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Ontology of Strategic Information Systems Planning

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Abstract:
Strategically planning and aligning information systems is still one the most challenging IT tasks for organizations. Literature has contributed to describe and analyze the phenomena labeling the process of Strategic Information Systems Planning (SISP) as the one that pursues the alignment of the IS/IT initiatives to achieve business goals. Statistics reveal, however, that those goals are significantly not being achieved, leaving the discussion open to know whether the SISP models, frameworks and methods are correct, complete, applicable, feasible or not. In order to understand and visualize the potential gaps and biases in the SISP literature, the paper introduces an ontology of the SISP process that allows systematically and symmetrically expand study to contribute to maturation of the scientific field as well as to identify the critical omissions within it. Later, the ontological analysis will allow the visualization of bright, light, and blind/blank areas of knowledge documented on SISP.

Keywords:
SISP, IS/IT Alignment, Ontology

1. The importance of revising SISP

The Strategic Information Systems Planning (SISP) process is one of the most critical areas in Management Information Systems (MIS) theory and applications. It has been recognized as one of the most challenging issues by the executives, ranking among the top ten concerns in information systems and technologies (IS/IT) (Luftman, et al., 2012, 2013; Raghunathan & Raghunathan, 1991; Teo & Ang, 1999). Accurate planning is important to the realization of the potential strategic impact of information systems, providing strategic advantages to enhance organizational performance. Research has documented that organizations with better SISP had fewer problems with their chosen hardware and a smoother and more effective implementation of their business plans (Altameem, Aldrees, & Alsaeed, 2014), unlike the inaccurate or incomplete planning.

There are numerous studies published on different aspects of SISP for last four decades; however, its understanding and practice continues to be a critical concern for academics and practitioners. Some key issues identified on SISP over time are: First, a diversity of approaches and domains of research have made it confusing for researchers and practitioners in the area to establish a research agenda (Amrollahi, Ghapanchi, & Talaei-Khoei, 2013). Second, few comprehensive and coherent review studies have been carried out to understand the field of SISP (Mangalaraj, 2014; Webster & Watson, 2002). Third, there is a strong gap between the academic debate and practitioners concerns in SISP, and IT managers intentionally ignored the academic body of knowledge on the field (Teubner, 2007).
Most studies on SISP examine the concept of planning as methods and measurement, omitting the process dimensions, characteristics, actions and behaviors (Grover & Segars, 2005). SISP

process itself seems to be complex and full of intricacies that impede the comprehensive identification of its variables for the effective modeling and management; or such that compels an oversimplification and loss of control over important variables. Besides, SISP has been biasedly developed in some contexts, for example, most models and frameworks have been constructed under positivistic perspectives for the industrialized economies, but they are not necessarily appropriate for a developing country context (Hicks, Culley, & McMahon, 2006; Levy & Powell, 1998; Newkirk, Lederer, & Johnson, 2008), where an array of problems within the process of SISP (hidden variables) can inhibit its success (Lederer & Sethi, 1991). In the same vein, there has been a call to research through methods that bring the scholars closer to the practice to disclose the micro processes and actual practice of SISP (Peppard, Galliers, & Thorogood, 2014). Therefore, researchers and practitioners in the MIS field may use a holistic meta-analysis framework to direct their efforts to better understand how to systemically, systematically and symmetrically address the issues of SISP in their future research that will help mature the body of knowledge of field.

The objective of this paper is to propose a logically constructed ontological framework for the SISP process that allows us to systematically study and describe the SISP literature, cases, theories, practice or practical evidence. Later, the ontological analysis will allow the visualization of bright, light, and blind/blank areas of knowledge documented. Thus, our central research questions are:

1. What are the critical domains for the SISP process?
2. What are the critical elements of SISP to plan/design/implement IS/IT that meet business objectives?

Though the introduction of the SISP ontology, we aim to systemically and symmetrically expand the spectrum of the varied avenues in theory and practice that may contribute to the development and maturation of the scientific field as well as to identify the critical omissions within it. The results of this study can be of help to students and researchers to better understand how to systemically address research issues in the SISP domain.

2. Evolution of SISP research

Over the last four decades, research in SISP has differing in form and content presenting variable cycles of publications documenting new knowledge. IS emerged in the late 1970s related to corporate data processing to support of day-to-day mundane tasks without relationship with corporate strategy (King, 1978; Mason & Mitroff, 1973). In the 80s, systems planning was understood as a process of requirements specification, reactive planning with little strategic value (today which we refer to as IS plan) where managers discussed about plans rather than strategy (Karimi, 1988). Later in the 90s its effectiveness was questioned in the "the productivity paradox", introducing themes related to alignment of IS with organizational goals and strategies (Pant & Hsu, 1995). During the 90´s, the most basic work in IS was establishing objectives and selecting feasible applications to implement (Alsène, 1999; Grover & Malhotra, 1999; Raghunathan & Raghunathan, 1994), and discover applications to gain competitive advantage (Lederer & Sethi, 1992; McGaughey, Snyder, & Carr, 1994). Also, directing the efficient and effective use of resources was a goal, leading to the development of technology policies and architectures (Earl, 1993). Then the focus shifted to IS strategic alignment (Reich & Benbasat, 1996; Teo & Ang, 1999). In more recent times, the key focus has been on uncertain and dynamic environments due to the globalization and constant technologic changes (Chi, et al., 2005; Mirchandani & Lederer, 2012; Newkirk & Lederer, 2006; Theodorou, 2006; Watanabe, Kishioka, & Nagamatsu, 2004).

The research in SISP seems however insufficient so far to understand its intricacies or fully develop practical approaches. There are few review articles and comprehensive literature review, that ground the basis to accelerate the discipline development (Mangalaraj, 2014; Webster & Watson, 2002). Peppard, Galliers & Thorogood (2014) stated that 'the process(es) of IS strategy is(are) commonly treated as a "black box" by researchers…', and 'that perhaps we still do not know what the phenomenon of interest really is'. In addition, the few literature review studies are based on few variables and commonly aim to examine other published academic research (Amrollahi, et al., 2013; Mangalaraj, 2014; Teubner & Mocker, 2008) , and not empirical data.

Although the mentioned studies present the current status on SISP and induce to a better understanding of the field, classifying their research to systematically identify new research areas and directing the efforts of researchers and practitioners to the right agenda is still necessary. Without direction, the research agendas in SISP is at risk to produce concentrations on a small number of topics, demanding a coherent review that emerges from a coherent conceptual structuring and representation of the topic itself (Webster & Watson, 2002). Therefore, a logically constructed ontological framework and ontological analysis may contribute to maturation of the scientific field as well as to identify the critical omissions within it. The ontological framework of SISP provides the opportunity to study the domain by mapping scientific papers as well as empirical data. It would not only help to systematically ascertain research gaps, but also to identify and visualize new research avenues, where academic and practitioner's documents could be contrasted against a fuller spectrum of relevant variables.

3. Ontology as a framework to study

An ontology is a powerful tool to meta-analyze and synthesize any research domain. An ontology represents the conceptualization of a domain (Gruber, 2008); it is a way of structuring and deconstructing the combinatorial complexity of the problem. It is organized on the terminologies and taxonomies in the natural language of the domain and can be used to systematize the description of a complex system (Cimino, 2006). Several automated ontology extraction tools based on linguistic extraction techniques such as part of speech (POS) tagging and natural language processing (NLP) exist (Alani, et al., 2003). Based on the nouns and verbs in the corpus, the extraction techniques can help develop comprehensive and detailed (with reference to the corpus) OWL-based ontologies (W3C, 2012), thesauri of hierarchically arranged terms, and other ISO-based ontology exchange standards (Ahmad & Gillam, 2005). The automated tools are designed for standardizing terminologies (Burton-Jones, Storey, Sugumaran, & Ahluwalia, 2005; Evermann & Fang, 2010; Staab, Gómez-Pérez, Daelemana, Reinberger, & Noy, 2004), but not to deduce semantically meaningful logical components of a domain as we do through of an ontological framework. Automated tools cannot yet formulate an ontology that is (a) parsimonious as the one we propose, and (b) organized such that the domain components can be concatenated from it as natural language sentences. Cumulative research is important and meta-analysis is an important method to synthesize it. However, meta-analysis is sometimes conducted in a very narrow sense to answer a specific question or verify a specific aspect of a domain (Hunter & Schmidt, 1996).

A logically constructed ontological framework simultaneously creates a number of specific hypotheses and theories related to the nature and structure of reality (Guarino, Oberle, & Staab, 2009; Wyssusek, 2004). The framework is schematically presented as a table with columns containing the dimensions of the problem and its elements organized in taxonomies logically constructed from the common terminology in the body of knowledge and discourse on each dimension, that when linked with other elements identify the specific elements of SISP. The ontology dimensions were derived from the main topic. A taxonomy may be extended by adding categories, reduced by eliminating them, refined by adding subcategories, and coarsened by aggregating them. The dimensions are arranged left to right, with adjacent suffixes and prefixes, such that one can construct a natural English sentence by concatenating an element from each dimension with the suffixes/prefixes.

A detailed description of ontological meta-analysis and synthesis is provided by Ramaprasad et al. (Ramaprasad & Syn, 2016; Ramaprasad, Syn, & Thirumalai, 2014; Ramaprasad, Syn, & Win, 2014). And the details of the process of abstraction, application, and attribution are described in Ramaprasad & Mitroff (1984). Therefore, the ontology by itself is parsimonious and meaningful; it is not intended to be as comprehensive and detailed as the ones derived from automated tools. Because the ontology is deduced from a problem's statement, it may vary from one problem to another. In these ways, it is new and different from an induced ontology.

4. Method

The ontology we propose is deduced from the domain's statement. It is based on Ramaprasad and Mitroff's framework (Ramaprasad, 1987; Ramaprasad & Mitroff, 1984) for formulating ill-structured problems; which is, in turn, based on the model proposed by Piaget (1974) for understanding causality. It too focuses on the key nouns and verbs (and sometimes adjectives) that define a domain and the relationship between them. However, instead of it being induced from the corpus, it is deduced from the domain's definition, applied to the domain's key documents, and modified iteratively until there is an acceptable fit. Its formulation is manual and not automated.

4.1 Constructing an Ontology of SISP

The dimensions (columns) of the ontology of SISP are derived from the main topic and divided in Strategic Planning (SP), Information Systems (IS) and Business Objective. The SP is composed in (a) Stage and (b) Resources; and IS is conformed in (c) Structure, (d) Level, and finally Business Objective represents the final focuses of SISP.

The taxonomy of *Stage* is composed of Define, Formalize, Plan, Execute, Monitor, Control, and Close. They represents the critical milestones in the process to manage SP to accomplish a lifecycle in project management (PMI, 2001). For example, the establishment of the need of an IT project and its scope are tasks in the Define stage. Failing to establish such need to be met and scope produces scope creep and several problems related in cascade in the rest of the evolution and execution of IT projects.

The taxonomy of *Resources* consists of Human, Financial, Material, Technological, Informational, and Spatial. They represent the common assets necessary and for the IT projects, derived from the surveying and analyzing of management literature. For example, managers, information officers, end-users, capabilities and skills are human resources or "assets" of an organization.

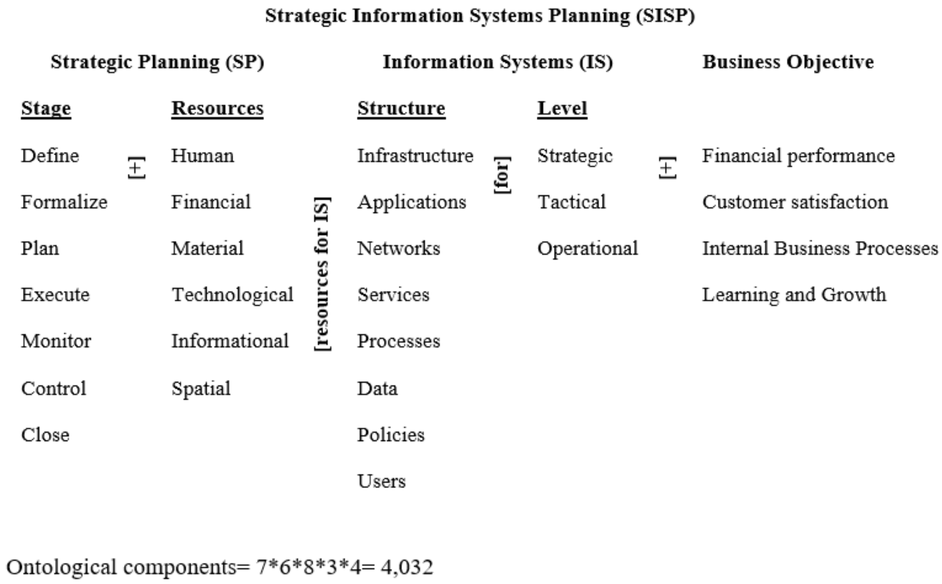

Figure 1. Ontology of SISP

Structure reveals the components of IS that includes Infrastructure, Applications, Networks, Services, Processes, Data, Policies, and Users. The taxonomy exhibits the ways in which IS are organized, according to the IS literature. For example, information security mechanisms are components of "Processes" as methods for the users to access and operate the systems; best practices and principles are elements of "Policies" pursuing IT governance.

The taxonomy of *Level* classifies the elements of SISP in three categories: the strategic, tactical and operational levels. It represents the traditional corporate roles in a company, also deduced from the Strategic Alignment Model (SAM) of (Henderson & Venkatraman, 1993). For example, applications used by top managers for monitoring long-term directions for the firm belong to the "Strategic Level".

Last, *Objective* is composed of main business areas in Financial performance, Customer satisfaction, Internal Business Processes and Learning and Growth. It represents the way IS assist the business in accomplishing their objectives and improve business performance, benefits grouped by the 4 perspectives from balanced scorecard (Kaplan & Norton, 1996). For example, ERP systems supporting the achievement of competitive advantages in coping with multiple sources of information can be referred to the objective "Internal Business Process".

Figure 1 presents the Ontology of SISP; and the following section provides three exemplifying statements derived from the ontology, and further below, section 4.3 presents the glossary of terms in the ontology.

4.2 Instances of ontological components:

In order to exemplify the use of the ontological framework, we present one example for each era of evolution of SISP -as presented in section 2- to clarify its instancing and analysis.

1. Define and Plan informational *resources for IS* processes and data *for* operational internal business processes.

Article Example: Strategic Planning for Management Information Systems (King, 1978).

2. Plan informational *resources for IS* infrastructure, processes and users.

Article Example: Strategic Planning for Information Systems: Requirements and Information Engineering Methods (Karimi, 1988).

3. Define informational *resources for IS* applications *for* strategic internal business processes.

Article Example: The Computer Integration of the Enterprise (Alsène, 1999).

4. *IS* services and processes *for* strategic customer satisfaction.

Article Example: Incremental and comprehensive strategic information systems planning in an uncertain environment (Newkirk & Lederer, 2006).

Figure 2 shows the ontological analysis part of the tool that the authors use to map, in this case research articles as instantiated and exemplified above, but also useful to potentially map other types of data (case studies, IS plans, etc.).

															Information Systems (IS)									Results						
		Stage							Resources						Structure								Level			Objective			
Reference	Title	Define	Formalize	Plan	Execute	Monitor	Control	Close	Human	Financial	Material	Technological	Informational	Spatial	Infrastructure	Applications	Networks	Services	Processes	Data	Policies	Users	Strategic	Tactical	Operational	Financial performance	Customer Satisfaction	Internal Business Processes	Learning and Growth
King, 1978	Strategic Planning for MIS	1		1									1						1	1					1			1	
Karimi, 1988	Strategic Planning for Information Systems: Requirements and Information Engineering Methods			1									1		1				1			1							
Alsène, 1999	The Computer Integration of the Enterprise	1											1			1							1					1	
Newkirk & Lederer, 2006	Incremental and comprehensive strategic information systems planning in an uncertain environment																	1	1				1				1		

Figure 2. Example of an Ontological analysis of SISP.

4.3 SISP Ontology Glossary

Strategic Information Systems Planning: Activities to define, command and execute IT projects, and maintain a consistent architecture of information systems and technologies that respond to the business model and business strategy.

Strategic Planning: Organizational process to define its course of action, and decide on the allocation of resources to commit to the strategy.

Stage: Set of processes grouped by the execution time.

Define: Identification of business needs, objectives and scope for the IT project.

Formalize: Officially authorize the execution of a defined project assigning roles, responsibilities, resources and estimates of time and budget.

Plan: Design a scheme of actions to achieve the objectives of a project.

Execute: Develop the actions to satisfy the project specifications.

Monitor: Systematic measurement and assessment of performance and results of the project.

Control: Regulate the progress and quality of the performance and results through necessary changes to the execution.

Close: Conclude all activities and deliver the products/services to formally finalize the project.

Resources: Endowment of assets necessary and available for the project.

Human: Workforce of an organization. For an IT project, usually includes development and maintenance managers, systems analysts, programmers, and operators, often with highly specialized skills, knowledge and capabilities. Also, related to other functional areas, we can count technical counterparts, end-users.

Financial: Assets available to fund the activities associated to the execution of a plan.

Material: Tangible assets that help to achieve a goal.

Technological: Systems and tools required to effectively produce or create a product or service. Examples are hardware, software, data warehouse, servers.

Informational: are defined as the data and information used by an organization. Examples are databases with customer, suppliers, etc.

Spatial: Spatial distribution for servers either physical or logical.

Information systems: Organized set of structures, processes, infrastructure, people and data for the collection, organization, storage and communication of information with given purposes.

Structure: Way information systems are organized.

Infrastructure: Hardware, networks, facilities and physical components to support the applications.

Applications: Software programs that run on the infrastructure to facilitate business processes.

Networks: Connecting systems that allow diverse computers and computational equipment to distribute data and informational resources.

Services: Intangible factors that provide some value to entity.

Processes: Methods with a logic to use, operate, and maintain information systems.
Data: Instantiation of facts or granular elements that are used by programs to produce information.
Policies: Rules and guidelines that govern the operation of information system.
Users: People or entities who use information systems or their outputs.

<u>*Level:*</u> Management-oriented types of routines, from the detailed and standardized operations to the strategic decisional level.
Strategic: Functions carried out at the top corporate level of executives and corporate boards responsible for setting and monitoring long-term directions for the firm.
Tactical: Activities performed by middle managers responsible for acquisition and allocation of resources, as well as monitoring for projects.
Operational: Routine actions performed by supervisors and end-user units to accomplish the objectives given by the strategy.

Business Objective: Outcomes that the business model aims to achieve. According the balanced scorecard there are "4 perspectives" to integrally identify and measure the implementation of strategy.

Financial performance: measures of how well a firm use assets and generate revenues that answer the question "How do we look to shareholders?". Examples are cash flow, sales growth, operating income, return on equity, working capital, cost base, borrowing, growth, rentability, profitability, liquidity / working capital, financial leverage or gearing ratios.
Customer satisfaction: measures of how products and services supplied by a company meet or surpass customer expectation that answer the question “How do customers see us?”. Examples: percent of sales from new products, on time delivery, share of important customers’ purchases, ranking by important customers, competitive advantage, social responsibility, community relations.

Internal Business Processes: measures that answer the question "What must we excel at?". Examples: cycle time, unit cost, yield, new product introductions, organizational structure, technology, productivity, efficiency, effectiveness.

Learning and Growth: measures that answer the question "How can we continue to improve, create value and innovate?". Examples: time to develop new generation of products, life cycle to product maturity, time to market versus competition, performance, innovation.

The five dimensions are arranged left to right with adjacent symbols, words, and phrases such that reading left to right concatenating a category from each dimension forms a natural English sentence. Each such sentence is a potential component of SISP. The total ontological components are 4,032 that fit in a half page to capture and represent the complexity of SISP concisely and thus help us take a systemic view of SISP systematically.

5. Conclusions

The ontological framework provides a useful tool to systemically, systematically and symmetrically study the SISP domain. It can be useful for describing and systematically mapping issues, questions, models, methods and in general the knowledge available in SISP. The synthesis of the accrued knowledge facilitates the analysis and discovery of new research avenues, and therefore the SISP ontology also serves as a tool to generate research agendas that mature the field.

Not only scientific papers can be mapped in the ontology, but also case studies and actual strategic IT planning documents could be contrasted against the full spectrum of 4.032 elements of SISP. Then our ontology is also practical and actionable to assess empirical evidence and propose holistic improvements to organizations in their strategic plans for IT.

As we have separated a stage, and defined a set of components of the IS structure, the evolution of technologies will still evolve and may require updating the ontology. Then adding categories to taxonomies, or reducing taxonomies to adapt this tool is feasible and the ontology easily adaptable.

Our research agenda considers mapping a relevant corpus of research in the form of scholarly papers. Such task will allow the visualization of bright, light, and blind/blank areas of knowledge documented in the literature. A ‘bright’ spot (frequently published themes in SISP) may be so because it is effective and important; it may also be a consequence of habit and herd effect, or be considered as the ‘low hanging fruit’ of SISP. A ‘light’ spot may be so because it is ineffective and unimportant; it may also be a consequence of difficulty of implementing or studying it, irrespective of its potential effectiveness or importance. A ‘blind/blank’ spot may have been simply overlooked by design or by accident; or, it may be infeasible.

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