A Unified Strategic Business and IT Alignment Model
A Study in the public universities of Nicaragua

Norman Vargas Chevez

Licentiate Thesis in Computer and Systems Sciences
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Licentiate thesis in Computer and Systems Sciences

Licentiate of Engineering (LicEng) is an intermediate academic degree between MSc and PhD awarded by Swedish and Finnish universities, likened to a Master of Philosophy (MPhil) degree in the British system.

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Abstract

A number of attempts have been made to define strategic business and information technology (IT) alignment; several representations of what it is are available in academic and practitioners’ fields. The literature suggests that firms need to achieve strategic business and IT alignment to be competitive. Strategic business and IT alignment impact business performance and IT effectiveness. We propose a unified strategic business and IT alignment model based on four strategic business and IT alignment models: Strategic Alignment Model (SAM), Strategic Alignment Maturity Model (SAMM), information system strategic alignment model and an operational model of strategic alignment. I argue that such a unified model will provide a better understanding of the nature and key aspects of strategic business and IT alignment from different, and sometimes complementary, theories. The unified model represents the concepts and instruments used in these four strategic businesses and IT alignment models. Our principal research goal is to pave the way to develop a common understanding between the different models. The components of the unified strategic business and IT alignment model were ranked with a group of IT experts and business experts from four public universities in Nicaragua. The result can be used as a basis for improving strategic business and IT alignment.
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1. Introduction

Strategic business and Information Technology (IT) alignment (henceforth referred as strategic alignment) has many synonyms such as alignment (Silvius, 2007), harmony (Luftman et al; 1996), linkage (Reich and Benbazat, 1996) and business – IT alignment (Maes et al; 2000). In the literature, we identify numerous definitions of strategic alignment. Tallon and Kraemer (1998) define strategic alignment as the extent to which the Information System (IS) strategy supports and is supported by the business strategy. Silvius (2007) defines strategic alignment as the degree to which the IT applications, infrastructure and organization, the business strategy and processes enables and shapes, as well as the process to realize this. Reich and Benbazat (1996) define strategic alignment as the degree to which the IT mission, objective and plans support and are supported by the business mission, objectives and plans.

In the article written by Maes et al; 2000; they define strategic alignment as a continuous process—involving management and design sub-processes—of consciously and coherently interrelating all components of the business-IT relationship in order to contribute to the organization’s performance over time. Luftman (2000) argues that strategic alignment refers to applying information technology in an appropriate and timely way, in harmony with business strategies, goals and needs. Henderson and Venkatraman (1993) state that strategic alignment is defined in terms of four fundamental domains of strategic choice: business strategy, information technology strategy, organizational infrastructure and processes, and information technology infrastructure and processes. We define strategic alignment as a continuous process which involve interrelating the coherent combination of the four fundamental domains: business strategy, IT strategy, organizational infrastructure and process, and IT infrastructure and process in order to contribute to the organization's performance.

For two decades, strategic alignment has consistently appeared as a top concern for IT practitioners and company executives (Luftman et al., 2005) and it has been constantly and repeatedly ranked as the most important issue facing corporations since the mid-1980s (Benbya and McKelvey, 2006). Despite the importance of strategic alignment, there is debate in the literature about what strategic alignment actually is (Avison et al; 2004).

Many authors have written about strategic alignment covering the range from the academic perspective to the practical perspective, providing several models to define strategic alignment (Hackney. et al; 2000) (Henderson and Venkatraman, 1993) (Maes et al; 2000) (Vargas et al; 2008). The model that has attracted the most attention in this area is the strategic alignment model (SAM) proposed in the article written by Henderson and Venkatraman in 1993. The SAM is the most widely cited according to the literature review developed in (Vargas et al; 2007). This model is based on the need to achieve alignment across internal and external domains as well as functional integration across business and IT areas (Allen. & Morton, 1994). The SAM model has received empirical support and has conceptual and practical value (Maes et al; 2000) (Avison et al; 2004) (Vargas et al; 2008).

Several scholars have built on and extended the SAM model (Chan and Reich, 2007), however it has its limitation. The SAM was refined in a practical way by elaborating on the critical management issues inside the domains (Luftman, 1996).
Luftman proposed a strategic alignment maturity model (SAMM) based on the twelve SAM components and the alignment inhibitors and enablers (Luftman, 1999a). In the article written by Avison et al.; (2004), They proposed a practical framework and demonstrated that SAM has practical and conceptual value (Avison et a; 2004). The SAM was enhanced in the article written by Maes et al; 2000. They proposed a unified framework that incorporates a strategic layer to reflect the current need for information and communication (Avison et al; 2004).

Some researchers have proposed their research models and instruments to assess the strategic alignment. Yolande Chan proposed an information system strategic alignment model based on the strategic orientation of business enterprises (STROBE) instrument proposed by Venkatraman and the strategic orientation of information system (STROIS) instrument proposed by Yolande Chan (Chan and Huff, 1993). The research model proposed by Yolande Chan was used by other researchers (e.g. Cragg et al; 2002) to assess the strategic alignment. In the article written by Bergeron et al; 2003 and Byrd et al; 2005; they included the STROBE instrument in their strategic alignment models to assess the strategic alignment.

This section has shown a brief overview of strategic alignment and the lack of consensus about it as a concept. The purpose of this thesis is to present a unified strategic alignment model based on some relevant theories in the area and identify the most importance components of the unified strategic alignment model in the public universities in Nicaragua.

1.1. Problem Area

The firms need to achieve strategic alignment to be competitive (Avison et al; 2004). Strategic alignment impacts business performance and IT effectiveness (Chan et al; 1993). Despite the importance of strategic alignment, there is no consensus about the definition of strategic alignment. Strategic alignment is a concept that has engendered much debate and many definitions (Chan et al; 1997) (Dendford and Chan, 2007). The lack of a shared definition of the components that define the strategic alignment can cause confusion and disagreement about the relevance of the components in the processes of establish the business strategy, IT strategy, IT infrastructure and organizational infrastructure in organizations.

In this thesis, we proposed a unified strategic alignment model for managing the problem of lack of consensus about the definition of strategic alignment. The unified strategic alignment model is for a better aims improving the understanding of the nature and significance of strategic alignment.

Despite the importance of strategic alignment, most of the studies of strategic alignment identified in the literature were developed in the context of private institutions (Vargas et al, 2007), although alignment is a concern not only for private institutions but also for public institutions. Many public universities in Nicaragua, have invested in IT to have a better performance educational processes and administrative processes. Many IT departments find themselves in a state of support service or cost centre to support some critical educational processes and administrative processes. Many decision makers from public universities in Nicaragua do not support their decisions based on previous studies.
We employed the unified strategic alignment model in a study in four public universities in Nicaragua to assess the relative importance of the components of the unified strategic alignment model. The result of this study should be taken as reference by the decision makers from public universities to assist to establish a better business strategy, IT strategy, organizational infrastructure and IT infrastructure.

1.2. Research goal

This thesis seeks to contribute to this research area by pursuing two goals.

1. Construct a unified strategic alignment model based on components of some well-known theories.
2. Assess the relative importance of the components of the unified strategic alignment model in the context of a number of public universities in Nicaragua.

The first goal is the construction of a unified strategic alignment model based on different streams of theories and approaches in the area. The construction of the unified strategic alignment model is for a better understanding of the nature and significance of strategic alignment. This unified strategic alignment model is used to define the concept of strategic alignment in a more complete way.

The second goal is an assessment of the relative importance of the components of the unified strategic alignment model in the context of four public universities in Nicaragua who have invested in IT for a better educational and administrative process. The unified strategic alignment model in conjunction with the AHP method are used to identify the relative importance of the components of the unified strategic alignment model. The result obtained in this study, should be taken as as reference by the decision makers from public universities to assist to establish a better business strategy, IT strategy, organizational infrastructure and IT infrastructure.

1.3. Research method

This section covers the research approach that has guided the present research work. The research approach adopted in this thesis is based on design science approach. The design science is an approach that has been under emphasized in Information Systems. Design science approach builds and evaluates IT artifacts\(^1\) with the objective to solve identified problems in the organization (Hevner et al; 2004). The creations of the artifacts rely on existing kernel theories (Markus et al; 2002). Evaluation is the process to determine how well the IT artifact performs (March and Smith; 1995).

Applying design science to the problem of strategic alignment presented in section 1.1 means that the focus on this research work is the construction and operationalization of a unified strategic alignment model. The design science research activities include: build and evaluate. In chapter three, we give details of the process of construction of the unified strategic alignment model that is based on

\(^1\) An IT artifacts are defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype).
existing strategic alignment theories in the information system discipline. In chapter four, we applied the unified strategic alignment model in four public universities in Nicaragua to identify the relative importance of its components.

Design science products are: construct models, methods and implementation (March and Smith, 1995). Construct is the language in which the problems and solutions are described and communicated. The constructs are used to represent models from real situations. A model is based on the relationship among constructs. The method provided the instruction about how to perform a task and instantiations refers to the operationalization of constructs, models and methods in certain task (Hevner et al; 2004).

Figure 1.1 gives an overview of the design research cycle that we used in this research. The design research cycle (Takeda, 1990) consists of five steps and they are: problem awareness, suggestion, development, evaluation and conclusion. During the problem awareness step, a problem in the domain under study is discovered and analysed. In this step, we identified the problem of our research area (see section 1.2) and we proposed a tentative solution to the identified problem in the step suggestion. The suggestion must be based on existing theory in the problem area. In this step, we proposed to construct a unified strategic alignment model based on existing theories in the area of strategic alignment as a possible solution to the problem identified in this thesis. We suggested doing an aggregation of four models identified in the literature and using a method that it is based on knowledge elicitation from scientific texts in order to construct such unified strategic alignment model.

Development is the implementation of the tentative design of the artifact. In this step, we identified four existing models in a literature review. We used the strategic alignment models and a method for knowledge elicitation from scientific texts to construct the unified strategic alignment model (See chapter 3). Evaluation: “The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods” (Hevner et al; 2004). According to Hevner et al; 2004, an artifact must prove to be useful to solve the problem for which it was designed to solve. However we will not carry out an evaluation of the unified strategic alignment model in this thesis in a real life due to time and resource limitations. Nevertheless, we show the applicability of the unified strategic alignment model through a survey in four public universities in Nicaragua (See chapter 4). An evaluation of the unified strategic alignment model is suggested as a future research activity. Conclusion is the termination of the projects (See chapter 5). Circumscription process is the knowledge gain during development and evaluation steps and it is used as input in problem awareness.
Ethical considerations. The author of this research work took into consideration the ethical issue of maintaining privacy. Therefore names of respondents and public universities are excluded from this thesis. The results of the semi-structured interviews have been verified by all respective respondents before they were finally adopted. This is to avoid misinterpretation of the information obtained in this study in the public universities in Nicaragua.

1.4 Research Design

The research work can be divided into two main phases: The first part includes the construction of the unified strategic alignment model based on the 23 articles. A literature study covering the area of strategic alignment was done to understand and gain knowledge about the area of strategic alignment. From the literature study, we identified the articles to be used in the construction of the unified strategic alignment model.

A method for knowledge elicitation from scientific texts and the notation of the Extended Influence Diagram (EID) were used for presenting and comparing theories and models from the articles selected in the literature study developed in this research work. Extended Influence Diagram is based on the Influence diagram (ID). The ID is an extension of the well-studied statistical tool of Bayesian Network (Johnson et al; 2007). A Bayesian network is a probabilistic graphical model and it consist of a set of variables and a set of directed edges between variables (Jensen, 2001). The semantic of the Bayesian networks consist of nodes and causal relation.

An Influence Diagram (ID) is a graphical and mathematical representation of decision situations (Clement and Reilly, 2004). ID has been adopted as a tool for developing models and communicating among people (Shachter, 1986). ID is useful for the structuring phase of a problem solving and they are ideal for obtaining overview for
A complex problem. ID is appropriate to communicate the problem to people with little technical background (Clement and Reilly, 2004).

The semantic of ID consist of three types of nodes and one types of arrow, see figure 1.2. The nodes are: utility nodes, chance nodes, and decisions nodes, drawn respectively as rhombus, ovals and rectangles (Clement and Reilly, 2004). The utility node represents the goal of the decision maker. A chance node represents an event and all their possible outcomes. The decision nodes represent the decisions causally affecting nodes in the diagram (Johnson et al; 2006). The nodes are connected by causal relation. The causal relation is graphically depicted as an arrow

As mentioned above, the only relation in the traditional influence diagram is the casual relation. To model causality, it is important to define the phenomena. Extended influence diagrams differ from the influence diagram in their ability to cope with definitional relation. The main contribution of the Extended Influence Diagram is the inclusion of the relationship type: definitional relation (Johnson et al; 2006). A definitional relation is depicted as an arc with a diamond at the end. Another relation added to the EID is the similarity relation. A similarity relation between two nodes symbolizes these nodes basically are the same. See figure 1.3.
The notations of the figure 1.3 are used to construct the unified strategic alignment model. The utility nodes and chance nodes represent the components of the unified strategic alignment model and the relationship types are used to do the connections among the nodes. Using the notation from figure 1.3, an example of the extended influence diagram is shown in figure 1.4. The example shows that there is a definitional relation between the components “strategic alignment”, “strategic fit” and “functional integration” and the direction the arrow points suggests that the former affects the component strategic alignment.

![Figure 1.4 Example of Extended Influence Diagram](image)

The second phase was devoted to assess the importance of the component of the unified strategic alignment model. A survey was formulated to be applied in four public universities in Nicaragua. We elaborated a protocol for the survey (see Appendix 5) for data collection. The protocol for the survey contains a glossary, the instrument, the procedures that should be followed and it contains the fundamental scale of Analytical Hierarchical Process (AHP) theory.

The instruments for the surveys are based on the components of the unified strategic alignment model. The utility node and chance node represents components of the unified strategic alignment model. The instruments for the survey consists of four matrices of comparisons (see appendix 5): business strategy, IT strategy, organizational infrastructure and process, IT infrastructure and process. The matrices were used for the data collection. Each comparison matrix contains the components of the unified strategic alignment model. For example, the matrix of IT infrastructure and process contains the components: continuous improvement, architecture integration, business metric, IT metric, benchmarking, formal assessment and service level agreement. Each component of the matrix of IT infrastructure and process were compared among them. Respondents apply the fundamental scale of the AHP (see appendix 5) to assign the importance to the components of the unified strategic alignment model.

We used AHP to do the data processing of the data obtained in the survey. The AHP allows the decision maker to structure a complex problem in the form of a hierarchy. The hierarchy in the AHP is not the tradition decision tree. Each level may represent a different view of the problem (Saaty, 1990b). The AHP theory compare alternative in a pairwise mode. The pairwise comparison approach has the advantage that it includes much redundancy and it is thus less sensitive to judgmental errors (Karlsson and Ryan, 1997). The AHP also has the advantage that it indicates the inconsistence of the results and it capture the ratio scale rank order inherent in inconsistent pairwise comparison judgments (Saaty and Hu, 1998).
The data processing was implemented in conjunction with the Expert Choice's software. Expert Choice incorporates the AHP theory and enables the analyst to structure the hierarchy and resolve the problem using relative or absolute measurements (Saaty and Vargas, 2001). The result of the ranking of the components of the unified strategic alignment model is detailed in chapter 4.

1.5. Research Contribution

The first contribution of this thesis is the unified strategic alignment model. The unified strategic alignment model is based on four strategic alignment models: Strategic Alignment Model (SAM), Strategic Alignment Maturity Model (SAMM), Information System Strategic Alignment Model proposed by Yolande Chan, and an operational model of strategic alignment proposed in the article written by François Bergeron et al; 2003.

The second contribution is a ranking of the components of the unified strategic alignment model with respect to their importance according managers, IT Directors and IT experts of the four public universities in Nicaragua. The result can be used for communicating to the rest of the organization what components are important and the result can be used for the decision makers to assist to establish a better business strategy, IT strategy, organizational infrastructure and IT infrastructure.

1.6. Structure of the thesis

Chapter 2 aims to identify the broad conceptual bases for this study of strategic alignment. These bases are drawn from a broad literature review of the main theories, approaches and models regarding strategic alignment. The chapter ends with a brief description of three of four strategic alignment models that were selected to construct the unified strategic alignment. In chapter 3, we include the process of constructing the unified strategic alignment model and the description of its components.

Chapter 4 provides a ranking of the components of the unified strategic alignment model through a survey in the public universities in Nicaragua. Chapter 5 contains the concluding remarks, the limitation of this research work and the future research area.

Chapter 6 provide the references used in this thesis. Appendix 1, presents the strategic alignment model (SAM); appendix 2, present the strategic alignment maturity model (SAMM); appendix 3, present the operational strategic alignment model proposed in Bergeron et al; 2003 and appendix 4, present the information system strategic alignment model proposed by Yolande Chan. Appendix 5, present the protocol for the survey.

1.7. List of Publications


5. Vargas, N; Plazaola, L; and Flores, J; "Constructing a General Framework Definition of the Business and IT Alignment Concern through selected papers," in proceedings of conference on systems engineering research (CSER 2007), New York, USA, March 2007.

6. Plazaola, L; Flores, J; Silva, E; Vargas, N; Ekstedt, M; "An Approach to Associate Strategic Business-IT Alignment Assessment to Enterprise Architecture," in proceeding of conference on systems engineering research (CSER 2007), New York, USA, March 2007.


8. Plazaola, L; Silva, E; Vargas, N; Flores, J; Ekstedt, M; "A Metamodel for Strategic Business and IT Alignment Assessment," in proceedings of conference on systems engineering research (CSER 2006), Los Angeles, USA, April 2006.


10. Silva, E; Plazaola, L; Flores, J; Vargas, N; "How to identify and Measure the Level of Alignment between IT and Business Governance," in proceedings of Portland International Conference on Management of Engineering and Technology (PICMET 05), Portland, USA, July 2005.
2. Introduction to strategic alignment

In the literature, we identified many definitions of strategic alignment. In the article written by Tallon and Kraemer, 1998; they define strategic alignment as the extent to which the IS strategy supports and is supported by the business strategy. Silvius (2007) defines strategic alignment as the degree to which the IT applications, infrastructure and organization, the business strategy and processes enable and shape, as well as the process to realize this. Reich and Benbazat (1996) define strategic alignment as the degree to which the IT mission, objective and plans support and are supported by the business mission, objectives and plans.

Maes et al (2000) define strategic alignment as the continuous process—involving management and design sub-processes—of consciously and coherently interrelating all components of the business-IT relationship in order to contribute to the organization’s performance over time. Luftman (2000) argues that strategic alignment refers to applying Information Technology in an appropriate and timely way, in harmony with business strategies, goals and needs. Henderson and Venkatraman (1993) state that strategic alignment is defined in terms of four fundamental domains of strategic choice: business strategy, information technology strategy, organizational infrastructure and processes, and information technology infrastructure and processes. Chan and Huff defined strategic alignment as the fit existing between business strategies and IS strategy. The difficulties in defining strategic alignment have also meant that it has been difficult to measure (Maes et al; 2000)

Despite the existence of many definitions, a shared definition is lacking about strategic alignment. The lack of a shared definition does not mean that there is a lack of good knowledge within the strategic alignment area. The aim of this thesis is to develop a unified strategic alignment model based on some well-known models in this area. It is our belief that the existence of such a unified model allows for a better understanding of the nature and significance of strategic alignment in theory and practice. Having provided an overview of some definitions of strategic alignment, in the next section we go into details of the literature review to identify the most relevant strategic alignment models.

2.1 Literature Review

This section aims to identify the broad conceptual bases for this study of strategic alignment. These bases are drawn from the literature of strategic alignment and particular streams of theory, research and practice within those areas. The first step toward creating the strategic alignment model was to gather the articles previously written about the topic. The selection of information sources was initiated with an extensive internet survey of academic and practitioners’ articles on the focus of interest (Strategic alignment). Several digital libraries were used to facilitate the selection of the articles.

A database for classifying strategic alignment articles was created. Several kinds of publications among the information found over internet were excluded from the
database, e.g. consultancy reports, books, publications not accessible online and publications with few occurrences of the term queried. Duplicate sources were also removed. Most of the information given in the omitted books can also be found in the corresponding academic articles (Vargas et al; 2007).

A table for classifying the articles found on internet was created and it supplies the following information about each article: title of the article, authors, number of citations, title of the journal or conference paper, searchers and keywords. We consider this information sufficient for our study, at least as regards the classification of articles belonging to the area of strategic alignment and the identification of the authors.

2.2 Selection of the publications

Our analysis of the strategic alignment literature was based on the study of journal and refereed conference papers instead of other publishing (consultancy reports, books, lectures, etc). The main reason for this decision is our belief that practitioners as well as academicians use journals and refereed conference papers more often, to both acquire and spread new knowledge (Nord and Nord, 1995); wherein current articles represent the highest level of research (Claver et al; 2000). The criteria used to choose among the journal and refereed conference papers identified in the literature review are the following:

1. The title of the article explicitly includes or implicitly refers to the area of interest, “strategic alignment.”
2. The article must have or propose a theory of strategic alignment.
3. The article must be oriented in the strategic alignment area.
4. The article must have been widely cited. The Google Scholar and CiteSeer were used for identifying the citation scores for the selected articles.

Five hundred seventy six articles written from 1992 to 2006 were identified in the literature review. Twenty three articles were selected according to the four criteria mentioned in this section to construct the unified strategic alignment model. The list of the articles to construct the unified strategic alignment model is in the table 2.1.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Title of the article</th>
<th>Theory / Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avison, D; Jones, J; Powell, P; Wilson, D</td>
<td>Using and validating the strategic alignment model.</td>
<td>The authors describe the practice use of SAM in a financial service firm.</td>
</tr>
<tr>
<td>Chan, Y. and Huff, S.</td>
<td>Investigating Information Systems Strategic Alignment</td>
<td>The authors provide an empirical assessment of the information system strategic alignment model proposed by Yolande Chan.</td>
</tr>
<tr>
<td>Henderson, J and Venkatraman, N.</td>
<td>Strategic Alignment: Leveraging information technology for transforming organizations</td>
<td>The authors propose the strategic alignment model (SAM) for conceptualizing and directing the area of strategic management of information technology. (Henderson and Venkatraman 1992)</td>
</tr>
<tr>
<td>Henderson, J and Venkatraman, N.</td>
<td>Strategic Alignment: A Model for Organizational Transformation Through Information Technology</td>
<td>The authors present SAM. They give a brief description of the components of SAM</td>
</tr>
<tr>
<td>Kearns, G; Lederer, A.</td>
<td>The effect of strategic alignment on the use of IS-based resources for competitive advantage</td>
<td>The authors contribute by distinguishing the alignment of information system plan with the business plan (ISP - BP) and the reciprocal alignment (BP - ISP)</td>
</tr>
<tr>
<td>Luftman, J.</td>
<td>Assessing Business / IT alignment maturity.</td>
<td>The authors discuss an approach for assessing the maturity of strategic alignment. Once a maturity is understood, an organization can identified opportunities for enhancing the strategic alignment.</td>
</tr>
<tr>
<td>Luftman, J; Lewis, P; Oldach, S.</td>
<td>Transforming the Enterprise: The alignment of Business and Information Technology Strategies</td>
<td>They explain the need for business transformation and the use of the IT to support the transformation.</td>
</tr>
<tr>
<td>Papp, R.</td>
<td>Business-IT Alignment: Productivity Paradox Payoff?</td>
<td>The authors proposed the use of a regression equation to measure performance controlling for alignment perspective and industry classification.</td>
</tr>
<tr>
<td>Pollalis, Y.</td>
<td>Patterns of co-alignment in information intensive organizations: business performance through Integration strategies.</td>
<td>Pollalis suggested develops and tests of a strategic co-alignment model by examining three types of integration that impact the planning process and the overall performance of information-intensive organizations: technological integration (TI), functional integration and strategic integration (SI).</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Title and Overview</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td>Sabherwal, R. and Chan, Y.</td>
<td>Alignment Between Business and IS Strategies: A Study of Prospectors, Analyzers, and Defenders. The paper examines the impact of alignment on business performance. They combine two approaches to measuring business strategy: the Miles &amp; Snow typology (1978) and STROBE (Venkatraman, 1989).</td>
<td></td>
</tr>
<tr>
<td>Tallon, P and Kraemer, K.</td>
<td>A process-oriented assessment of the Alignment of Information systems and business strategy: Implication for IT Business Value. The authors introduced a conceptual model containing the determinants (management practices) and consequences (IT business value) of strategic alignment.</td>
<td></td>
</tr>
<tr>
<td>Venkatraman, N; Henderson, J; and Oldach, S</td>
<td>Continuous Strategic Alignment: Exploiting Information Technology Capabilities for Competitive Success. The theoretical underpinnings of the Strategic Alignment Model developed in this paper are based on works of Henderson and Venkatraman (1991) (Chan and Reich, 2007a).</td>
<td></td>
</tr>
<tr>
<td>Venkatraman, N.</td>
<td>Strategic Orientation of Business Enterprises (STROBE): the construct. This paper reports the results of a research study aimed at conceptualizing and developing valid measurements of key dimensions of a strategy construct—termed Strategic Orientation of Business Enterprises. (Venkatraman 1989).</td>
<td></td>
</tr>
<tr>
<td>Bergeron, F., Raymond, L; and Rivard, S.</td>
<td>Ideal Patterns of strategic alignment and business performance. In this article, they proposed an operational model of strategic alignment and they empirically validated their model.</td>
<td></td>
</tr>
<tr>
<td>Broadbent, M. and Weil, P.</td>
<td>Improving business and information strategy alignment: Learning from the banking industry. They sought to identify organizational practice that contribute to and enhance strategic alignment.</td>
<td></td>
</tr>
<tr>
<td>Burn, J and Szeto, C.</td>
<td>A Comparison of the Views of Business and IT. Management of Success Factors for Strategic Alignment. This article reports on a study to determine the existence of significant differences in perspectives of IT and business managers on what factors contribute to successful strategic alignment using SAM.</td>
<td></td>
</tr>
<tr>
<td>Chan, Y, Huff, S, Barclay, W. and Copeland, D.</td>
<td>Business Strategy Orientation, Information Systems Orientation and Strategic Alignment, Information Systems Research. The foundation for this study is an extension of Venkatraman’s conceptualizations of fit and STROBE. This extension includes IS in his model (Chan and Reich, 2007a).</td>
<td></td>
</tr>
<tr>
<td>Luftman, J, and Brier, T.</td>
<td>Achieving and sustaining business-IT alignment. In this article, the authors designed six step approaches to maximize strategic alignment enablers and minimize inhibitors.</td>
<td></td>
</tr>
<tr>
<td>Luftman, J; Papp, R; and Brier, T.</td>
<td>Enablers and Inhibitors of Business-IT Alignment. The authors determine the most important enablers and inhibitors to alignment.</td>
<td></td>
</tr>
</tbody>
</table>
Based on the articles of table 2.1, we identified the following strategic alignment models:

1. Strategic alignment model (SAM) proposed by Henderson and Venkatraman.
2. Strategic alignment maturity model (SAMM) proposed by Luftman.
3. The information system strategic alignment model proposed by Yolande Chan.
4. The operational model of strategic alignment proposed by François Bergeron, Louis Raymond and Suzanne Rivard.

In the next section, we go into detail of the first three strategic alignment theories: strategic alignment model, strategic alignment maturity model and the information system strategic alignment model proposed by Yolande Chan.

### 2.3 Strategic Alignment Model

The strategic alignment model (SAM) proposed by Henderson and Venkatraman is one of the most cited strategic alignment models (Chan and Reich, 2007a). SAM is composed of two main dimensions: strategic fit and functional integration. Strategic fit refers to the concordance between internal and external domains (see figure 2.1). Functional integration refers to two type of integration between business and IT domains. The first type is termed strategic integration and reflects the link between business strategy and IT strategy. The second type is termed operational integration and deals with the link between organizational infrastructure and process, and IT infrastructure and process (Henderson and Venkatraman 1993). SAM is a conceptual model that it has been used to understand strategic alignment from the perspective of four components, i.e. Business Strategy, IT Strategy, Organizational Infrastructure and IT Infrastructure, and their interdependencies.
Many scholars and consultants have taken SAM as reference (Maes et al; 2000) (Chan and Reich, 2007a). One of the best known models based on the components of SAM is the Strategic Alignment Maturity Model (SAMM) proposed by Jerry Luftman. In the next section, we give more details about SAMM.

2.4 Strategic Alignment Maturity Model

Jerry Luftman proposed an approach to evaluate the maturity of a firm’s strategic alignment (Luftman 2000). Luftman terms this approach the strategic alignment maturity model (SAMM). SAMM is based on the SAM components, in concert with the enablers/inhibitors research identified in Luftman et al 1999 (Luftman 2003). The maturity of the strategic alignment is determined by six criteria and every criterion is composed of several attributes (Luftman 2000). SAMM’s criteria and their attributes determined by Luftman are:

**Communications:** refers to ensuring ongoing knowledge-sharing across organizations (Luftman et al 2004). The communication's attributes are: understanding of business by IT, understanding of IT by business, inter/intra organizational learning, protocol rigidity, knowledge sharing, liaison breadth/effectiveness (Luftman 2000) (Luftman et al 2004).

**Competency/Value Measurements:** “Demonstrating the value of IT in terms of contribution to the business” (Luftman et al 2004). The competency value measurements' attributes are: formal assessment/review, service level agreement, balanced metrics, IT metrics, benchmarking, continuous improvement and business metrics (Luftman 2000) (Luftman et al 2004).

**Governance:** “Ensuring that the appropriate business and IT participants formally discuss and review the priorities and allocation of IT resources” (Luftman et al 2004). Governance's attributes are: prioritization process, steering committee, IT investment management, budgetary control, IT strategic planning, reporting/organization structure and business strategic planning (Luftman 2000) (Luftman et al 2004).
**Partnership**: refers to “the relationship that exists between business and IT organization” (Luftman et al 2004). Partnership's attributes are: role of IT in Strategic business planning, business perception of IT value, IT program management, business sponsor, trust style business, shared goals, risk, rewards/penalties (Luftman 2000) (Luftman et al 2004).

**Scope and Architecture**: The extent to which IT is able to support flexible infrastructure, provide solutions customizable to customer needs, evaluate and apply emerging technologies effectively, and enable or drive business processes and strategies as a true standard (Luftman et al 2004). Scope and architecture's attributes are: systemic competencies, traditional, enabler/driver external, standard articulation, architectural transparency, flexibility and architecture integration (Luftman 2000) (Luftman et al 2004).

**Skills**: “Includes all of the human resources considerations for the organization” (Luftman et al 2004). Skill's attributes are: locus of power, innovation, entrepreneurship, social, political, trusting environment, education, cross-training, career crossover, change readiness, hiring and retention (Luftman, 2000) (Luftman et al 2004).

Luftman proposed to use the six maturity criteria and their attributes to do the assessment and identify the alignment level. Each criterion is measured by a team of IT and business unit executives on a Likert scale from 1 to 5. Luftman’s strategic alignment maturity assessments involve five levels of maturity:

1. Initial/Ad Hoc Process
2. Committed Process
3. Established Focused Process
4. Improved/Managed Process
5. Optimized Process

Luftman (2000) proposed the overall strategic IT alignment level to be calculated as an average evaluation (rated using a Likert scale) for the six criteria of the Strategic Alignment Maturity assessment.

**2.5 Information System Strategic Alignment Model**

Yolande Chan empirically investigated strategic alignment and its effect on other components in the organization (Hale and Cragg, 1996). Chan examined the relationships among Information System (IS) strategic alignment, IS effectiveness and business performance (Chan and Huff, 1993). Figure 2.2 shows Chan's conceptual model. It depicts the proposition that the relationship between the business strategy and information system strategy is directly related to IS strategic alignment. It is also directly relates to IS effectiveness and business performance.
In the article written by Chan & Huff in 1993, they proposed an instrument based on the comparative approach to assess the realized information strategy of the organization. This instrument was based on Venkatraman's Strategic Orientation of Business Enterprises (STROBE) instrument which assessed the realized business strategy. The instrument was called Strategic Orientation of Information Systems (STROIS). Both STROBE and STROIS used the same eight dimensions of strategy (Hale and Cragg, 1996).

Chan & Huff proposed combining Venkatraman's strategic orientation of business enterprise (STROBE) instrument and Chan's strategic orientation of information systems (STROIS) instrument to assess strategic alignment. Chan and Huff showed that a HighSTROBE * HighSTROIS combination was associated with peak performance whereas the LowSTROBE * LowSTROIS had a significantly different impact on performance (Chan & Huff, 1993). A brief description of the STROBE instrument is provided in the following table:

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggressiveness</td>
<td>It refers to the posture adopted by a business in its allocation of resources for improving market positions at a relatively faster rate than the competitors in its chosen market (Venkatraman 1989). Push to dominate (i.e. increase market share) even if this means reduced prices and cash flow (Venkatraman, 1989). (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Analysis</td>
<td>“Reliance on detailed, numerically oriented studies prior to action” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>External defensiveness</td>
<td>“Forming thigh marketplace alliance. (e.g. with customers, suppliers and distributors)” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Internal defensiveness</td>
<td>“Emphasis on cost cutting and efficiency” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Futurity</td>
<td>“It reflects temporal considerations reflected in key strategic decisions, in terms of the relative emphasis of effectiveness (longer-term) considerations versus efficiency (shorter-term) considerations” (Venkatraman, 1989).</td>
</tr>
</tbody>
</table>
Innovativeness

“Creativity and experimentation” (Chan & Huff, 1993).

Proactiveness

“It reflects proactive behavior in relation to participation in emerging industries, continuous search for market opportunities and experimentation with potential responses to changing environmental trends” (Venkatraman, 1989). Step ahead – first to introduce new products, etc (Venkatraman, 1989) (Chan & Huff, 1993).

Riskiness

“It captures the extent of riskiness reflected in various resource allocation decisions as well as choice of products and markets” (Venkatraman, 1989).

The STROIS instrument assesses and conceptualizes IS strategy by determining whether IT in the business enabled that firm to be aggressive, analytical, future oriented, proactive, risk-averse, innovative and internally and externally defensive (Hale and Cragg, 1996). A brief description of the STROIS instrument is provided in Table 2.3:

Table 2.3 The STROIS Instrument (Chan & Huff, 1993)

<table>
<thead>
<tr>
<th>Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggressive IS</td>
<td>“IS deployment used by the business unit when pursuing aggressive marketplace action” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Analytical IS</td>
<td>“IS deployment used by the business unit when conducting analyses of business situations” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Internally defensive IS</td>
<td>“IS deployment used by the business unit to improve the efficiency of company operations” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Externally defensive IS</td>
<td>“IS deployment used by the business unit to strengthen marketplace links” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Future oriented IS</td>
<td>“IS deployment used by the business unit for planning and projection purposes” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Proactive IS</td>
<td>“IS deployment used by the business unit to expedite the introduction of products and services” (Chan &amp; Huff, 1993).</td>
</tr>
<tr>
<td>Risk Averse IS</td>
<td>“IS deployment used by the business unit to make business risk assessments” (Chan &amp; Huff 1993)</td>
</tr>
<tr>
<td>Innovative IS</td>
<td>“IS deployment used by the business unit to facilitate creativity and exploration” (Chan &amp; Huff, 1993).</td>
</tr>
</tbody>
</table>
3. Unified strategic alignment model

The previous chapter presented an overview of some theories that emphasize the dimension of strategic alignment. The purpose of this section is to develop the unified strategic alignment model and give more details about it. This section unfolds as follows: the extended influence diagram is presented in section 3.1. Next, the method for generating strategic alignment with its process steps and rules is presented in section 3.2. Section 3.3 presents the structure of the unified strategic alignment model.

3.1 Extended Influence Diagram

Extended Influence Diagram (EID) is based on the Influence Diagram and was proposed in Johnson et al; 2006. Our selection of the EID as the notation to be used in the construction of the unified strategic alignment model is based in an evaluation of existing language developed in (Johnson et al; 2007). The EID syntax is shown in figure 3.1 below.

<table>
<thead>
<tr>
<th>Node Type</th>
<th>Relationship Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility Node</td>
<td>Causal Relation</td>
</tr>
<tr>
<td>Chance Node</td>
<td>Definitional Relation</td>
</tr>
<tr>
<td>Decision node</td>
<td>Similarity Relation</td>
</tr>
</tbody>
</table>

*Figure. 3. 1. Extended influence diagram syntax (Lagerström R. et al; 2007)*

The rectangles represent decisions, ovals represent chance events and diamonds represents the goal of the decision-maker (Clement and Reilly, 2004) e.g. *strategic alignment*. The node types are linked with arrows to show the relationship among the nodes. Causal relation is graphically depicted as an arrow. Causal relations represent either relevance or sequence (Clement and Reilly, 2004). The main extension in the EID is the definitional relation and similarity relation. (Johnson et al; 2006). “A similarity relation between two nodes symbolizes that these nodes basically are the same”. (Johnson et al; 2007). For more detail about the EID, the reader is referred to (Johnson et al; 2006) (Johnson et al; 2007).
3.2. Method for generating the unified strategic alignment model

In this section, we used the EID notation and the method for eliciting knowledge from scientific texts proposed in the article written by Lagerström et al 2007 to construct the unified strategic alignment model. The EID is used as a means for presenting and comparing theories and models of the articles listed in table 2.1 of chapter 2. Figure 3.2 depicts the process for constructing the unified strategic alignment model.

![Diagram of the process for constructing the unified strategic alignment model]

**Step 1:** “Select the scientific articles” (Lagerström et al; 2007). For illustration purposes, the article “Strategic Alignment: Leveraging information technology for transforming organizations” (Henderson and Venkatraman, 1993) has been chosen as an example of the process of developing the unified strategic alignment model.

**Step 2:** Identify the component representing the goal (Lagerström et al; 2007). This is done by browsing the text of the scientific article under analysis to identify the component that represents the goal. In the text of the chosen scientific article Strategic Alignment: Leveraging information technology for transforming organizations, the component that represents the goal was Strategic Alignment. Once the goal has been
Step 3: “Identify evidence to extract” (Lagerström et al; 2007). In this step, we identified all the occurrences of the component under consideration where a causal, definitional or similar relation to another component is implied (Lagerström et al; 2007). In the paper Strategic Alignment: Leveraging information technology for transforming organizations, the component under consideration is Strategic Alignment. The identified piece of evidence related to this component under consideration is: “our concept of strategic alignment is based on two building blocks: strategic fit and functional integration” (Henderson and Venkatraman, 1993).

Step 4: Translate the extracted evidence to an intermediary model (Lagerström et al; 2007). The intermediary notation has many similarities with the EID syntax and object-oriented design. The intermediary notation includes entities such as variables and classes (Lagerström et al; 2007). In this step, we used the evidence identified in the step 3 to construct the intermediary model. In figure 3.3, we present the intermediary model of the evidences identified in step 3.

Figure 3.3. Intermediary model representing the strategic alignment

Step 5: “Integrate the intermediary models” (Lagerström et al; 2007). All the intermediary models constructed with the evidence identified in step 4 are unified with each other (Lagerström et al; 2007).

Step 6: Select a new component and iterate (Lagerström et al; 2007). In this step, we took figure 3.3 as the reference to set new components and iterate with step 3 in the process (Lagerström et al; 2007), continuing the iteration until no more pieces of evidence are identified. As can be seen in figure 3.3, we identified in this iteration the new components strategic fit and functional integration. Employing strategic fit and functional integration during the following iterations new evidence was extracted. In this step, we used as a piece of evidence figure 3.4 and the next sentence: “The functional integration (see figure 5) identifies the need to specify two types of integration between business and IT domains. The first termed, strategic integrations, is the link between business strategy and IT strategy reflecting the external components. The second type, termed operational integration, deals with the corresponding internal domains, namely, the link between organizational infrastructure and processes and I/S infrastructure and processes” (Henderson and Venkatraman, 1993).
Figure 3.4. Strategic Alignment Model (Henderson and Venkatraman, 1993)

The second iteration will result in the following intermediary model:

Figure 3.5. Intermediary model representing the functional integration

The third iteration will result in the following intermediary model:

Figure 3.6. An intermediary model representing the strategic integration

Figure 3.7. An intermediary model representing the operational integration
The fourth iteration will result in the following intermediary model

Figure 3.8. An intermediary model representing the business strategy

Figure 3.9. An intermediary model representing the IT strategy

Figure 3.10 An intermediary model representing the IS infrastructure and processes

Figure 3.11. An intermediary model representing the organizational infrastructure and processes
Step 7: Unify the intermediary models (Lagerström et al; 2007). We made some carefully documented interpretations. For example, in the paper Strategic Alignment: Leveraging information technology for transforming organizations, the authors sometimes speak of information system infrastructure and processes and sometimes of information technology infrastructure and processes. It is obvious in the article that the authors are speaking of the same term, namely information technology infrastructure and processes. In this step, the dimension information system infrastructure and processes and information technology infrastructure and processes were merged together. All previous intermediary models (see figure 3.3, 3.5 - 3.11) were unified as presented in figure 3.12.

![Diagram of the unification of the intermediary model for SAM](image)

Step 8: Perform translation from unified intermediary model to an extended influence diagram (Lagerström et al; 2007). In this step, we removed the classes from the intermediary model (see figure 3.12) to chance and utility nodes (see figure 3.13). In the paper Strategic Alignment: Leveraging information technology for transforming organizations (Henderson and Venkatraman, 1993), we find that the strategic alignment is achieved by good strategic fit and functional integration.
Step 9: Unification of the extended influence diagrams. For each article selected we have an extended influence diagram constructed by following the eight steps mentioned in this section. The first action of the unification processes is to map all the chance nodes from the different EID models. In the second action all synonyms in the models are identified and merged. This is done by identifying the similarity relationship type and node type between the EIDs. When all relationship types and node types are identified, the nodes associated through this relation are merged into one. If the name of the relationship type and node type do not match, we aggregate them as-is to the unified strategic alignment model, as presented in the figure 3.14.
Figure 3.14. Unified strategic alignment model
3.3 Structure of the unified strategic alignment model

The unified strategic alignment model presented in figure 3.14 includes the model from the strategic alignment dimension. The unified strategic alignment model constitutes an aggregation of four strategic alignment models: Strategic Alignment Model (SAM), Strategic Alignment Maturity Model (SAMM), information system strategic alignment model proposed by Yolande Chan, and an operational model of strategic alignment proposed by François Bergeron, Louis Raymond and Suzanne Rivard (Vargas et al., 2008).

The unified strategic alignment model is structured in terms of: Business strategy, IT strategy, organizational infrastructure and process, IT infrastructure and process. Each one of these dimensions is composed of components that constitute the operationalized level of the unified strategic alignment model. In the next section, we give more details about the components of the four dimensions: business strategy, IT strategy, organizational infrastructure and process, and IT infrastructure and process.

3.3.1 Structure of the Business Strategy

Business strategy is defined in terms of: business scope, business governance and distinctive competencies. Business Scope refers to everything that might effect the business environment (Papp and Luftman 1995). It includes the markets, products, services, groups of customers/clients and locations where an enterprise competes as well as the competitors and potential competitors that affect the business environment (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992).

Distinctive Competencies refers to all the things that make the business a success in the marketplace (Papp and Luftman 1995). This includes the critical core competencies that provide a firm with a potential competitive edge. It also includes brand, research, manufacturing and product development, cost and pricing structure, and sales and distribution channels (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992).

Business Governance refers to the relationships that exist between the stakeholders of the company and senior management, mainly the board of directors. It also includes any governmental regulations and relations between other strategic business partners (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992). The business strategy dimension includes components that constitute the operationalized level of it. These components are values or properties of the dimension (See table 3.1).

<table>
<thead>
<tr>
<th>Table 3.1 Components of the business Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business Strategy</strong></td>
</tr>
<tr>
<td>Understanding of business by IT, Understanding of IT by business, Inter/intra organizational learning/education, Protocol rigidity, Knowledge Sharing Liaison(s) effectiveness (Luftman, 1993) (Luftman, 1999b) (Luftman, 2003) (Luftman, 2005). Defensiveness, Proactiveness Analysis, Riskiness, Aggressiveness, Futurity (Bergeron, et al; 2003), (Chan, 1993) (Chan, 1997), (Hale and Cragg, 1996), (Venkatraman, 1989). The description of these components is in the glossary (see appendix 5).</td>
</tr>
</tbody>
</table>
3.3.2 Structure of the Information Technology Strategy

IT strategy is defined in terms of: IT scope; systemic competencies, IT governance and communication. IT Scope is simply all of the essential information applications and technologies that the business uses (Papp and Luftman 1995). Systemic Competencies is all capabilities (e.g., access to information that is important to the creation of a company’s strategies) that set the IT services apart from the rest (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992) (Papp and Luftman, 1995). This involves how much access the business has to information that is important to business’s strategy (Papp and Luftman 1995). IT governance describes the makeup of the authority behind the IT and how the resources, risk and responsibility are distributed among the business partners, information technology management and service providers. (Papp and Luftman, 1995). Communication uses a common and clear language between business and IT organizations (Luftman 2003) (Luftman et al; 1999b).

The IT strategy dimension includes components that constitute the operationalized level of the IT strategy. These components are values or properties of the dimension (See table 3.2).

Table 3.2 Components of the IT Strategy

<table>
<thead>
<tr>
<th>IT Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prioritization processes, steering committee, IT investment management, budgetary control, IT strategic planning, reporting/organization structure, business strategic planning, traditional, enabler/driver external, standard articulation, understanding of business by IT, understanding of IT by business, inter/intra organizational learning, protocol rigidity, knowledge sharing, liaison breadth/effectiveness. They are based on SAMM (Luftman, 2003) (Luftman et al; 1999b), environment scanning, strategic use of IT (Bergeron et al; 2003). Aggressive IS, analytical IS, externally defensive IS, future oriented IS, proactive IS and innovative IS (Chan, 1993) (Chan, 1997) (Hale and Cragg, 1996). The description of these components is in the glossary (see appendix 5).</td>
</tr>
</tbody>
</table>

3.3.3 Structure of the Organizational infrastructure and processes

Organizational infrastructure and processes are defined in terms of: administrative structure, processes and skills. Administrative structure refers to how the organization runs its business (Papp and Luftman, 1995). This includes choices about organizational structure, roles, responsibilities and reporting relationships (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992). Processes refer to just that, all of the activities and how they operate. Concepts like value-added activities and process improvement apply here (Papp and Luftman, 1995). Skills indicate the choices about the capabilities of the individuals to execute the key tasks that support business strategy (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992).

The organizational infrastructure and process dimension includes components that constitute its operationalized level. These components are values or properties of the dimension (See table 3.3).
Table 3.3 Components of the organizational infrastructure and process

<table>
<thead>
<tr>
<th>Organizational infrastructure and process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locus of power; management style; innovation entrepreneurship; social, political, trusting environment; education; cross-training; career crossover; change readiness; role of IT in strategic business planning; business perception of IT value; IT program management; business sponsor/champion; relationship/trust style; shared goals; risk; rewards/penalties (Luftman, 2003) (Luftman et al; 1999b), formalization; administrative intensity; professionalization; specialization; vertical differentiation (Bergeron et al; 2003). The description of the components are in the glossary (see appendix 5)</td>
</tr>
</tbody>
</table>

3.3.4 Structure of the IT Infrastructure and processes

IT Infrastructure and processes are defined in term of: architecture, processes and skills. The architecture consists of applications, data and technology “articulated in terms of the configurations of hardware, software and communications” (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992). Processes include the work processes central to the operations of the IT infrastructure, including processes for systems development and maintenance as well as monitoring and control systems (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992). Skill involves the knowledge and capabilities required to effectively manage the IT infrastructure within the organization (Henderson and Venkatraman, 1993) (Henderson and Venkatraman, 1992). The IT infrastructure and process dimension include components that constitute its operationalized level. These components are values or properties of the dimension (See table 3.4).

Table 3.4 Components of the IT infrastructure and process

<table>
<thead>
<tr>
<th>IT infrastructure and process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal assessments/review; service level agreement; balanced metrics; IT metrics; benchmarking; continuous improvement; business metrics; locus of power; management style; innovation entrepreneurship; social, political, trusting environment; education; cross-training; career crossover; change readiness; architectural transparency and architectural integration (Luftman, 2003) (Luftman et al; 1999b). IT planning and control, and IT acquisition and implementation (Bergeron et al; 2003). The description of the components is in the glossary (see appendix 5)</td>
</tr>
</tbody>
</table>
4. A Study in public universities of Nicaragua

For two decades, strategic alignment has consistently appeared as a top concern of IT practitioners and company executives (Luftman et al; 2005). Most of the studies of strategic alignment identified in the literature review in chapter 2 and the database published in (Chan and Reich, 2007) were developed in the context of private institutions, although strategic alignment is a concern not only for private institutions but also for public institutions. In this research, we conducted a study in the public universities of Nicaragua. The public universities of Nicaragua are four. These four universities have shared a common vision and general objectives in an Information and Communication Technology (ICT) project since 2001 and they have invested strongly in IT for improved administrative processes and to support educational propose. They are very similar in their governance. It means that they are similar in their management, policies and processes. In this chapter, we developed a study in four public universities of Nicaragua. The Nicaragua public universities are those recognized as public universities by the National Council of Universities (CNU2) and whose main objectives are not to make economic profit.

In section 4.1, we give a brief description of the four public universities; in section 4.2, a brief description of the method of ranking. In section 4.3, we describe the methodology followed for the data collection, data processing and results of the study conducted in four Nicaragua public universities. In section 4.4, we described some lessons learned from the study.

4.1. The studied public universities

As stated in the introduction, four public universities in Nicaragua were identified for the study. In this section we briefly describe the studied organizations.

University W is a public university with approximately 406 + 505 staff (academic and administrative, respectively) and a student population of approximately 10,988 + 182 (undergraduate and postgraduate, respectively). The ICT (Information and Communication Technology) division was established in 2006. There are five main core services, and each has a substantial number of functions. The ICT division offers core services such as: network service, system support services, support for teaching, consulting services and support, and research support. The majority of the information systems (databases) in the organization, which handle thousands of records, are not integrated. This means they offer services independent of each other although most of the subjects (customers) are the same. The Internet connection is 15 Mbps link.

University X is a public university with approximately 821 + 1,155 staff (academic and administrative) and a student population of approximately 25,339 + 1,295 (undergraduate and postgraduate). The ICT (Information technology) division was established in 2008. There are five main core services and each has a substantial number of functions. The ICT division offers core services such as: network service, system support services, support for teaching, consulting services and support, and research support. The majority of the information systems (databases) in the organization, which

2 CNU is an autonomous body that formulates and coordinates national policy of higher education, authorizes new universities or technical schools and promotes higher education quality and relevance. (http://www.cnu.edu.ni/)
handle thousands of records, are not integrated. This means they offer services independent of each other although most of the subjects (customers) are the same. The Internet connection is 30 Mbps link.

University Y is a public university with approximately 652 + 657 staff (academic and administrative) and a student population of approximately 15,494 + 406 (undergraduate and postgraduate). The ICT (Information technology) division was established in 2008. There are five main core services and each has a substantial number of functions. The ICT division offers core services such as: network service, system support services, support for teaching, consulting services and support, and research support. The majority of the information systems (databases) in the organization, which handle thousands of records, are not integrated. This means they offer services independent of each other although most of the subjects (customers) are the same. The Internet connection is 15 Mbps link.

University Z is a public university with approximately 172 + 317 staff (academic and administrative) and a student population of approximately 3,389 + 72 (undergraduate and postgraduate). This public university has an ICT division, which was established in January 2001 and is composed of 8 people. There are six main core services and each has a substantial number of functions. The ICT division offers core services such as: network service, management support, system support services, consulting services and support, support for teaching, and research support. The majority of the information systems (databases) and networks in the organization, which handle thousands of records, are not integrated. This means they offer services independent of each other although most of the subjects (customers) are the same. The Internet connection is 4 Mbps link.

4.2 Method of ranking

Many methods and techniques have been developed for systematic evaluation of alternatives in various decision-making settings, however AHP publications have far outnumbered those in any other in the field of multiple criteria decision-making and multi-attribute utility theory field (Wallenius et al; 2008).

The use of a ratio scale in the AHP is a major departure from traditional methods of decision analysis, which typically employ interval measure (Harker and Vargas, 1987). The primary advantage of the AHP is its use of pair-wise comparisons to obtain a ratio scale of measurements (Liberatore and Nydick, 1997). The pair-wise comparison approach includes much redundancy and is thus less sensitive to judgmental errors common to techniques using absolute assignments (Karlsson and Ryan, 1997).

Another important advantage of the AHP is that it actually indicates inconsistencies by calculating a consistency ratio of judgmental errors (Karlsson and Ryan, 1997). AHP allows inconsistency, but provides a measure of the inconsistency in each set of judgments. This measure is an important by-product of the process of deriving priorities based on pair-wise comparisons (Forman & Selly, 2001).

These two advantages of AHP are based on the eigenvalue method proposed by Saaty. Eigenvalue Method is the only valid method for deriving the priority vector from a pair-wise comparison matrix, particularly when the matrix is inconsistent. The
The eigenvalue method is necessary and sufficient to uniquely capture the ratio scale rank order inherent in inconsistent pair-wise comparison judgments. (Saaty and Hu, 1998).

4.2.1 The analytic hierarchy process

The methodologies for ranking the most relevance components of the unified strategic alignment model are based on survey results, where the preferences of specific groups are used as a basis for ranking. We have selected AHP method proposed by Thomas Saaty to do the ranking of the components of the unified strategic alignment model in the public universities in Nicaragua.

AHP is a multiple criteria decision-making tool (Saaty 1980) (Vaidya and Kumar, 2006) that employs a pair-wise comparison procedure to arrive at a scale of preference among sets of alternatives (Saaty and Ramanujam, 1983). With AHP, the decision-maker carries out simple pair-wise judgments that are then used to develop overall priorities for ranking the alternatives (Saaty and Vargas, 2001). AHP is based on the eigenvalue method proposed by Saaty. Eigenvalue Method is the only valid method for deriving the priority vector from a pair-wise comparison matrix, particularly when the matrix is inconsistent. The eigenvalue method is necessary and sufficient to uniquely capture the ratio scale rank order inherent in inconsistent pair-wise comparison judgments. (Saaty and Hu, 1998).

The AHP involves structuring any complex problem into different hierarchical levels with a view to accomplishing the stated objectives of a problem (Saaty, 1990a) (Bayazit, 2005). A decision-maker can insert or eliminate levels and elements as necessary to clarify the task of setting priorities or to sharpen the focus on one or more parts of the system (Saaty, 1990b).

In figure 4.1, we show the hierarchical structure of the unified strategic alignment model. This structure focuses on the components of the IT strategy, business strategy, organizational infrastructure and process and IT infrastructure and process defined in section 3.3.1, 3.3.2, 3.3.3 and 3.3.4. The hierarchical structure is composed of three levels. On the first (or top) level is the overall goal of strategic alignment. At the second level of the hierarchy are the business strategy, IT strategy, organizational infrastructure and process and IT infrastructure and process. On the third (or bottom) level are the components of: business strategy, IT strategy, organizational infrastructure and process and IT infrastructure and process.
Saaty (1990b) suggests that one of the uses of a hierarchical structure is that it allows judgment to be focused separately on each of several properties essential for making a sound decision. The most effective way to concentrate judgment is to take a pair of elements and compare them on a single property without concern for other properties or other elements. This is why paired comparisons in combination with the hierarchical structure are so useful in deriving measurement.

In a typical AHP pair-wise comparison, matrices are prepared between alternatives with respect to each criterion being considered. Each entry in the matrix $A = a_{ij}$ represents the strengths of preferences that the decision-maker believes exist for the alternative. There is an infinite number of ways to derive the vector of priorities from the matrix ($a_{ij}$), but emphasis on consistency leads to the eigenvalue formulation:

$$\lambda_{\text{max}} w = Aw \quad \text{Eq (4.1)}$$

Where $A$ is the matrix of pair-wise comparison, $\lambda_{\text{max}}$ is the principal eigenvalue of the comparison matrix and $w$ is the vector of priority $[w_1, w_2, w_3, \ldots, w_n]$. Thomas Saaty proposed a method known as averaging over normalized columns. “This method calculates the sum of the $n$ columns in the comparison matrix. Next, divides each element in the matrix by the sum of the column the element is a member of, and calculate the sums of each row. Then it normalizes the sums of the rows”. (Karlsson and Ryan, 1997). The result of this method is referred to as the priority matrix and it is an estimation of the eigenvalues of the matrix.

The Analytic Hierarchy Process includes a consistency index (CI) for an entire hierarchy. In the equation 4.2, the CI of a matrix of comparison is given by Saaty and Vargas, 2001.

$$\text{CI} = (\lambda_{\text{max}} - n) / (n - 1). \quad \text{Eq (4.2)}$$

The $\lambda_{\text{max}}$ is the principal eigenvalue of the comparison matrix. The closer the value of $\lambda_{\text{max}}$ is to $n$, the smaller the judgmental errors and thus the more consistent the result.
(Karlsson and Ryan, 1997). The consistency ratio (C:R) defines the accuracy of the pair-wise comparison.

\[
C.R = \frac{C.I}{R.I} \quad Eq (4.3)
\]

It is obtained by comparing the CI with the appropriate one of the following set of numbers (see table 4.1) (Saaty and Vargas, 2001).

<table>
<thead>
<tr>
<th>N</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.I.</td>
<td>0.0</td>
<td>0.52</td>
<td>0.89</td>
<td>1.11</td>
<td>1.25</td>
<td>1.35</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
<td></td>
</tr>
</tbody>
</table>

Let see an example of AHP. We performed the pairwise comparison of the components of IT infrastructure and process of the unified strategic alignment model to calculate the priority matrix. The fundamental scale used for this purpose is shown in table 4.5. We put the components in a matrix and assign them a relative intensity of value. In all position of the main diagonal, we inserted “1”. The red numbers represent the reciprocal value. The next step is to calculate the sum of each column.

<table>
<thead>
<tr>
<th></th>
<th>Architecture integration</th>
<th>Continuous improvement</th>
<th>Benchmarking</th>
<th>Business Metrics</th>
<th>IT metrics</th>
<th>Balance metric</th>
<th>Service Level Agreement</th>
<th>Formal Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture integration</td>
<td>1.00</td>
<td>1.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>5.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Continuous improvement</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>0.33</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Business Metrics</td>
<td>0.33</td>
<td>0.33</td>
<td>1.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>IT metrics</td>
<td>0.33</td>
<td>0.33</td>
<td>1.00</td>
<td>0.20</td>
<td>1.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Balance metric</td>
<td>0.33</td>
<td>0.33</td>
<td>1.00</td>
<td>0.20</td>
<td>0.33</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Service Level Agreement</td>
<td>0.20</td>
<td>0.33</td>
<td>0.33</td>
<td>0.20</td>
<td>0.33</td>
<td>1.00</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Formal Assessment</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.20</td>
<td>0.33</td>
<td>1.00</td>
<td>0.33</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.87</strong></td>
<td><strong>4.67</strong></td>
<td><strong>8.67</strong></td>
<td><strong>8.80</strong></td>
<td><strong>14.00</strong></td>
<td><strong>18.00</strong></td>
<td><strong>21.33</strong></td>
<td><strong>22.00</strong></td>
</tr>
</tbody>
</table>

After that, we divide each component with the corresponding sum of its column and calculate the row sums. See table 4.3.
### Table 4.3. Estimation of the priority matrix

<table>
<thead>
<tr>
<th></th>
<th>Architecture integration</th>
<th>Continuous improvement</th>
<th>Benchmarking</th>
<th>Business Metrics</th>
<th>IT metrics</th>
<th>Balance metric</th>
<th>Service Level Agreement</th>
<th>Formal Assessment</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture integration</td>
<td>0.26</td>
<td>0.21</td>
<td>0.35</td>
<td>0.34</td>
<td>0.21</td>
<td>0.17</td>
<td>0.23</td>
<td>0.14</td>
<td>1.91</td>
</tr>
<tr>
<td>Continuous improvement</td>
<td>0.26</td>
<td>0.21</td>
<td>0.12</td>
<td>0.34</td>
<td>0.21</td>
<td>0.17</td>
<td>0.14</td>
<td>0.14</td>
<td>1.59</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>0.09</td>
<td>0.21</td>
<td>0.12</td>
<td>0.11</td>
<td>0.07</td>
<td>0.06</td>
<td>0.14</td>
<td>0.14</td>
<td>0.93</td>
</tr>
<tr>
<td>Business Metrics</td>
<td>0.09</td>
<td>0.07</td>
<td>0.12</td>
<td>0.11</td>
<td>0.36</td>
<td>0.28</td>
<td>0.23</td>
<td>0.23</td>
<td>1.48</td>
</tr>
<tr>
<td>IT metrics</td>
<td>0.09</td>
<td>0.07</td>
<td>0.12</td>
<td>0.02</td>
<td>0.07</td>
<td>0.17</td>
<td>0.14</td>
<td>0.14</td>
<td>0.81</td>
</tr>
<tr>
<td>Balance metric</td>
<td>0.09</td>
<td>0.07</td>
<td>0.12</td>
<td>0.02</td>
<td>0.02</td>
<td>0.06</td>
<td>0.05</td>
<td>0.05</td>
<td>0.47</td>
</tr>
<tr>
<td>Service Level Agreement</td>
<td>0.05</td>
<td>0.07</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02</td>
<td>0.06</td>
<td>0.05</td>
<td>0.14</td>
<td>0.45</td>
</tr>
<tr>
<td>Formal Assessment</td>
<td>0.09</td>
<td>0.07</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02</td>
<td>0.06</td>
<td>0.05</td>
<td>0.05</td>
<td>0.36</td>
</tr>
</tbody>
</table>

The last step is to normalize the sums of the rows. (i.e. divide each row sums with the number of components). In our case, we divide by 8.

\[
\begin{pmatrix}
1.91 \\
1.59 \\
0.93 \\
1.48 \\
0.81 \\
0.47 \\
0.45 \\
0.36 \\
\end{pmatrix} \times \frac{1}{8} = \begin{pmatrix}
0.24 \\
0.20 \\
0.12 \\
0.18 \\
0.10 \\
0.06 \\
0.06 \\
0.04 \\
\end{pmatrix}
\]

The last matrix with all the values (i.e. 0.24, 0.20, 0.12, 0.18, 0.10, 0.06, 0.06, and 0.04) represents the priority matrix. Based on the values of the priority matrix, we can draw the following conclusion:

Architecture integration, degree of importance is 24 %,
Continuous improvement, degree of importance is 20 %,
Benchmarking, degree of importance is 12 %,
Business Metrics, degree of importance is 18 %,
IT metrics, degree of importance is 10 %,
Balance metric, degree of importance is 6 %,
Service Level Agreement, degree of importance is 6 %,
Formal Assessment, degree of importance is 4 %.
The final phase is to calculate how consistent the prioritization has been done. It means that it is possible to measure judgment errors by calculating the consistency index of the comparison matrix and then calculating the consistency ratio (Karlsson and Ryan, 1997). For example, if a respondent prioritize that Architecture integration is more important than continuous improvement, continuous improvement is more important than benchmarking. Next, respondent prioritize that benchmarking is more important than architecture integration. It means that architecture integration is more important than architecture integration, which can not be true. The consistency index is calculating by the Eq (4.2). To estimate the value for $\lambda_{\text{max}}$, we take the matrix in table 4.2 and multiple it with the priority vector:

$$\begin{bmatrix}
1.000 & 1.000 & 3.000 & 3.000 & 3.000 & 5.000 & 3.000 \\
1.000 & 1.000 & 1.000 & 3.000 & 3.000 & 3.000 & 3.000 \\
0.333 & 1.000 & 1.000 & 1.000 & 1.000 & 3.000 & 3.000 \\
0.333 & 0.333 & 1.000 & 1.000 & 5.000 & 5.000 & 5.000 \\
0.333 & 0.333 & 1.000 & 0.200 & 1.000 & 3.000 & 3.000 \\
0.333 & 0.333 & 1.000 & 0.200 & 0.333 & 1.000 & 1.000 \\
0.200 & 0.333 & 0.333 & 0.200 & 0.333 & 1.000 & 3.000 \\
0.333 & 0.333 & 0.333 & 0.200 & 0.333 & 1.000 & 1.000 \\
\end{bmatrix} \times \begin{bmatrix}
0.24 \\
0.20 \\
0.12 \\
0.18 \\
0.10 \\
0.06 \\
0.04 \\
\end{bmatrix} = \begin{bmatrix}
2.22 \\
1.88 \\
2.04 \\
1.74 \\
0.88 \\
0.49 \\
0.47 \\
0.38 \\
\end{bmatrix}
$$

The next step is to take the first element of the resulting vector and divide it with the first element of the priority vector and then do the same with the second element and so on.

$$\frac{2.22}{0.24} = 9.29$$
$$\frac{1.88}{0.20} = 9.45$$
$$\frac{2.04}{0.12} = 17.45$$
$$\frac{1.74}{0.18} = 9.69$$
$$\frac{0.88}{0.10} = 8.66$$
$$\frac{0.49}{0.06} = 8.41$$
$$\frac{0.47}{0.06} = 8.44$$
$$\frac{0.38}{0.04} = 8.38$$

To calculate $\lambda_{\text{max}}$, average over the elements in the resulting vector:

$$\lambda_{\text{max}} = \frac{9.29 + 9.45 + 17.45 + 9.69 + 8.66 + 8.41 + 8.44 + 8.38}{8} = 9.97$$

Now we have the information to calculate the consistency index. We use E.q 4.2:

$$\text{CI} = \frac{9.97 - 8}{8 - 1} = 0.28$$

According to the E.q 4.3 and table 4.1
4.3. Methodology

The methodologies for ranking the most relevance components of the unified strategic alignment model are based on survey results, where the preferences of specific groups are used as a basis for ranking. We have selected the Analytic Hierarchy Process (AHP) method proposed by Thomas Saaty to do the analysis of the data to obtain in the public universities in Nicaragua. In the next section, we give more details about the conduction of the survey in the public universities of Nicaragua.

4.3.1 Data collection

In August and September 2009, a survey was applied to 20 IT experts and business experts from Nicaragua, asking them to prioritize the components of the unified strategic alignment model. An e-mail was sent to the IT directors of the Nicaraguan public universities to explain to them the purpose of the survey and ask them time to do a presentation about the survey.

A presentation was done to 4 IT directors of the public universities under study. The presentation was based mainly on the purpose and the methodology adopted for the survey. IT directors were promised that the information obtained from the survey would be handled with confidentiality. After the presentation, the names of the selected respondents were given by their IT directors according to the following criteria:

- The respondent should be a practitioner (IT expert, business manager or IT director) with more than 5 years working in the field of the public university in Nicaragua. Their experience is fundamental to minimize judgmental errors (Johansson et al; 2005). The longer the experience, the higher the credibility of individual answers.

- The respondents should be involved in the annual planning of ICT activities at the public universities in Nicaragua.

We booked an appointment of two hours with the selected respondents through the IT director and sent the protocol for the study by e-mail to them a week in advance of the personal interview. The protocol was made up of a glossary, a scale and the instrument. The glossary contains the description of the components of the unified strategic alignment model (see appendix 5). The scale is the fundamental scale of the AHP. The instrument is based on the unified strategic alignment model.

The application of the ranking proceeds as follows: the components at level 3 of the hierarchical structure are compared with one another in relation to their importance and are organized into 4 matrices. The matrices used in this survey were named as business strategy, IT strategy, IT infrastructure and processes, and organizational infrastructure and processes. One example of matrix is the table 4.4. The others matrices are in the appendices 5. The respondents were asked to grade the relative importance between the components. The pair-wise comparisons are entered in a matrix.
Table 4.4 Matrix of IT Infrastructure and process

<table>
<thead>
<tr>
<th></th>
<th>Architecture integration</th>
<th>Continuous improvement</th>
<th>Benchmarking</th>
<th>Business Metrics</th>
<th>IT metrics</th>
<th>Business Metrics</th>
<th>Balance metric</th>
<th>Service Level Agreement</th>
<th>Formal Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture integration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benchmarking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business Metrics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT metrics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance metric</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Level Agreement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formal Assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The scale used to indicate the relative preference for one component over another is shown in table 4.5. This scale enables the decision-maker to incorporate experience and knowledge intuitively (Harker and Vargas, 1987). This fundamental scale has been validated for effectiveness, not only in many applications by a number of people, but also through theoretical comparisons with a large number of other scales (Saaty, 1990b) (Saaty and Vargas, 2001).

Table 4.5. Fundamental scale (Adopted from Saaty 1990a)

<table>
<thead>
<tr>
<th>Intensity of importance</th>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two activities contribute equally to the objective</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance of one over another</td>
<td>Experience and judgment slightly favor one activity over another</td>
</tr>
<tr>
<td>5</td>
<td>Essential or strong importance</td>
<td>Experience and judgment strongly favor one activity over another</td>
</tr>
<tr>
<td>7</td>
<td>Very strong importance</td>
<td>An activity is strongly favored and its dominance is demonstrated in practice</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
<td>The evidence favoring one activity over another is of the highest possible order of affirmation</td>
</tr>
<tr>
<td>2,4,6,8</td>
<td>Intermediate values between the two adjacent judgments</td>
<td>When compromise is needed</td>
</tr>
</tbody>
</table>

In total, 367 comparisons were done for each respondent and it took approximately 2 hours for each respondent to do the pair-wise comparisons.
4.3.2 Data Processing

Saaty (1977) showed that the estimation of weight could be accomplished via an iterative computation (Zahedi, 1986). His computational algorithm is in the Expert Choice software. Expert Choice incorporates the AHP methodology and enables the analyst to structure the hierarchy and resolve the problem using relative or absolute measurements, as appropriate (Saaty and Vargas, 2001).

The data obtained from the respondents were processed using the Expert Choice software to weight the priorities of the components. Expert Choice is decision support software that reduces complex decisions to a series of pair-wise comparisons and then synthesizes the results (Alanbay, 2005). A database is generated from the data collected, which includes the survey instrument with the answers of the respondents in Expert Choice.

4.3.3 Result

The result of the ranking of the components of the unified strategic alignment model should be taken as reference by the decision makers to assist them to establish business strategy, IT strategy, organizational infrastructure and IT infrastructure. Decision makers should make more emphasis on the weightiest components over the least weighty components to assist them in the achievement of strategic alignment.

The weightiest component in the figure 4.2 is analysis. It means that the decision-makers should first consider the analysis in the business strategy. Analysis of the business strategy in the public universities could be done through the SWOT (Strengths, Weaknesses, Opportunities, and Threats) tool. The second most important component is futurity. After considering the "analysis" components, the decision-makers should consider the "futurity" components in the business strategy of the public universities. The "futurity" components consider having a forward-looking, long-term focus. It means that all public universities should have a vision, mission and goal. The “analysis” and “futurity” components add up to 0.245 (25 percent) in weight of importance. The inconsistency of the result of the business strategy is 0.0087. The decision-makers should take into consideration this procedure of choosing the weightiest components over less weighty components in order to establish business strategy.

The result of figure 4.3 corresponds to the IT strategy. The weightiest component in the figure 4.3 is prioritization process. This means that decision-makers should promote

![Figure 4.2. Ranking of the components of business strategy](image-url)
prioritization processes to make a more critical contribution in the IT strategy in the public universities. The second most important component is IT strategic planning. IT strategic planning is based on the goals of the firms and IT. This process defines the general direction regarding how to attain these goals via an IT strategic plan. The decision-makers should take into consideration this procedure of choosing the weightiest components over less weighty components in order to establish the IT strategy.

The result of figure 4.4 corresponds to the IT infrastructure and process. The weightiest component in the figure 4.4 is continuous improvement. It means that decision-makers should promote the audits in information technology and the applications of standards in the public universities more as part of continuous improvement. The second most important component is “Architecture Integration.” Architecture integration consists of applications, data and technology “articulated in terms of the configurations of hardware, software, and communications.” It means that the public universities should continue working strongly on integrating those systems that are isolated and those that are not transparent to the staff (academic and administrative) and students (undergraduate and postgraduate) of the public universities. It is necessary to further monitor the implementation of integrated systems or networks.

The “continuous improvement” and “architecture integration” components add up to 0.31 (31 percent) in weight of importance of the IT infrastructure and process in the public universities in Nicaragua. The inconsistency of the result of the IT infrastructure and process is 0.02. Decision-makers should take into consideration these results and this procedure of choosing first the weightiest components over less weighty components in order to establish the IT infrastructure.
The result of figure 4.5 corresponds to the organizational infrastructure and process. The weightiest component in the figure 4.5 is Role of IT in strategic business planning. It means that decision-makers should promote as a first priority the participation of the IT Directors in defining the business strategies. The second most important component is “Relationship/trust style.” This means that relationship-building is critical for the success of a sound understanding and a sense of partnership between business and IT. Relationship also helps foster a better understanding of each other's point of view and helps change incorrect perceptions. Decision-makers should take into consideration these results and this procedure of choosing first the weightiest components over less weighty components in order to establish the organizational infrastructure.

### Figure 4.5. Ranking of the components of organizational Infrastructure and process

Figures 4.2, 4.3, 4.4 and 4.5 have shown that some components of the unified strategic alignment model are more relevant or critical than others in the public universities in Nicaragua according to the result obtained in the survey. The sort of importance from ascending to descending of the components of the unified strategic alignment model should be taken as reference by the decision makers of the four public universities because the sort of importance from ascending to descending can make possible to improve a successful business strategy, IT strategy, organizational infrastructure and process, IT infrastructure and process and these four components will impact positive in the strategic business and IT alignment in the public universities under study.

### 4.4 Lessons learned from this study

It was a good step to start with a presentation to the IT directors of the four public universities in Nicaragua. The presentations to the IT directors allowed us to apply the survey in these four institutions because they identified the respondent to be interviewed in terms of the two criteria mentioned in the section data collection.
The application of the unified strategic alignment model was done in four public universities with the participation of the IT experts, business managers and IT directors of the public universities. The participants represented two organizational levels of the public universities: strategy level and operational level. The surveys were conducted in two hours and the easy recognition of answer choices was evident. It was the first time that someone applied a survey related to area of strategic alignment in Nicaraguan public universities.

The survey was sent by email to the respondents a week in advance of the personal interviewing. This allows us to receive questions from the respondents about the description of the terminology of the unified strategic alignment model and some adjustments were made to the terminology used in the survey. All examples of the terminology used in the survey are related to the public universities environment.
5. Concluding Remarks and Future research

5.1 Concluding Remarks

In this research we proposed a unified strategic alignment model based on the components of four well know strategic alignment models: Strategic Alignment Model, Strategic Alignment Maturity Model, information system strategic alignment model and a operational model of strategic alignment proposed. The unified strategic alignment model differs from others strategic alignment models in the sense that it search reconcile some strategic alignment models instead of propose a new one without take in consideration the components of the existences of some well know strategic alignment models in the literature. The presence of these four models in one model enrich the strategic alignment field. It means that the unified strategic alignment model is more complete and broad in the context of the representation of the knowledge in the domain of the strategic alignment.

As was stated in our goals, our intention is to construct a unified strategic alignment model. To do this, we used the notation of the EID and the method for generating it. The EID is used as a means for presenting and comparing theories and models from existing literature. The intent of using the method for generating EID was to facilitate the construction of the four models that are part of the unified strategic alignment model. We added one step to the method for generating EID to merge the four strategic alignment models and construct the unified strategic alignment model. This model contributes to a better understanding of the nature and key aspects of the strategic alignment from some complementary theories.

During the construction process of the unified strategic alignment model, we identified similar components between the four strategic alignment models and at the same time, we identified differences components between the four strategic alignment models but all the components of the unified strategic alignment model are complementary in the domain of strategic alignment. In the unified strategic alignment model, we have conceptual model and other models are oriented to evaluate the strategic alignment. The SAM is a conceptual models however the other models are more oriented to practical issues.

We used the analytical hierarchical process to assess the relative importance of the components of the unified strategic alignment. We developed a hierarchy structure of the unified strategic alignment model in order to organize the unified strategic alignment model in a more simple way and increase the understanding about the unified strategic alignment model. The hierarchical representation of the unified strategic alignment model was used as reference to design the survey which was used in four public universities in Nicaragua. In this study, we identified that the components of the unified strategic alignment model are closer to the language used by the respondents in the public universities. It was therefore relatively easy to explain to the respondents the components of the unified strategic alignment model.
The result obtained in the study reflects the relative importance of the component of the unified strategic alignment model according to IT expert and business expert from different staff level that participated in the survey. This type of study should be apply every time that decision makers elaborate the new IT strategies, business strategy, organizational infrastructure and IT infrastructure of their public universities.

5.2. Limitation

We do not carry out an evaluation of the unified strategic alignment model in this thesis. Nevertheless, we show the applicability of the unified strategic alignment model through a survey in the public universities of Nicaragua. An evaluation of the unified strategic alignment model should be consider in a future research activity.

This study has the limitation that it is based on one method of prioritization. A method of prioritization based on a literature review can be very useful for a future research activity because we would be able to do a comparative study among the results.

It has the limitation that the ranking is based only in the public universities of Nicaragua. It will be good extend this study to private universities and semi private universities to have a better picture of the ranking of the components of unified strategic alignment.

5.3. Future Research

In this section, we briefly discuss a few possible directions for future research.

- One potential area for future research is to do an evaluation of the strategic alignment model. The evaluation of the unified strategic alignment model can be done through case study in the public universities. Pattern matching logic can be applied in the case study as an analysis tool.

- A second area of future research is to propose a method to assess the strategic alignment in an institution and its effect on organizational performance in the public universities.
6. References


Appendix 1. Strategic Alignment Model
Appendix 2. Strategic Alignment Maturity Model
Appendix 3. Operational model of strategic alignment model proposed by François Bergeron, Louis Raymond and Suzanne Rivard
Appendix 4. Information System Strategic Alignment Model
Appendix 5. Protocol for the survey in the public universities in Nicaragua

Name of the University:

Name of the respondent:

Years of experience:

Position in the University:

Request for organizational chart:

Date:
Glossary

Aggressiveness: There is a push to dominate or be leaders in certain areas even if this means reduced prices and cash flow. For example, strategies to open new post graduate within the institution or acquire new technologies to be implemented in the institution.

Aggressive IS: deployments used by the administrative unit when pursuing aggressive marketplace action.

Analysis: Reliance on detailed, numerically oriented studies prior to action. Example: The institution uses the instrument SWOT.

Analytical IS: IS deployments used by the administrative unit when conducting analyses of public universities situations.

Architectural transparency, flexibility: Evaluate and apply emerging technologies effectively.

Architectural integration: Assume a role supporting a flexible infrastructure that is transparent to all the staff and students in the institution. For example it can be done through the implementation of networks or systems.

A champion: Describes a person – typically a senior business executive – who has the compelling vision of the “to be” state of affairs. This person is willing to lend his/her organizational credibility and reputation to the idea being advocated and to communicate this vision of a future state to all levels of the organization. Champions tend to be more focused on communicating the vision and driving the organization to embrace his/her vision.

A sponsor: Describes a person—typically an executive of the administrative area—who uses his/her organizational influence to obtain the resources needed to implement the champion's vision. Example, A Sponsor can be a director, rector or dean.

Balance metrics: is linked to administrative area metrics and IT metrics. For example: Analysis of IT investments in the administrative areas.

Budgetary control: (“The How” and “why” of financial resources allocated to projects). Though this is the most basic governance mechanism, a flaw in it is that it tends to promote the perception of IT as a “cost center” rather than a potential “value center.”

Business: The activity of providing goods and services.

Business metrics: The organization devotes significant resources to measuring performance factors such as human resource, cost. For example: 1. the organizational budget allocated to administrative and operational activities. 2. Return on investment (ROI),

Business strategic planning: This process defines a business strategy that is enabled / driven by IT. It defines the enterprise demands of its IT function through the strategic
planning period and the opportunity IT has in meeting these demands. For example: The institution has a strategic plan.

**Business Strategy:** A business decision taken at particular points in time by different people in response to sets of perceived environmental factors. Strategy is about making choices that include:

- The selection of business goals
- The choice of products and services to offer
- The design and configuration of policies that determine how the firm positions itself to compete in its markets.
- The appropriate level of scope and diversity (e.g. specialization).
- The design of the organizational structure, administrative systems and policies used to define and coordinate work.

**Career Crossover:** This is an excellent alternative and is good for “seeding” business or IT organizations with people who have perspectives that can generate empathy and build relationships and understanding. For example: IT staff working in the administrative unit; administrative staff working in IT unit.

**Change readiness:** The implementation of new systems always involves changes. Acceptance occurs when people have a positive emotional response to the change. Example: Implementing a new system of academic register. Is it well accepted by the staff?

**Communication:** Use a common and clear language between administrative and IT organizations.

**Culture Locus of Power:** The IT governance is concerned with the locus of decision-making power regarding the use of IT and the processes for making these decisions. The IT governance mechanism for international strategies will tend to reflect the form of decision-making authority for each of these strategies and the need for standardization of process and communication between headquarter and local organizational entities.

**Defensiveness:** Puts emphasis on cost cutting and efficiency; internally ‘lean and mean.’ Forming tight marketplace alliances (e.g. with customers, suppliers and distributors).

**Defensive IS:** IS deployments used by the administrative unit to improve the administrative operation in the institution.

**Education/cross-training:** (IT must understand the business; business must understand IT). Institutionalizing formal training for business executives in their roles and responsibilities regarding IT and, in turn, requiring formal training of IT management and key staff in the operational and management aspects of the business will enhance understanding, rapport and communication between the communities. In turn this
improved communication will result in improved communication of business needs to IT management on how these needs are aligned with the strategic objective of the organization. This requires a substantial and sustained investment of time and resources by the organization. Example: There is a cross training program in the institution.

**Formalization:** It is measured by the extent to which rules, procedures and activities. Examples: Rules, regulations, procedures and activities are written.

**Futurity:** Having a forward-looking, long-term focus. For example, the institution has a vision, mission and goals.

**Future-Oriented IS:** IS deployments used by the administrative unit for planning and projection purposes.

**IT metrics:** A balanced “dashboard” that demonstrates the value of IT in terms of contribution to the institution is needed. Example: 1. the number of computers. 2. The number of routers in the institution.

**IT Governance:** The degree to which the authority for making IT decisions is defined and shared among management, and the process managers in both IT and business organizations apply in setting IT priorities and the allocation of IT resources

**IT strategic planning:** Based on the goals of the institution and IT, this process defines the general direction regarding how to attain these goals, via an IT strategic plan. Example: The institution has an IT strategic plan.

**IT's role in strategic business planning:** The IT function has an equal role in defining business strategies. Example: The IT director is part of the strategic business planning.

**IT Strategy:** It is therefore a set of decisions made by IT and functional senior management that either enables or drives the business strategy. It leads to the deployment of technology infrastructure and human competencies that will assist the organization in becoming more competitive.

**IT Scope:** The important information applications and technologies.

**IT planning and Control:** Is how well the firm manages its IT function, resources and infrastructure. For example: 1. Maintaining control over the projects that involve the acquisition of new IT. 2. Strategic planning of information systems in relation to the institutional objectives.

**IT acquisition and implementation:** Relates to how well the institution manages the selection and introduction of new IT applications. For example: 1. The institution has some criteria to choose new Information technology. 2. The Institution has an IT acquisition office.

**Inter/Intra organizational learning:** Some examples of these components are: Courses, seminars, workshop, and training in the institution.
Knowledge sharing: is about understanding of business by IT or understanding of IT by business. For example: Knowledge sharing can be done through Formal meetings, planned or unplanned meetings.

Liaison effectiveness: The approach about facilitator tends to stifle rather than foster effective communications.

Liaison: (Primary point of contact for facilitating IT business relationship.) This person facilitates the administrative unit and IT unit relationship. Liaison communicates well with both IT and administrative staff. Example: This person is in charge of communicating the needs and requirements between the IT division and the administrative area in the institution.

Prioritization process: All IT process are important. Each process will contribute to the effective management and performance of IT. However, if they are examined from the perspective of the administrative unit, depending on the environment and demands, many of the processes have an important contribution critical to the firm's success. Example: A method exists to establish a prioritization process.

Proactiveness: Analysis Reliance on detailed, numerically oriented studies prior to action.

Proactive IS: IS deployments used by the administrative unit to expedite the introduction of products and services.

Protocol rigidity: It impedes discussion and the sharing of ideas about understanding of business by IT or understanding of IT by business and should be avoided.

Professionalization: The number of professional staff members in the institution indicates professionalization. Example: The choice of personnel is through their academic titles and work experience. This can be measured by the number of professionals in the institution.

Relationship/trust style: Partnership of administrative unit and IT. In continuation with communication and marketing, relationship building is critical for the success of a sound understanding and a sense of partnership among administrative units and IT. Relationship also helps foster better understanding of each other's point of view and helps change wrong perceptions. Examples: Is there trust between administrative area and IT area?

Reporting /Organization structure: The degree of centralization of the IT function and organizational lines of reporting (e.g. Does the IT director report to the CFO?)

Return on Investment (ROI): is widely cited as a technique for assessing the value of IT investments.

Riskiness: Reluctance to embark on risk projects. Examples: 1. the institution takes the risk to open a new master's program. 2. The institution takes the risk to embark on new IT projects.
**Risk-Averse IS:** IS deployments used by the administrative unit to make business risk assessments.

**Service level agreement (SLA):** Assesses the commitment of IT to the business. The service levels should clearly define the rewards and penalties for surpassing or missing objectives.

**Steering committee:** is considered a “best practice” governance mechanism for making decisions regarding organizational investments and use of IT.

**Shared risks, responsibilities, rewards/penalties:** (Strong partnership of business and IT leaders.) This approach drives the business and IT communities toward a more partnership-oriented operating model where the responsibilities for IT decisions are jointly assumed by business and IT management and accountability for IT investment result is shared by business and IT communities. This alternative requires a shared perception of value and trust and is highly dependent on prevailing organizational culture and its perception of contribution to business value. Examples: Some projects are shared by the IT division and the administrative area.

**Standard articulation:** Enables or drives business processes and strategies as a true standard. Examples: IEEE, ISO, etc.

**Skill:** Going beyond the traditional considerations such as training, salary, performance feedback and career opportunities are factors that enhance the organization's cultural and social environment as a component of organizational effectiveness.

**Specialization:** (or horizontal differentiation) is measured by the number of distinct job titles in the organization chart.

**Traditional, enabler/driver, external:** Goes beyond the back office and into the front office of the organization.

**The partnership:** Connects and integrates business and IT planning and management processes.

**The architecture:** Consists of applications, data and technology, “articulated in terms of the configurations of hardware, software, and communications.”

**Understanding of business by IT:** Too often there is little awareness on the part of IT. Example: The IT people are informed about the strategic planning process of the institution.

**Understanding of IT by business:** Too often there is little IT appreciation on the part of business. Example: The administrative staffs are informed about the IT strategic planning processes of the institution.

**Vertical differentiation:** The number of levels in the firm’s hierarchy below the chief executive level assesses vertical differentiation. There is a coordinate relation between all the individuals who are part of the institution.
We define strategic alignment as a continuous process which involve interrelating the coherent combination of the four fundamental domains: business strategy, IT strategy, organizational infrastructure and process, and IT infrastructure and process in order to contribute to the organization's performance.

Methodology to follow for applying the survey.

The survey is composed of the instruments, the glossary and the fundamental scale. The respondents will receive the instruments, glossary and fundamental scale (fig 1) with enough time. I will apply the survey to every respondent and will grade the components based on the answer from the respondents. To capture which components of the unified strategic alignment model are the most important, a method for pair-wise comparison called the Analytical Hierarchical Process (AHP) will be utilized. This method allows several respondents to make pair-wise comparisons of individual components of the unified strategic alignment model. The algorithm also offers the possibility to aggregate the results of rankings made by different respondents, and has a way of calculating the degree of consistency in the results.

<table>
<thead>
<tr>
<th>Intensity of importance on an absolute scale</th>
<th>Definition</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two activities contribute equally to the objective</td>
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<td>3</td>
<td>Moderate importance of one over another</td>
<td>Experience and judgment slightly favor one activity over another</td>
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<td>5</td>
<td>Essential or strong importance</td>
<td>Experience and judgment strongly favor one activity over another</td>
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<td>7</td>
<td>Very strong importance</td>
<td>An activity is strongly favored and its dominance demonstrated in practice</td>
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<td>9</td>
<td>Extreme importance</td>
<td>The evidence favoring one activity over another is of the highest possible order of affirmation</td>
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<td>2, 4, 6, 8</td>
<td>Intermediate values between two adjacent judgments</td>
<td>When compromise is needed</td>
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Table: Fundamental Scale

Respondent selection from business perspective

The success in capturing the most important component of the unified strategic alignment model in the public universities in Nicaragua is contingent on the respondents that participate in the ranking. The method advocates selecting respondents with the following characteristics:

- The respondents should be selected from the senior management and operational levels of the company with more than 5 years working in the field (business perspective) in the use of the IT system at the public universities in Nicaragua.
• The respondents should represent a multitude of business views within the organization, by coming from different (sub) departments within the organization.

Respondent selection from IT perspective

• The respondent should be an IT Director and operational level of the public universities with more than 5 years working in the field in the use of an IT system at the public universities in Nicaragua.

• The respondent with experience in the use of an IT system should personally perform the work tasks covered by the system functionality, or at least know how other people do so, in order to be acquainted with the work process that the functionality supports.
**Business strategy**

Compare between the business strategy components, which component do you consider more important in order to achieve a successful business strategy? Use the fundamental scale to compare the relative importance with respect to business strategy.

<table>
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<tr>
<th>Liaison Breadth</th>
<th>Knowledge sharing</th>
<th>Protocol rigidity</th>
<th>Inter/Intra organizational learning</th>
<th>Understanding of IT by business</th>
<th>Understanding of business by IT</th>
<th>Defensiveness</th>
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**IT strategy**

Compare between the IT strategies components, which component you consider more important in order to achieve a successful IT strategy? Use the fundamental scale to compare the relative importance with respect to IT strategy.

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<tr>
<th>Business strategic planning</th>
<th>Reporting organization structure</th>
<th>IT strategic planning</th>
<th>Budgetary Control</th>
<th>IT investment management</th>
<th>Steering committee</th>
<th>Prioritization Process</th>
<th>Traditional, enabler / Driver external</th>
<th>IT environment scanning</th>
<th>Standard articulation</th>
<th>Externally defensive IS</th>
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IT infrastructure and process

Compare between the IT infrastructure and process components, which components do you consider more important in order to achieve a successful IT infrastructure and process? Use the fundamental scale to compare the relative importance with respect to IT infrastructure and process.

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Organizational infrastructure and process

Compare between the organizational infrastructure and process components, which components do you consider more important in order to achieve a successful organizational infrastructure and process? Use the fundamental scale to compare the relative importance.

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