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An Experiment to Apply Some Substance-Theories to the Development of an ODSS in a Small Company

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Abstract

The focus of this research is on the appropriateness of the Substance-Theory-Oriented approach to the implementation of an Organizational Decision Support Systems in a small company. An ODSS is a general-purpose, multiple-user, large-scale system that has a relatively definite, continuous and organized position in the planning and decision making processes of an organization and which are designed for a variety of organizational decisions. We constructively show by means of a real case how the substance theories can be used to determine the actual contents of an ODSS. We have tested design guidelines and implementation strategies that can be exploited in small business companies in general.

The main idea of the proposed approach is that the managerial substance-theories should be utilized at each phase of the development process, beginning from the initial problem review and ending with the use and the evolution of the developed system. It is assumed that only these theories can direct the design and development process in the right direction and carry appropriate information and knowledge into the organization. By applying the proposed approach small companies are able to decide the contents of an ODSS, manage the development process, increase their managerial knowledge, and finally, make more structured and better decisions.

Key words: organizational decision support system, small company, dss development methodology

1. Introduction

Most Decision Support Systems (DSSs) are designed to support a specific, relatively narrow decision problem met by a single decision maker. However, it is possible, that DSSs cover the whole organization and are aimed to support organizational decision making. Such organization-wide systems have recently gained increasing attention in the DSS literature and in practice (Aggarwal *et al.* 1995, Carter *et al.* 1992, George 1992, George *et al.* 1992, Kaula and Dumdum 1991, Philippakis and Green 1988). An Organizational Decision Support System (ODSS), is a general-purpose, multiple-user, large-scale system, which is designed for a variety of organizational decisions and has a relatively definite, continuous and organized position in the planning and decision making processes of a company. Specifically, ODSSs support general coordination and integration of activities, consolidation of the budgets or other analyses presented by various divisions or departments, and test the implications of decisions by one part of the company on the rest of the company.

Almost all architectures and development processes discussed in the DSS literature are highly technology-oriented. Typically, they are either model, data, or dialogue-centered prescriptions of potential systems. Some attention is also paid to the decision-oriented architectures and respective development processes (Stabell 1983, 1988). However, where managerial decision making in firms and other organizations is concerned, a lot of generic theories are available for different kinds of decision situations. In principle, most of the theories in finance, marketing, and production are descriptive or prescriptive (normative) statements of how decisions in these functional areas are made or should be made in the best way. The value of these theories is, however, underestimated in the current DSS literature.

DSS research has mostly concentrated on larger companies and their decision problems. Smaller companies and their specific characteristics are largely ignored in the applied DSS literature. In this study the Substance-Theory-Oriented approach to design and develop a corporate-wide ODSS, as illustrated in Kivijärvi (1992), is applied to a small wholesale company in jewelery business. We will show by means of a real case how the substance theories can be used to guide what should be included in, and how to develop a DSS. Special emphasis is placed on the characteristics and requirements of a small business company. The case company is a small Finnish wholesale company. We build our approach on the theoretical knowledge of the main decision situations in business and industrial firms. The aim is to establish a substance-theory-oriented DSS for corporate-wide decision making which integrates the functional plans at different planning levels. Although we aim at a holistic, corporate-wide system, we apply an incremental approach where the whole DSS is divided into separate, manageable parts.

Theoretically, from a philosophical point of view, this research is an application of a DSS design theory to a small business context. In their pioneering study Walls *et al.* (1992) argue for the building of design theories for different types of information systems. They propose that theories from natural or social sciences form the 'kernel theories' of any information system design theory. The kernel theories cover both the design requirements (product) and the design process. At the conceptual level, there is a clear analogy between the underlying substance theories of our framework and the kernel theories.

This paper aims at three goals. First, we present a general methodology for designing and developing an ODSS in small companies. Second, we show the potential value of substance-theories as essential ingredients of such a methodology. Third, we evaluate the appropriateness of the methodology by a real development effort.

To meet the above goals the remaining of this paper is organized as follows. First we define the concept ODSS and give some criteria with which a company can be classified as small. In this context we also discuss corporate planning and decision support problems related to small companies. In chapter three a general framework for development of an ODSS for small companies is presented. After that in chapter four we apply the framework to a real case company, where we build an ODSS following the guidelines presented in chapter three. Chapter five concludes this paper with final remarks.

2. Conceptual Considerations

2.1. Organizational Decision Support Systems

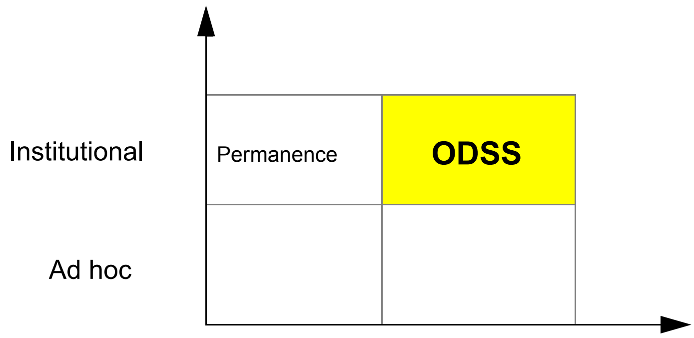
A key task of corporate management is to organize planning, decision making, and control activities concerning the entire firm. These activities can be delegated to or supported by planning departments but finally, corporate management is alone responsible for the quality of these tasks. Planning is a future-oriented, intellectual process that is systematically pursued by means of appropriate methods towards attaining the goals and objectives of a target-system. An extended, more comprehensive notion of planning also includes decision making and control activities. In a small, entrepreneurial firm most planning activities are carried by one person, usually, by the owner.

An objective of corporate planning is to prepare for events that involve risk and uncertainty. These events include, for example, competitors' actions, changes in worldwide trade-conditions, legislation, exchange rates, etc. Usually, corporate management has a very partial, if any, conception of events like these, although they certainly are of great importance to the success of the firm. A purpose of corporate planning is to improve decision makers' ability to cope with the problems and opportunities involving risk and uncertainty. Another purpose is to discover direct and indirect effects of the functional decisions throughout the company.

Corporate planning can be arranged and supported by different means and methods. One way to support managerial planning and decision making is a DSS. By means of the DSS the effectiveness of the management can be significantly improved. DSS can be classified according to different criteria. In Figure 1 the DSS are classified into four groups by two criteria.

The first criterion to classify DSS is the scope of the original problem situation to be supported by the system. Most DSSs are designed to support a specific,

FIGURE 1. A classification of Decision Support Systems



relatively narrow decision problem met by a single decision maker. However, it is possible that DSS cover the whole corporation and are aimed to support corporate-wide decision making. This is true particularly with small companies. The corporate-modeling literature offers the means to develop such systems (Naylor 1979, Rosenkranz 1979). The extremes of the first criterion are labeled *functional* and *corporate-wide*.

Although iterative and evolutionary style of development is crucial to DSS—indicating that the final goal is not a ready system—some DSS are designed for constant usage and other systems for occasional use. Donovan and Madnick (1977) label these two extremes institutional and ad hoc DSS. By institutional DSS, as opposed to ad hoc DSS, we mean general-purpose systems that have a relatively definite, continuous and organized position in the planning and decision making processes of a firm. Organizational Decision Support Systems (ODSS) are institutional and corporate-wide systems that "support people making enterprise-wide decisions in an interactive environment" (Aggarwal *et al.* 1995). Many small companies do not have sufficient resources to develop ad hoc systems for single decisions but they need to keep already developed systems for recurring usage.

Because the two criteria of classification are continuous concepts most DSSs fall between the extreme values in both criteria. In this study, however, attention is paid only to ODSS, that is, to the shaded quadrant of Figure 1. ODSSs have to support all decision types (input, process, and output decisions), and every phase of the decision process by refining product-demand, factor-supply, technology, and finance information. Because these systems reflect the company as a whole, they typically, but not of necessity, incorporate marketing, production, and finance activities. Especially, ODSSs support general coordination and integration of activities, consolidation of budgets or other analyses presented by various divisions or departments, and test the implications of decisions by one part of the firm on the rest of the company.

2.2. Small companies and DSS

The size of a firm is a very relative concept. Usually, a small company does not have a dominant position in the industry and it is independently owned. The number of employees in a firm and sales turnover are frequently used as quantitative criteria to differentiate a small company from a large one. Brooksbank (1991), for instance, suggests that small companies should have less than 100 employees and the sales turnover should be less than £ 2.5 M. In defining a small business, or a small company, the prevailing conditions of the specific country also need to be considered: a firm defined as small in United States could be defined as large in Finland.

Small companies differ substantially from large ones in several respects. First, small companies are more unique compared with each other than larger firms. They differ considerably in several dimensions from each other. Small companies are so close to their entrepreneurial owners, that the owner's personal characteristics reflect in the behavior of the company, too. These dissimilarities are increased by the lack of standardizing education (Stanworth *et al.* 1992). Most small business executives are technicians with little or no business or managerial education. Due to the variety of small business companies, general theories of the firm are of less value since they are based on 'universal laws'.

Partly due to the above reasons, small companies have expertise only in a narrow area and rarely in managerial and administrative fields. Paperwork is disliked and attention is mostly paid to actual business operations. Lack of expertise is particularly common in planning, decision making, and the use of information systems.

The environment of small companies changes relatively more than the environment of large companies. One single technological innovation made by a competitor can be an ultimate disaster for a small company. For this and other reasons small companies must respond quickly to particular external stimuli. Small companies do not usually have such financial resources that they can sustain unprofitable operations over a long period. "A small firm cannot exist for long periods of time running in the red, as many large corporations do" (McGrail, 1978). Undercapitalization, lack of creditability, poor money management, etc. require extra attention to enable quick reaction to the environmental changes.

No matter how small or large the firm is, a critical dimension of success is the quality of planning and decision making. "Large or small, business exist and survive because decisions were made" (McGrail 1978). The degree of formality of planning and decision-making may, however, differ considerably. Large, multinational and multidivisional corporations have resources, need and knowledge to develop complex, formal systems of planning. By comparison, small companies have limited resources and staff expertise available for such systems. Poor planning has been found to be one of the key reasons for entrepreneurial failures (Sauser 1987).

Cause or effect, the same difference seems to prevail in theoretical literature concerning corporate planning. Green (1982), for example, criticizes the prevailing state: "While much has been written of planning concepts over the years, much confusion has also, unfortunately, resulted from all the attention. Literature is profuse in quantity and for most part aimed at large corporations. Generally, that which has been directed toward small business, falls mainly into two groups: extremely theoretical, or extremely basic. This material is often of little use to the professional interested in the specific field of small business planning."

In small companies the degree of formality in planning can vary substantially from informal and unwritten to formal and written. The degree of formality is highly situational and depends on, for example, the following variables: Administrative style and ability, ability of the officer group, complexity of the business, strength of competition, perceived potential gain, role of leadership, level of uncertainty, understanding of formal planning, and effective planning (Thurston 1983).

Corporate planning is performed in one way or another in every company, in small, entrepreneurial firms, medium sized, and large, multinational and multidivisional corporations. In small companies the respective term would rather be *business planning* or *enterprise-wide planning*. Burch (1986), for example, defines the business plan as follows: "The business plan is a written document prepared by the entrepreneur that describes the business venture, the product or service, the customer, the competition, the production and marketing methods, the management, the financing, and all those things necessary to enter business and make or sell the product or service." Thus, the business plan and, hence, the business planning covers the whole company and it can be regarded as a synonym for corporate planning.

Faced with the problem of limited resources and expertise in planning and decision making, the managers of a small company need to seek methods that do not require too much of their time and other limited resources, but which still contribute in their managerial tasks. Gupta & Harris (1989) have shown by a survey of 348 small business executives that the "executives would like to use computers in decision-making and use commercially available decision support software packages. They think that a DSS can enhance management planning, decision-making in small business, and enable them to have a better understanding of their business."

It has been shown that computerization in general has a significant impact on the development of small companies (Raymond 1993). How well, then, does a DSS fit to the needs and characteristics of small companies, particularly to their planning and decision making? If the characteristics of small companies and DSS are compared it becomes clear that the essence of the DSS fits surprisingly well to the characteristics and requirements of small companies. Because small companies are unique and close to their owners personality, it is natural that the DSSs are designed by users initiative and the design is made for the user. Usually, these kinds of support systems are procured to increase the overall effectiveness of the decision making and the organization. Therefore the central focus in small companies lies on aiding the owner—the decision maker—in his decision-making and decision implementation. The lack of experience in planning and decision-making, know-how with information systems and managerial skills calls for special flexibility in building and designing DSSs. The use of such a DSS should be easy (interactive) and the systems should include built-in support for the decision maker.

The turbulent business environment surrounding small companies requires flexible planning tools that give quick responses to the user. In small companies it is especially important that the decision support tools can deal with various types of problems, such as quantitative, qualitative unstructured and semistructured problems. To support the decision making the DSS should focus on the present and on the future. In other words they should be designed for planning and control purposes. How good the DSS is can only be evaluated by using behavioral criteria, such as user satisfaction, decision-making improvement, etc.

3. A Framework for Development of ODSS for Small Companies

3.1. Prerequisites for the methodology

The central theme of this paper is to show that the substance-theories can be used to direct what should be included in and how to develop an ODSS in a small company. Generally, substance is "the essence which underlines and is capable of having attributes or causing phenomena, but which in spite of changes in outward manifestation remain the same" [Webster]. March & Simon (1993) distinguish between procedural and substantive programs when defining the problem-solving process. By substantive programs they mean programs that "are meant the structuring of the problem-solving process that comes about as a reflection of the structure of the problem to be solved." In the organizational context, substance, as opposed to methods or procedures, means the underlying essence of the organizational processes, structures, decision making, business conditions, etc. Recently, the need for such substance-oriented approaches is well recognized in the DSS literature. Silver (1991), for example, asks "What do we do substantively as we design in an adaptive, middle-out, and evolutionary manner?"

A potential source of the substantive knowledge are theories presented in the management and organizational literature. By a managerial substance-theory, as opposed to methodological theory, we mean a theory, or a theoretical model, that explains the general principles how things are or should be related in managerial context. In principle, the substance-orientation of any methodology can vary from fully ignorance to tight commitment to specific theories for given functional area. Here, the whole ODSS implementation process is explicitly tied to managerial substance theories. The role of the managerial substance-theories is to serve as 'kernel theories' for the approach (Walls *et al.* 1992).

The proposed frameworks for DSS development as well as the architectures of the systems have been mainly technological and problem-oriented. A reason for the generality of technique-orientation might be that all decision situations are perceived to be specific, entirely different; managers handle their actual decision problems without interference from theoretical frameworks or research results (Carlsson and Östermark 1989, McCormac 1986). Some researchers, Stabell (1983, 1988) at the forefront, have made efforts to recall the original objective of DSS—the decision making.

However, when managerial decision making in companies and other organizations is concerned, a lot of common theories have been developed for different kinds of decision situations. In principle, theories in finance, marketing, and production are descriptive or prescriptive (normative) explanations of how decisions within these functional areas are made or should be made in the best possible way. These substance-theories represent the best knowledge we have of organizational behavior, managerial problems, economic rules, etc. Unfortunately, these theories are lacking in the DSS literature, especially where ODSSs are concerned.

The development of a computer-based information system usually follows a process called the life cycle of an information system. The phases of such a process can be generalized, for instance, into the following six phases: problem definition, feasibility study, systems analysis, systems design, systems implementation, post-implementation audit (Bidgoli 1989). The life cycle model is appropriate for most traditional information systems, MIS, and OR/MS models. Constructing a DSS, however, differs significantly from other IS development activities; the different phases are interrelated and they tend to proceed concurrently. DSSs are process rather than product-oriented. The DSS development process is usually characterized to be iterative, and evolutionary prototypes are often used. Conceptually, it is difficult to isolate the use and development phases of DSS from each other. Also the role of the end-user is critical in the development process.

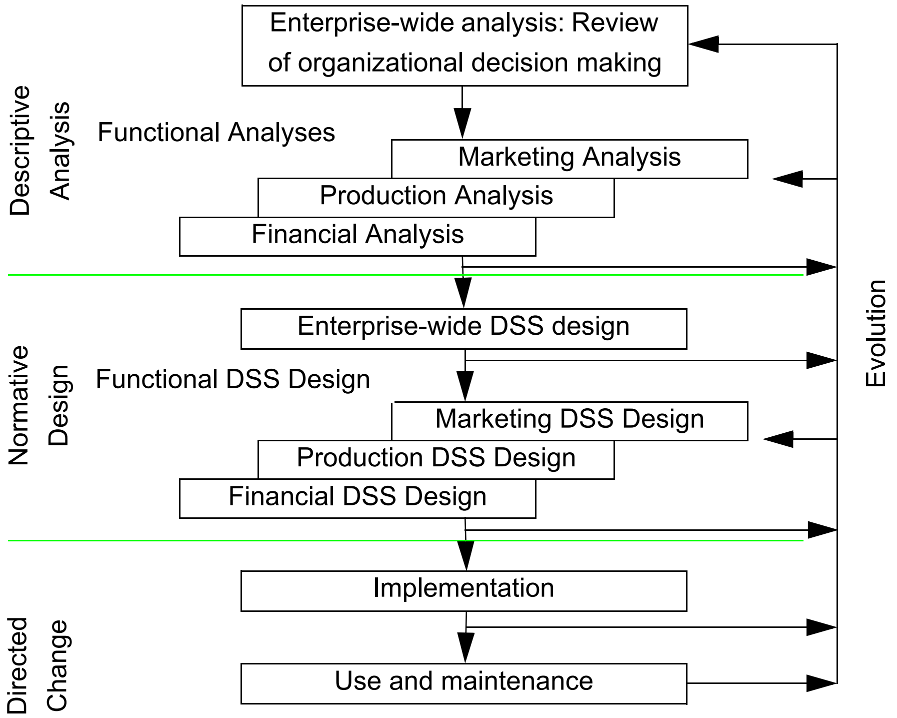
When an ODSS is about to be developed for a small company, the entire planning system of the company is usually changed. A starting point for the implementation of a DSS for a small company could then be the available knowledge and theories concerning the development of planning and planning-systems in small companies in general. Thurston (1983) presents the following set of steps for moving the small company toward more formal planning:

1. Understanding the business
2. Determining objectives
   - business goals
   - personal goals
3. Evaluating possibilities
   - generate, weigh, and choose among alternatives
4. Implementation and feedback

These sequential steps are closely interrelated and they constitute the primary requirements for DSS development in a small company.

An advantage of DSSs for small companies is that, if properly implemented, they can carry substantial amounts of external information and knowledge into the organization. Therefore, in this study, instead of a technological approach, we apply an alternative method to implement a corporate-wide ODSS as advocated in Kivijärvi (1992). The main idea of the methodology is that the managerial substance-theories should be utilized at each phase of the development process, beginning from the initial problem review and ending with the use and the evolution of the developed system. It is assumed that only

FIGURE 2. A substance-theory-oriented procedure for DSS implementation (adapted from Kivijärvi 1992)



these theories can direct the design and development process in the right direction and carry appropriate information and knowledge into the organization.

As Figure 2 indicates, the ODSS development process is divided into three main phases: Descriptive analysis, normative design, and directed change. Each phase is then sub-divided into activities. The first main phase attempts to find an answer to the question 'what is', the second to the question 'how should be' and the third to the question 'how to change'. If these steps are compared with those of Thurston, as presented above, a broad similarity can be found. In both of them the procedure advances from descriptive analysis to predictive design, implementation and evolutionary feedback. And in both of them the different organizational levels are recognized, for example, the business goals and personal goals.

3.2. *Descriptive analysis*

The primary purpose of the descriptive analyses, enterprise-wide or functional, is to settle the existing operations, decision procedures and the resulting requirements for decision support. The success of the analysis phases is best supported by the descriptive theories and research methodologies and a measure of the quality of the phases is the number and quality of the links created between the axioms of the descriptive theories and observations of the business behavior.

Enterprise-wide analysis
The first phase of the development process—after the decision to build an ODSS has been made -involves a holistic review of the current organizational decision making. The analysis should be performed at the enterprise or corporate-wide level in order to build the initial picture of the existing decision behavior over the whole organization. The analysis phase may involve the use of different kinds of tools: questionnaires, structured interviews, group discussions, direct observation, etc. In small companies discussions with the entrepreneurial owner may be the best, if not the only, technique for reviewing the decision making procedures.

The review phase may be supported by several organizational and decision theories and research methodologies. For example, the five archetypal decision processes and their variations by Nutt (1984) may help to structure, describe and understand the ongoing decision processes in the organization. The structured observation techniques used by Minzberg (1980) and his findings may serve as a reference methodology for investigating managerial activities. The state of the information systems can be compared to Nolan's (1979) stage model.

In small companies the description of the present organizational structure and behavior is a relatively uncomplicated task. Discussions and interviews with the managing director and observations of his work are usually sufficient. The numerous descriptive theories and surveys of entrepreneurial behavior can support these tasks substantially.

Functional analysis
The major aims of the second phase are to identify and characterize the current functions of the company and to establish the functional requirements of decision support. Although small companies do not have deep, formal organizations, they have to manage such functional activities as production, marketing and finance. These functions and the planning and decision making within them are essential for the successful performance of the company. Therefore, it is imperative to perform functional analyses especially in small companies. The reference viewpoint that directs the analysis is the goals and objectives and furthermore, the needs and the requirements of the wider enterprise-wide system analyzed in the previous phase.

The functional analysis can be supported by an extensive set of functional theories such as empirical financial theories, theories of the development of production systems, theories in logistics, theories of consumer behavior, etc. All these theories help to understand the behavior of the functions and the decisions that have been made.

3.3. Normative Design
The second main phase of the DSS development procedure is the normative design which is conceptually a completely different task if compared to the descriptive analysis. For the distinction between normative design and descriptive analysis see for example Keen

(1977), Keen & Scott Morton (1978) and Stabell (1983, 1988). The purpose of the phase is to find an answer to the question 'How should be' or 'How ought to be' not to the question 'How is'. The system of (normative) managerial theories is the necessary element needed to connect the normative design to the descriptive analysis. Without the normative theories the analysis and design phases remain conceptually distinct and practically confused. Normative design should be performed from enterprise-wide, organizational design to functional design. The purpose is to develop systems that are explicitly linked to the larger context of the organizational goals, objectives, and strategies.

Enterprise-wide design

In principle, enterprise-wide design includes the same tasks as enterprise-wide analysis but performed from the normative point of view: "how things should be." One of the key tasks of enterprise-wide design is to coordinate horizontally across the functional activities and vertically across organizational levels. Because it is not feasible to build a holistic DSS that initially contains all the facilities required, it is necessary to set priorities for the functional development activities in this phase.

Enterprise-wide design is the phase where an actual planning system is created for a small company. It is the most important phase for the success of the whole DSS. In this phase, theoretical, external knowledge is used to determine

- What goals, objectives and strategies should the company have?
- What kind of organization structure should the company have?
- If possible, how should the business environment be changed?
- What kinds of planning and decision making procedures should the company have?
- What kinds of information systems serve planning and decision making best?

All these and other analogous questions aim at the identification of DSS opportunities for more effective decision making. In principle, only the normative managerial literature can give answers to these critical questions.

Functional Design

A starting point for the functional design phase is the results of the functional analysis. The functional design phase is bounded by the results of enterprise-wide design which establishes prerequisites and other limits. Normative functional theories provide insightful prescriptive guidelines for the functional design phase in order to change the current state within the constraints to the desired state. Strong and precise definitions of goals, objectives, and strategies in the enterprise-wide design reduce the salience of alternatives in functional design.

The second, methodological objective of the functional design is to move one abstraction level down in the DSS design. An outcome of functional analysis is an initial plan for the primary architecture of DSS. Models, model bases, model management systems, databases, database management systems, etc. need to be specified. Within these initial designs, which later will be implemented, all previous work is concretized. Still, the outcome of the design phases is rather a statement of intent than a working DSS.

For the success of a small company certain functions are critical. Financial operations, especially money management, are often regarded to be one such critical function within a company. “Although small businesses are confronted with a multiplicity of problems associated with sales revenues, costs of goods, expenses, and profitability, all which are extremely important, the solvency achieved through cash management is frequently the most critical aspect of small business management. For many businesses, cash and survival are synonymous.” (Hayen 1982). The development of an efficient budgeting support system can sufficiently improve the cash management of the company. Fortunately, a lot of relevant literature is available to develop budgeting systems even for small companies (Bhabdari 1982).

3.4. Directed change

Implementation

Broadly defined, the whole design and development process of a DSS can be regarded as an implementation process. From a narrower perspective, implementation is the phase in the design and development process of an enterprise-wide DSS where the normative designs are changed to an operative DSS. It is a mapping from the design context to managerial context and it is the first part of the directed change.

In the design-phase the preliminary plans that the system should include concern the models, data bases, and user-interfaces. In the implementation phase efforts are made to fulfill these requirements technically. The initiative for a DSS effort, a problem or an issue, comes from managers’ reality, in the course of the development process emphasis may move to technological dimensions, but in the implementation phase the point of view is again moved to managerial reality.

The distinction between the design and implementation phases is inconclusive and it may be necessary to return to the preliminary phases from the implementation phase. Although implementation is a relative concept, generally, the degree of implementation is related to the degree of changes made. The direction of the change is determined during the preceding phases. Also, the implementation phase can be based on sound theories. The theories serve the implementation phase as the means to achieve the goals given in the previous phases.

The widespread availability of microcomputers and workstations and their price development have removed one limitation to the utilization of computerized information systems in small business. Since DSS-generators have also become available to micro computers, there are no significant technological restrictions to the implementation of a DSS in small companies. Different kinds of ready, template systems are of special value as they can be easily used and may bring managerial know-how to the company.

In small companies, outside support is needed to ensure the success of the implementation phase. Technical consulting and other support given by the vendor of the DSS-generator are certainly necessary, but for the implementation success, it would be ideal if at least one expert with wide, theoretical managerial education could be engaged in the development process. For several reasons it is essential that top management in the small company is actively involved in the development process.

Use and maintenance
The second part of the directed change is the use of the ODSS. In the use phase the developed ODSS is used to support the original problem solving, or rather, in the case of an ODSS, as a support in solving and coordinating the original problems. If properly designed and implemented, the ODSS supports all phases of the decision process and integrates the plans across organizational levels and functional borders.

After successive, long-standing usage the position or status of the system will be, and should be, institutionalized as a key managerial instrument. Because the design and development of an enterprise-wide, institutional ODSS is a costly and risky activity, efforts should be made to institutionalize its position. Institutionalization is the refreezing phase in an organizational change-process in the course of which the developed system is integrated into the organization (Lewin 1952, Schein 1961). Voluntary systems, like DSS, can be institutionalized only by successive usage; the user must feel satisfaction and pleasure with the new system if the system is going to be accepted and institutionalized. The institutionalization process can be accelerated by user education, organizational arrangements and by ongoing technological maintenance.

Also, the usage of the DSS can be based on managerial theories. First, if the system is developed by the theory-oriented approach then the managerial theories are inherent in the system's structure and, of necessity, the usage of the system is well founded theoretically. Secondly, with the theory-oriented DSS the users should always have access to the theoretical knowledge to support their decision making. Help-systems and direct connections to scientific libraries give theoretical support in the use-phase.

3.5. Evolution
The DSS development process is usually characterized to be iterative, and evolutionary prototypes are frequently employed. Perhaps the most essential difference between the development of a DSS and other information systems (MIS, OR/MS models) lies in the attitudes towards the degree of system completeness. Traditional IS development activities tend to aim at finished systems: products which are then used, and in the long run, probably evolve. Decision Support Systems, on the contrary, are never meant to be complete systems but are expected to be under continuous modification, expansion, and movement, that is, under continuous evolution. Although the development of ODSS requires more institutionalization than the development of other DSS there still remains a lot of space for evolution.

Actually, a DSS can evolve in three ways. First, as Figure 2 indicates, a DSS evolves during the development process before the system is truly 'used'. Iterations are needed between and within the three main phases. Second, a DSS evolves toward an internal stability or system efficiency. Because the DSS deals with semi-structured or unstructured problems the initial versions of the system will prove to be incomplete. Therefore, the first iterations after dissatisfied experiences with the system aim to improve the system quality by filling the gap between expectations and achieved results. Third, a DSS evolves toward an external stability or system effectiveness. When the system has reached its internal stability, internal or external conditions may change and the system must adapt to the new conditions.

In this section, a procedure for a substance-theory-oriented approach to the implementation of an ODSS was shortly described. The effort for implementing an enterprise-wide, institutional, DSS might seem to be an overwhelmingly extensive and complicated task. This is not necessarily the case, because a relatively simple, specialized system can be an enterprise-wide, holistic system. The scope and organization of the development process described above certainly depends on the size of the organization. In a small company, responsibility for DSS development and planning activities in general, may be assigned to the same person.

In the next chapter an application of an ODSS is described. The case described is an actual undertaking carried out in an actual company. Certain key figures are, however, changed for the sake of confidentiality. The authors of this paper have actively participated in the design and development process of the entire system.

4. An application of the Substance-Theory-Oriented approach: A case study

4.1. The case company and the development process

The organization described in this study, is a small family owned and run wholesale, entrepreneurial company operating in Helsinki and selling products throughout Finland. The company was established 1965 and it has grown steadily. The company operates in watches, gold, and jewelry business. It imports high-quality watches and jewel products, purchases ornamental and silver products and sells the products on to retailers and directly to big customers on the home market. Two retail companies operating in the same business area work closely with the wholesale company.

The company employs 5 persons and sales amount to almost 6 million (FIM) per year. It is typical of the management in the company that most relevant information exists only in the hands of the managing director. As is common in small companies, the most important information systems are the accounting system with the customer ledger and the 'rationale' of the managing director.

The management of the company was recently transferred to a member of the family and the new managing director is keen to apply a DSS in decision making. The most important decision problems faced are related to the supply of new products, inventory management, pricing, advertising, finance, terms of sale, and the decisions related to some accounting principles (depreciations, inventory valuations, etc.). The managing director is willing to find answers to 'what-if' questions concerning the consequences of certain financial strategies.

The company buys and sells different kinds of products and these can be classified into four product groups:

1. Watches:	This product group is most important to the company (about 50 % of sales). Such trade marks as Rado, Dior and Heuer are represented.
2. Gold and Jewelry:	Gold, goldrings, necklets, decorations, jewels and jeweled products are classified to this group. About 30% of total sales comes from this group.
3. Silver products:	This group consists of silverware and accounts for 15 % of total sales.
4. Others:	For example locks, crystal and bronze products belong to this group. This group represents only 5 % of total sales.

The development process of the system was organized so that the authors of this paper had full responsibility for the project. During the building process the Substance-Theory-Oriented approach was actively and consciously adapted. The system was built on a template-system developed by the authors for teaching purposes (Kivijärvi & Kuula 1991). The template system is a corporate model generated by the IFPS generator.

The system was developed with the full cooperation of the managing director and with the recently retired former managing director. During the critical phases of the development process we had almost daily meetings. The necessary information was collected by face-to-face interviews and by means of questionnaires filled in by the managers. In some situations, data were directly stored in a portable micro computer.

The managers of the company had such a favorable attitude towards the project that they allowed us to examine all material related to accounting, billing, and customer ledger. Therefore it was possible to reach even the most detailed and confidential information. The relevant indicators concerning the development of the industry and national economy were collected from the Finnish Center of Statistics.

During the development process different managerial substance-theories were used explicitly or implicitly. The most explicit theories are collected into Table 1. In addition to those theories we, as academicians, certainly exploited a number of other theories, theoretical models and frameworks.

As Table 1 indicates, the substance-theories needed to develop the system originate mainly from managerial economics, finance, and inventory theories. In order to avoid implementation problems the managers of the company were intentionally tied to every step of the project as most of the implementation theories suggest. The managerial theories were transformed into an ODSS by the IFPS generator. In this paper only the first iteration of the system is described. The application is under continuous evolution.

In the beginning of the development effort a tight schedule was imposed on the project: the first version (prototype) had to be ready within two months. Such a rapid progress was meant to keep the managers' interest in the project high, achieve results quickly, and keep the development costs at an appropriate level.

TABLE 1. Substance-theories used for ODSS-development

Development Phase	*Theory*
Decsriptive Analysis	Positive Accounting Theory Theory of capital structure Budgeting theory Theory of organizational decision processes Behavioral theory of the firm Theory of consumer behavior
Normative design	Theory of Cost-Volume-Profit analysis Inventory theory Investment theory Theory of demand Theory of IS development Relational database theory
Directed Change	Theory of organizationa change

4.2. System architecture

The primary architecture of the developed system consists of three subsystems: model base, database, and dialog subsystems.[1] The model base includes all models needed. The most important models are marketing, inventory, and financial models. The detailed structure of these models and, thus, the architecture of the whole system is tied to the substance-theories of each functional area and to the present and desired characteristics of the company. In addition to these functional models the model base includes reporting and consolidation models.

Broadly defined, the database includes a relational database and ordinary files stored in character form. The dialogue subsystem (user interface) includes command files with menu-options. A user-oriented interface is under development using the Vantage Point System.

Next, the principles of each subsystem are discussed. Because the database and dialog subsystems are not central for this paper they are dealt with briefly.

4.2.1. Model Subsystem

The model subsystem consists of three primary models: marketing model, inventory control model, and financial model.

Marketing Model

First, at the descriptive functional analysis phase, we applied a model of econometric type to describe the demand behavior of each product group. Initially, as the marketing theories suggest, the demand for each product group was assumed to depend simply on the price of the products, advertising, and the available income of consumers. The following econometric model was specified:

where $S_i^t = f(P_i^t, A_i^t, R^t)$

for $i = 1, 2, 3, 4; t = 1, 2, \ldots$

S_i^t = Sales of product (group) i in period t
P_i^t = Price of product i in period t

A_i^t = Advertisement of product i in period t
R^t = Consumers' available income in period t
All in FIM.

It soon became evident that there were serious problems estimating parameters with this model. First, the company has some big customers, whose orders are known well in advance. Sales to these big customers cause peaks in the sales data which are difficult to handle by statistical methods. Second, the price level has remained almost unchanged for several years except for the changes due to currency rate fluctuations (devaluations) that affect the purchase prices and further the sales prices. In spite of these increases in prices, demand has not decreased. Third, the purpose of the advertisements has been to remind or maintain the name of the famous products (Rador, Dior, etc.) in the minds of consumers rather than capture new markets aggressively. Fourth, it was not possible to find factors that affected the sales of all the product groups simultaneously.

Therefore, alternative models were specified to describe the demand in each product-group separately. For example, for watches the following model was specified:

where $S_1^t = f(A_1^t, D^t, R^t, O^t, I^t, W_1^t)$

for $t = 1, 2, \ldots$

S_1^t = Sales of watches in period t
A_1^t = Advertisement of whatches in period t
D^t = Industry sales in period t
R^t = Consumers' available income in period t
O^t = Level of overall price index in period t
I^t = Level of import price index in period t
W_1^t = Level of salesmen's efforts in period t
All in FIM.

For these models historical data over three years was available. The sales data were 'cleared' from the peaks (big customers) to better describe the normal demand for the products. The parameters were estimated to the linear and quadratic models. The R^2-coefficients of the models vary between 0.6 and 0.9. These coefficients could be higher but for the descriptive purposes they were considered to be acceptable. There are two obvious reasons for the shortcomings. First, sales to the big customers, as mentioned above, still cause some problems. Second, the industry has some seasonality with peaking sales (December due to Christmas, May due to the end of schoolterm) and some periods of receding sales that recur year after year and are known. These problems, random and seasonal variations, are difficult to handle with simple statistical methods.

In addition to the statistical problems, a more serious problem is the form of the specified equations. Actually, among the independent variables there are too few decision variables (A and W) and thus, marketing decisions cannot be supported by such a model. Due to the above reasons it became evident that the econometric marketing model, as specified and estimated above, is not appropriate and sufficient to support marketing decisions.

According to the original principles of the DSS we decided to utilize the experience of the managing director and his knowledge of the market's behavior in the industry. Two alternatives were presented. It is possible to estimate the parameters of the econometric model subjectively (Little 1971) or to use time series models. It is clear from the marketing theories that the price of the product is a key variable determining the demand of the product. Other such kinds of decision variables are advertisement and the level of sales efforts. Therefore, in the normative phase of the development process, the following model was specified:

where $S_i^t = f_i(P_i^t, A_i^t, W_i^t, D^t, R^t)$

for $i = 1, 2, 3, 4; t = 1, 2, \ldots$

S_i^t = Sales of product (group) i in period t
P_I^t = Price of product i in period t
A_i^t = Advertisement of product i in period t
W_i^t = Level of salesmen's efforts of product i in period t
D^t = Industry sales in period t
R^t = Consumers' available income in period t
All in FIM.

This model was specified although we knew that no historical data are available for the 'objective' estimation of the parameters; the value of the parameters had to be estimated subjectively. It is known from the marketing theories that the price of a product and its sales are inversely related and that the marginal effect of advertisements is usually decreasing. The parameters were simply estimated subjectively by 'what-if'-questions such as: "What do you think, what would happen to sales if you increase / decrease the price / advertising / sales efforts by 10 / 20 / 30 %?" After a few iterations a satisfactory model was achieved to prescribe the sales of the product groups as a response to pricing, advertising and sales effort decisions.

As a second alternative, a simple time series model was specified and estimated for supporting marketing decisions. Due to the prevailing market situation it appeared that the most important factor to explain the sales variations is the sales of the industry sector. We determined to couple this finding to the subjective knowledge of the managers concerning the forthcoming development of the industry.

Inventory model

The most important questions related to inventory control are: how much to buy and when it is time for replenishment? Because the inventory system used by the company at the moment best resembles the **(S,s)** inventory replenishment system (see, for example, Moder & Elmaghraby, 1979), it was used in this model system. In the **(S,s)** system the products are sold until the minimum level s is met. Then the inventory is replenished to the maximum level **S**. The sales forecasts needed in the inventory model are based on the marketing model. The size of the inventory at the beginning of the planning period is i0 and the respective replenishment batch size of the previous period is Q_0. In the inventory model the FIFO principle is applied. As an output, the decision maker also gets detailed information about the items in the inventory that are not older than five months.

The following equations describe the theoretical core of the inventory model (in the equations, symbols **S** and **s** are replaced by **M** and **m**).

$$i_i^t = i^0{}_i + \sum_{r=1}^{t} (Q_i^{r-1} - S_i^r)$$

$$Q_i^t = \begin{cases} M_i^t - i_i^t & \text{if } (i_i^t < m_i^t) \\ 0 & \text{if } (i_i^t \geq m_i^t) \end{cases}$$

where

i_i^t = Inventory of product group *i* in period *t* before replenishment
m_i^t = Safety stock for product group

i in period *t*
M_i^t = Maximum inventory level for product group *i* in period *t*
Q_i^t = Lot size for product group *i* in period *t*
S_i^r = Sales of product group *i* in period *t*
t = Time period
r = Previous period(s) $(r \leq t)$
i = Product group

The values for **M** and **m** are determined before the actual usage of the model. In principle, they can vary from month to month depending on the variations of the seasonal sales volume, but up to now, they have remained constant. Also, a report generator was developed for the inventory model to make the model easier to use. The report generator provides monthly information about the value of the inventory in Finnish Marks (FIM), the size of the inventory in units, the purchasing costs in FIM, the purchasing amount in units, the value of the products sold in FIM and the amount of goods sold in units. In the future, experiments will be made to replace the **(S,s)**-system by a more complex inventory model, where an optimal lot size is determined by different cost items, e.g. holding costs, costs of lost sales, etc.

Financial model

The core of the model base is the financial model. It is designed to be used in analyzing the performance of past periods and/or calculating forecasts for future periods. The financial model consolidates the marketing and inventory plans to integrated corporate plans and provides pro forma financial reports and financial ratios. Balance sheet, income statement, investment statement, cash flow statements, sources and uses of funds statement and various financial ratios are examples of output reports generated by the financial model.

In principle, there exist two different approaches to the design and development of a financial model: (1) *Funds needed to balance approach* and (2) *Direct approach* (Hayen 1983), the direct approach was chosen for this project. In the funds needed to balance approach the balance sheet and income statement are first determined for period **t**. All accounts other than cash and short-term borrowing are revised. The total assets are then compared to the sum of total liabilities and equities. If total assets are less than the sum of total liabilities and equities, the difference is automatically added to cash. Otherwise, if total assets are bigger than the sum of total liabilities and equity, the difference is added to short-term borrowing. This method always leads to the following:

assets = liabilities + equity,

where cash and short-term borrowing have positive values.

In the direct approach, new values were calculated for the balance sheet accounts using the following formula:

$$\text{Balance sheet}_t = f(\text{balance sheet}_{t-1}, \text{income statement}_t, \text{cash flow statement}_t)$$

This formula leads directly to the cash balance. However, it is possible that the cash account is negative after the calculations. In this case, the decision maker gets an alarm signal to investigate the income statement in more detail and, if needed, to decide how the shortfall should be made up. There are, of course, many options available. The decision maker may prefer to cut costs, raise new long-term debt, etc. Because the direct approach allows the use of different kinds of financial strategies, it was applied to this model.

The logic of the financial model is basically the same as the logic in the double entry accounting system. Consequently, all theories and standards behind the double entry accounting system are also valid for the construction of the financial model. Similarly, financial theories provide a background for investment and financial equations. For example, determining depreciation policies, allocation of overhead costs, and establishing the capital structure are decisions that can be supported by the developed system and which are based on the respective theories. The main structure of the financial model is described in Figure 3.

In the financial model the equations are more definitional than empirical. The account (or the equation) names are those used by the company. All the equations in the model are solved simultaneously. Therefore, for example, the investment costs affect at the same time the balance sheet, income statement, sources and uses of funds statement and cash flow statements. The direct approach also makes it possible to control the input data via the balance sheet (total assets and total liabilities should equal).

The financial model requires various types of internal and external input data. The internal data needed can be divided into two separate groups: policy assumptions and initialization data. The policy assumptions are used in the model to determine, for example, what the depreciation policies for different fixed assets are, or what the dividends policy of the company is. All this data is collected from the decision maker. The initialization data or more precisely the initial balance sheet and income statement are directly found from the bookkeeping system. The minimum requirement for the model is one previous balance sheet and income statement, but if the decision maker is willing to investigate the past development of the company it is also possible to feed the balance sheets and income statements from several previous periods into the model. Because the external factors have a great impact on the company there should also be external data available for the financial model. For example, the actual interest rates for different loans and deposits are used in the model. The contents of the database subsystem are discussed next.

4.2.2. Database Subsystem

The database subsystem consists of a relational database, where all data used in the model system are collected. As mentioned above the model system needs various types of input data. Such input data as forecasted investments, plans to raise new loans, or to repay or restructure loans taken prior to and/or during the planning period, policy parameters, income statements and balance sheets for at least the previous year, inventories and the mean prices of each product group and furthermore, the interest rates for debts and savings are needed.

In addition to the input data, the model system also requires data generated in the model system. For this reason, all the solutions from the models are saved in the database. When the data is organized

FIGURE 3. The structure of the financial planning model

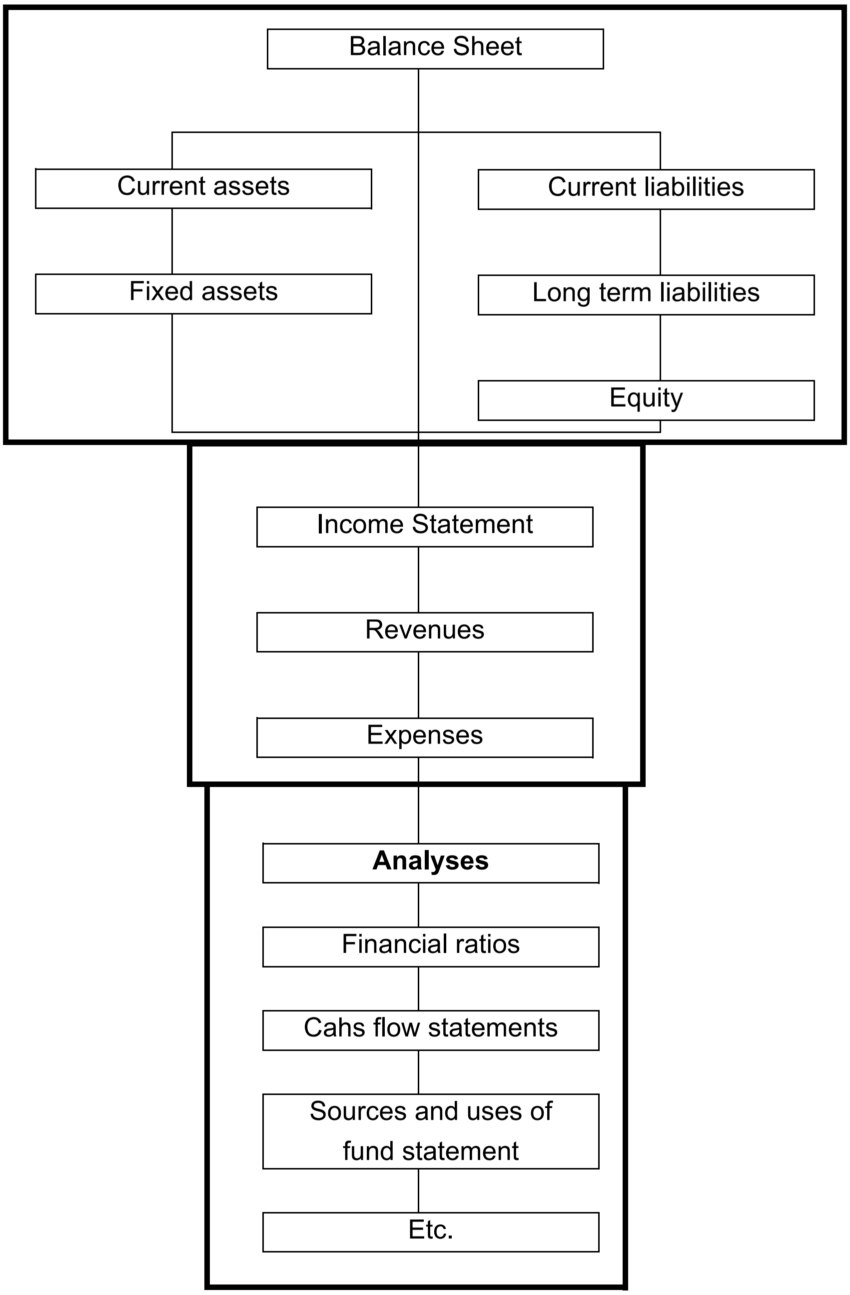
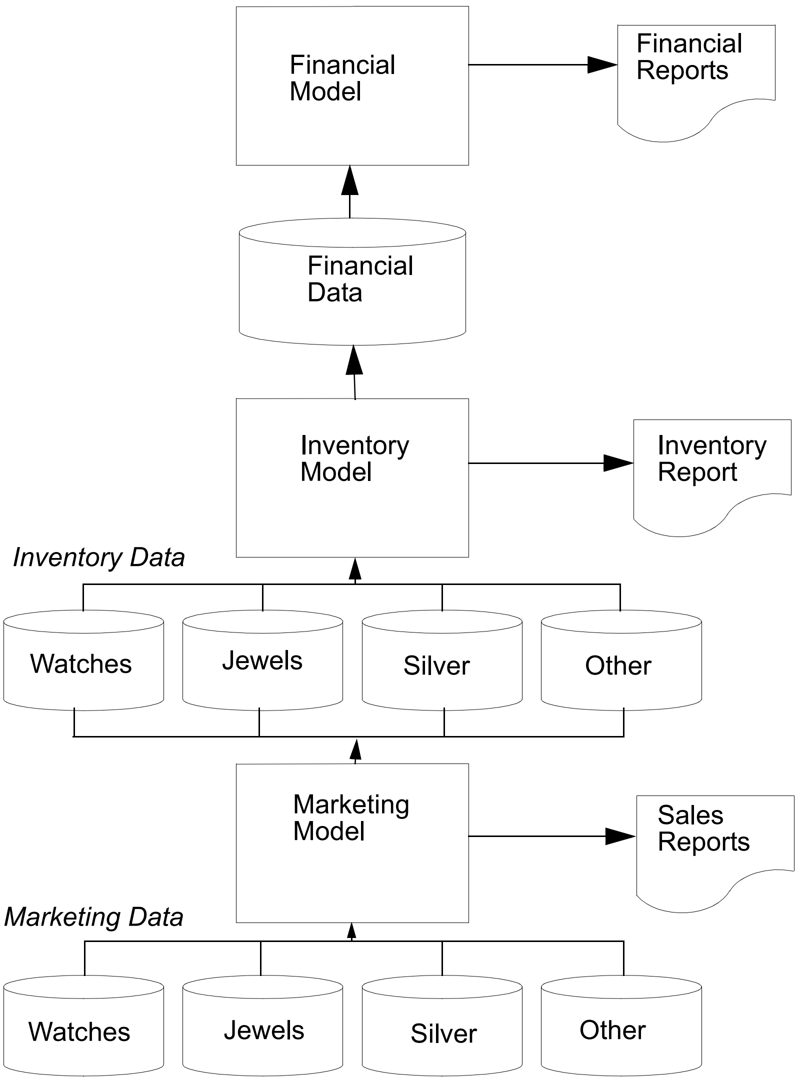


FIGURE 4. The layout of the structure subsystem



in a database, the decision maker can freely make different database inquiries and make quick ad hoc reports under the database system. The user-oriented system also allows him to collect and save to a command file the database commands which can afterwards be repeated.

4.2.3. Dialog subsystem

Using the user-oriented dialog subsystem the decision maker can easily com-

TABLE 2. The inventory report for the product group watches and the balance sheet of the base solution

Product group: watches

Inventory Report

Inventory	*May 92*	*Jun 92*	*Mar 95*	*Apr 95*
5 months	.00	.00	.00	.00
4 months	.00	.00	24.89	.00
3 months	.00	.00	.00	.00
2 months	.00	645.82	.00	609.75
1 months	1,000.00	.00	975.11	.00
Inventory total (units)	1,000.00	645.82	1,000.00	609.75
Inventory replenishments (units)				
Buying (units)	1,510.51	.00	975.11	.00
Buying (FIM)	151,051.20	.00	117,900.15	.00
Value of inventory	100,000.00	64,582.05	120,859.11	73,724.05
Selling (units)	510.51	354.18	338.87	390.25
Value of products sold	51,051.20	35,417.95	40,291.86	47,185.05
Average price of products sold	100.00	100.00	118.90	120.91

Assets

	May 92	*Jun 92*	*Mar 95*	*Apr 95*
Cash	279,394	399,875	3,750,864	3,761,270
Accounts Receivable	151,317	171,386	835,432	851,095
Inventory	6,895,171	6,699,778	4,199,318	4,058,354
Total current assets	7,325,882	7,271,038	8,785,614	8,670,719
Net fixed assets	278,668	277,557	253,032	252,562
Total assets	7,604,550	7,548,596	9,038,646	8,923,281

Liability and Equity

	May 92	*Jun 92*	*Mar 95*	*Apr 95*
Total current liabilities	1,142,249	1,058,579	1,273,648	1,176,747
Long-term debts total	6,011,923	6,011,923	6,011,923	6,011,923
Reserves	64,000	64,000	64,000	64,000
Equity	96,063	96,063	96,063	96,063
Retained earnings	179,641	290,214	1,617,225	1,593,012
Net income	110,573	27,816	-24,214	-18,464
Total equity	386,277	414,094	1,689,075	1,670,611
Total liabilities and equity	7,604,550	7,548,596	9,038,646	8,923,281

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municate with the different models and the database subsystem. The dialog subsystem, developed for the case company, was built using the command files of the IFPS-generator. The language used in the models, command files etc. is Finnish. The first level of the dialogue tree includes four options: Data input and editing, model solution, reports, and quit.

Using the first option, data input and editing, the user can give all the data described above or he can make changes to the data using the full screen editor. In the second option, a universal consolidation is used to consolidate solutions across all the product groups (the organizational structure of the company). The structure subsystem, as described in Figure 4, defines a network which consists of models, relations and data files. This structure calculates first the sales forecasts and inventories for all the four product groups and then consolidates the product group information for the financial model. At the top of the hierarchy, the financial model is solved. Wherever changes have been made in the data system will affect the financial model. The third alternative enables the decision-maker to choose between the ready made pro forma reports described in the previous chapters. Finally, the user may quit the menu system.

The dialog subsystem is under further development. In the near future the graphical user interface (on the level of executive information systems) will be developed by a graphical user interface program. After this stage, it will be possible to provide the decision maker with graphic outputs of high quality and the interface will be more user-friendly.

4.3. System usage

As described above, a user-friendly dialog subsystem for the system has been developed. The decision maker can use the system without knowing anything about the technical background. He does not need to understand how the data system is connected to the model base. But, if the decision maker is willing to spend his time in learning more about the DSS-generator, then he can, of course, use the model more flexibly and make, for example, direct database searches and use the query capabilities to make ad hoc analyses. Below, the usage of the developed system will be demonstrated with simplified examples from real life planning situations. These examples are related to: (1) inventory planning, (2) tax planning (3) company budgeting.

Inventory planning

In the inventory planning the decision maker is interested in reducing the value of the inventory. This means, of course, that the size of the inventory should be reduced and, as a consequence, it should be replenished more often. The following example shows, how the decision maker can investigate the changes in the inventory level, by using the *what if*-analysis across all levels of the organizational structure (in IFPS by *alter* command). First, in order to allow the comparison, the base solution is computed (Table 2). In the sample report, only the two first periods and the two last periods of the inventory report and balance sheet are provided.

It is easy to investigate the changes in the financial model and inventory model that occur when the maximum inventory level has been changed. The replenishment size or the maximum size of the inventory affects almost all lines in the inventory report. It also affects the following accounts in the balance sheet: cash, inventory and accounts payable.

In the *Alter*-analysis the maximum replenishment size of the inventory for watches is reduced from 1000 to 700 units. Note, that the *alter*-analysis causes changes not only in the inventory submodel but also in the financial model. Consequently, the cash increased 3,000 FIM, inventory reduced 30,000 FIM and the total current liabilities reduced 27,000 FIM in the balance sheet. Because the company had enough money in cash to finance the bigger inventory and, because the accounts payable was interest free, the reduction in the inventory sizes did not affect the net income. However, this is not necessarily always the case.

The consolidation capability is one of the major advantages in the enterprise-wide modeling. When the decision maker investigates one part of the company the model immediately calculates through the structure of the whole company. The decision maker can immediately see what consequences his inventory-decisions have, for example, to the bottom line of the income statement.

Tax planning

According to the Finnish tax system there are several possibilities to adjust the yearly tax payments. New reservations from the income, for example, can be made, or, the yearly depreciation percentage can be chosen freely within given limits. Typically, the company uses prefixed policy for both reservations and depreciations. The reservations are related to future investment plans and the depreciations from fixed assets are connected to the economical and technical usage of different fixed asset items.

However, when the yearly net income is positive, the decision maker can test, with the *goal seeking*-procedure, how much bigger the depreciations should be to reach the target net income level and to also find all the other influences on the financial statements. For example, the decision maker may want to decrease the net income and, as a consequence, the direct tax payments, for April 1995 from 23,333 FIM to 20,000 FIM by increasing the depreciations of other fixed assets. The *goal seeking*-analysis indicates that the depreciations for other fixed assets in April 1995 should be increased from 468 FIM to 6,022 FIM, which causes required changes to the net income. The system also reports what depreciation percentage is used during that year. Note that, in the balance sheet, the reduced tax payments influence the cash, the increased depreciations influence the other fixed assets and, of course, the value of total assets. Similarly, the net income (after taxes) decreases and the value of total liabilities and equity decreases.

Company budgeting

Because all the variable names used in the model correspond with the account names used in the balance sheet, income statement, etc., the decision maker can easily follow the logic of the model and is able to use it without any assistance. The model provides several different tools for company budgeting. First, it is possible to produce budgets based on different assumptions. This is supported by the ready statistical and financial functions and subroutines. Therefore, it is easy, for example, to estimate the future sales based on the sales information of several previous periods by using different forecasting methods or to calculate the net present values or internal rate of return values of the different investment alternatives.

Second, the decision maker can investigate the behavior of different variables more deeply by the IFPS commands, such as explain, analyze or diagram. The *explain* activates a full-screen facility for asking why questions about the consolidated results. The *analyze* breaks a variable definition into its constituent parts. This analysis is useful for debugging and following trends back to their sources. The *diagram* produces a diagram itemizing the direct inputs and outputs for a selected variable or consolidated node. With these commands it is easier to understand the structural relationships within the budget variables. Third, the database system described above is available for the ad hoc reports needed in the budgeting process.

In order to make the system more user-oriented a help-system is under development. The help-system will provide more information about the theoretical backgrounds of the models used and give guidelines where to find detailed information concerning the particular problems at hand. The aim is that the decision maker can learn more about the substance theories by using this help system. When the decision maker is more familiar with the theoretical concepts, frameworks and models he can base his future decisions on them and is thus capable of managing the business more profitably.

5. Discussion and Conclusion

In this study we have built an ODSS where the main technical elements are the common model subsystem, database subsystem, and dialogue subsystem (Sprague & Carlson 1982). The model subsystem includes nine separate models in marketing, finance, purchasing and inventory modules. The database subsystem has only one database with two relations where all historical and forecast-data needed are stored. The dialogue subsystem is built to make the system more flexible and easier to use.The developed system is general in the sense that it can be used, after some tailoring, in firms in a variety of industries to solve managerial decision-making problems in marketing, finance and production.

Especially, we have addressed the relevance of the DSS concept for small business companies. Particularly, we have been investigating the adequacy of the Substance-Theory-Oriented approach to the implementation of an enterprise-wide DSS. When Walls *et al.* (1992) argue for the building of design theories for the development of different types of information systems they propose that theories from natural or social sciences form the kernel theories of the information systems design theory. This study is an attempt to apply and test the potential principles of a DSS design theory. We have constructively shown by means of a real case how the substance theories can be used to determine the actual contents of a DSS. Special emphasis has been placed on the characteristics and requirements of a small company.

The case company in this study was not selected at random but we intentionally chose the company where one of the authors worked before. The familiarity with the company meant a lot to the project, and actually, made it possible within the available resources. First, it was possible to build confidential connections to the managers of the company and, thus, get an opportunity to collect data throughout the organization during the development process. Second, it was much easier to perform the descriptive analysis phase within a relatively short time.

The case study reemphasized that the characteristics of small companies set special requirements for DSS. These special requirements, or prerequisites, are involved, for example, with the goals and objectives of the system, resources available, development method, architecture of the system, and the system interface.

Perhaps the most fundamental goal of ODSS in small companies is to make decision making more structured. In small companies decisions are often made in a disorganized manner with little or no technical support. The purpose of an ODSS is to organize and support the decision making process by leading the decision makers through the necessary steps to the final decisions. The second objective of a Substance-Theory-Oriented ODSS is to transform outside information and knowledge into the company. Managerial know-how is especially needed in small companies.

Small companies do not have ample technical staff, computational or other resources available. Outside support, consultants or other personnel, are needed to facilitate system development processes. In addition, system development and the developed system must be cost efficient.

The realization levels of the goals and objectives of an ODSS depend on the quality of the development process. Hence, the selection of appropriate development methodology should be determined by the goals and objectives of the project. The selected Substance-Theory-Oriented approach emphasizes the conversion of new knowledge into an organization. In the study, there was one major problem: the absence of appropriate theories, and above all, their laborious adaption. If general managerial theories are going to be applied in small companies, then a lot of effort is needed to apply and to adapt them. In this adaption process, in the parameter estimation, subjective data was essential. The second problem with the development process in small companies is the difficulty to change some fundamental attitudes of the decision makers. The managers of small companies are used to knowing what is best and to making everything by themselves. It is difficult for them to understand or to accept that an outsider could have better knowledge or information that could affect, be useful, or even support their decision making. It is also difficult for them release themselves from the actual day-to-day business problems.

In small companies the managing director is commonly the principal information user. Therefore, the involvement, commitment and participation of the managing director in the development process is critical. It is essential to stimulate the need to improve the critical managerial decisions. Since the managing director is responsible for all the functions within a small company he needs a support system that covers the entire company, i.e. a system that is enterprise-wide. He or she has not time or desire to analyze specific problems with different tools and shift solutions from one system to another; the subsystems must be technically integrated and facilitate holistic analyses. This is the primary requirement to the system architecture. Another requirement is that the systems should allow analyses of very different types: what if analyses, optimization, explanation, data query, statistical analyses, etc.

The system architecture is closely related to the user interface. Because small companies do not have the technological expertise in-house, the user interface of the system must be user-friendly, preferably an interface that meets the standards of EIS graphic interface. In the study, there was a problem with labeling. It was difficult to find such terminology for the interface that the decision makers are sufficiently familiar with.

Notes

[1]Readers wishing to have more information about the reported system and examples of the usage may contact the authors to obtain a detailed working paper (Kivijärvi & Kuula 1992).

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