the first part, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is performed. This test shows whether the analyzed factors can be grouped and form a variable (Kaiser, 1974). The second part determines if the analysis is appropriate through Bartlett's test of sphericity. More specifically, this test determines whether it is significant by using the obtained p-value and comparing it against the significance value corresponding to 95% and assuming a normally-distributed population. The KMO test produced values above 0.500, which makes the first part acceptable, whereas the second part is significant based on Bartlett's test of sphericity. It should be noted that this test omits X_2 and Y_1 due to the fact that they are measured with only one indicator, and it is not possible to obtain results (Table IV).

Hypothesis testing

To prove the hypothesis (Xi – Y), we used a "t" statistic on a two-tailed test with an inferior limit of 1.96 for a 95% confidence level (Hair *et al*., 2011). Such a statistic can show which variables are significant for the set of dependent variables. According to Anderson (Anderson *et al*., 2012), one way to determine the relevance between latent and dependent variables is to compare the theoretical "t" (0.98) against the practical "t". Both t-statistics can be found in Table VI, where in all cases the practical "t" is greater than the theoretical "t", and therefore, all proposed hypotheses are accepted.

TABLE IV
QUALITY CRITERIA

	AVE	Composite Reliability	Average cross loadings	R^2	Cronbach's alpha	KMO – Sig.
X_1	0.852	0.920	0.536		0.828	0.500 – 0.000
X_2	1.000	1.000	0.481		1.000	–
X_3	0.672	0.860	0.546		0.759	0.662 – 0.000
X_4	0.748	0.899	0.535		0.832	0.724 – 0.000
X_5	0.616	0.828	0.596		0.690	0.666 – 0.000
Y_1	1.000	1.000	0.431	0.430	1.000	–
Y_2	0.772	0.872	0.489	0.394	0.705	0.500 – 0.000

Source: Analysis of results using SMART-PLS.

TABLE V
DISCRIMINANT VALIDITY

	X_1	X_2	X_3	X_4	X_5	Y_1	Y_2
X_1	0.923						
X_2	0.537	1.000					
X_3	0.556	0.821	0.820				
X_4	0.479	0.426	0.512	0.865			
X_5	0.751	0.484	0.562	0.674	0.785		
Y_1	0.439	0.285	0.435	0.400	0.534	1.000	
Y_2	0.454	0.336	0.459	0.514	0.588	0.595	0.879

Source: Analysis of results using SMART-PLS.

TABLE VI
"t" STATISTIC

	Causal relation	t-statictic (practical "t")	t-statistic (theoretical "t)	Hypothesis
$X_1 \rightarrow Y_1$	0.690	0.964		H_1: Rejected
$X_2 \rightarrow Y_1$	-0.203	-2.519		H_2: Rejected
$X_3 \rightarrow Y_1$	0.279	3.247		H_3: Accepted
$X_4 \rightarrow Y_1$	-0.039	-0.610		H_4: Rejected
$X_5 \rightarrow Y_1$	0.216	2.566		H_5: Accepted
$Y_2 \rightarrow Y_1$	0.397	6.884	1.96	H_6: Accepted
$X_1 \rightarrow Y_2$	0.019	0.259		H_7: Rejected
$X_2 \rightarrow Y_2$	-0.160	-1.939		H_8: Rejected
$X_3 \rightarrow Y_2$	0.278	3.206		H_9: Accepted
$X_4 \rightarrow Y_2$	0.178	2.765		H_{10}: Accepted
$X_5 \rightarrow Y_2$	0.374	4.465		H_{11}: Accepted

Source: Analysis of results using SMART-PLS.

Discussion

In this study, we found that the correlation between planning and investment is positive. As long as planning meetings are scheduled to manage the outsourcing project investment, there should not be any cost increments in products or services. Therefore, due to the low number of planning meetings to discuss outsourcing projects, it is not always easy to specify all the business needs as well as analyze the various costs and activities that need to be performed, as mentioned by McIvor (McIvor, 2000).

On the other hand, the structural model allowed us to obtain the following findings. The analysis of outsourcing investment (Y_1) with all the latent variables showed the following. First, for cost management (X_1), we found that companies who have hired an outsourcing service have not terminated it despite cost increments. However, some objectives have not been met on time, but in general, projects have been completed. On the other hand, with innovation (X_2), the relationship is negative and it is not significant. In this case, companies hire outsourcing services so that they can focus on their core activities; however, in several cases, product or service innovation is not working as expected, mainly because of late deliveries and not reaching the proposed objectives. Hence, companies should pay more attention to these kinds of projects. With leadership (X_3), there is a significant and positive relationship, with problem solving (X_4), the relationship is negative and not significant, and with work experience (X_5), there is a positive and significant relationship. All three latent variables are part of a lack of skills that the client needs in the provider. Lastly, for the relationship $Y_1 \rightarrow Y_2$ (Software developer performance), as mentioned before, it was found that providers are not reaching the proposed objectives on time as well as the activities. Clearly, the latter affects the client's investment to the point that it can generate losses in many cases. In addition, it has low predictive relevance, in line with what Balmelli mentioned (Balmelli *et al*., 2006). That is, for those who claim that projects are not completed on time, they end up not only spending more but also losing focus on their main activities. Despite all these problems, projects have been completed.

Moreover, software developer performance (Y_2), as a dependent variable, was 39.4% defined by its respective variables. First, in the case of cost management (X_1) and innovation (X_2), both are not significant. The relationship with leadership (X_3) is significant. It was discovered that both client and provider personnel integrate effectively. Likewise, their determination and risk-taking are appropriate. However, client requirements sometimes are not easily understood, probably due to inefficient planning. Regarding problem solving (X_4), provider personnel are complying with their work; however, sometimes the objectives are not reached on time. According to Colombo, we concur that software developers must have the ability to identify and solve complex problems. However, based on our findings, this variable is a skill that is acquired during professional development and is part of each developer's personality. Lastly, in terms of work experience (X_5), outsourcing providers perform all work activities, although not always on time. According to Gorla (Gorla and Chiravuri, 2011), it has been shown that a client company has concerns regarding the abilities, capacities, and experience a given provider has, and therefore, this variable has medium predictive relevance. More specifically, in some cases, providers assign personnel who do not have enough experience. Our study shows that project personnel are neither proficient in using certain programming languages and tools needed to complete the project, nor do they have evidence that

they have the appropriate training and certifications, which explains why sometimes objectives are not met on time.

Conclusions

In this work, we have presented a structural model with two dependent variables: outsourcing investment (Y_1) and software developer performance (Y_2). Regarding the impact of outsourcing investment on internal production costs, we discovered that, due to a lack of planning, several companies reported cost increases on their projects, which consequently lead to losses. The previous result is even more surprising given the fact that planning meetings are held during the entire project. Another situation that increases investment costs is the result of inefficient performance from software developers.

Even though the proposed model complies with the described quality criteria, the analysis for each dependent variable has been made with five and six relationships respectively with Y_1 and Y_2, and none of these were conceptual due to the data we had at that time. The aforementioned limitation is not exclusive to this work; in fact, it is common with hypothesis searches for statistical correlations without knowing the nature of the relationship among them.

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