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AVALIAÇÃO DO ALINHAMENTO DOS PORTFÓLIOS DE PROJETOS DE TECNOLOGIA DA INFORMAÇÃO COM A ESTRATÉGIA ORGANIZACIONAL UTILIZANDO ANÁLISE ENVOLTÓRIA DE DADOS

INFORMATION TECHNOLOGY PROJECT PORTFOLIO AND STRATEGY ALIGNMENT ASSESSMENT BASED ON DATA ENVELOPMENT ANALYSIS

Marisa Analía Sánchez
Doutora em Ciência da Computação pela Universidad Nacional del Sur, AR
Professora da Universidad Nacional del Sur, AR
E-mail: mas@uns.edu.ar (Argentina)

Lidia Susana Toscana
Professora da Universidad Nacional del Sur, AR
E-mail: ltoscana@criba.edu.ar (Argentina)

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RESUMO

As pesquisas recentes revelem que as empresas enfrentam dificuldades grandes ao avaliar a contribuição de valor da estratégia dos investimentos em tecnologia da informação (TI). Um dos principais obstáculos é estabelecer a relação e quantificar os benefícios dos investimentos em TI com os objetivos estratégicos organizacionais. Esto é muito difícil para as organizações .O objetivo deste artigo é definir uma abordagem para avaliar o alinhamento dos portfólios de projetos de TI com a estratégia organizacional. Nesta abordagem utilizou-se o Mapa Estratégico para definir a contribuição de valor dos portfólios e a técnica Análise Envoltória dos Dados (DEA) para avaliar a eficiência dos portfólios de projetos.

Palavras-chave: Avaliação dos Portfólios de Projetos; Alinhamento da Estratégia; Mapas Estratégicos; Análise Envoltória dos Dados (DEA).

INFORMATION TECHNOLOGY PROJECT PORTFOLIO AND STRATEGY ALIGNMENT ASSESSMENT BASED ON DATA ENVELOPMENT ANALYSIS

ABSTRACT

Recent research has shown that companies face considerable difficulties in assessing the strategy value contribution of Information Technology (IT) investments. One of the major obstacles to achieving strategy alignment is that organizations find it extremely difficult to link and quantify the IT investment benefits with strategic goals. The aim of this paper is to define an approach to assess portfolio-strategy alignment. A formal specification of Kaplan and Norton Strategy Map is developed utilizing Unified Modeling Language (UML). The approach uses the Strategy Map as a framework for defining the portfolio value contribution and Data Envelopment Analysis (DEA) is used as the methodology for measuring efficiency of project portfolios.

Keywords: Project Portfolio Assessment; Strategy Alignment; Strategy Maps; Data Envelopment Analysis.

1 INTRODUCTION

In the current business environment Information Technology (IT) is considered a key source of competitive advantage. The information technology is an important part of the costs of an organization but at the same time has the potential to bring great opportunities. IT supports most of the processes of the organization and also IT strategy must be aligned with organizational strategy. The Information Systems/Information Technology strategy is composed of two parts: the component of IS and IT. The IS strategy define requirements or demands for information and systems that give support to the overall strategy of the organization. In other words, it defines and prioritizes the investments necessary to achieve the portfolio, the nature of the expected benefits and the changes required to achieve those benefits, within the constraints of resources and interdependencies of projects. The IT strategy focuses on defining how IT will support the demands for organizational information and systems (Ward & Peppard, 2002).

The alignment of IT strategies to the organization's strategy refers to have an IT strategy that makes a contribution to the value creation. A report by the Standish Group indicates that 35% of IT projects are successful, 19% fail, and estimate projects exceed the costs budgeted by 54% (Rubinstein, 2007). In (Maizlish & Handler, 2005) the authors indicate that only 52% of the projects realize the strategic value. These numbers are difficult to ignore and suggest that care should be taken when evaluating projects performance and costs. Investments are exposed to multiple sources of risks both endogenous (specific of the projects portfolios) and exogenous (that faces the industry). This situation can lead to excessive costs, non-compliance with the agreed dates, the deterioration of the quality, or the failure of a project.

The consideration of the benefits and risks associated with a project must be made both in the conception of the project and during its development. IT assets include the already implemented technology and new project opportunities. In valuating opportunities we should consider the support that can provide to strategy and current processes, and if the related innovations can enable new opportunities to improve the organization. In addition, during the project development, sometimes there is the possibility (or need) to make decisions under uncertainty which can have a very large impact in benefits and costs.

These circumstances define the strategic importance of Project Portfolio Management (PPM) that is a central activity in most organizations. Project Portfolio Management aligns individual project management with operations management. In 1952 Harry Markowitz introduced the concept of modern theory of portfolios in the financial investment domain. This theory allows the determination of a selection of investments that generate the highest return for a given level of risk. This concept was applied to the project management domain and becomes the basis of Project Portfolio Management. But in IT projects we must also consider non-financial aspects, and therefore a financial perspective is not enough.

In (Kapplan, 2005) PPM is defined as a method to govern IT investments throughout the organization, and manage them so that they provide value. It can be described as the process in which active projects are reviewed and updated. During this process, projects may be cancelled, and new projects may be evaluated, selected or prioritized.

PPM is a process that faces major challenges. PPM is characterized by the presence of unknown information, multiple objectives that often compete against each other, and the presence of inter-related projects. A study carried out by Planview ® (Nauyalis & Carlson, 2010) shows that managers find it difficult to prioritize resources and to stop development work on a project. One of the problems is that few organizations perform a constant monitoring of projects due to lack of data and information to support such decisions. In terms of the greatest risks in PPM, the main risks are time-to-market; develop the incorrect product; not abandon products with less value that appropriate resources of higher value initiatives; and very inaccurate cost estimates. It also highlights the lack of alignment of projects to the organization's objectives. These results show up difficulties for having information that effectively gives support to the decision-making process during the PPM.

If we also consider that the trend from a technological point of view is to adopt service-oriented architectures we have reasons to believe that the difficulties to assess and monitor projects alignment to strategy will increase. Service-oriented architectures reduce transaction costs and the implementation of a project from a technical point of view would be simpler. Now, that same reduction of costs and technical flexibility to deploy new solutions makes the organization more ready to implement and sustain the concept of agility, i.e. react and respond more quickly to changes in market and business opportunities. Then, the organization needs to be prepared to manage projects emphasizing the value that projects add. And the organization that is more prepared to manage a portfolio (based on services) and monitor the value contribution to the business will have more opportunities to succeed.

Despite the importance of PPM for strategic management and the extensive literature that addresses these issues, very few proposals describe how to conduct a PPM that explicitly considers how to model the dependencies between projects´ performance and benefits or contributions to value creation. Accordingly, during PPM there are difficulties to assess the strategic value of a project both during project selection and monitoring of projects in progress.

The aim of this paper is twofold: (a) to define a conceptual framework for projects management that explicitly represents the relationships between strategic objectives and projects; and (b) based on the conceptual framework we intend to define how to measure efficiency of portfolios and projects based on their value contribution.

The rest of this work is structured as follows: Section 2 provides literature review and research background. Section 3 presents the proposed framework. A demonstrative example illustrating how such a framework could be used is also presented. Finally, Section 4 concludes the paper with a discussion of the benefits and limitations of our approach.

2 LITERATURE REVIEW

The problem of evaluating investments in IT projects has been extensively addressed in the literature. Traditional financial literature often addresses the problem and suggests using Net Present Value (NPV) calculations for cost-benefit analyses. In an NPV analysis, analysts convert future values of benefits to their present-value equivalent by discounting them at the organization´s cost of funds. They then can compare the present value of the future benefits to the cost required to achieve those benefits in order to determine whether the benefits exceed the costs (Turban, Leidner, McLean, & Wetherbe, 2006). But NPV analysis works well in situations where costs and benefits are well defined and can easily be converted in monetary values. The value of IT projects depends on company´s internal operations, changes in process, technology, people, organization and culture.

We extensively reviewed works that focus on IT-strategy alignment and PPM. For space reasons and the scope of this paper we briefly describe the contributions closer to our research. In (Wang, Lin, & Huang, 2010) the authors propose a risk management framework that aligns project risk management with corporate strategy and a performance measurement system to increase success rates of Research and Development (R&D) projects. The Balanced Scorecard is used to identify major performance measures of an R&D organization, and a matrix to relate organizational performance measures and the project performance measures. They measure the R&D risk in terms of the expected loss from unsatisfied performance measures. In this way, the authors link performance measures with risks. One of the key benefits of the proposed performance-oriented risk management is linking R&D risk management with the firm´s strategy.

In (Sanchez, Benoit, & Pellerin, 2008) the authors introduce a framework to identify risks and opportunities during portfolio risk management that helps to decrease the uncertainty of achieving the strategic goals defined for the organization. The final output of the framework is a portfolio risk-opportunity register, which highlights the potential events that could impact the achievement of the goals. Events, projects, and financial and strategic consequences are related in a matrix. The proposal has not been validated in a real case. Perhaps the main difficulties may arise during the identification of events since they suggest using the Checkland method (Checkland, 1999) based on conceptual maps which is powerful but of difficult application in organizations. The authors do not indicate how to measure the impact of an event on benefits or goals.

In what follows, in order to make the paper self-contained we define Balanced Scorecards (BSC), Strategy Maps and Data Envelopment Analysis. This is followed by a discussion of some works that integrate BSC and DEA.

2.1 STRATEGY MAP

More than a decade ago, Robert Kaplan and David Norton introduced the Balanced Scorecard, a strategy-based measurement system that allows translating a strategy to operational terms (Kaplan & Norton, 2000). The Balanced Scorecard organizes its measurement system in four perspectives. In each perspective we define key areas for all concerns that should be monitored. Each key area (or goal) is related with metrics. The financial perspective includes traditional accounting measures; the customer perspective groups measures relating to the identification of target groups for the company's products in addition to marketing-focused measures of customer satisfaction, retention, etc. The internal business process perspective includes all the processes relating to the realization of products and services. Finally, the learning and growth perspective includes all metrics relating to employees and systems available to facilitate learning and knowledge diffusion.

It soon became natural to describe the causal relationships between strategic objectives and the Balanced Scorecard evolved to a representation known as the Strategy Map (Kaplan R., 2010), (Kaplan & Norton, 2004). In the Strategy Map, objectives are linked in a cause-and-effect relationship that culminates in a relation to financial objectives. A strategy map, customized to the organization's particular strategy, describes an organization value creating strategy.

2.2 THE INTEGRATION OF DATA ENVELOPMENT ANALYSIS AND BALANCED SCORECARD

DEA is a non-parametric technique used to measure the efficiency of Decision Making Units (DMUs) and was proposed by Charnes (Charnes, Cooper, & Rhodes, 1978). It considers that each DMU is engaged in a transformation process, where by using some inputs (resources) it is trying to produce some outputs (goods or services). DEA uses all the available data to construct a best practice empirical frontier to which each inefficient DMU is compared. The interested reader is refereed to (Cook & Seiford, 2009) and (Cooper & Seiford, 2004) for a comprehensive review of DEA models.

Most works that integrate BSC and DEA are descriptive and classificatory or have been carried out to test theoretical propositions. Rickards (Rickards, 2003) developed the first DEA model aiming to capture the four perspectives of the BSC using data of 69 units of a multinational company. The contribution of the research is the DEA-based transformation of a long list of performance indicators, selected on the basis of a BSC, into a global performance score. García-Valderrama uses a combination of inputs from one perspective with outputs from a different perspective in the DEA models (García-Valderrama, Muleno-Mendigirri, & Revuelta-Bordoy, 2009). The work aims to test the hypothesized cause and effect relationships suggested by the advocates of BSC in the context of R&D activities. García-Valderrama surveys data from several companies.

Some applications in the context of projects´ evaluation used DEA to determine the relative value of projects. Eilat *et al.* propose to evaluate R&D projects using a methodology based on DEA and the BSC (Eilat, Golany, & Shtub, 2006), (Eilat, Golany, & Shtub, 2008). In the first paper a methodology is proposed for developing and analyzing the efficiency, effectiveness and balance of a portfolio of R&D projects that mutually interact. Projects are considered as DMUs and the scores obtained are utilized to establish the list of candidate projects. The inputs are work content and material costs; and the outputs are economic contribution, scientific contribution and social contribution. In the second paper a method is developed for evaluating R&D projects in different stages of their life cycle. The measurement of the inputs and outputs is integrated on “cards” associated with a BSC for R&D projects.

In (Amado, Santos, & Marques, 2012) the authors propose a conceptual framework to assess DMUs from multiple perspectives. They combine BSC and DEA by using interconnected models which encapsulate four perspectives of performance (financial, customers, internal processes, and learning and growth). They use accounting data from a single company in order to promote learning. Inputs and outputs are defined for a particular case. There are no general guidelines on which measures should be chosen.

In (Asosheh, Nalchigar, & Jamporazmey, 2010) the authors propose a new approach for IT project selection using the BSC as a framework for defining IT projects evaluation criteria; and DEA as a nonparametric technique for ranking IT projects. The proposed BSC includes the original perspectives of BSC (financial, customer, internal-business-processes, learning and growth, and uncertainty). The uncertainty perspective includes measures such as processes risks, human resource risks and technological risks. The inputs are the usual resource data (cost, time and human resource); and some outputs measures are defined for each perspective. The authors developed a DEA model that considers cardinal and ordinal data. However, although the measures are grouped on perspectives, they are used as single and isolated outputs (for example, cost reduction and security are used as outputs without acknowledgment of the cause and effect relationships between them). No clues are given as to how to exploit this information on a BSC. Hence, one of the main benefits of the BSC -the integration of different measures and the explicit links between different dimensions of performance in a single system- is lost. Additionally, the DEA evaluation should be performed for each project.

3 THE PROPOSED ASSESSMENT FRAMEWORK

In order to accurately represent the relationships between the benefits delivered by the set of projects that make up a portfolio and the strategic goals, we developed a more precise specification of the Strategic Map and a portfolio. This conceptual framework allows connecting the potential and the realized value of a project with strategic objectives. Thus, the conceptual model is the basis to structure the information necessary for portfolio selection and for monitoring the implementation of projects.

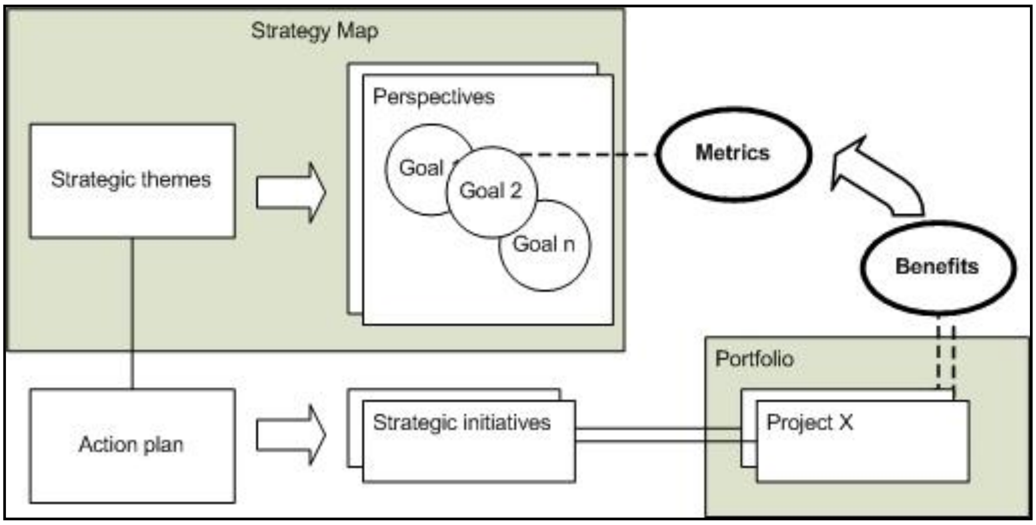
This framework can be used in two stages of Project Portfolio Management. First, it allows evaluating several portfolios and determining which are efficient with respect to its value contribution. In this way, the approach supports portfolio selection. The measurement of the portfolio value contribution is based on DEA and we propose to define a model of efficiency to consider the portfolio with respect to each of the perspectives defined in the Strategic Map. Second, once a portfolio is selected, DEA helps to monitor the portfolio value realization. Different contingencies can undermine the realization of the potential value of a project. In addition, strategic goals may change, and then some projects might support past objectives. In any of these two situations there is a misalignment of IT strategy to organizational strategy.

3.1 CONCEPTUAL MODEL

In (Sánchez & Mellado, 2004) and (Sánchez & Mellado, 2005) we elicited the gap between business strategies and process, and we proposed a conceptualization of Strategy Maps based on UML. In this work, we extend the initial conceptualization by including project portfolios. The formal conceptual model is included in Appendix A. Figure 1 depicts a schematic diagram of the conceptual model that integrates the Strategy Map and project portfolios. A Strategy Map is made around a set of themes. For each objective, there is a set of metrics. The set of action programs that will enable the targets for all measures to be achieved are referred as Strategic Initiatives. The action plans that define and provide resources for the strategic initiatives must be aligned around the Strategy Map´s themes. The actions plans are an integrated bundle of projects. A portfolio is composed of many projects. A project may add to a goal; it may be neutral or detracting. For instance, a "Data Mining" project may add to a "Good segmentation of customers" goal, but it may be detracting to a "Cost reduction" goal. Projects provide a set of benefits. And goals achievement is dependent on the realization of these benefits. Benefits are the link between projects and strategic goals. If a strategic objective is not related with any benefit then it is not supported by any project.

Benefits delivered by projects have a potential and realized value. Goh defines potential value as the maximum feasible payoff of an IT investment under efficient production conditions (Goh & Kauffman, 2006). This expected return on investment may not be achieved due to factors that arise in the process of implementing the IT or in running the business process in which it is used. Then the realized value is defined as the measurable value that can be identified after the implementation ensues. This representation of IT value emphasizes the consideration of potential value for an IT investment both in *ex ante* project selection and *ex post* investment evaluation. For the purpose of our research we use the potential value during portfolio selection and the realized value during projects monitoring.

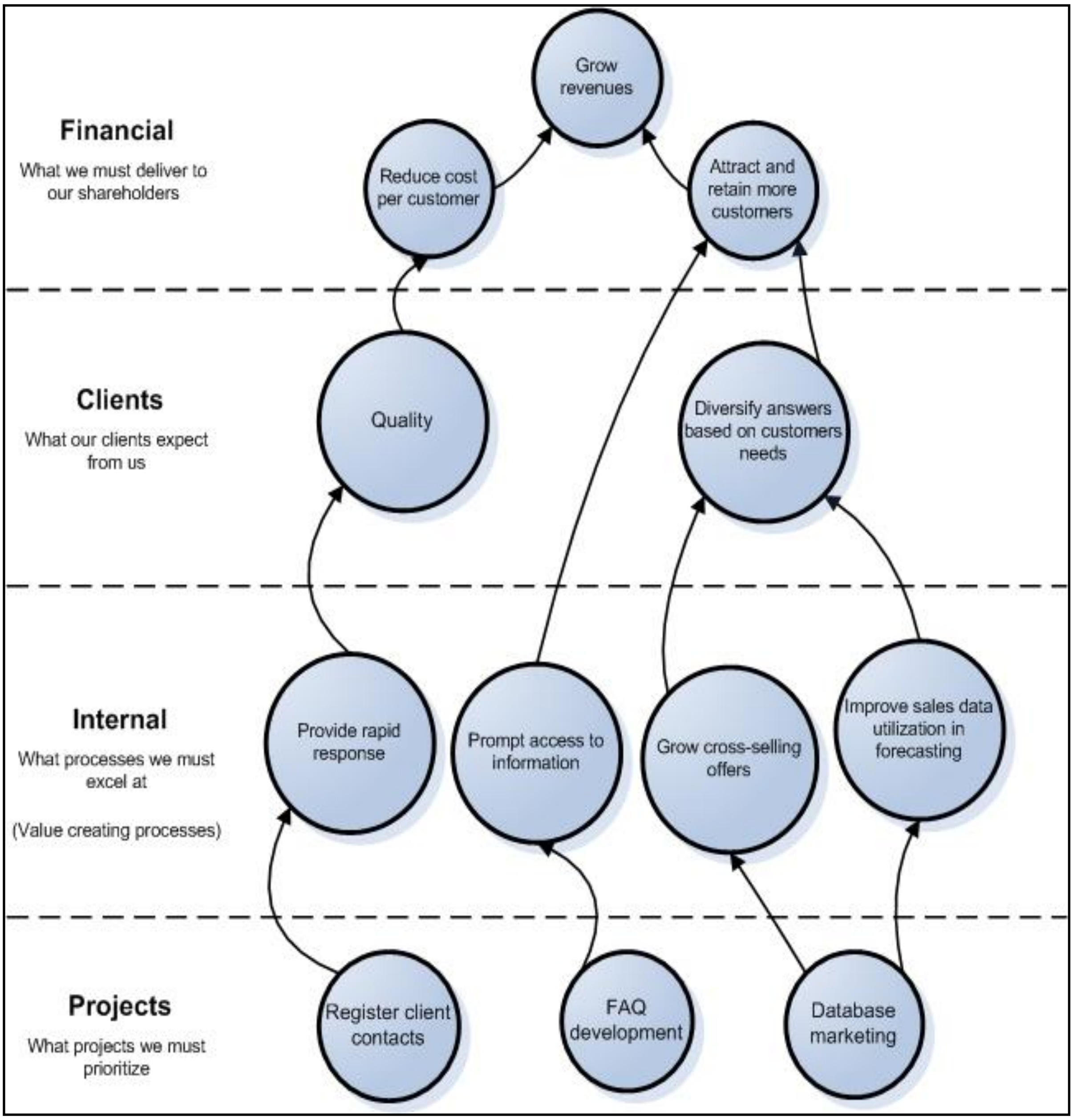
Figure 1 - Information Technology-Strategy Map Conceptual Model.



Source: Elaborate by authors.

As an illustration consider Figures 2 and 3 which show how IT initiatives combine to create a financial payoff from the strategy based on the templates provided by Kaplan and Norton. One operational project (Register customer contacts) and two strategic projects (Database marketing and FAQ development) combine to improve customer value proposition by diversification based on customer needs and providing rapid response.

Figure 2 - Partial view of a Strategy Map. Strategic theme: Customer satisfaction. Observe cause-and-effect relationships between Projects and Internal Perspective.



Source: Elaborate by authors.

Figure 3 - Action Planning for Customer Satisfaction Strategic Theme.

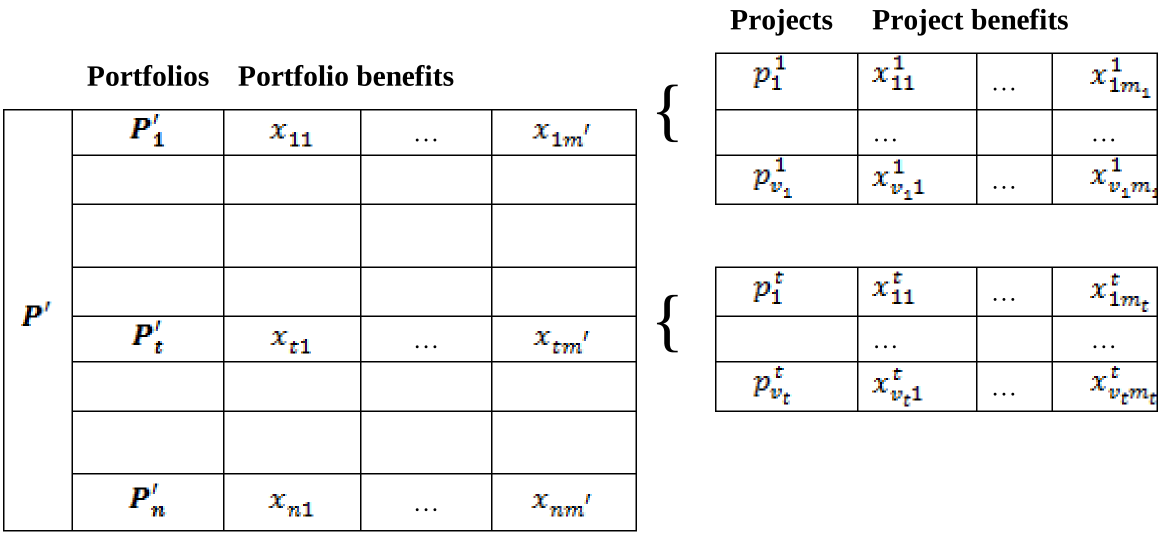
STRATEGY MAP. THEME: CUSTOMER SATISFACTION			ACTION PLAN	PORTFOLIO	
	GOALS	**MEASURE**	**INITIATIVE**	**PROJECT**	**BENEFITS**
FINANCIAL	Grow revenues	-Market value			
	Reduce cost per customer				
	Attract and retain more customers	-Number of new customers -Percentage of customers placing repeated orders			
CUSTOMER	Quality	-Number of customers calls for the same complaint			
	Diversify answers based on customers´ needs				
INTERNAL	Prompt access to information	-Time required to provide information relative to benchmark -Customer satisfaction with prompt information	Web site improvement	FAQ development	Number FAQ replied by operator
	Provide rapid response	-Time delay to reply complaints	Relationship management	Register customers contacts (Relationship management)	Time to answer complaints
	Improve sales data utilization in forecasting	-Percentage of sales data used in forecasting	Database marketing	Database marketing	Use of historical sales data in forecasting
	Grow cross-selling offers	-Cross-sell ratio			

Source: Elaborate by authors.

3.2 DEA MODELS PORTFOLIO SELECTION

We consider a portfolio database *D*, containing n candidate portfolios. Let $P = \{P_t, 1 \le t \le n\}$ be the set of portfolios. Let $P_t = \{p_k^t, 1 \le k \le v_t\}$ denote the projects in portfolio P_t where v_t is the number of projects and $1 \le t \le n$. Assume projects in P_t delivering m_t benefits and let $X_t = \{x_{ij}^t: 1 \le i \le m_t, 1 \le j \le v_t\}$ be the set of all benefits; and producing s_t outputs and let $Y_t = \{y_{ij}^t: 1 \le i \le s_t, 1 \le j \le v_t\}$ be the set of all outputs (forecasted value contribution to goal). The set of outputs is given by the set of all measures that have a "dependency relationship" with any project benefit. The DEA model is employed to select a portfolio (see Figure 4). The approach exploits the Strategy Map as a framework for defining IT portfolio selection criteria and projects evaluation.

Figure 4 - Scheme of DEA-based portfolio selection..



Source: Elaborate by authors.

In portfolio selection, since portfolios in P may have different benefits, we define $P' = \{P'_t, 1 \le t \le n\}$ delivering $m' = |X'|$ benefits where $X' = \cup_{t=1}^{n} X_t$ be the set of all benefits. In other words, $X' = \{x_{gh}: 1 \le g \le m', 1 \le h \le n\}$. Furthermore, let $Y' = \cup_{t=1}^{n} Y_t$, $s' = |Y'|$ where $Y' = \{y_{gh}: 1 \le g \le s', 1 \le h \le n\}$ be the set of all outputs. Note that each portfolio P'_t, $1 \le t \le n$, is the same as P_t except that it has all the benefits in X' (this is necessary to satisfy DEA assumption that units consume the same type of resources). If a portfolio does not provide a benefit X_t then we assume X_t assumes the observed value as it would be if the portfolio is not realized.

In the portfolio selection phase, given a set of candidate portfolios we want to compare portfolios. We propose an assessment of efficiency by means of the comparative study between inputs (benefits delivered by portfolios) and outputs (target measures supported by the portfolio). We assume the units consume the same type of resources in order to obtain the same type of output. We consider the following models of efficiency of the portfolio performance:

- Model P-IP measures the efficiency obtained by the portfolio with respect to the Internal Processes Perspective, that is, the value contribution of the portfolio to the internal processes.
- Model P-C measures the efficiency obtained by the portfolio with respect to the Customer Perspective, that is, the value contribution of the portfolio to the customers´ value proposition.
- Model P-F measures the efficiency obtained by the portfolio with respect to the Financial Perspective, that is, the value contribution of the portfolio to the financial desired results.

In all cases, we are interested in measuring the portfolio and strategy alignment, and hence an “efficient” portfolio should be interpreted as “aligned” or that which benefits supports organizational goal targets.

Table 1 – Portfolio selection efficiency models.

EFFICIENCY	OUTPUTS	INPUTS
P-IP	Internal processes perspective measures supported by portfolio.	Portfolio benefits.
P-C	Customer perspective measures supported by portfolio.	Portfolio benefits.
P-F	Financial perspective measures supported by portfolio.	Portfolio benefits.

Table 1 presents the DEA models developed for evaluating portfolios. These models assume an output orientation and are computed under the assumption of variable returns to scale (VRS). The formulation of the DEA problem as proposed by Banker (Banker, Charnes, & Cooper, 1984) is as follows:

$$\text{Max}\,\varphi \qquad (1)$$

Subject to:

$$\sum_{h=1}^{n} X'_{gh}\delta_h \leq X_{g0} \quad (g = 1, \dots, m')$$

$$\sum_{h=1}^{n} Y'_{rh}\delta_h \geq \varphi * Y_{h0} \quad (r = 1, \dots, s')$$

$$\sum_{h=1}^{n} \delta_h = 1$$

$$\delta_h \geq 0 \quad (h = 1, \dots, n)$$

Assume n DMUs, each consuming m' inputs and producing s' outputs. In our context, we regard these DMUs as portfolios. Let Y_{r0} be the amount of output r generated by unit 0 and δ_h be the intensity variable for DMU h. The score φ obtained from the solution to this linear programming problem is the maximum rate of proportional expansion in all outputs of DMU 0, without decreasing its inputs. The efficiency rate of DMU 0 can be obtained by calculating $1/\varphi$.

By solving model (1) n times (each time evaluating a different DMU at the objective function) we get the relative efficiency scores for all the DMUs with respect to each Strategy Map perspective. Any deviation or inefficiency should be interpreted as a misalignment of the portfolio contribution to the value proposition (we do not have the right portfolio).

Although DEA is a model that empirically establishes a function of production, the objective of this proposal is to assess the fulfillment of the strategic goals by means of three models of efficiency. DMUs are given by portfolios whose inputs values are defined by the estimated benefits, and whose outputs are defined by the strategic goals they support. Hence, an ideal portfolio represents the desired efficiency target. Strategic goals are bounded by the target value. However, in this initial proposal we do not consider bounded variable DEA models.

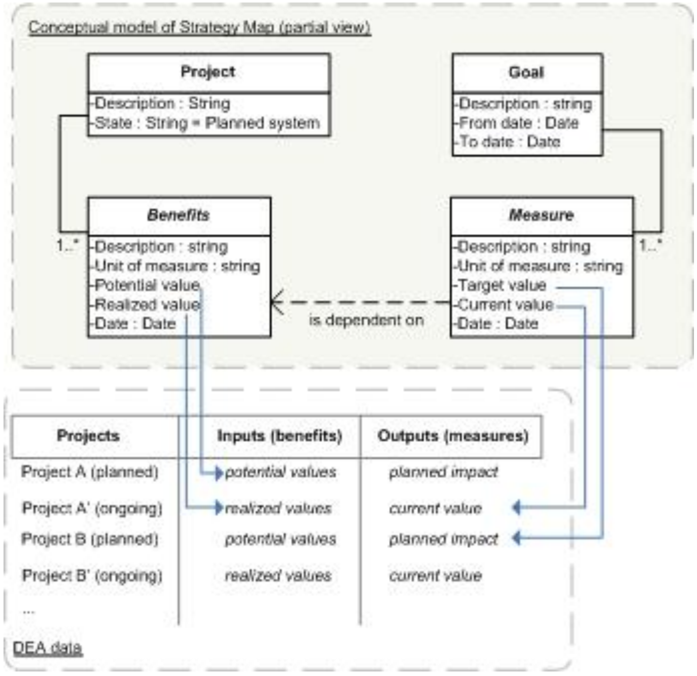
Projects Monitoring

Once we have selected a portfolio, say $P_t = \{p_k^t, 1 \leq k \leq v_t\}$, the focus shifts to projects performance. In the selection phase, the analysis is based on the potential value of projects described in terms of their expected benefits and impact on strategic goals. However, during monitoring the analysis is based on the realized value of projects. The purpose of monitoring is twofold: (a) to assess the realized value of projects with respect to the potential (planned) value; and (b) to measure the value contribution of projects to the organizational strategy. In (Davern & Kauffman, 2000) the authors discusses the pervasive impacts of conversion contingencies within organizations and highlight that a lot has to go “right” for the potential value of an Information Technology project to be achieved following implementation. For example, after a successful implementation of a database marketing project, the cross-sell ratio may not increase as expected because the marketing department has not received an adequate training. Additionally, the Strategy Map is in constant update as new goals are set or existing goals are dismissed as a result of changes in organizational strategy. Hence, it may happen that some projects support past goals. Also, new defined goals may not be supported by any project. Both of these situations reveal a misalignment of IT strategy to the organization´s strategy. And we aim to capture these scenarios using DEA.

The formulation of the DEA problem is as follows. Each project in P_t defines two DMUs: one DMU represents the ongoing project and input and output data are given by the realized value; the other DMU represents the planned project and input and output data are given by the potential or planned value. Hence, based on definitions provided in Section 3.2 we assume $2 * v_t$ DMUs. Also, there may be additional DMUs representing projects that started before selecting portfolio P_t.

Since the purpose of the analysis is to assess misalignment with respect to strategic goals, we consider “current” goals and we gather DEA data as follows: outputs are given by measures of current strategic goal, and inputs are given only by those projects´ benefits linked with at least one measure. More formally, let $M = \{m_i, 1 \leq i \leq s\}$ where m_i represents a measure related with a current goal in the Strategy Map and s is the number of measures. The set of outputs for DEA is given by M. The set of inputs is given by the subset of benefits $X_t^m \in X_t$ where each benefit in X_t^m is linked to at least one measure in M.

Figure 4 - Projects Monitoring (relationship between Strategy Map and DEA data spreadsheet).



We consider the models of efficiency of the projects performance as defined for portfolios, *i.e.* models P-IP, P-C and P-F. However, instead of portfolios we consider projects (see Table 2). In this phase we aim to monitor projects alignment to goals. DEA allows measuring the relative efficiency of the units, and the analysis provides information about projects that have a low impact on current goals.

Table 2 - Projects monitoring efficiency models.

EFFICIENCY	OUTPUTS	INPUTS
P-IP	Current Internal processes perspective measures.	Portfolio benefits related to P-IP measures.
P-C	Current Customer perspective measures.	Portfolio benefits related to P-C measures.
P-F	Current Financial perspective measures.	Portfolio benefits related to P-F measures.

3.3 ILLUSTRATIVE EXAMPLE

We will illustrate DEA by means of the example presented in Section 3.1 (see Figures 2 and 3). We assume there are five portfolios consisting of a number of projects. The model captures the Internal Process Perspective by including three inputs and five outputs. It is desirable that the number of DMUs exceeds the number of inputs and outputs several times (Cooper, Seiford, & Tone, 2006). However, since the focus of this example is on describing how to apply DEA we used a small number of portfolios and projects in order to keep the explanation as simple as possible.

Portfolio Selection

According with our proposal, selected inputs are benefits provided by projects and outputs represent strategic goals' metrics. The inputs are "number of FAQ replied by operator" (a software system is supposed to provide proper information and then customers do not need to call the operator); "time to answer complaints" (a software system would support relationship management by providing access to all transactions performed by the customer); "use of historical sales data in forecasting" (the database development projects would enable the access of data generated by different systems such as sales, financial, customer support); "payroll processing time". The outputs used are "time required to provide information" and "customer satisfaction with prompt information"; "time delay to reply complaints", "percentage of sales data used in forecasting" and "cross-sell ratio" which measure the strategic goals as described in Figure 3.

Table 3 - IT Portfolios.

PORTFOLIO	PROJECTS
1	Web site improvement (minor adjustments)
2	Web site improvement (major development, Relationship management (major development), Database marketing (minor adjustments), Payroll system (major perfective maintenance)
3	Web site improvement, Relationship management, Database marketing (major development)
4	Web site improvement (minor adjustments),Relationship management

5	Payroll system (major perfective maintenance)

The DEA model was run following the BCC formulation, with output-orientation, in order to obtain relative performance scores for the five portfolios considered. Table 4 includes the data used. As can be seen from Table 5, results may be considered an appropriate representation of the portfolios. The DMUs considered good performers (Portfolios 2 and 3) include projects that support strategic goals. DMUs 1 and 4 do not support all goals. DMU 1, should improve all inputs for approaching the efficiency frontier, that is Portfolio 1 should include more projects to provide more benefits. Portfolio 5, which presents the lowest score, includes a payroll system that is not linked to any strategic goal. Table 6 reveals that the output values for DMU 5 ranges from 150 to 700% worse than its reference set. As it can be seen, the lowest score is for the most misaligned portfolio.

To summarize, the ranking is consistent with the value contribution of each portfolio. These results support the decision making process and the final decision regarding the selected portfolio should also take into account other issues such as the available budget and time deadlines.

Table 4 – Portfolio selection, input and output data.

PORTFOLIO	**INPUTS**				**OUTPUTS**				
	Number FAQ replied by operator	Time to answer complaints	1/Use of historical sales data	Payroll procesing time	1/Time required to provide information	Customer satisfaction with prompt information	1/Time required to answer complaints	Percentage of sales data used	Cross-sell ratio
1	80,00	20,00	0,10	5,00	0,08	3,00	0,04	10,00	1,00
2	10,00	10,00	0,02	0,30	0,10	8,00	0,10	50,00	5,00
3	20,00	12,00	0,01	5,00	0,08	6,00	0,08	100,00	10,00
4	20,00	12,00	0,05	5,00	0,07	3,00	0,07	20,00	1,00
5	150,00	20,00	0,10	0,30	0,03	1,00	0,04	10,00	1,00

Table 5 – Portfolio selection: DEA efficiency scores.

DMU	SCORE	RANK	1/SCORE	REFERENCE SET	LAMBDA
Portfolio 1	0,8	3	1,25	Portfolio 2	1
Portfolio 2	1	1	1	Portfolio 2	1
Portfolio 3	1	1	1	Portfolio 3	1
Portfolio 4	0,66666667	4	1,5	Portfolio 2	1
Portfolio 5	0,4	5	2,5	Portfolio 2	1

Table 6 – Portfolio Selection: projection for inefficient DMUs 1, 4 and 5.

DMU I/O	1/SCORE DATA	PROJECTION	DIFFERENCE	%
Portfolio 1	1,25			
Number FAQ replied by operator	80	10	-70	-87,50%
Time to answer complaints	20	10	-10	-50,00%
1/Use of historical sales data	0,1	0,02	-0,08	-80,00%
Payroll procesing time	5	0,3	-4,7	-94,00%
1/Time required to provide information	0,08	0,1	0,02	25,00%
Customer satisfaction with prompt information	3	8	5	166,67%
1/Time required to answer complaints	0,04	0,1	0,06	150,00%

Percentage of sales data used	10	50	40	400,00%
Cross-sell ratio	1	5	4	400,00%
Portfolio 4	1,5			
Number FAQ replied by operator	20	10	-10	-50,00%
Time to answer complaints	12	10	-2	-16,67%
1/Use of historical sales data	0,05	0,02	-0,03	-60,00%
Payroll procesing time	5	0,3	-4,7	-94,00%
1/Time required to provide information	6,67E-02	0,1	3,33E-02	50,00%
Customer satisfaction with prompt information	3	8	5	166,67%
1/Time required to answer complaints	6,67E-02	0,1	3,33E-02	50,00%
Percentage of sales data used	20	50	30	150,00%
Cross-sell ratio	1	5	4	400,00%
Portfolio 5	2,5			
Number FAQ replied by operator	150	10	-140	-93,33%
Time to answer complaints	20	10	-10	-50,00%
1/Use of historical sales data	0,1	0,02	-0,08	-80,00%
Payroll procesing time	0,3	0,3	0	0,00%

1/Time required to provide information	0,025	0,1	0,075	300,00%
Customer satisfaction with prompt information	1	8	7	700,00%
1/Time required to answer complaints	0,04	0,1	0,06	150,00%
Percentage of sales data used	10	50	40	400,00%
Cross-sell ratio	1	5	4	400,00%

Projects Monitoring

We now turn into the monitoring phase. Assume that Portfolio 3 is selected and 4 projects are on development (three are part of Portfolio 3 and the other is older, from now on we will refer to it as the "Old project"). Also assume that the "Old project" was conceived to fulfill some strategic goals that were dismissed as a consequence of changes in the strategy. Hence, DEA outputs represent measures linked to current goals and benefits that contribute to their realization. The "Old project" is not related with any current goal and its benefits are not included in the DEA spreadsheet. Table 6 shows data. Figure 5 and Table 7 summarize results: DMUs that represent planned projects define the efficiency frontier; DMUs that represent the current realization of projects have lower scores; and the "Old project" has the lowest score. Realized projects may not have score 1 for different reasons: because they are not ended, or the planned benefits were overestimated, or some contingencies occurred that undermined the realization of benefits. The "Old project" has the lowest score because it does not support any of the goals present in the current Strategy Map.

Table 7 – Projects Monitoring, input and output data (P:Planned; R:Realized).

PROJECTS	INPUTS			OUTPUTS				
	Number FAQ replied by operator	Time to answer complaints	1/Use of historical sales data Payroll procesing time)	1/Time required to provide information	Customer satisfaction with prompt information	1/Time required to answer complaints	Percentage of sales data used	Cross-sell ratio
Web site improvement (P)	20,00	20,00	0,10	0,08	6,00	0,04	10,00	1
Web site improvement (R)	40,00	20,00	0,10	0,05	5,00	0,04	10,00	1
Relationship management (P)	150,00	12,00	0,10	0,03	1,00	0,08	10,00	1
Relationship management (R)	150,00	15,00	0,10	0,03	1,00	0,05	10,00	1
Database marketing (P)	150,00	20,00	0,01	0,03	1,00	0,04	100,00	10
Database marketing (R)	150,00	20,00	0,02	0,03	1,00	0,04	50,00	3
Old Project	150,00	20,00	0,10	0,03	1,00	0,04	10,00	1

Figure 5 - Projects monitoring: ranking of value contribution based on DEA.

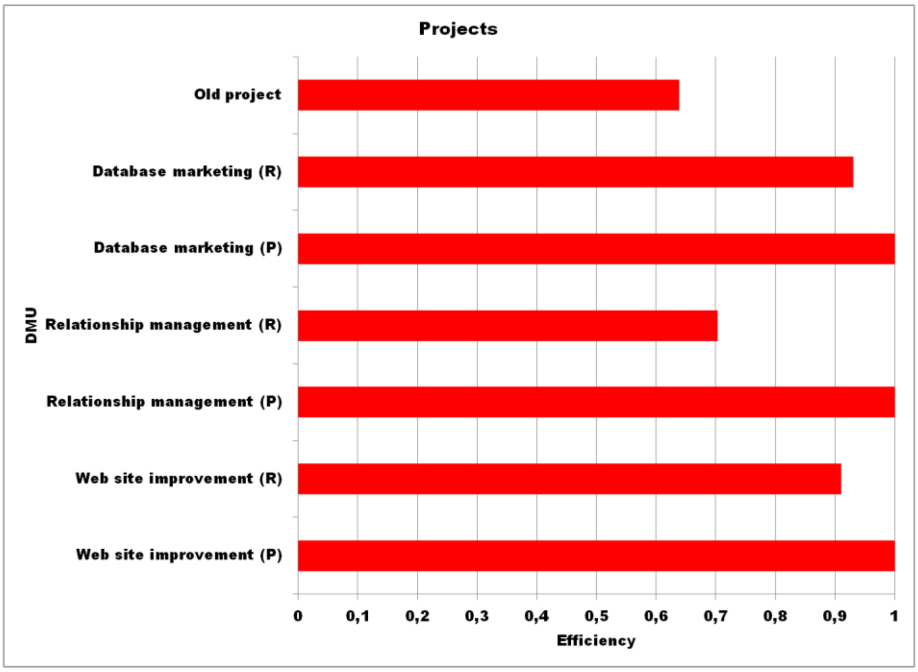


Table 8 - Projects monitoring: DEA efficiency scores.

DMU	SCORE	RANK	1/SCORE	REFERENCE SET	LAMBDA
Web site improvement (P)	1	1	1	Web site improvement (P)	1
Web site improvement (R)	0,91048202	5	1,09831933	Web site improvement (P)	0,89831933
Relationship management (P)	1	1	1	Relationship management (P)	1
Relationship management (R)	0,70376466	6	1,42092955	Web site improvement (P)	0,23677287
Database marketing (P)	1	1	1	Database marketing (P)	1
Database marketing (R)	0,93041151	4	1,07479324	Web site improvement (P)	4,21E-02

Old Project	0,63896318	7	1,56503542	Web site improvement (P)	0,41564713

4 CONCLUSIONS

This research aimed at defining a systematic method to prioritize portfolios and projects according to their value contribution to organizational strategy. Therefore, we need to link the strategy definition with the description of the IT portfolio. We assume that the organization defines its strategy using a Strategy Map. The assumption is not restrictive given the widespread use of this tool in organizations of all types and sizes. In particular, the Strategy Map contains the definition of the organizational goals and their related measures of performance. At the same time, given a portfolio consisting of a set of projects, each project provides benefits. Any investment proposal should include a description of both costs and benefits expected from the investment. In our approach, we relate each of these benefits to strategic metrics. In this way, it is explicit how objectives achievement depends on the realization of projects´ benefits.

Based on this conceptual model we formulate two decision problems to be solved using DEA. In the portfolio selection problem, portfolios are the decision units, and the efficient are the ones that are aligned with strategy, that is those whose benefits better contribute to the realization of goals. To this end, inputs are given by projects´ benefits and outputs are given by the strategic metrics. Once the decision problem is formulated it is possible to apply DEA and as a result we get a score for each portfolio based on portfolio benefits-organizational goals relationships. In the projects monitoring decision problem, projects are the decision units and the higher scores are for those that remain aligned to organizational goals. Since DEA outputs represent up-to-date goals, any project whose benefit does not add up to goals will get a low score. In addition, DMUs representing planned projects will define the efficient frontier and ongoing projects have the chance to be compared with reference to their potential value contribution. We may think about planned projects data as benchmark data.

The main contribution of this work is the ranking of portfolios and projects based on value contribution, as opposed to traditional valuation methods based on financial measures. The approach is based on two solid tools. First, the use of the Strategy Map allows value measuring close to the locus of value. Second, portfolio scoring is calculated using a mathematical based tool such as DEA.

The proposed approach extends previous research by (a) allowing IT value measurement close to the locus of value; and (b) introducing a systematic and formal approach to rank IT portfolios based on the value contribution to the organizational strategy. In (Davern & Wilkin, 2010) the authors address the issue of measuring the value of IT. They explain that one stream of research, which draws on financial accounting and economics, employs independently observable measures, such as capital market reactions, return on assets and changes in market share, to assess the value of IT in an organization. Another stream of research, which draws on the behavioral sciences, uses more subjective measures such as assimilation, user satisfaction, perceived net benefit, and perceptions and expectations of quality. Independently observable measures are more objective but not as proximal to the locus of value, whereas perceptual measures are custom designed to be proximal but are more open to subjectivity (Davern & Kauffman, 2000). A key contribution of our framework is that it facilitates an understanding of the process of IT value creation, from projects´ immediate perceived effects right up to financial measures. The link between projects´ benefits and strategic goals targets builds on the Strategy Map representation and supports analyzing trade-offs among measures and among the perspectives. Therefore, the framework allows both measurements close to the locus of value (using the explicit links between projects´ benefits and goals targets) and using observable measures.

It is worth noting that the proposed approach needs to consider bounded output variables to represent strategic target values. In future research studies we will consider a bounded variable DEA model. Additionally, given that DEA does not provide more information about efficient units, super-efficiency DEA models can be used in ranking the performance of efficient DMUs.

While the proposed framework provides a good starting point for further research, more empirical research on real cases is needed in order to guide the development of tools to support the implementation of Information Technology-Strategy Map requirements.

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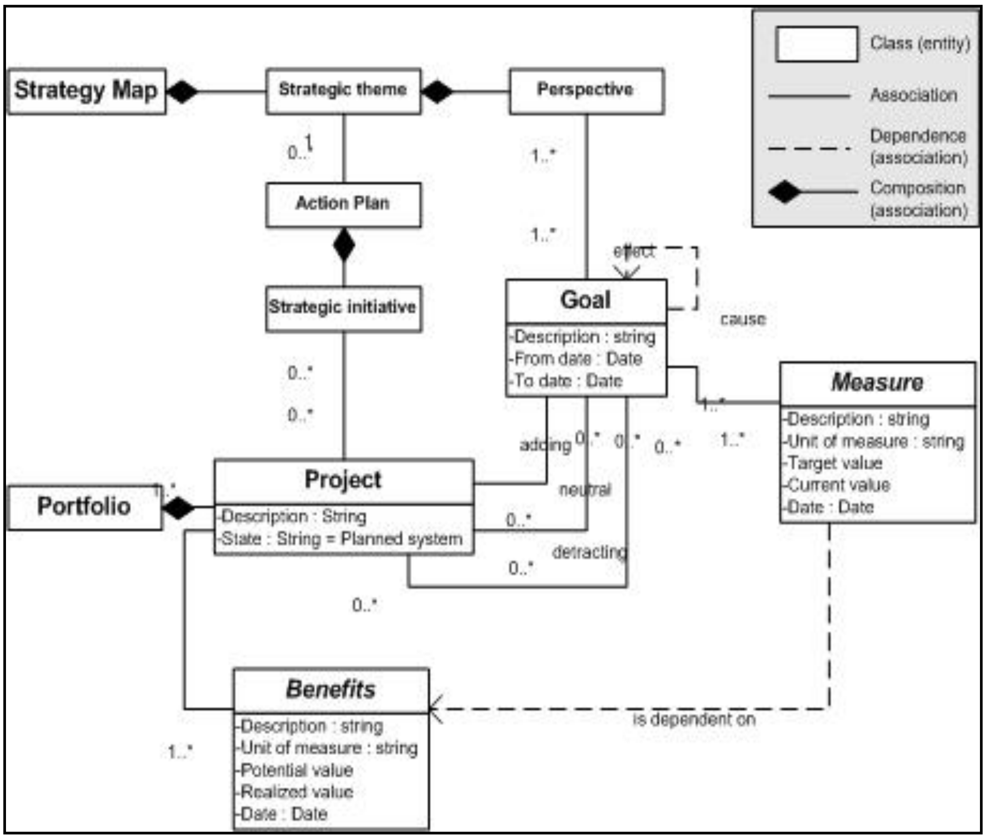
Appendix A: Information Technology-Strategy Map Conceptual Model based on UML

Figure 6 - Information Technology-Strategy Map Conceptual Model based on UML. Source: Own elaboration.



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