An IT Strategic Planning Dynamic Simulation Model under Service Management Orientation

Abstract

Strategic planning is one of the most important processes of any IT Governance model given the economic cost of decisions taken. This research presents a method to determine the strategic objectives in the Information Technologies Strategic Planning process in any type of organization. This method includes a simulation tool that allows suitable and optimal selection for each of the four basic strategies that the model presents: market spaces and service catalogs, organization and outsourcing, technological architecture and value and cost. It also optimizes the value obtained through this dynamic simulation of the basic strategies to achieve these objectives, determines the best possible future scenarios, and prioritizes IT investments. The method has been validated with strong practitioner involvement using action research.

Keywords: IT Strategy Planning, Simulation, IT Governance

1. Introduction

Strategic Planning is one of the most important processes of any IT Governance model given the economic cost of decisions taken [King & Teo, 2000]. It is a process of systematic evaluation of a business to define the medium and long-term objectives, identify goals and metrics, develop strategies to reach these objectives, locate resources to implement the strategies and improve in order to be more competitive [Ward & Peppard, 2002]. This paper presents a method to tackle the strategy of Information Systems (IS) in organizations. It covers both the valuation of IS strategic options as well as the formulation of the IS strategy. The authors propose a way to adequate and optimize the use of strategic methods and tools (SWOT analysis, 5 strength, visioning, etc) of functional areas to evaluate the strategic options of information systems areas. This is done by adapting the techniques to the specific characteristics of the IS and achieving a list of critical change factors or aspects to be improved in the IS domain. After the above process, a strategy is formulated with the help of a simulation model that is fed with the business requirements (the model uses function points without adjustments); the progress is simulated in the planning, design, transition and operation phases. This simulation determines the cost, schedule and value of different scenarios, helping to optimize the strategies and decides on the best combination of basic strategies.

The UK Academy of Information Systems defines information systems as the means by which people and organizations, using technology, gather, process, store, use and disseminate information [Ward & Peppard, 2002]. In all of the Information Technology Strategic Planning (ITSP) definitions, strategy planning is a process in which a series of activities is considered in sequence to carry out an internal and external analysis and to determine the strategic goals that agree with the conclusions of the previous analysis. In strategic planning, not all the definitions include the action plans to attain the strategic objectives. The action plans incorporate a general but clear definition of what resources to use, the conceptual requirements to include and the periods in which to develop the actions.

From an economic point of view, the strategic planning process has to be contemplated at the beginning in order to determine costs, value, risk and flexibility of all the proposed objectives and plans [Porter, 1996]. A complete strategic plan also has to include a definition of the principal metrics that are going to be used in order to control the deviations of the actions proposed in the strategy. This paper presents a model that helps to define the strategic objectives and the basic strategies to achieve them.

In the Cobit model of IT Governance, ITSP corresponds to one of 34 processes, called “PO1 - To define an IT Strategic Plan", that is directly interrelated with 30 other processes in the Cobit domain [ITGI, 2007]. This also the case in Versions 2 and 3 of the IT Infrastructure Library (ITIL); the ITSP is gathered in the "Service Strategy" book in v3 and the "Planning to Implement Service Management" book in v2 [Taylor et al., 2007]. In v2 of the ITIL, the IT Service Management (ITSM) processes are dealt with independently, with a slightly more general orientation and does not centre mainly on the IT services operation [Vernon et al., 2002]. In comparison, in ITIL's v3 Service Strategy, the strategy emphasizes the following processes: analyzing the demand, defining the IT services portfolio, marking and determining the directives of the IT services to provide the maximum value to a given risk. The priority role in ITIL v3 is also considered in the present paper. Other IT-oriented Strategic Planning models of interest to this study are Lederer's methodology [Lederer& Sethi, 1988], King’s Information Systems Strategic Planning model [King, 1978] or the small and medium enterprise approach that reflect on the role of information as a strategic resource [Levy & Powell, 2000].

Our model follows the ITIL’s v3 philosophy because:

- It orients IT services and deals with levels of service that facilitate integration with the functional areas (finance, logistics, distribution, etc.) [Braun & Winter, 2007].
- It follows the IT services life cycle, which is the natural order of IT Services processes, and it facilitates the use of simulation tools based on system models with feedback.

The complete strategic planning scheme proposed is similar to Mintzverg's four-level scheme [Mintzberg, 1994]:

- **Strategic perspective:** To define the path to achieve the Vision and Mission.
- **Strategic position:** To describe the decisions to adopt in greater details.
- **Strategic planning:** To indicate how to get from "what" to "how".
- **Execution pattern:** To describe how to act and be consistent with the defined strategies.

This paper presents the first two steps of IT Strategic Planning, which are re-defined in this research as follows:

- **Valuation of IT strategic options:** The first aspects to be defined in a strategic planning process of IT Services are: the mission or purpose, the vision or future scenarios to position an IT organization as well as the *raison d'être* and the values that the IT organization wants to pursue. This includes the use of all the existing internal and external analysis techniques. Section 4 (To identify IS Critical Change Factors & scenarios) describes a method to integrate and provide IT orientation for the different strategic techniques.
- **Formulation of the IT strategy:** The proposed model has to be guided by a strategic decision frame governed by the basic strategies. This IT strategic frame, apart from the decisions IT organization takes, will be influenced by the maturity of the company compared to others in the sector. The simulation model, which has the essential techniques to forecast the extent to which each of the basic strategies is used to optimize the IT value, is executed in this step. The model is summarized in section 5 (Definition of the Strategic Planning Simulation Model).

Simulation is an indispensable technique in IT Strategy Planning since multiple internal and external variables have to be considered to take the right decisions. In IS, as in other areas of an organization, bad decisions result in significant losses for the organization. In addition, in environments subject to vertiginous changes, where the IT organizations have to carry out important changes over a long period [Porter, 1980, 1996] and modeling tools are essential too. Models are constructed by means of scenarios that allow the correct adjustment of the basic strategies in any IT strategic planning process [Bequette, 1998] [Lederer& Mendelow, 1987]. The authors define basic strategy as “the declaration of the ways in which the strategic objectives will be reached". Figure I shows the decision-making process for each basic strategy. The basic strategies the simulation model optimizes are:

- **Basic strategy of market spaces and service catalogs:** It will indicate the scope of our IT services from the point of view of demand. It defines combinations of IT service archetypes and IT asset services for planning as well as the market each is oriented to.
- **Basic strategy of organization and outsourcing:** It tells us in which areas of the organization each of the IT services are decided and developed. It also determines the scope management with information on number of subprojects and phases and team size threshold according to the level of risk. This aspect determines the number of teams working in parallel. The degree of outsourcing is defined in this basic strategy. Also defined in this strategy is the centralized or distributed level of the IT solutions.
- **Basic strategy of technological architecture:** The high-level considerations for the technological architecture are identified, determining the extent of the use of commercial solutions versus custom development, CASE tool use, type or generation of programming language and database type, level of design, development and project management methodologies. Also measured by the degree of synergy is reusability and dispersion in time using similar or divergent technologies.
- **Basic strategy of value and cost:** The commitment to value strategies (best of the breed solutions and very innovative or high adapted solutions) or opting for other solutions focused on cost savings (free software solutions, software packaged for mass use, personnel with little experience, etc.) are defined. Also defined in this strategy is the level of adaptation to the commercial solutions.

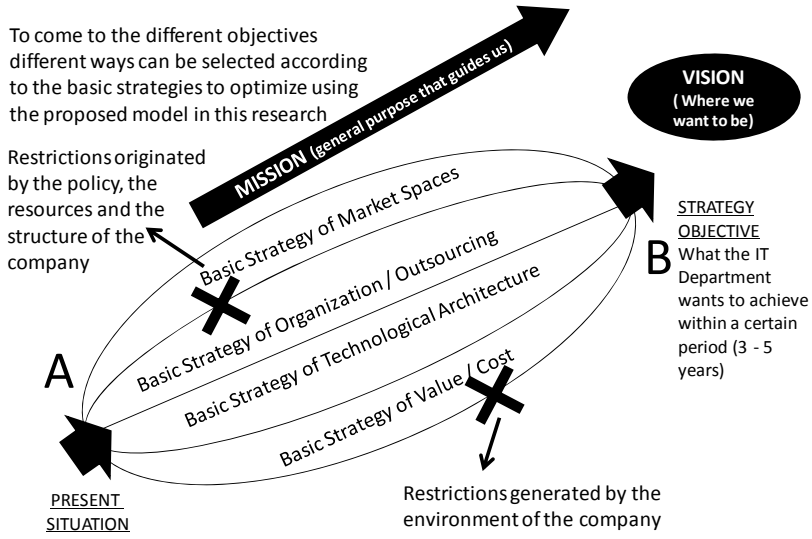


Figure I: Different ways and definitions of basic strategies to reach the IT strategic objectives.

2. Research goal and methodology

This research answers the question of how strategic planning in IT organizations has to be done to achieve results aligned with the business considering the IT operation and IT developing and the peculiarities of IT services. We propose a model that covers the following two objectives:

- Evaluate strategic options to propose strategic lines according to some critical factors identified for improvement.
- Formulate the strategy through dynamic simulation model to propose an optimal configuration for the variables that underlie the IS basic strategies (productivity, number of employees, maturity of the tools, IS quality, etc).

This model should help to propose strategic lines under value concerns, considering all the phases which ITIL v3 provides.

The contributions of this model are closely linked to the two objectives mentioned:

- Provide a dynamic model that encompasses the strategic functioning of the IT department as a whole that is not limited to managing a single project. Inter-linkages, synergies and penalties that occur between projects makes this approach interesting.
- Employ one of the best practices such as ITIL v3, currently used in IT organizations. Service orientation allows to integrate the development and operation phases within a single simulation model.
- Propose a model where input data are structured according to basic strategies. The basic strategies are the decisions it makes in any IT planning process, and these make using the model easier.
- Consider the language and variables that governance models contemplate (residual risks, alignment, demand management, resource efficiency, etc), providing a greater degree of maturity than classical models based on the software field or that are not limited to strategic range.

One of the longest task in the simulation models is the validation [Balci, 1997][Jain, 1991][Kleijnen, 1995]. The model was tested through "action-based research" with deep involvement of ten IT Governance practitioners with over twenty years' experience and two review cycles, 1) reading detailed design document that defines the model, resolving questions and filling in a form consisting of nineteen questions and 2) after including the improvement proposals identified in the first review. The validation period lasted three years from the first available version of the model.

The hypotheses used in the last step of the validation were:

- The method and the proposed model structures add value to the IT strategic planning process compared to traditional solutions.
- It is helpful for IT Strategic Planning to consider the following aspects: identify critical change factors, determine the basic strategies and scenarios and define and implement the simulation model.
- The list of tools and methods for strategic planning proposed in the study is complete.
- Customized tools and methods for the IT sector and, as a result of all the methods proposed, a structured list of Critical Change Factors add value to the IT Strategic Planning process.
- The four basic strategies proposed in the research are the most important to be defined in any process of IT strategic decision.

- The proposed simulation model helps to define IT strategic objectives more appropriately and encourages internal debate to optimize the strategies.
- The dynamic process to move Function Points (FP) between different phases (planning, design, transition, operation and continuous improvement) is considered the most suitable for simulating the performance of an IT department.
- The variables and relationships shown in market spaces and service catalogs are considered the most appropriate.
- The variables and relationships shown in organization and outsourcing are considered the most appropriate.
- The variables and relationships shown in technological architecture are considered the most appropriate.
- The variables and relationships shown in value and cost are considered the most appropriate.
- The output variables that the model proposes (value, cost, time, synergies and quality) are the most suited to assess the IT strategy.

The general questions in the validation form were:

- Years of experience in IT Governance or IT Strategic Planning.
- How many IT strategic planning processes have you ever conducted or participated in?
- Do you know any reference or bibliography of interest in the subject that is not included in this publication?
- Do you know and have you used the tools and methods applied in IT strategic planning mentioned in the research?
- Have you ever used or are you familiar with simulation models and their use in IT strategic planning?
- Which department or role within your organization is responsible for IT Strategic Planning? Do all the functional areas involved in IT strategic planning participate in an integrated manner?

The hypotheses mentioned cover the two research objectives. During the validation, based on action research, the proposed model was applied to several real business cases research in ten companies (large telecom company, large oil & gas company, large distribution company, large transportation company, medium insurance company, medium gaming company, small telecommunications company, large health software company and two consulting companies). Table I shows a summary of four cases. In the complete version, Table I incorporates a column with the ITSP technique used and another with the critical variables to load as entry data in the simulation (it depends directly on the Critical Change Factors). Critical Change Factors or IS_CCF are every internal or external improvement feature of the Information Systems; they have strategic importance, add value under an assumed risk level and must be valued according to value, cost, risk and future synergies.

Table I: Three Most Important Critical Change Factors of four IT organizations studied for model testing.

	CRITICAL CHANGE FACTORS
Test 1: Process Industry (SAP R/3)	- Technological obsolescence. - Lack of integration with other applications. - Disparity of control methods.
Test 2: Telecommunications Industry (SAP R/3+ Customized Development)	- Better systems for reduction and control of accounts receivable and unpaid. - Creation of a pilot study to choose new system architecture. - Correct control of stress tests.
Test 3: Retail Industry (JDEdwards+ Customized Development)	- Adjustments in packaged solutions control. - Technological integration of a new organizational reality. - New changes in the environment with fixed completion date.
Test 4: Distribution Industry (SAP R/3)	- Utilization of synergies of previous investments. - Technological solutions agreed on by company

	- group with possibility of sharing management efforts. - Refine historical information.

3. State of the Art of IT Service Management Models to Simulate IT Strategic Planning

Simulation models are essential in any strategic planning process given the difficulty of forecasting the future in environments affected by many variables, generally with unknown evolution. Among the variables of interest to the decisions to be made in any IT department are: external variables (regulations, fashions, technological work force, etc), internal variables of the functional areas of the company (mergers, new products and technological services, experience, etc) and internal variables of the IT department (business processes to be covered, degree of IT outsourcing, customized or packaged solution, etc) [Lederer & Sethi, 1996].

One of the core concepts in strategic planning is the alignment between business and IT. There are models to help align both the strategies and processes between business and IT [Silva & Chaix, 2008][Dickmann et al., 2007]. Based on the ITIL best practice, as in the present research, we find dynamic simulation models of incident management process [Bartolini et al., 2008] which report metrics such as Mean Time To (incident) Resolution (MTTR) and Mean Incidents Closed Daily (MICD). With a broader scope covering the service desk, incident and problem management, Lee's proposal helps to understand the delays and variance between activities [Lee et al., 2007]. There are several research models based on IT service management which, although not supported in simulation tools, report the main factors to consider. A decision support tool to evaluate different strategies to help organizations to better align with business objective is proposed by Bartolini [Bartolini et al., 2009]. Braun & Winter show a meta-model of service management and relations with the other components of enterprise architecture [Braun & Winter, 2007]. There are detailed models that explain the relationship between customers and suppliers of IT services, and the main variables of a user help desk [Garschhammer et al. 2001]. There are proposals of a model classified as organizational, process and technological model to use with ITIL [Zhen & Xin-yu, 2007].

Another standard such as ITIL, that works in the strategic, tactical and operational areas, is CMMI. A simulation model based on CMMI can help improve the CMM level while anticipating risk of changes [Raffo et al., 1999]. The outputs of this model are effort, staffing, schedule and product quality. Some models proposed that entries and exits should have the simulation models for each level of maturity and thus optimize the implementation of CMM [Christie, 1999] [Miller et al., 2002] [Zhang, 2007]. Also simulation models can be used to find strategies to change and improve existing software development practice using the relationship between the CMMI process areas and the balanced scorecard perspectives [Dickmann et al.2007].

A summary of the whole references consulted and considered in this investigation are shown in Table II. The X axis shows the planning phase and the Y axis provides information on the scope of planning (a software process, information systems or the organization or sector as a whole). There are references that provide a simulation model supported by a tool and graphic results and there are others more conceptual models or theoretical approaches. The criteria for selecting these references is their proximity to the scope of this research:

- Those covering simulation models in the software engineering or information systems fields.
- Those dealing with the IT strategic planning process by presenting a model or selecting factors or variables to consider.

Table II: References considered classified according to the scope and the planning phase.

		RESEARCH SCOPE		
		SOFTWARE ACQUISITION & DEVELOPMENT PROCESSES	INFORMATION SYSTEMS	ORGANIZATION / SECTOR / SOCIETY
PLANNING PHASE	PERSPECTIVE AND POSITION	Kahen et al., 2001; Kellner, et al. 1999; Madachy, 1994; McChesney, 1995; Sterman 2000	Cohen, 2008; Kagen et al. (2001); Kardaras & Karakostas, 1999; King & Teo, 2000; Kunnathur & Shi, 2001; McIvor, et al. 1997; Min, et al. 1999; Peffers & Tuunanen, 2005; Segars & Grover, 1998 Thong, 1999; Teo & King,	Armstrong, 1982; Boonstra & Vries 2008; Croteau, 2001; Doherty et al. 1999; Ein-Dor & Segev, 1978; King & Teo , 1997; Forrester, 1994; Fowler, 1999, 2003; Haltiwanger, 2007; Keating et al. 1999; King & Teo, 2000, King 1978; Kunnathur, 2001; Lederer & Sethi, 1988, 1996; Levy,

		RESEARCH SCOPE		
		SOFTWARE ACQUISITION & DEVELOPMENT PROCESSES	INFORMATION SYSTEMS	ORGANIZATION / SECTOR / SOCIETY
			1997; Wang & Tai, 2003; Ward & Peppard 2003; Wexelblat & Srinivasan, 1999; Wolstenholme, 2003	1994; Levy & Powell, 2000; Li & Chen, 2001; Liu et al.2006; Luftman et al. 1993; Marshall & McKay, 2004; Melao, 2000; Mintzberg, 1994; Mohdzain, 2007; Morecroft, 1984; Rozinat et al.; 2008; Senge, 1994; Teubner, 2007;
	PLANNING AND EXECUTION	Abdel-Hamid, Tarek, 1989, 1991; Balsamo & Marzolla, 2003; Choi et al., 2005, 2006; Chroust, 1996; Collofello et al., 1998; Curtis et al., 1992; Donzelli & Iazeolla, 2001; Houston, 2001; Kouskouras & Georgiou 2007; Lin et al.1992; Merrill & Collofello, 1997; Olson, 2003; Pfahl & Lebsanft, 1994; Raffo et al., 1999; Rodrigues & Bowers, 1995,1996; Rodrigues & Willians, 1996; Rus et al.,1999; Scacchi, 1998; Shen, 2008; Stallinger & Grunbacher, 2001; Sterman 2000; Tvedt & Collofello, 1995;	Bartolini et al., 2008, 2009; Birkhölzer, 2005; Christie, 1999; Garschhammer, etal. 2001; Lee et al., 2007, Li et al. 2001; Miller et al.; 2002; Williford & Chang, 1999	Bider & Johannesson 2002; Ford & Sterman 1997; Kahen, 2001; Kardaras & Karakostas, 1999; Kunc, 2005; Lakey, 2003; Levy, 1994; Spector et al., 2001;

After analyzing the state of the art it was considered beneficial to develop a dynamic model that covers only the strategic level, gives instructions per basic strategies and to integrate the development and operation phases as ITIL v3 proposes. None of the references analyzed completely cover the aspects mentioned.

4. To identify IS Critical Change Factors & scenarios.

There is a wide range of techniques used in the first steps of the IT strategic planning process [Porter, 1980] [Marshall&McKay, 2004] [Levy & Powell, 2000]. These have all been taken from the strategic planning area of big companies and simplified and adapted to the IT field to facilitate their practical use. The reason is that many of the techniques fall outside the responsibilities of the CIOs and have to be adapted to IT.

As these techniques have different uses, some can be more useful than others. For example, although the SWOT analysis may overlap, it is not a substitute for the five forces analysis since the latter only focuses on external topics and its classification gives more importance to competitive factors than general details on threats and opportunities.

It is essential not to forget that there is a link between the different steps of the strategic planning process [Rogers & Bamfordb, 2002] [Silva&Chaix, 2008]. Often the "Valuation of Strategic Options" step leads us to treat it independent of the “Formulation of the Strategy" step. To avoid this, the authors propose that the different valuation techniques should generate a list of Information Systems Critical Change Factors (IS_CCF), the starting point to defining the strategic objectives. With the IS_CCF list, we can then think about the strategic objectives that the IS_CCF resolves. The simulation tool proposed validates the strategic objectives and the basic strategies to achieve them.

Another problem of importing Strategic Planning techniques from big business corporations is adapting them to the IS department. For example, Porter's value chain is an indispensable tool to analyze the different activities of the company and the sequence of these activities. In the IT world, the same value chain has to be used to analyze the centralization and decentralization of the systems and how they are covered. The analysis of the sequence of Porter's activities must provide the quality of the principal interfaces and the delays that they incorporate.

Table II shows the different techniques relating to “Evaluation of Strategic options" and “Formulation of the Strategy" (grey columns) and the type of IS_CCF obtained. Although the IT Balanced Scorecard (IT BSC) is used in the deployment of the strategy (after the valuation and formulation phases), it is also considered in the initial steps of the strategy because it helps to define the strategic objectives and ensures that the definitive strategic objectives are well balanced (present and future needs as well as internal and external needs). Table I summarizes the three most important IS_CCFs that were detected in real projects where the model was tested.

Table II: Valuation and formulation of IT strategic planning techniques

Technique Used In The IT Strategic Planning Process	Valuation	Formulation	Planning and Execution	Type of Strategic Information Obtained or Critical Change Factor to Obtain
Visioning	X			IS_CCF to consider when defining the orientation of the IS, or to determinate how to position the department.
Stakeholder Analysis	X	X		IS_CCF to bear in mind in order to meet the expectations of associates and the rest of the entities influenced by the IT organization.
Drama Theory	X	X		IS_CCF that help us in the positioning with other parts of the organization (principally functional departments) or in relation to suppliers and competitors.
Methods of Problems Structuration	X	X		In view of some problems detected, IS_CCF that is necessary to consider when solving the existing problems IT or detecting future problems early.
Resource analysis	X	X		To face the shortage of resources because of the magnitude of the technological investments. With this technique IS_CCF, related to the resources of all kinds of system assets (financial, human resources, hardware capacity, etc), are detected.
SWOT Analysis	X			IS_CCF relative to the goals detected after analyzing internal (strengths and weaknesses) and external (threats and opportunities) aspects.
Five Forces	X			IS_CCF relating to competitors.
Matrix of Portfolio Management of IT Services and Products/ Life's cycles of IT Services & Products / Hype Curves	X	X		They provide the IS_CCF related to improving the maturity and obsolescence of the technologies as well as controlling the risks that the new technologies carry.
Risk and Decision Analysis	X	X	X	IS_CCF at the moment of incorporating the risks in the decisions taken.
Financial measures and Impact on Profits	X	X	X	CCF will indicate what innovative IT strategies will contribute to value as well as considerations relative to the different Market Spaces the IT services will operate in.
Analysis of Strength	X	X	X	Among different alternative strategies, it will allow to find the IS_CCF that help to determine which are more adapted to the IT strategies
Real Options	X	X	X	It will allow to determine which alternative strategy is more adapted to obtain IT value.
Balanced Scorecard		X	X	To assure that all the objectives defined are correctly balanced and contemplate innovation and the stakeholders needs.

5. Definition of the Strategic Planning Simulation Model

5.1. To establish the IT Service Management generic Model

The model follows the life cycle of the IT services ITIL v3 proposes. The five phases of the life cycle are established: service planning, service design, service transition, service operation and service continuous improvement. The model moves function points (FP) [IFPUG, 2005] without adjustments from one phase to the other according to how fast the design, development, transition and operation advance. The model calculates the flow rate according to the productivities of design, transition and operation ranging from 0% to 100% according to some variables. These productivities are multiplied by the standard or FP that are designed, operated (in maintenance) or in transition for one month under ideal conditions of operation. To determine the total FP to be finished in the month, it is necessary to multiply productivity by standard and number of people. These three variables are dynamic variables that evolve over time. The starting FP is given based on the market space in which they will be presented and the composition of the service catalog.

As figure II shows, the model contemplates that the development is by coding or configuration as happens in today's organizations. The model considers the operation supporting the FP in incidents and problems, where incidents can convert to problems or revert to the operation phase. The model is tested to support less than 30% of outsourcing because above this value the model loses its meaning and has to be

used by service provider organizations. The following paragraphs describe how the model works according to the four basic strategies that it simulates.

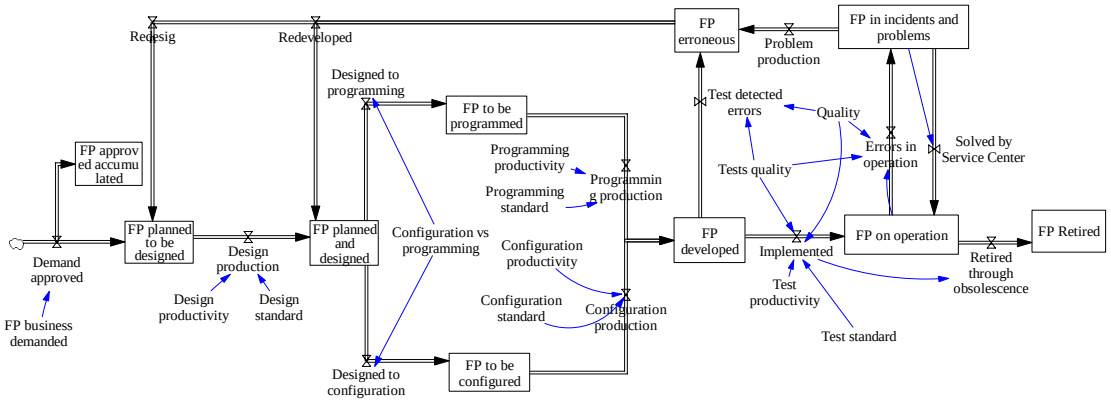


Figure II: Schema of overall simulation model.

5.2. Market spaces and services catalog view.

Strategic planning, together with continuous improvement, is the domain in which changes in the organization's information systems are introduced. The need for change will depend on the current misalignment of the information systems of the organization with the business [Coveney et al, 2003], the obsolescence of the information systems technologies as well as technological advances in the IT environment. The speed of change will depend on the extent of the organization's investments and their efficiency.

The model maintains the function points of the service catalog grouped by nine service areas:

- **Four areas of support services:** communication services (networks, routers, etc) computational services (computers, servers and databases), technology management services (support centers, capacity management, security management, backup, micro, etc) and IT governance services.
- **Five areas of business application services:** HR services, production and logistics applications services, customer management services, financial services and business governance services.

The model takes the planned evolution of theoretical or ideal requirements of the sector as input data [Ward, 2002]. As the requirements do not have similar dimension, the model uses function points without adjustments. This demand is believed to be how the industry should evolve. In the model the additional function points is charged by month for each of the nine service areas mentioned. In real life this information is based on forecasts or trend analysis IT analysts and experts send, or the evolution of more advanced sectors.

The model can be used in new organizations without information systems in place as well as in organizations with information systems running. The theoretical demand to implement in the organization is obtained from the difference between current function points running in the organization and the evolution of function points according to the latest trends. The latest trends are defined in the model as the requirements innovative organizations would implement for a logical risk from a value searching point of view. The model also translates the number of function points in a maturity level by service area.

This theoretical demand has to be adjusted to the factor that measures the demand that the organization itself is able to recognize and depends on several aspects: how simple or complicated the business is, IT governance maturity (this variable incorporates concepts such as alignment, maturity in the understanding of new technology and leadership, among others) and maturity in change management. This demand is called recognized demand in the model. According to the above variables the model assigns a delay and reduction-rate on theoretical demand function point. Another model variable is change management maturity that measures the ease of the organization to carry out information systems changes and the profile of the team to lead and assimilate change. In the model, recognized demand is converted into approved demand by a factor that takes into account the level of investment, the organization risk profile and the position of competing organizations. The risk profile will depend on the sector innovation level, the compliance requirements and the degree of innovation that the new demand incorporates.

5.3. Organization and outsourcing view

The shorter the period to implement the change, the bigger the project is and the bigger the communication complexity the different teams will have. The reason is that many of them have to work in parallel and, consequently, the workload and the difficulty increase. The quality of communication

between teams is a variable that is considered in all the phases of the IT services life cycle of the IS of the model. The model is loaded with the maximum number of FP that the organization is able to design or to implement in one month and it will affect the completion date and the quality of information systems. This is how the model considers the number of projects, subprojects and phases in the simulation. Also another variable is the minimum number of FP that has to be designed to begin development (depending on the use of agile methodologies). The model also controls the minimum FP that must be developed to begin the testing phase.

The planned demand is calculated for a standardized organization where all functional requirements are performed by a single Information Systems department. In the case of much disparate software in different business areas of an organization, function points or requirements will be penalized by the variable synergy. Synergy is the future savings based on present decisions (shared training, shared communication networks, shared information, etc). Many different providers and architectures under a single IT organization will result in significant future expenses. The variable synergy measures the percentage of effort that involves a second implementation in a similar environment when the first was done. As the model works by simulating information systems over several years, it can calculate a degree of synergy (100% fully equal architectures are used, or 0% each new project does not use resources from a previous project).

In the case of much decentralization, which entails the same requirement to be developed and installed in more than one location or organization, the variable decentralization inform about them. The reuse variable considers the reduction of effort that the organization can achieve using modular software previously implemented. Instead of IS decentralization leading to a large distribution of applications, it will duplicate the same functionality for different business lines. Both the degree of synergy and the degree of decentralization are standardized and over-load or under-load percentage is measured against full synergy and no-decentralization organization.

The model is for use by design and development organizations. In organizations where the work is fully subcontracted, the model does not work because the cost model is given by the suppliers' invoicing plan and the risk is transmitted to the suppliers. In any case, the model allows up to 30% of outsourcing and in this case FP are loaded directly in the planned month in the operation phase without affecting either detailed design or development.

5.4. Technological architecture view

This view identifies high-level considerations for the technological architecture. It determines the extent commercial solutions used versus custom development, CASE tool use, type or generation of programming language and database type, employment level of design, development and project management methodologies. All these variables affect productivity and quality in both the design and development phases, with the quality of information systems being a formula weighted by the quality of design and development. The quality goes from 1 to 5 following a maturity scale. To know the FP designed, developed or tested in a month it is necessary to multiply the standard, the productivity and the number of people. The standard is the number of function points completed in a month in an environment working under perfect conditions and depending only on the technological architecture to be used (for example, the standard changes depending on the case tool or the generation of language programming). Productivity depends on specific conditions of the organization and goes from 0 to 100. The variables involved in the productivity of design and development are:

- Planning and design phase: Business complexity, experience and training design team, ease of communication, design tools and paradigms, maturity in project management, quality of project documentation, design team motivation and user involvement.
- Development Stage: Innovation and stability of programming languages, innovation and stability of COTS, Business complexity, experience and training development team, ease of communication, development tools and paradigms, maturity in project management, quality of project documentation, development team motivation.

The variables have different weights and are used to calculate productivity and quality (with different conversion weights). In existing organizations data are often taken from the records of the projects (lessons learned information). When organizations are new, the values taken may be provided by the International Software Benchmarking Standards Group. The Project Delivery Rates (PDR) give information by project attribute (application type, development type, database used, language type, use of methodology, etc) and by lifecycle phase breakdown (plan, specify, build, test and implement). The translation of the PDR to the variables used by the model (standard and productivity) is direct.

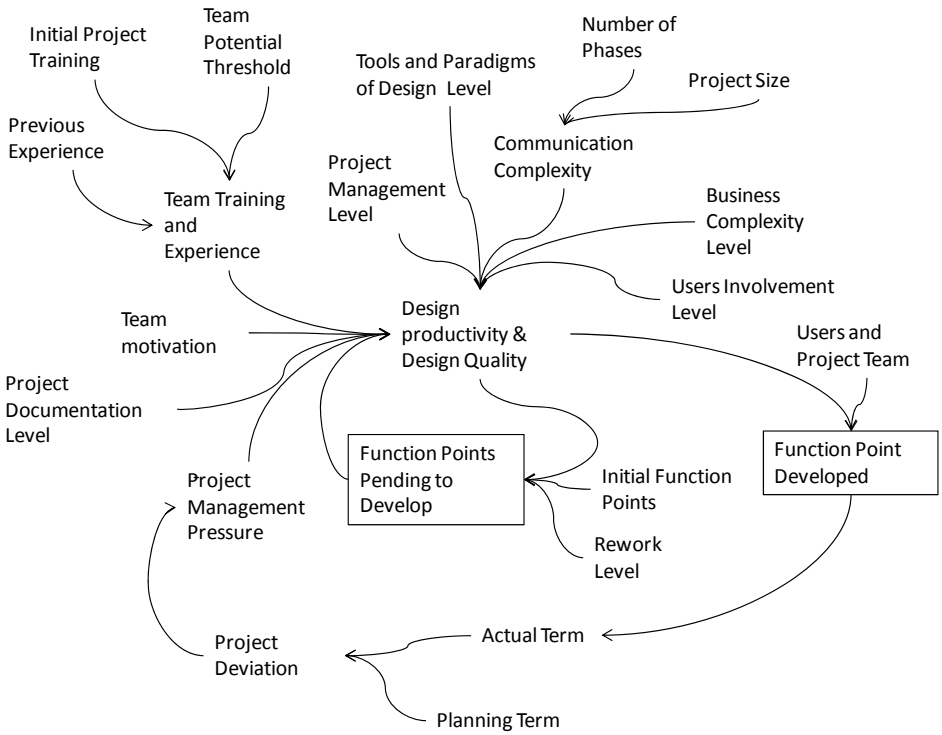


Figure III: General operation of the model to implement the standard and productivity that control the speed of the model (the figure is about design).

Given the large number of COTS that is currently used in organizations, the model considers the percentage of function points that are developed through coding and configuration, with different standards and productivity.

A key aspect of the model is the rework that is based on two variables: the quality of information systems (taking quality of design and quality of development separately) and the quality of the test. The quality of information systems provides a number of incidents and problems that will arise in operation (the model considers that the lack of quality has to be solved). If the quality of the test is good, a large number of these incidents and problems are detected in the testing phase; and will not be detected by users. If the test quality is bad most will be found in the operation phase.

5.5. Value and cost view.

The model does not calculate an exhaustive cost detail or value detail that the IT services generate. Often, to calculate the value or cost in detail implies an effort that is not worth it because of the degree of uncertainty and risk in the initial steps of the planning process (the forecast is for 3 or 5 years). But this does not eliminate the importance of providing comparative information on cost and value in different scenarios. It is more than enough to know by how much costs vary (without being excessively meticulous) according to the scenario chosen. The outcome variables of the simulation model proposed are:

- **Value:** The demand management model communicates the function points distributed by service areas. Once the FP go into operation the model distributes them by service area. To calculate the value will depend on how these function points will impact on the ten value carriers that the model defines: optimized physical and financial inventory; improved asset utilization; reduced future investments; optimized interest, taxes and expenses by compliance; reduced administrative and marketing expenses; lower production and logistics costs; increased volume of revenue from new products / services; increased revenue from new customers; increased revenue margins; improved corporate image / brand. Each of these value carriers are associated with a formula that gives the value in Euros. For example, if 1000 FP go into operation, the model, by cross multiplication, calculates the FP by service area (for example: 150 FP of customer administration service area) and if every 1000 FP in customer administration service area gain 10 clients and each client has an annual margin of 23 Euros, the model has all the data to dynamically calculate the value by month of function points in operation. The value is calculated out of the model.
- **Deliver achievement:** It measures the term since planning and designing the requirements are pending until the systems are in operation, and compares the simulated with the planned term.

The other term that the model controls is in operation (depending on the useful life parameter loaded in the model).

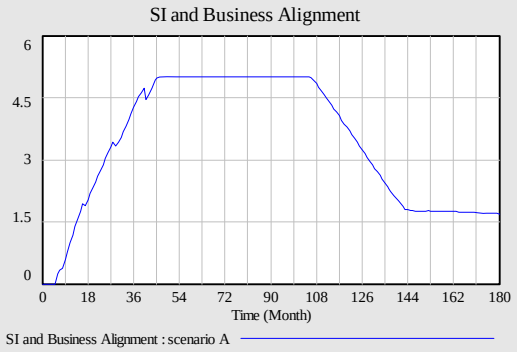
- **Cost:** It is considered as the simplified version of the “Total Cost of Ownership" with only three items: cost of hardware services, cost of software services (licenses, outsourcing, software design and software testing) and cost of operation services. The whole dynamic model contemplates a scenario between 3 and 5 years (obtaining simulations up to ten years is excessive considering the degree of uncertainty), but is considered in hours of mixed team (mix of management + senior + staff) for calculation purposes. The model does not consider inflation, but it will not be difficult to incorporate.
- **Alignment with the business:** It shows the number of requirements that the information systems incorporate. The number of requirements covered by the sector’s best practices (informed by demand management) and the differences in FP (requirements) in our solution in operation are showed.
- **Risk:** The model considers residual risks (risks after applying controls) that are fed into it with three variables: probability of occurrence, impact of asset loss and impact of availability loss. The risks have an impact on three parts of the model: planning and design execution, development execution and value attainment risks. The first two result in cost and time variance and value risk in the model results with more value carrier variance. The risk is calculated out of the model.

With the outcome variables shown, it is possible at any time to compare different scenarios and to decide which is more interesting. Each of the scenarios shows different percentages of the basic strategies that are established in the model.

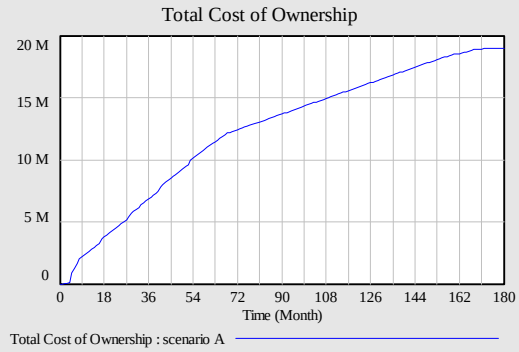
Table IV: Examples of model performance: most significant variables.

SOME VARIABLES EXAMPLE

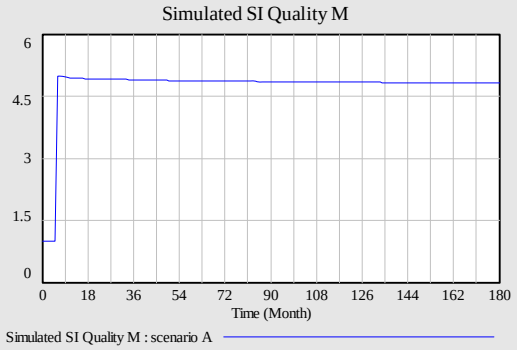
Alignment with Business and Sector:



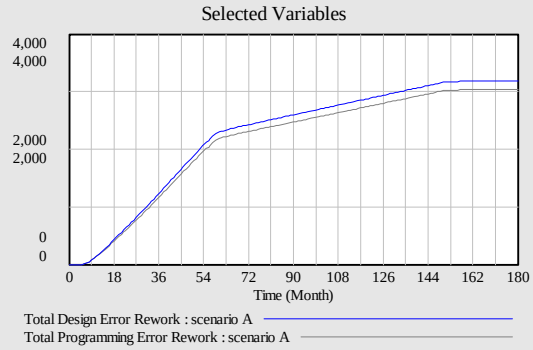
Total Cost of Ownership:

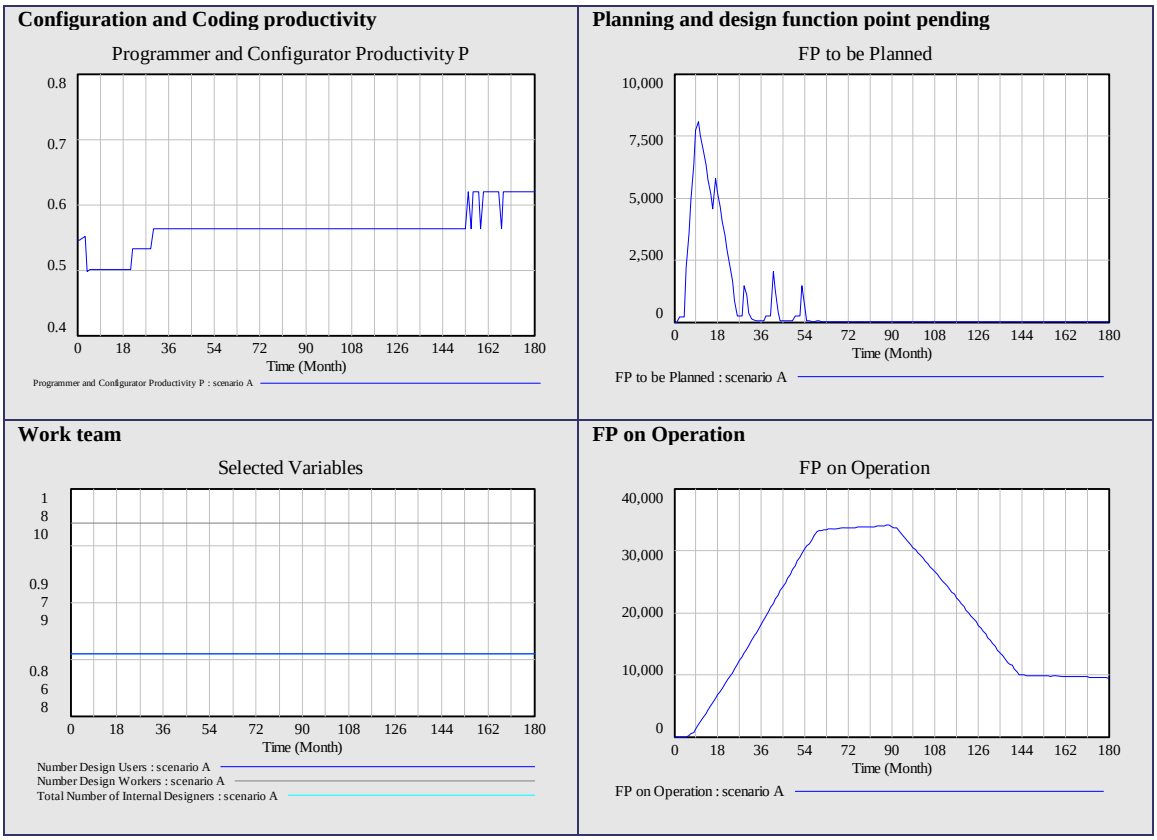


Information System Quality



Total rework in design and development





6. Conclusions

This research formulates a method that allows optimizing the valuation and formulation of the IT strategies in an organization. The proposed model is supported by a dynamic simulation tool that facilitates IT change and recommends the best combination of the basic IT strategies to reach the strategic objectives. This paper covers the first two activities of the IT Strategic Planning process proposed by the model: valuation of IT strategic options and formulation of IT strategies. The model works with unadjusted function points as inputs and represents information systems planning to be implemented in the coming years. The reason for taking groups of information systems and not just individual projects is that in real organizations synergies between projects greatly influence costs and values provided by the IS.

In the case of the strategic options valuation, it indicates and compiles the methods and evaluation techniques of the internal and external environments. The method deals with these techniques in an integrated way to ease the translation to the business change in IT strategic objectives through Critical Change Factors that are weighted by their influence in the IT strategy. It then proposes a modeling tool with a dynamic simulation based on the ITIL v3 philosophy. By means of this simulation tool it is possible to foresee and discuss options, minimizing costs and risks; what strategic objectives to follow and the most adapted future scenario (from 3 to 5 years) for an IT organization.

The model is validated if the Strategic Objectives defined above are more valued for a given risk. In addition, the model allows simulating the results of applying different combinations of basic strategies to obtain the same strategic objectives and to determine the "mix" of basic strategies that are more convenient for an IT organization. The four basic IT strategies considered, simulated and optimized by the model are: IT market spaces, cost / value, organization / outsourcing and technological architecture.

The model, having simulated the functioning of an IT organization, allows interesting conclusions to be obtained. Some examples are presented below:

- At three years' sight, the team's previous experience had little medium-term weight as opposed to the potential of the team and the initial training.
- The model visualized how, having worked together with the IT services life cycle (design and transition close to operation), inadequate testing lengthens the instability of the system and generates additional tasks that must be reworked, eliminating the initial savings and lengthening the implementation period of the IS.
- When the IS are dealt with as a group opposed to individual projects, a third conclusion reached is the important role that reuse and the synergies play if good decisions are taken at first projects.

Correct decisions will have a bearing on the future for example, avoiding costly training and maintenance of widely dispersed technological platforms.

- The model shows the importance of the operation when determining the costs. For all scenarios tested, operation always assumes rates of over 60% of the total costs of the systems.
- Having gained good quality and alignment (4.5 of 5), setting deadlines for the completion of the project can optimize costs more than delaying the projects in order to better optimize the quality of the systems.
- Not all function points of any system provide the same value and it is necessary to determine the contributions of value by service areas to prioritize and optimize the implementation of the IS portfolio.

Reference

[1] Abdel-Hamid, Tarek (1989) The Dynamics of Software Project Staffing: A System Dynamics Based Simulation Approach. IEEE Transactions on Software Engineering, VOL. 15. NO. 2, February 1989.

[2] Abdel-Hamid, Tarek & Madnick, Stuart E. (1991). Software project dynamics an integrated approach. Prentice Hall Software Series.

[3] Armstrong, J. Scott (1982) The Value of Formal Planning for Strategic Decisions: Review of Empirical Research. Strategic Management Journal, Vol. 3, No. 3. (Jul. - Sep., 1982), pp. 197-211.

[4] Balci, Osman (1997) Verification, validation and accreditation of simulation models. Proceedings of the 1997 Winter Simulation Conference.

[5] Balsamo, Simonetta & Marzolla, Moreno (2003). A Simulation-based approach to Software Performance Modeling. Proceedings of the 9th European software engineering conference held jointly with 11th ACM SIGSOFT international symposium on Foundations of software engineering.

[6] Bartolini, Claudio; Stefanelli, Cesare & Tortonesi, Mauro (2008) SYMIAN: A simulation tool for the optimization of the IT incident management process. IFIP International Federation for Information processing. DSOM 2008, LNCS 5273 pp83-94

[7] Bartolini, Claudio; Stefanelli, Cesare & Tortonesi, Mauro (2009) Business-impact analysis and simulation of critical incidents in IT service management. 2009 IFIP/IEEE International Symposium on Integrated Network Management (IM 2009)

[8] Bequette, B.Wayne (1998) Process dynamics modeling, analysis and simulation. Prentice Hall International Series in the Physical and Chemical Engineering Sciences.

[9] Birkhölzer, Thomas; Dickmann, Christoph; Vaupel, Jürgen & Dantas, Laura (2005) An Interactive Software Management Simulator based on the CMMI Framework. Software Process Improvement and Practice. 2005; 10: 327–340. Published online inWiley InterScience (www.interscience.wiley.com). DOI: 10.1002/spip.233

[10] Bider, Ilia & Johannesson, Paul (2002) Modeling Dynamics of Business Processes: Key for Building Next Generation of Business Information Systems. Springer-Verlag Berlin Heidelberg 2002.

[11] Boonstra, Albert & de Vries, Jan (2008) Managing stakeholders around inter-organizational systems: A diagnostic approach. Journal of Strategic Information Systems 17 (2008) 190–201

[12] Braun, Christian & Winter, Robert (2007) Integration of IT Service Management into Enterprise Architecture. SAC'07, March 11-15, 2007, Seoul, Korea. ACM 1-59593-480-4/07/0003

[13] Choi K, Bae D & Kim T. (2005). DEVS-based software process simulation modeling: formally specified, modularized, and extensible SPSM. In Proceedings of the International Workshop on Software Process Modeling and Simulation. (ProSim '05), St. Louis, MO.

[14] Choi K, Bae D & Kim T. (2006). An Approach to a Hybrid Software Process Simulation using the DEVS Formalism. Software process improvement and practice Softw. Process Improve. Pract. 2006; 11: 373–383. Published online 12 June 2006 in Wiley InterScience.

[15] Chroust, Gerhard (1996) What is a software process? Journal of Systems Architecture 42 (1996) 591-600. Elsevier.

[16] Chung, Christopher A. (2004) Simulation modeling handbook. A Practical Approach. CRC Press LLC

[17] Cohen, Jason F. (2008) Contextual determinants and performance implications of information systems strategy planning within South African firms. Information & Management 45 (2008) 547–555. Elsevier.

[18] Collofello, James; Rus, Ioana; Chauhan, Anamika; Smith-Daniels, Dwight; Houston, Dan &Sycamore, Douglas M.(1998) A System Dynamics Software Process Simulator for Staffing

Policies Decision Support. Proceedings of the Thirty-First Annual Hawaii International Conference on System Sciences-Volume 6 - Volume 6
[19] Coveney, Michael; Ganster, Dennis; Hartlen, Brian & King, Dave (2003) The Strategy Gap: Leveraging Technology to Execute Winning Strategies. John Wiley & Sons, Inc.
[20] Christie, Alan M. (1999) Simulation and process improvement. Simulation in support of CMM-based process improvement. The Journal of Systems and Software 46 (1999) 107-112. Elsevier.
[21] Croteau, AM ; Bergeron, F (2001) An information technology trilogy: business strategy, technological deployment and organizational performance. The journal of strategic information systems, 2001 – Elsevier.
[22] Curtis, Bill; Kellner, Marc I. & Over, Jim (1992) Process modeling. Communications of the ACM/Septernbcr 1992/Vol,35, No.9.
[23] Dickmann, Christoph; Klein, Harald ; Birkhölzer, Thomas; Fietz, Wolfgang; Vaupel, Jürgen & Meyer, Ludger (2007) Deriving a Valid Process Simulation from Real World Experiences. Q. Wang, D. Pfahl, & D.M. Raffo (Eds.): ICSP 2007, LNCS 4470, pp. 272–282, 2007. Springer-Verlag Berlin Heidelberg 2007
[24] Doherty, N.F., Marples, C.G. & Suhaimi, A. (1999) The relative success of alternative approaches to strategic information systems planning: an empirical analysis. Journal of Strategic Information Systems 8 (1999) 263–283. Elsevier.
[25] Donzelli, Paolo & Iazeolla, Giuseppe (2001) A dynamic simulator of software processes to test process assumptions. The Journal of Systems and Software 56 (2001) 81-90.
[26] Donzelli, Paolo & Iazeolla, Giuseppe (2001) Hybrid simulation modeling of the software process. The Journal of Systems and Software 59 (2001) 227-235.
[27] Ein-Dor; Phillip & Segev, Eli. (1978) Strategic Planning for Management Information Systems. Management Science, Vol. 24, No. 15. (Nov., 1978), pp. 1631-1641.
[28] Forrester, Jay W. (1994) System dynamic, system thinking and soft ER. System Dynamics Review. Vol 10, No 2.
[29] Fowler, Alan (1999) Modeling, simulation and innovative design in complex adaptive business management systems. Computing & Control Engineering Journal, 1999.
[30] Fowler, Alan (2003) Systems modeling, simulation, and the dynamics of strategy. Journal of Business Research 56 (2003) 135–144. Elsevier.
[31] Galliers, R.D. & Leidner, D.E. (2003) Strategic Information Management Challenges and strategies in managing information systems. Third edition. Butterworth-Heinemann.
[32] Garschhammer, M., Hauck, R., Kempter, B., Radisic, I., Roelle, H., Schmidt, H. (2001) The MNM Service Model - Refined Views on Generic Service Management. KICS
[33] Hagel, J. & Brown, J.S. (2001) You next IT strategy. Harvard Business Review.
[34] Haltiwanger, John; Lynch, Lisa M. & Mackie, Christopher (2007). Understanding business dynamics. An integrated data system for America´s future. The National Academies Press.
[35] Hamilton Scott & Norman L. Chervany, "Evaluating Information System Effectiveness. Part I. Comparing Evaluation Approaches," MIS Quarterly, Vol. 5, No. 3, September 1981, pp. 55-69.
[36] Houston, Dan X.; Ferreira, Susan; Collofello, James S.; Montgomery, Douglas C.; Mackulak, Gerald T. & Shunk, Dan L. (2001) Behavioral characterization: finding and using the influential factors in software process simulation models. The Journal of Systems and Software 59 259-270.
[37] International Function Point Users Group, IFPUG (2005) Function Point Counting Practices Manual. Release 4.2.1, January 2005.
[38] ITGI (2007) COBIT 4.1. IT Governance Institute. www.itgi.org
[39] Jain, Raj (1991) Art of Computer Systems Performance Analysis Techniques For Experimental Design Measurements Simulation And Modeling. Wiley Computer Publishing, John Wiley & Sons, Inc.
[40] Kahen, G.; Lehman, M.M.; Ramil, J.F. & Wernick, P. (2001). System dynamics modelling of software evolution processes for policy investigation: Approach and example. The journal of systems and software 59 271-281. Elsevier.
[41] Kangas, Kalle (2003) Business Strategies for Information Technology Management. Idea Group Publishing
[42] Kardaras, D. & Karakostas, B. (1999) The use of fuzzy cognitive maps to simulate the information systems strategic planning process. Information and Software Technology 41 (1999) 197–210. Elsevier.
[43] Keating, Elizabeth K.; Oliva, Rogelio; Repenning, Nelson P.; Rockart, Scott & Sterman, John D. (1999) Overcoming the Improvement Paradox. European Management Journal , Vol. 17, No. 2, pp. 120-134, 1999.

[44] Kellner, Marc I.; Madachy, Raymond J. & Raffo, David M. (1999) Software Process Simulation Modeling: Why? What? How? Journal of Systems and Software, Vol. 46, No. 2/3 (15 April 1999).
[45] King, W.R. (Mar., 1978). Strategic Planning for Management Information Systems. MIS Quarterly, Vol. 2, No. 1. pp. 27-37.
[46] King, William R & Teo Thompson S H () Integration between business planning and information systems planning: Validating a stage hypothesis. Decision Sciences; Spring 1997; 28, 2; ABI/INFORM Global.
[47] King, William R. & Teo, Thompson S.H. (2000) Assessing the impact of proactive versus reactive modes of strategic information systems planning. Omega. The International Journal of Management Science. 28 (2000) 667±679.
[48] Kleijnen, Jack P.C. (1995) Verification and validation of simulation models. European Journal of Operational Research 82 (1995) 145-162. Elsevier.
[49] Korac- Kakabadse, Nada and Andrew Kakabadse, Andrew (2001) IS/IT Governance: Need for an integrated model. Corporate Governance 1,4 2001pp 9 11 MCB University Press.
[50] Kouskouras, Konstantinos G. & Georgiou, Andreas C. (2007) A discrete event simulation model in the case of managing a software project. European Journal of Operational Research 181 (2007) 374–389
[51] Kunc, Martin (2005) Illustrating the competitive dynamics of an industry: the fast-moving consumer goods industry case study. Revista de Dinámica de Sistemas Vol. 1 Núm. 1 (Septiembre 2005)
[52] Kunnathur, A.S. y Shi, Z.(2001). An investigation of the strategic information systems planning success in Chinese publicly traded firms. International Journal of Information Management 21 423–439
[53] Lakey, Peter B. (2003) A hybrid software process simulation model for project management. Proceedings of the 6th Process Simulation Modeling.
[54] Lamb,B. (2005) Process Modeling and Simulation within ITIL Framework. Release 1.0.0.0. Consulting Handbook. Birchwood Solutions Limited. April 2005.
[55] Larsen, Michael Holm, Pedersen, Mogens Kühn & Andersen, Kim Viborg (2006) IT Governance: Reviewing 17 IT Governance Tools and Analysing the Case of Novozymes A/S. Proceedings of the 39th Hawaii International Conference on System Sciences – 2006. IEEE.
[56] Law, Averill M. & Kelton, W.David (1982) Simulation modeling and analysis. Mc-Graw-Hill Series in Industrial Engineering and Management Science. Mc-Graw-Hill Book Company.
[57] Lederer, A.L. & Sethi, V.. (Septiembre 1988). The Implementation of Strategic Information Systems Planning Methodologies. MIS Quarterly, Vol. 12, No. 3., pp. 445-461.
[58] Lederer, A.L., & Mendelow, A.L. (1987). Information Resource Planning: Overcoming Difficulties in Identifying Top Management's Objectives. IS Quarterly, 11(3), 389–399.
[59] Lederer, Albert L & Sethi, Vijay (1996) Key prescriptions for strategic information systems planning. Journal of Management Information Systems; Summer 1996; 13, 1; ABI/INFORM Global.
[60] Lee, Jung Hoon; Han, Young Soon & Kim, Chan Hoon (2007) IT Service Management Case based Simulation Analysis & Design: Systems Dynamics Approach. 2007 International Conference on Convergence Information Technology. IEEE Computer Society.
[61] Levy, M. (1994) Chaos theory and strategy theory, application and managerial implications. Strategic Management Journal, Vol. 15, 167-178(1994). John Wiley & Sons, Ltd.
[62] Levy, M. & Powell, P. (2000) Information systems strategy for small and medium sized enterprises: an organisational perspective. Journal of Strategic Information Systems 9 (2000) 63-84. Elsevier.
[63] Li,C; Li, H & Li,M (2001) A Software Factory Model Based on ISO9000 and CMM for Chinese Small Organizations. apaqs, pp.0288, Second Asia-Pacific Conference on Quality Software (APAQS'01), 2001
[64] Li, Eldon Y. & Chen, Houn-Gee (2001) Output-driven information system planning: a case study. Information & Management 38 (2001) 185±199. Elsevier.
[65] Lin, C.Y.; Abdel-Hamid, T. & Sherif, J.S. (1992) Software-engineering process simulation model (SEPS). TDA Progress Report 42-108.
[66] Liu, Xiaoqing (Frank); Sun, Yan; Veera, Chandra Sekhar; Kyoya, Yuji & Noguchi, Kunio (2006) Priority assessment of software process requirements from multiple perspectives. The Journal of Systems and Software 79 (2006) 1649–1660. Elsevier.
[67] Luftman, Jerry N; Lewis, Paul R; Oldach, Scott H (1993) Transforming the enterprise: The alignment of business and information technology Strategies. IBM Systems Journal; 1993; 32, 1; ABI/INFORM Global

[68] Madachy, Raymond Joseph (1994) A software project dynamics model for process cost, schedule and risk assessment. A Dissertation Presented to the Faculty of the Graduate School University of Southern California in Partial Fulfillment of the Requirements for the Degree Doctor Of Philosophy.
[69] Marshall,P. & McKay,J. (Mayo 2004). Strategic it planning, evaluation and benefits management: the basis for effective it governance. Australasian Journal of Information Systems Vol 11 No 2.
[70] McChesney, I R (1995) Toward a classification scheme for software process modelling approaches. Information and Software Technology 1995 37 (7) 363-374. Elsevier Science B.V.
[71] McIvor, R.T.; Humphreys, P.K. & McAleer, W.E. (1997) A strategic model for the formulation of an effective make or buy decision. Management Decision 35/2 [1997] 169–178 MCB University Press
[72] Melao, Nuno & Pidd, Michael (2000) A conceptual framework for understanding business processes and business process modelling. Info Systems J (2000) 10 105-129. Blackwell Science Ltd.
[73] Menascé, Daniel A. & Almeida, Virgilio A.F. & Dowdy, Lawrence W. (2004) Performance by Design: Computer Capacity Planning by Example. Prentice Hall PTR.
[74] Merrill, D & Collofello, J (1997) Improving Software Project Management Skills Using a Software Project Simulator. Frontiers in Education Conference, 1997 - Citeseer
[75] Miller, Martin J.; Pulgar-Vidal, Francisco & Ferrin, David M. Achieving higher levels of CMMI maturity using simulation. Proceedings of the 2002 Winter Simulation Conference E. Yucesan, C.-H. Chen, J. L. Snowdon, andL M. Chonies, eds.
[76] Min,S.K., Suh E.H. y Kim,S.Y. (1999). An integrated approach toward strategic information systems planning. Elsevier. Journal of Strategic Information Systems 8 373–394
[77] Mintzberg, Henry. (1994). Rethinking Strategic Planning Part II: New Roles for Planners. Long Range Planning Vol. 27, No. 3, pp. 22 to 30. 1994. Copyright 0 1994 Elsevier Science I.td
[78] Mintzberg, Henry. (1994). The rise and fall of strategic Planning. Basic Books.
[79] Mohdzain M.B. y Ward, J.M. (2007). A study of subsidiaries' views of information systems strategic planning in multinational organizations Journal of Strategic Information Systems 16 324–352
[80] Morecroft, John D. W. (1984) Strategy Support Models. Strategic Management Journal, Vol. 5, No. 3 (Jul. - Sep., 1984), pp. 215-229. John Wiley & Sons.
[81] Newkirk, H.E., Lederer, A.L. y Srinivasan, C. (2003). Strategic information systems planning: too little or too much? Journal of Strategic Information Systems 12 201–228.
[82] Olson, D.L., "Software Process Simulation." Encyclopedia of Information System S-Z 4 (2003):143-153.
[83] Peffers, Ken & Tuunanen, Tuure (2005) Planning for IS applications: a practical, information theoretical method and case study in mobile financial services. Information & Management 42 (2005) 483–501. Elsevier.
[84] Pfahl, Dietmar & Lebsanft, Karl (2000) Using Simulation to Analyse the Impact of Software Requirement Volatility on Project Performance. Information and software technology, ISSN 0950-5849, Vol. 42, Nº 14, 2000 , pags. 1001-1008
[85] Porter, M.E. (1980) Competitive Strategy: Techniques for Analyzing Industries and Competitors, The Free Press, New York, 1980.
[86] Porter, M.E. (1996) What Is Strategy? Harvard Business Review November-December 1996.
[87] Raffo, D.M., J.V. Vandeville, & R.H. Martin, (1999) Software Process Simulation to Achieve Higher CMM Levels. Journal of Systems and Software, 1999. 46(2/3).
[88] Rodrigues, Alexandre & Williams, Terry (1996) System Dynamics in Software Project Management: towards the development of a formal integrated framework. Management Science. Theory, method & practice. Research Paper No. 1996/5.
[89] Rogers. P.R. & Bamfordb, C.E. (2002). Information planning process and strategic orientation: The importance of fit in high-performing organizations. Elsevier. Journal of Business Research 55 205– 215.
[90] Rozinat, A., Mans, R.S., Song, M. & van der Aalst, W.M.P. (2008) Discovering simulation models. Information Systems. Elsevier.
[91] Rus, Ioana; Collofello, James & Lakey, Peter (1999) Software process simulation for reliability management. The Journal of Systems and Software 46 (1999) 173-182. Elsevier.
[92] Sallé, Mathias (2004) IT Service Management and IT Governance: Review, Comparative Analysis and their Impact on Utility Computing. Copyright Hewlett-Packard Company 2004
[93] Scacchi, Walt (1999) Experience with software process simulation and modeling. The Journal of Systems and Software 46 (1999) 183-192. Elsevier.

[94] Segars, Albert H. & Grover, Varun. (1998) Strategic Information Systems Planning Success: An Investigation of the Construct and Its Measurement. MIS Quarterly, Vol. 22, No. 2. (Jun., 1998), pp. 139-163.
[95] Senge, Peter M. (1990), The Fifth Discipline: The Art and Practice of the Learning Organization. Doubleday Business; 1st edition (October 1, 1994).
[96] Shen, Beijun (2008) Support IT Service Management with Process Modeling and Analysis. ICSP'08 Proceedings of the Software process, 2008 international conference on Making globally distributed software development a success story Springer-Verlag Berlin, Heidelberg 2008
[97] Silva, Enrique & Chaix, Yves (2008) Business and IT Governance Alignment Simulation Essay on a Business Process? and IT Service Model," hicss, pp.434, Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008), 2008
[98] Spector, J. Michael; Christensen, Dean L.; Sioutine, Alexei V. & McCormack, Dalton (2001) Models and simulations for learning in complex domains: using causal loop diagrams for assessment and evaluation. Computers in Human Behavior 17. 517–545
[99] Stallinger, Friedrich & Grünbacher, Paul (2001) System Dynamics Modeling and Simulation of Collaborative Requirements Engineering. Journal of Systems and Software 59. 311-321.
[100] Sterman, John D. (2000) Business Dynamics Systems Thinking and Modeling for a Complex World. McGraw-Hill Higher Education.
[101] Taylor, S.; Iqbal, M. y Nieves, M. (2007). ITIL V3 – Service Strategy. Office of Government Commerce.
[102] Teo, Thompson S H & King, William R (1997) Integration between business planning and information systems planning: An evolutionary-contingency perspective. Journal of Management Information Systems; Summer 1997; 14, 1; ABI/INFORM Global. pg. 185
[103] Teubner, R.A. (2007) Strategic information systems planning: A case study from the financial services industry. Journal of Strategic Information Systems 16 (2007) 105–125. Elsevier.
[104] Thong, James Y L (1999).An integrated model of information systems adoption in small businesses. Journal of Management Information Systems; Spring 1999; 15, 4; ABI/INFORM Global. pg. 187
[105] Tvedt, John D. & Collofello, James S. (1995) Evaluating the Effectiveness of Process Improvements on Software Development Cycle Time via System Dynamics Modeling. IEEE Computer Society Press.
[106] Vernon, L., Peters, L., Rupchock, K. y Wilkinson, P. (2002). Planning to Implement Service Management. The Stationery Office.
[107] Wang, Eric T.G. & Tai, Jeffrey C. F. (2003) Factors affecting information systems planning effectivenss: organizational contexts and planning systems dimensions. Information & management 40 (2003) 287-303. Elsevier
[108] Ward, John & Peppard, Joe (1995) Reconciling the IT/Business Relationship: A Troubled Marriage in Need of Guidance. Cranfield Working Papers
[109] Ward, John & Peppard, Joe (2002) Strategic Planning for Information Systems. Third Edition. John Wiley & Sons Ltd.
[110] Wexelblat, Richard L. & Srinivasan, N. (1999) Planning for information technology in a federated organization. Information & Management 35 (1999) 265-282. Elsevier.
[111] Williford, Judson & Chang, Andrew (1999) Modeling the FedEx IT division: a system dynamics approach to strategic IT planning. The Journal of Systems and Software 46 (1999) 203-211
[112] Wolstenholme, E.F. (2003) The use of system dynamics as a tool for intermediate level technology evaluation: three case studies. Journal of Engineering and Technology Management 20 (2003) 193–204
[113] Zhang, He ;Kitchenham, Barbara & Jeffery, Ross (2007) A Framework for Adopting Software Process Simulation in CMMI Organizations. Q. Wang, D. Pfahl, and D.M. Raffo (Eds.): ICSP 2007, LNCS 4470, pp. 320–331, 2007. Springer-Verlag Berlin Heidelberg 2007