Strategic Information Systems Planning: A Review

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Abstract

Information has emerged as an agent of integration and the enabler of new competitiveness for today's enterprise in the global marketplace. However, has the paradigm of strategic planning changed sufficiently to support the new role of information systems and technology? We reviewed the literature for commonly used or representative information planning methodologies and found that a new approach is needed. There are six methodologies reviewed in this paper. They all tend to regard planning as a separate stage which does not connect structurally and directly to the information systems development. An integration of planning with development and management through enterprise information resources - which capture and characterize the enterprise - will shorten the response cycle and even allow for economic evaluation of information system investment.

1. Background

For a long time relationship between information system functions and corporate strategy was not of much interest to Top Management of firms. Information Systems were thought to be synonymous with corporate data processing and treated as some back-room operation in support of day-to-day mundane tasks (Rockart, 1979). In the 80's and 90's, however, there has been a growing realization of the need to make information systems of strategic importance to an organization. Consequently, strategic information systems planning (SISP) is a critical issue. In many industry surveys, improved SISP is often mentioned as the most serious challenge facing IS managers (Pavri and Ang, 1995, Beath and Orlikowski, 1994; Martin, 1993; Porter and Miller, 1985).

Planning for information systems, as for any other system, begins with the identification of needs. In order to be effective, development of any type of computer-based system should be a response to need--whether at the transaction processing level or at the more complex information and support systems levels. Such planning for information systems is much like strategic planning in management. Objectives, priorities, and authorization for information systems projects need to be formalized. The systems development plan should identify specific projects slated for the future, priorities for each project and for resources, general procedures, and constraints for each application area. The plan must be specific enough to enable understanding of each application and to know where it stands in the order of development. Also the plan should be flexible so that priorities can be adjusted if necessary. King (King, 1995) in his recent article has argued that a strategic capability architecture - a flexible and continuously improving infrastructure of organizational capabilities - is the primary basis for a company's sustainable competitive advantage. He has emphasized the need for continuously updating and improving the strategic capabilities architecture.

SISP is the analysis of a corporation's information and processes using business information models together with the evaluation of risk, current needs and requirements. The result is an action plan showing the desired course of events necessary to align information use and needs with the strategic direction of the company (Battaglia, 1991). The same article emphasizes the need to note that SISP is a management function and not a technical one. This is consistent with the earlier distinction between the older data processing views and the modern strategic importance view of Information Systems. SISP thus is used to identify the best targets for purchasing and installing new management information systems and help an organization maximize the return on its information technology investment. A portfolio of computer-based applications is identified that will assist an organization in executing its business plans and realize its business goals. There is a growing realization that the application of information technology (IT) to a firm's strategic activities has been one of the most common and effective ways to improve business performance.

This paper reviews the existing methodologies for SISP in an attempt to answer the critical question: how to move ahead and further improve the effectiveness of strategic planning for information-based enterprises? In particular, we examine their capacity for driving the development of corporate information systems ensuing the planning, and their potential to support economic evaluations of information systems investments.

2. The Perspective of Strategic Information Systems Planning

In order to put the planning for strategic information systems in perspective, the evolution of information systems according to the three-era model of John Ward, et al.(1990) is pertinent. According to this model there are three distinct, albeit overlapping, eras of information systems, dating back to the 60's. The relationship over time of the three eras of information systems is shown in table 1:

	ERA	CHARACTERISTICS
60s	Data Processing (DP)	Standalone computers, remote from users, cost reduction function.
70s &80s	Management Information Systems (MIS)	Distributed process, interconnected, regulated by management service, supporting the business, user driven.
80s &90s	Strategic Information Systems (SIS)	Networked, integrated systems, available and supportive to users, relate to business strategy, enable the business - business driven.

Table 1: The Three Era Model of IS [Adapted from Ward (1990)]

Applications in the overall Data Processing (DP), Management Information Systems (MIS) and Strategic Information Systems (SIS) area need to be planned and managed according to their existing and future contribution to the business. Traditional portfolio models consider the relationship of systems to each other and the tasks being performed rather than the relationship with business success. A portfolio model derived from McFarlan (1984) considers the contribution of IS/IT to the business now and in the future based on its industry impact. Based on this model applications are divided into four categories, as shown here:

Strategic	**Turnaround**
(Applications which are critical for future success. Examples: computer-integrated manufacturing, links to suppliers, etc.)	(Applications which may be of future strategic importance. Examples: electronic data interchange with wholesalers, electronic mail, etc.)

Factory	Support
(Applications which are critical to sustaining existing business. Examples: employee database, maintenance scheduling, etc.)	(Applications which improve management and performance but are not critical to the business. Examples: time recording, payroll, etc.)

Table 2: A Portfolio Model [McFarlan (1984)]

Some characteristics of strategic IS planning are:

- Main task: strategic/competitive advantage, linkage to business strategy.
- Key objective: pursuing opportunities, integrating IS and business strategies
- Direction from: executives/senior management and users, coalition of users/management and information systems.
- Main approach: entrepreneurial (user innovation), multiple (bottom-up development, top down analysis, etc.) at the same time.

Strategic Information Systems Planning in the present SIS era is not an easy task because such a process is deeply embedded in business processes. These systems need to cater to the strategic demands of organizations, i.e., serving the business goals and creating competitive advantage as well as meeting their data processing and MIS needs. The key point here is that organizations have to plan for information systems not merely as tools for cutting costs but as means to adding value. The magnitude of this change in perspective of IS/IT's role in organizations is highlighted in a Business Week article, 'The Technology Payoff' (Business Week, June 14, 1993). According to this article, throughout the 1980s US businesses invested a staggering $1 trillion in the information technology. This huge investment did not result in a commensurate productivity gain - overall national productivity rose at a 1% annual rate compared with nearly 5% in Japan. Using the information technology merely to automate routine tasks without altering the business processes is identified as the cause of the above productivity paradox. As IT is used to support breakthrough ideas in business processes, essentially supporting direct value adding activities instead of merely cost saving, it has resulted in major productivity gains. In 1992, productivity rose nearly 3% and the corporate profits went up sharply. According to an MIT study quoted in the above article, the return on investment in information systems averaged 54% for manufacturing and 68% for all businesses surveyed. This impact of information technology on re-defining, re-engineering businesses is likely to continue and it is expected that information technology will play increasingly important roles in future. For example, Pant, et al. (1994) point out that the emerging vision of virtual corporations will become a reality only if it is rooted in new visionary information technology. It is information technology alone which will carve multiple 'virtual corporations' simultaneously out of the same physical resources and adapt them without having to change the actual organizations. Thus, it is obvious that information technology has indeed come a long way in the SIS era, offering unprecedented possibilities, which, if not cashed on, would turn into

unprecedented risks. As Keen (1993) has morbidly but realistically pointed out that organizations not planning for strategic information systems may fail to spot the business implications of competitors' use of information technology until it is too late for them to react. In situations like this, when information technology changes the basics of competition in an industry, 50% of the companies in that industry disappear within ten years.

3. Strategic Information Systems Planning Methodologies

The task of strategic information systems planning is difficult and often time organizations do not know how to do it. Strategic information systems planning is a major change for organizations, from planning for information systems based on users' demands to those based on business strategy. Also strategic information systems planning changes the planning characteristics in major ways. For example, the time horizon for planning changes from 1 year to 3 years or more and development plans are driven by current and future business needs rather than incremental user needs. Increase in the time horizon is a factor which results in poor response from the top management to the strategic information systems planning process as it is difficult to hold their attention for such a long period. Other questions associated with strategic information systems planning are related to the scope of the planning study, the focus of the planning exercise - corporate organization vs. strategic business unit, number of studies and their sequence, choosing a strategic information systems planning methodology or developing one if none is suitable, targets of planning process and deliverables. Because of the complexity of the strategic information systems planning process and uniqueness of each organization, there is no one best way to tackle it. Vitale, et al. (1986) classify SISP methodologies into two categories: *impact* and *alignment*. Impact methodologies help create and justify new uses of IT, while the methodologies in the "alignment" category align IS objectives with organizational goals. These two views of SISP are shown in figure 1.

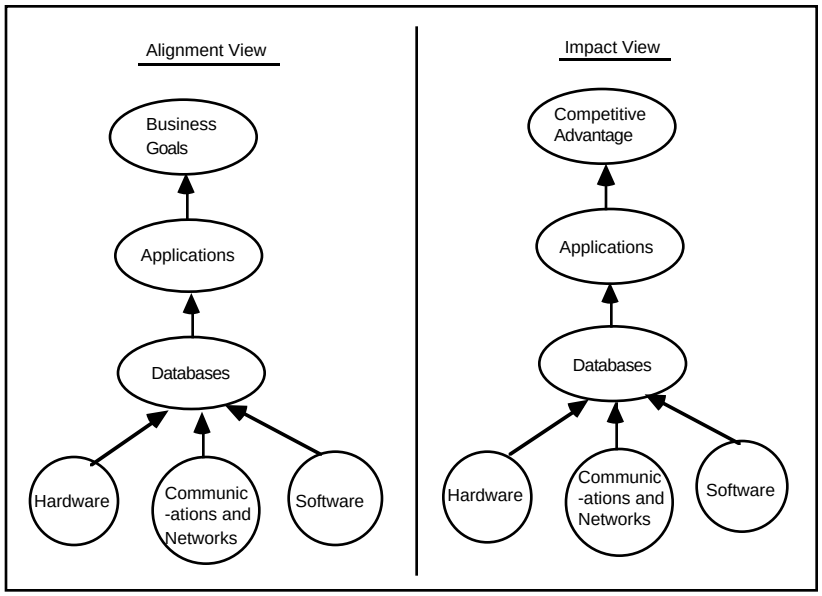

Figure 1: Two Views of SISP Methodologies

A. Impact Methodologies

1. Value Chain Analysis: The concept of value chain is considered at length by Michael Porter (1984). According to him, 'every firm is a collection of activities that are performed to design, produce, market, deliver, and support its product. All these activities can be represented using a value chain.' Porter goes on to explain that information technology is one of the major support activities for the value chain. "Information systems technology is particularly pervasive in the value chain, since every value activity creates and uses information. .. The recent, rapid technological change in information systems is having a profound impact on competition and competitive advantage because of the pervasive role of information in the value chain. ..Change in the way office functions can be performed is one of the most important types of technological trends occurring today for many firms, though few are devoting substantial resources to it. .. A firm that can discover a better technology for performing an activity than its competitors thus gains competitive advantage" (Porter, 1985). A typical value chain is summarized in the figure 2.

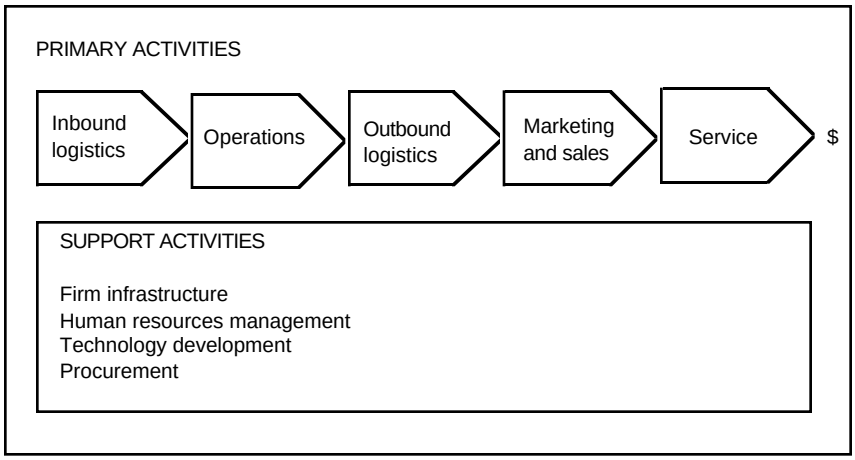

Figure 2: Porter's Value Chain (Porter, 1985)

Once the value chain is charted, executives can rank order the steps in importance to determine which departments are central to the strategic objectives of the organization. Also, executives can then consider the interfaces between primary functions along the chain of production, and between support activities and all of the primary functions. This helps in identifying critical points of inter-departmental collaboration. Thus, value chain analysis:

(a) is a form of business activity analysis which decomposes an enterprise into its parts. Information systems are derived from this analysis.

(b) helps in devising information systems which increase the overall profit available to a firm.

(c) helps in identifying the potential for mutual business advantages of component businesses, in the same or related industries, available from information interchange.

(d) concentrates on value-adding business activities and is independent of organizational structure.

Strengths : The main strength of value chain analysis is that it concentrates on direct value adding activities of a firm and thus pitches information systems right into the realm of value adding rather than cost cutting.

Weaknesses: Although a very useful and intuitively appealing, value chain analysis suffers from a few weaknesses, namely,

(a) it only provides a higher level information model for a firm and fails to address the developmental and implementation issues.

(b) because of its focus on internal operations instead of data, it fails to define a data structure for the firm.

(c) the basic concept of a value chain is difficult to apply to non-manufacturing organizations where the product is not tangible and there are no obvious raw materials.

(d) it does not provide an automated support for carrying out analysis.

Value chain analysis, therefore, needs to be used in conjunction with some other methodology which addresses the development and implementation issues and defines a data structure.

2. Critical Success Factor Analysis: Critical success factors analysis can be considered to be both an impact as well as an alignment methodology. Critical Success Factors (CSF) in the context of SISP are used for interpreting more clearly the objectives, tactics, and operational activities in terms of key information needs of an organization and its managers and strengths and weaknesses of the organization's existing systems. Rockart (1979) defines critical success factors as being 'for any business the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization.' As shown in figure 3, CSFs can exist at a number of levels. They represent the few key areas where things must go right for the business to flourish. Consequently, critical success factors are areas of activity that should receive constant and careful attention from management.

Rockart originally developed the CSF approach as a means to understanding the information needs of CEOs. The approach has subsequently been applied to the enterprise as a whole and has been extended into a broader planning methodology. It has been made the basis of many consulting practices and has achieved major results where it has been used well.

CSFs can exist at a number of levels, i.e., industry, organizational, business unit, or manager's. CSFs at a lower level are derived from those at the preceding higher level. The CSF approach introduces information technology into the initial stages of the planning process and helps provide a realistic assessment of the IT's contribution to the organization.

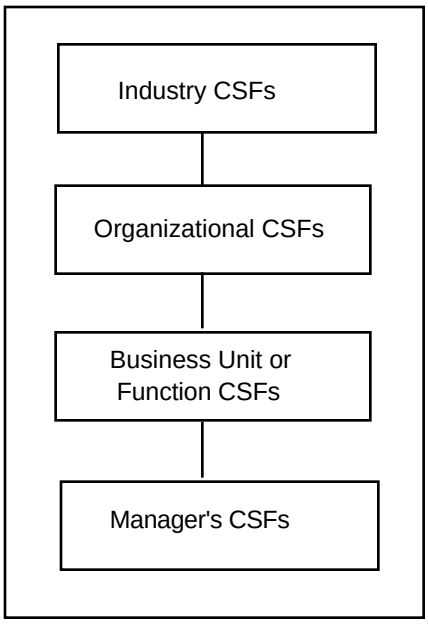

Figure 3: Hierarchy of CSFs

Strengths: CSF analysis provides a very powerful method for concentrating on key information requirements of an organization, a business unit, or of a manager. This allows the management to concentrate resources on developing information systems around these requirements. Also, CSF analysis is easy to perform and can be carried out with few resources.

Weaknesses: (a) although a useful and widely used technique, CSF analysis by itself is not enough to perform comprehensive SISP - it does not define a data architecture or provides automated support for analysis.

(b) to be of value, the CSF analysis should be easily and directly related back to the objectives of the business unit under review. It has been the experience of the people using this technique that generally it loses its value when used below the third level in an organizational hierarchy (Ward, 1990, p.164).

(c) CSFs focus primarily on management control and thus tend to be internally focused and analytical rather than creative (Ibid.).

(d) CSFs partly reflect a particular executive's management style. Use of CSFs as an aid in identifying systems, with the associated long lead-times for developing these systems, may lead to giving an executive information that s/he does not regard as important (Ibid.).

(e) CSFs do not draw attention to the value-added aspect of information systems. While CSF analysis facilitates identification of information systems which meet the key information needs of an organization/business unit, the value derived from these systems is not assessed.

B. Alignment Methodologies

1. Business Systems Planning (BSP): This methodology, developed by IBM, combines top down planning with bottom up implementation. The methodology focuses on business processes which in turn are derived from an organization's business mission, objectives and goals. Business processes are analyzed to determine data needs and, then, data classes. Similar data classes are combined to develop databases. The final BSP plan describes an overall information systems architecture as well as installation schedule of individual systems.

Steps in a BSP study are:

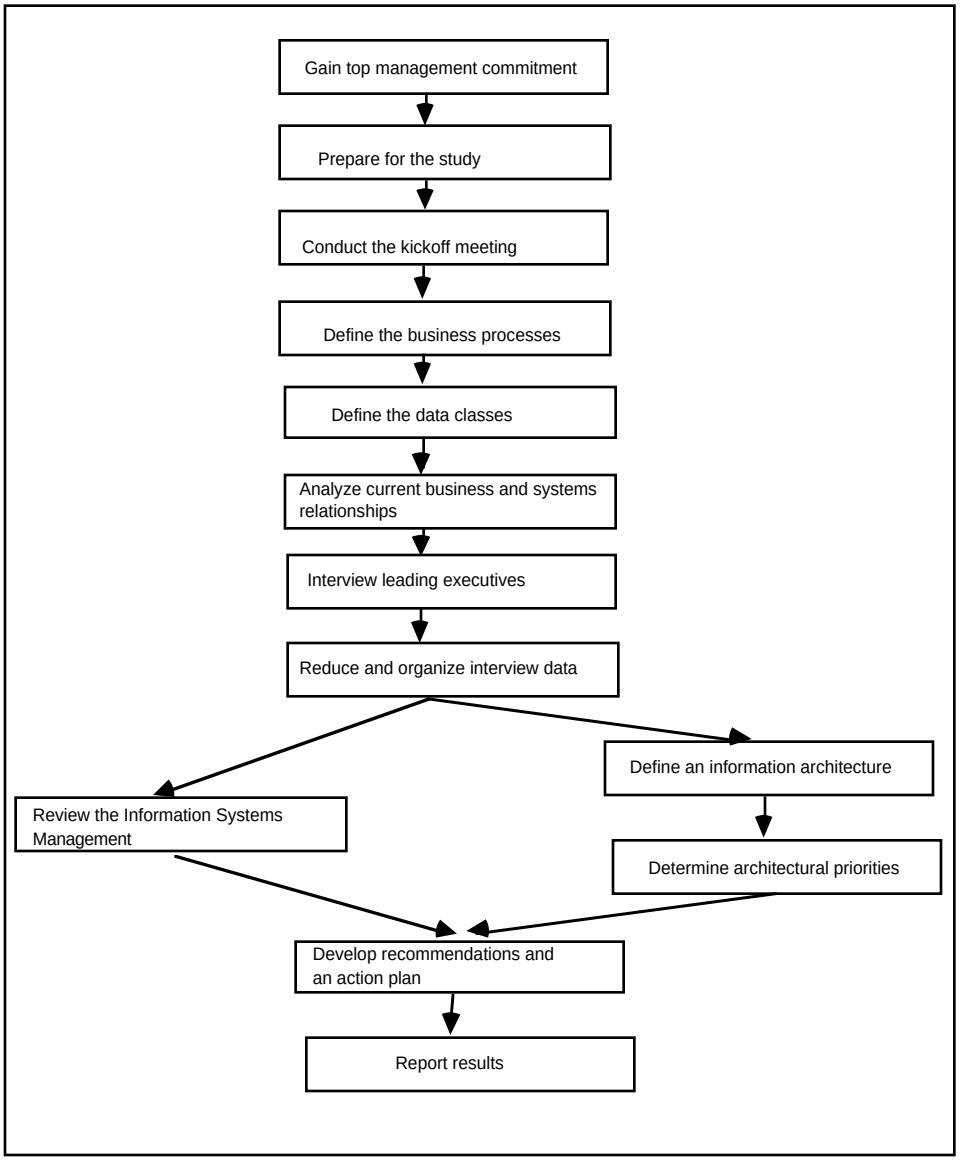

Figure 4: Steps in a BSP Study (Martin, 1982)

Barlow (1990) and Ledrer and Sethi (1988) have discussed strengths and weaknesses of BSP.

Strengths: Because BSP combines a top down business analysis approach with a bottom up implementation strategy, it represents an integrated methodology. In its top down strategy, BSP is similar to CSF method in that it develops an overall understanding of business plans and supporting IS needs through joint discussions. IBM being the vendor of this methodology, it has the advantage of being better known to the top management than other methodologies.

Weaknesses: (a) BSP requires a firm commitment from the top management and their substantial involvement.

(b) it requires a high degree of IT experience within the BSP planning team.

(c) there is a problem of bridging the gap between top down planning and bottom up implementation.

(d) it does not incorporate a software design methodology.

(e) major weakness of BSP is the considerable time and effort required for its successful implementation.

2. Strategic Systems Planning (SSP): Also known as PROplanner and developed by Robert Holland, this methodology is similar to BSP. A business functional model is defined by analyzing major functional areas of a business. A data architecture is derived from the business function model by combining information requirements into generic data entities and subject databases. New systems and their implementation schedules are derived from this architecture. This architecture is then used to identify new systems and their implementation schedule. Although steps in the SSP procedure are similar to those in the BSP, a major difference between SSP and BSP is SSP's automated handling of the data collected during the SISP process. Software produces reports in a wide range of formats and with various levels of detail. Affinity reports show the frequencies of accesses to data and clustering reports give guidance for database design. Users are guided through menus for on-line data collection and maintenance. The software also provides a data dictionary interface for sharing SSP data with an existing data dictionary or other automated design tools. Steps in the SSP procedure are shown in figure 5. In addition to SSP, Holland System's Corporation also offers two other methodologies - one for guiding the information system architecture and another for developing data structures for modules from the SISP study. The strengths and weaknesses of BSP apply to SSP as well.

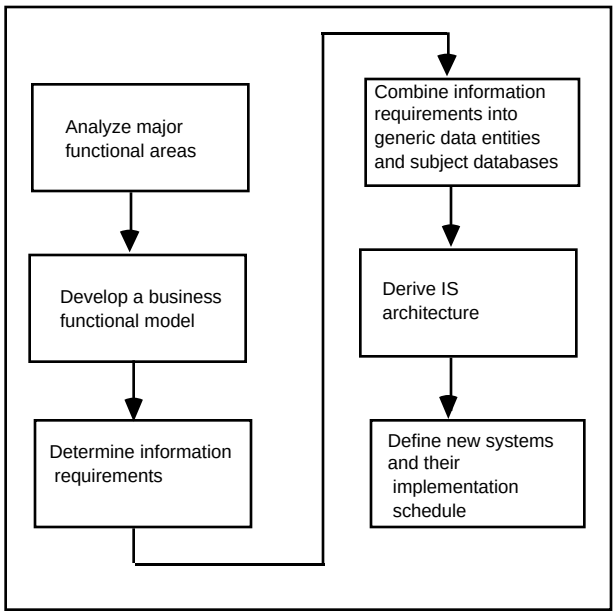

Figure 5: Steps in SSP Procedure

3. Information Engineering (IE): This methodology was developed by James Martin (1982) and provides techniques for building enterprise, data and process models. Theses models combine to form a comprehensive knowledge base which is used to create and maintain information systems. Basic philosophy underlying this technique is the use of structured techniques in all the tasks relating to planning, analysis, design and construction of enterprise wide information systems. Such structured techniques are expected to result in well integrated information systems. IE relies on an information systems pyramid for an enterprise. Such a pyramid is shown in the figure 6. The pyramid has three sides which represent the organization's data, the activities the organization carries out using the data and the technology that is employed in implementing information systems. IE views all three aspects of information systems from a high-level, management oriented perspective at the top to a fully detailed implementation at the bottom. The pyramid describes the four levels of activities, namely, strategy, analysis, systems design and construction, that involve data, activities and technology.

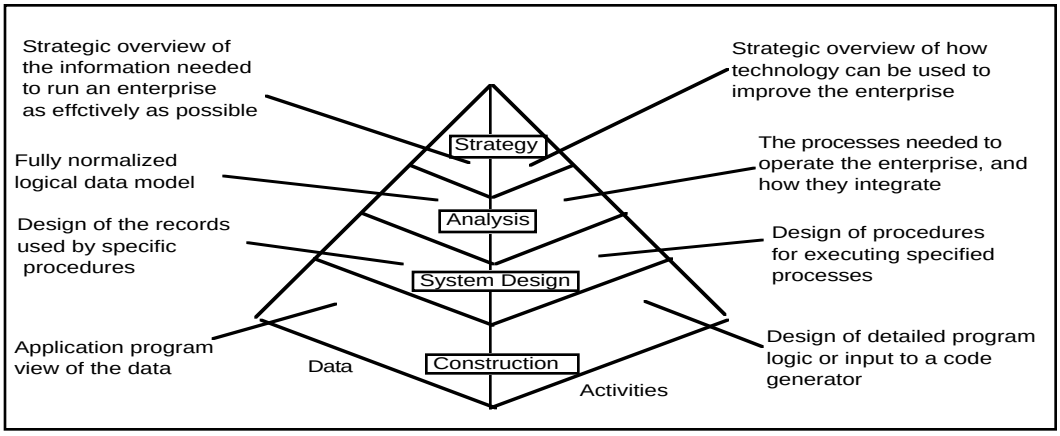

Figure 6: The IS Pyramid (Martin, 1989)

In addition to information engineering, Martin advocates the use of critical success factors. A major difference between IE and other methodologies is the automated tools provided by IE to link its output to subsequent systems development efforts, and this is the major strength of this methodology. Major weaknesses of IE have been identified as difficulty in securing top management commitment, difficulty in finding the team leader meeting criteria, too much user involvement and that the planning exercise takes long time.

4. Method/1: Method/1 (Arthur Anderson and Co., 1982) is a layered approach for SISP. The top layer is the methodology itself, the middle layer of techniques supports the methodology, and a bottom layer of tools supports the techniques. Techniques supported by this methodology include data flow diagramming, matrix analysis, functional decomposition, focus groups and Delphi studies. Andersen Consulting's CASE tool set FOUNDATION includes computer programs that support Method/1.

This methodology has five distinct objectives (Lederer and Gardiner, 1992):

- To identify the organization's information needs.

- To find new opportunities for using information to achieve competitive advantage.
- To define an overall IT strategy for satisfying the organization's IT objectives.
- To define data, applications, technology and organizational requirements for supporting the overall IT strategy.
- To define the activities needed to meet the above requirements and thereby implement the overall IT strategy.

This methodology incorporates the value chain analysis in its approach towards business and competitive assessment. The ten work segments of Method/1, their actions and products are shown in table 3 (Lederer and Gardiner, 1992).

Work Segment	Actions	Product
1. Scope Definition and Organization	Determine key planning issues Determine project scope Organize project team Obtain management commitment	Definition of key planning issues Definition of project scope Schedule of key management checkpoints Proposal letter
2. Business and Competitive Assessment	Study business and competitive environment Identify competitive information opportunities Define strategic information needs	Opportunities to use information competitively Definition of priority-setting criteria
3. Present State Assessment	Document present systems Assess effectiveness of information services Review functional operations Assess present operations Evaluate competitive IT position	Evaluation of organization's IT position Description of present and planned application characteristics Assessment of present operations, architecture, and capacity

4. Information Technology Opportunities	Analyze IT trends Determine information needs Define major IT objectives Identify opportunities for improvement	Summary of needs of each major functional department Description of opportunities for improvement Summary of IT objectives and trends
5. Information Technology Strategies	Develop high-level IT strategies Define conceptual architecture of required information systems Identify high-priority projects	IT strategies Description of high-priority projects
6. Organization Plan	Develop change management approach Develop human resources plan	Organization plan
7. Data and Applications Plan	Define data and applications Define data and maintenance approaches Develop data and application plan	Data and application plan
8. Technology Plan	Develop technical architecture Develop technology plan	Technology plan
9. Information Action Plan	Develop migration plan Prepare information action plan Approve and initiate information action plan	Information action plan
10. Product Definition and Planning	Initiate project definition Define requirements Develop a conceptual design Obtain management advisory committee approval	Project definition report

Table 3: Work Segments, Actions and Products in Method/1

4. Key Issues in SISP Methodologies:

Lederer and Sethi (1988) surveyed 80 organizations to examine the problems faced by

information systems managers when they attempt to implement one of three alignment methodologies, BSP, SSP or IE. Barlow (1990) has also examined the SISP methodologies and has provided some insights into their structure and implementation problems. Bergeron et al. (1991) examined the issue of application of two 'impact' methodologies, Porter's Value Chain Analysis and Wiseman's Strategic Thrust Methodology. These studies and the insights developed by us form the basis of this section which provides a critique of the existing methodologies.

The detailed list of problems in implementing SISP methodologies has been classified by Lederer and Sethi as resource, planning process, or output related problem associated with the three methodologies. According to this survey, the most severe problem identified by IS managers is the failure to secure top management commitment for carrying out the final plan. The second most severe problem identified is the requirement for substantial further analysis after the completion of the IS plan. Both these problems are related to the output of the planning process. Besides these top two, six of the next top eight problems are related to the resources required to carry out the strategic information systems planning (success of the plan depends on the team leader, difficulty in finding the team leader meeting the criteria specified in the study, methodology lacking computer support, planning exercise taking long time, etc.). Among the top ten problems encountered while implementing one of these methodologies (or, even while implementing an in-house methodology), three are common: difficulty in obtaining top management commitment for implementing the outputs, the requirement of substantial further analysis and difficulty in finding a good team leader. The results of this survey suggest that IS planners are not particularly satisfied with their methodologies. If the objective of the SISP exercise is to align IS objectives with business goals, then detailed, lengthy and complex SISP may be of limited value. Where the objective is to use IT to impact a business strategy, these methodologies may not generate useful ideas for that purpose. Bergeron et al. (1990), however, point out that the value chain analysis and Wiseman's strategic methodologies do help in achieving that purpose. Barlow (1990) suggests that the large number of methodologies that have been developed can often 'add confusion rather than clarity to the (IS) planning process.'

Salient points which emerge from this and the preceding sections are:

- Although strategic information systems planning is a major concern, most organizations find it difficult to undertake it. Besides their lack of experience with SISP, absence of a comprehensive, structured, easy to use methodology may also be a main reason for it. It is possible that the advances in Information Technology and their applicability in organizations has outpaced all formal methodologies evolved in the 70s and 80s or evolved in 90s as marginally modified versions of the earlier methodologies, which were largely dominated by IBM's Business Systems Planning.
- Further, as pointed out by Barlow (1990) also, the overall success of an integrated business/technology architecture depends upon the organizational structure, the level of IT

experience within the company and the availability of information resources. Since these factors differ between firms, there may not be a single best way to view IT planning.

- A comprehensive methodology for SISP will need to incorporate both the 'impact' and the 'align' views. Method/1 incorporates Value Chain Analysis. IE supports Critical Success Factors Analysis. Even BSP is now incorporating CSFs.
- Since it is difficult to find a team leader who meets the criteria specified in SISP methodologies, it is proposed that detailed guidelines on how to perform a SISP study by way of an automated tool will help. Such a tool will make the task more structured and less leader-critical. Some such tools for strategic business planning have been developed by the Search Technology, Inc. and are reported in Rouse and Howard (1993).

5. Conceptual Framework for SISP - A Research Agenda

A conceptual framework for SISP is necessary both from a theory building perspective as also providing a basis for undertaking SISP. The latter is expected to answer the following questions frequently encountered by the practitioners in this area:

- What is involved in SISP and how to go about doing it?
- How to link the products of SISP to systems analysis, design and implementation in a timely manner?
- Is one SISP methodology more suitable than another in a given context?
- How to evaluate alternative information systems plans?

The theory building perspective of SISP is expected to contribute to research in this area, which, being in its infancy, has been largely anecdotal.

Based on the literature in this area and a careful study of the current methodologies, certain generic steps in a typical SISP formulation can be identified. These are:

- Study Internal Business Environment. This is a prerequisite to determining the business IS needs. The internal business environment is comprised of mission of the organization, its objectives, strategies and plans, business activities, the organizational environment, core competencies, its critical success factors and the internal value chain.
- Study external business environment. This helps an organization focus attention on the forces and pressure groups it encounters. These external forces exert a very strong influence on the business strategy of an organization. Factors to be considered here are the industry that the organization is in and that industry's critical success factors, competitive position of the organization in the industry, relationship with major buyers and suppliers.
- Study internal IS/IT environment. This is mainly comprised of the current and planned applications portfolio that supports the business. Other aspects to be considered here are the present IS organization, skills and attitudes of people in the organization, IT environment and the IS/IT budgets.

• External IS/IT Environment. This consists of scanning the environment for available and emerging technologies and their business implications. An important aspect of this is to understand how the competitors are using information technology.

Strategic Information Systems Planning essentially provides a high level business/information model for an organization. Conceptually, the entire process of planning down to its detailed implementation can be looked at as occurring at three levels as shown in figure 7.

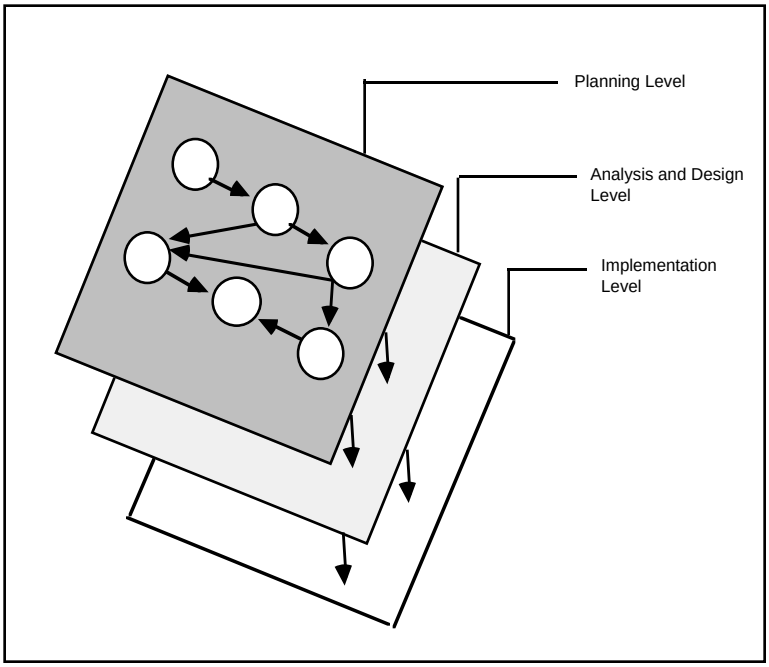

Figure 7: Three Levels of IS Planning and Implementation

All the generic tasks associated with SISP are performed at the top level and the information flows at that level are diagrammed. The outflows from the top level flow vertically into the next Analysis and Design level. This level has its own generic flows, associated with the analysis and design cycle of the systems development life cycle. The vertical flows do two things: (a) provide constraints on the flows and entities at this level and (b) create entities which link the analysis and design level to the upper, planning level. Similarly, outputs from the analysis and design level create and constraint flows at the implementation level. It is hypothesized that different combinations of flows and entities at the top level will result in different information architecture for the organization. For example, a different set of critical success factors will give rise to different constraints and hence different architecture. Similarly, if entities are changed at the top level, a different flow and hence a different architecture will emerge. For example, if the planning level model uses the internal value chain as against the external value chain - the resulting vertical flows, and hence the architecture, will be different. This should provide an organization the capability to (a) experiment with different architecture and (b) to modify its current architecture in response to high level changes without having to redo the entire systems development life cycle.

It is also hypothesized that the above model will provide an organization a third alternative to develop applications based on either a comprehensive systems development life cycle or rapid prototyping. Either after the completion of the top level model or even during its completion, some critical vertical flows can be identified - for example those based on the critical success factors, or some competitive advantage/threat. Applications can then quickly be developed, tested and implemented along those critical/competitive flows. The rest of the model can await completion and subsequent implementation while the organizational resources are concentrated on developing applications demanded by the exigencies of the current situation.

Developing a Theoretical Perspective

Hsu and Rattner (1993) developed a theory of information integration in CIM environment. This theory developed a concept of parallel paradigm of integration which asserts that by the sharing of information between processes interdependent decisions are pooled into concurrent processes. This parallel formulation of processes is a major change from the traditional sequential formulation of processes. In traditional CIM formulation, functions are supported by isolated decision spaces. That is, only the information pertaining to that decision is handled as a variable. Other information is inherited as a constraint. For example the part cycle inherits the information processed by the production cycle as a constraint which in turn is constrained by the information processed at the product development cycle. One can look at the degree of non-integration as the number of constraints a decision space inherits. The extent to which these constraints can be converted into variables represents the degree of integration. For instance, the design function in sequential formulation will constraint the process planning function. Because of the isolation of decision spaces, a mere interfacing between these two functions will require repeated iterations. Integration of the functions, will, however, provide for real-time interaction between these functions. From an enterprise point of view, parameterized decision spaces are fragmented and their existence prevents the associated set of functions from operating as an information-processing and decision-making whole, since results reflect a sequence of discrete decisions. Hsu and Rattner's work suggests that while such functions operate as though they are using local variables, they are in fact tightly coupled (through, perhaps second or third order relationships) to many other apparently local variables. Part of the difficulty in achieving integration stems from the obscured local vs. global distinction.

Another distinction which needs to be made here is that between local and global optimality. Since constraints from both higher levels and from peer-level are inherited as constraints, they are not evaluated in local decisions. Therefore, it is possible that while an enterprise may try to achieve local optimality, it may prevent global optimality of enterprise performance. This is further explained with reference to figure 8.

Figure 8(a) depicts a traditional, sequential formulation of manufacturing functions. Each oval represents a decision space . Within each level in the hierarchy, the arrows depict the explicit flow of information between pairs of peer functions. Between hierarchy levels, the arrows

symbolize the assertion of constraints.

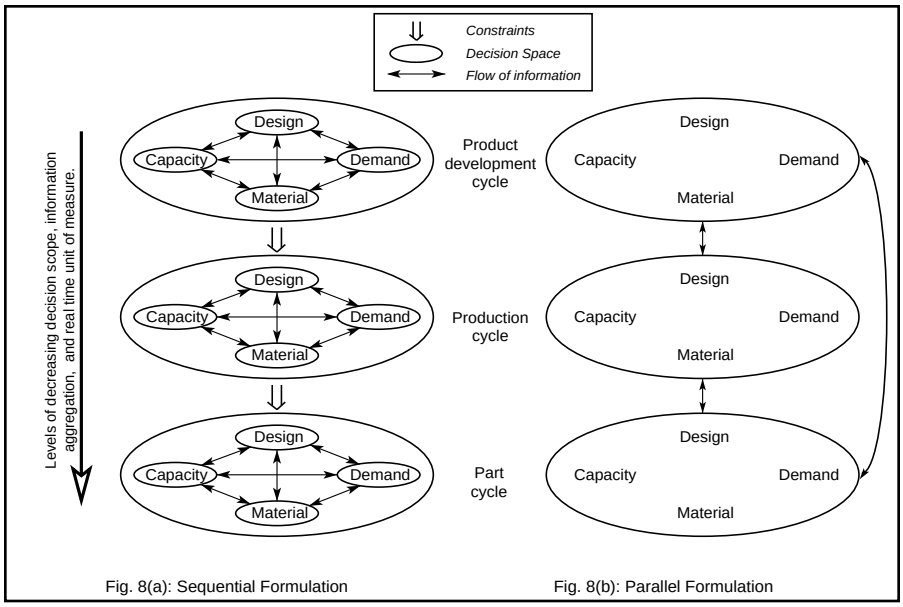

Figure 8: Sequential and Parallel Formulation of Decision Making Hierarchy (Rattner, 1990)

In contrast, manufacturing functions can be organized in parallel; i.e., to explicitly share unified decision spaces. The extent to which parameters and constraints are converted to decision variables is a measure of integration strength among sub-functions. The implication is that by explicitly managing global decision variables as such, each local function supports global performance objectives. The impact of optimizing global performance is ultimately measurable from the firm's production function. The paradigm is rooted in the premise that local productivity is largely irrelevant and that an enterprise achieves competitive success if it achieves optimal global productivity. Formulating tasks in parallel is a means towards that end.

The paradigm alters the decision-making hierarchy so that peer functions operate in parallel. Thus, all decisions are made in support of explicit global requirements. In this way, decisions contribute to synergy. Figure 8(b) depicts the concept of parallel formulation. Each oval again represents a decision space and each arrow represents the flow of constraints (downward) and feedback (upward) between hierarchy levels. There is no longer a need for explicit flows among peer functions since such iterations (sequential iterations) have been replaced by a comprehensive decision space.

The three level approach to information systems development can also be brought into the ambit of the above theoretical framework. The decisions at the planning level constraint those at the analysis level and from there down to the design level. The task here is to convert these constraints into variables which can be manipulated as the need arises. For example, the critical success factors at the planning level constraint the analysis, design and implementation of a particular application. In a parallel formulation this constraint would become a variable - that is not only do CSFs determine applications to support them but the CSFs set itself will be altered depending on the realities of an enterprise's information system. This provides a new perspective on SISP - the

bottom up planning - where the planning level variables (at least some of them) are manipulated by the 'state of the IS' in the organization. Where these variables can not be manipulated, for example those reflecting the external environment (competitors, technology available, etc.), this bottom-up approach will explicitly acknowledge those limitations and hopefully initiate a corrective action. It is not that organizations are not doing some or all of the things suggested here. The parallel formulation of information systems development tasks is expected to formalize and structure these steps and provide automated support for carrying them out in an interactive manner.

This parallel formulation of IS development tasks will also help organizations tide over a major limitation of SISP methodologies: planning is unnecessarily detailed and takes a long time. When the entire hierarchy of tasks related to developing down to implementing a plan is modeled in terms of its explicit information flows and data and knowledge classes, information systems can be developed quickly along the preferred paths (flows) without having to develop the entire system. Systems so developed will be different from those developed in an ad hoc manner in response to exigencies of the situation - these systems will be integrated with the overall system at the logical level as they are developed out of the shared information, data and knowledge spaces. This concept has its parallel in Physics. Holographic images are made up of a multitude of images where each individual image is derived from and contains the big image. In the same way, individual systems will be derived from the overall system and will in turn holistically support the overall system.

To conclude this theoretical perspective, it offers a viable alternative to the SISP process. Although not as well defined as in the CIM scenario, there is a structure to the SISP process. The literature and the analysis of existing methodologies, as mentioned earlier, does point to certain generic tasks and information flows required for SISP. This will provide the starting point for building a framework for a parallel formulation of SISP tasks.

6. Conclusions

Information-based enterprises must be planned in an integrated way whereby all stages of the life cycle are engaged to bring about agility, quality, and productivity. This integration is similar in nature to the integration of product life cycle for an enterprise. The existing methodologies, however, tend to support information planning as an island separated from the wealth of the enterprise's information resources. A needed new approach would tap into these resources which capture and characterize the enterprise to allow for integration of the planning stage with information systems development stages and support a shortened and adaptive cycle. This paper is a small first step towards a big task: developing a framework and a theory for strategic information systems planning. The need for such a framework is established by the existing problems in implementing SISP methodologies and also by what these methodologies themselves lack. A possible approach to building a framework is traced to the theoretical work of Hsu and Rattner (1993) and that is where the thrust of this line of research is expected to lie.

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