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Forest Planning in a Swedish Company – a Knowledge Management Analysis of Forest Information

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Forest data and forest information are central to forest management planning. The knowledge a large forest-owning company possesses about its forests could potentially be a strategic capability. In this study, the forest-planning process of a large forest company is analyzed in terms of knowledge management (KM). The study was conducted as a case study of Sveaskog – the largest forest-owning company in Sweden. The study focuses on the long-term harvest strategy through medium-term planning until the stands are transferred to the tract bank and ready for operational planning. Interviews with key persons within the organization were conducted to assess how forest knowledge is used in this process. The results are presented for the four knowledge management processes: creation, storage-retrieving, transferring and applying. They show that the planning system relies to a great extent on codified knowledge realized by a push strategy.

Keywords forest planning, long-term planning, medium-term planning, knowledge management, knowledge, information
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1 Introduction

To ensure sustainable forest management, forest owners plan their management of the forest. Forest planning by large forest-owning companies typically focuses on optimizing the outcome of harvest activities in the long- and short-term, taking into account restrictions imposed by the law, certification and other factors. As in any planning, information is essential, for example information about customers and competitors, and also predictions regarding the future state of the market. In particular, the forest owner needs up-to-date information about the forests.

The forest owning company needs to create sustained competitive advantage, as any company. According to the resource based view (RBV), the success or failure of a company is also dependent on how well internal resources are utilized (Barney 1991). One of those resources is the data on the forest resource. According to TBV a resource needs to be valuable and unique to create sustained competitive advantage. However, forest data is not a unique resource. Still, the way it is utilized and managed can be a source of superior competitiveness.

New methods to collect data, e.g., air- and spaceborne sensors, are soon likely to offer more detailed and accurate data at an affordable cost than is currently available (Packalén et al. 2008, Lindberg et al. 2010). Thus, forest companies may be able to enhance their competitive position by applying these new methods. However, the achievement of a sustained competitive advantage – the main factor governing profits – does not automatically follow with the introduction of new technology. Information and management information systems should therefore, either through intended or emerging processes, form part of the company strategy for enhancing competitive advantage (Mintzberg and Waters 1985, Conner and Prahalad 1996, Zack 1999). Thus, assessment of the potential of new information technologies requires an understanding of the implications of the technologies on strategies and managerial processes.

When assessing the exploitation of forest information and knowledge within an organization, knowledge management (KM) theory can be used. This theory provides an understanding of the role of forest information in the company. KM theory offers different perspectives of the relation between concepts, such as information and knowledge (Holsapple 2008), different forms of knowledge (Zack 1999, Alavi and Leidner 2001), and different processes involved in KM (Alavi and Leidner 2001). In the early 1990's, studies of the KM theory of firms concluded that a company´s performance is dependent on what knowledge it possesses and how this knowledge is used within the company (Conner and Prahalad 1996, Hansen et al. 1999, Zack 1999, Eisenhardt and Martin 2000, Bourgeois 2003, Rauscher et al. 2007).

In forestry, KM has been used in studies on forest supply chain (Mosconi et al. 2011), and for policy analysis (Thomson et al. 2007). Although not explicitly referring to KM, analyses of forest decision support systems (DSS) relate to how knowledge is processed with emphasis on the capabilities of the software (Johnson et al. 2007, Reynolds et al. 2008). In this study, the KM theory was used since the focus is on the nature of the planning process itself. It is particularly relevant for forestry companies because they often have elaborate planning systems, the structure of which, at least in part, is formed in response to data availability (Duvemo, 2009).

The purpose of this study was to characterize, utilizing KM as analysis tool, how data and information about the forest is managed as knowledge and used in the forest planning process of a large forest company. The study is based on data from Sveaskog in Sweden. It is limited to long- and medium-term planning and only concerns the planning of timber production. Additionally, the study focuses on KM applied to forest information, and little attention is paid to information from other sources. In the following section, forest planning in Swedish forest companies and the concepts of KM theory that are applied in this study are introduced. Next, details of the company and methods used for collecting data about the planning process are given. The results are then described in terms of organizational and KM processes. Finally, the results are evaluated and discussed.

1.1 Forest Planning on Company Land

For large industrial forests owners, a planning hierarchy consisting of three stages has evolved:

(i) long-term planning that encompasses the entire forest with a focus on sustainability and sets the framework for shorter term planning; (ii) medium-term planning that is concerned with allocating harvest and silvicultural operations to stands in coming years; and (iii) operational planning that schedules resources for harvesting and deliveries, often with a time-frame of less than one year (Church 2007, Epstein et al. 2007, Gunn 2007). (The literature often refers to strategic planning and tactical planning for the first and second phase, respectively. However the terms used here are long-term and medium-term planning.) The major forest-owning companies in Sweden, controlling about 40 percent of the forested area, introduced this sequence of stages in the late 1960's (Lonner 1968, Andersson 1971, Lönner 1973) and they remain largely unchanged today (Söderholm 2002, Eriksson 2008).

The procedure of forest planning follows the same general pattern for all four major forest owners in Sweden, i.e., Bergvik Skog, Holmen, SCA and Sveaskog. This account is essentially based on two Master's theses (Söderholm 2002, Eriksson 2008) and the personal experience of the authors. The general pattern of forest planning focuses on the structural elements of the planning process that are common to all four major companies and disregards organizational ties as these differ between companies.

1.1.1 Long-Term Forest Planning

The long-term planning stage involves a quantitative analysis of the harvest and silvicultural management potential of the forest area. The single most important figure obtained during this planning stage is the allowable cut for the next 10 years. It may be associated with stipulations of, e.g., the amount of certain forms of harvest and the distribution of harvests on final felling and thinning. This information is used as input for the medium-term planning stage.

The Forest Management Planning Package (FMPP) (Jonsson et al. 1993) is the forest decision support system employed for long-term planning in all companies. It is used to find the management that maximizes the net present value, while ensuring a sufficiently constant harvest level over the 100 year planning horizon. The following three data sources form the basis for the FMPP system.

The *Eclogical landscape plan (ELP)* delineates the forest into different care-demanding biotopes and habitats that should not be subject to regular forest management. This ELP is motivated by the fact that all major companies are certified according to the Forest Stewardship Council protocol. The *stand register* consists of all stands of the forest represented on maps and in tables. Data are originally derived from an inventory of the whole forest area, in which stands are demarcated and inventoried with a combination (a first step) photo interpretation and (a second step) subjective field inventory. Historically, the entire area was inventoried at regular intervals, i.e., every 10th year, but in recent decades there has been a tendency to rely more on continuous revisions after forest operations and updates with growth and yield functions. The stand register is not used directly for long-term planning but provides the basis for a *stratified sample of stands* used by FMPP. Trees in about 10 sample plots in each stand are callipered.

1.1.2 Medium-Term Forest Planning

The main output from the medium-term planning stage is a register, a so called tract bank, of inventoried tracts that are subsequently utilized in the operational planning. A tract consists of one or several stands or part of stands that are adjacent and are planned to be harvested simultaneously. The tract may contain thinnings as well as final fellings. The tract bank corresponds to a volume of about two years of harvest (differs between companies). In the course of planning, improvements needed to the road network are identified. The effort put into medium-term planning varies among companies However, some form of field inventory is always performed to comply with FSC (Forest Stewardship Council) certification rules.

The planning begins with an analysis of which stands to harvest over the next three to ten years. Essential requirements for selecting the stands are that, firstly, they comply with the long-term plan in terms of volumes and composition, and sec-

ondly, they are concentrated on a limited number of roads (Gustafsson et al. 2000, Duvemo 2009). The reason that planning is performed over a longer time period than covered by the tract bank is to avoid the first few years' selection of stands to harvest to become non-sustainable.

Among those selected for harvest over the next three to ten years a number should be selected for field inventory and subsequently fed into the tract bank. This stage may involve consultations with authorities and stakeholders. The chosen stands should, together with those in the existing tract bank register, cover the harvests for about two years. Objective inventories with circular plots, where the trees are callipered, or subjective assessments, are both used. Systems for this purpose are in use and integrate GPS and GIS.

1.1.3 Operational Forest Planning

The main output from this planning stage is a schedule of what tracts should be harvested when and by what harvesting crew. The plan is detailed and generally specifies by day when harvesting should begin and end on a specific tract. The forest data of the tract bank are utilized.

The procedures at this planning stage vary considerably among companies. Nevertheless, a one year delivery plan is usually developed as a first step. Within this, a rolling three-month planning horizon is often employed, with the first month as the implementation period. The schedule is composed of tracts in the tract bank. The selection should satisfy a number of requirements, of which the demand for industry deliveries is fundamental. Deliveries are specified for the current month (shorter periods are also found) and a projection of the following two months is made. Available harvesting capacity must of course also be considered as well as the availability of tracts due to ground conditions.

1.2 Knowledge Management

KM can be described as a process in which old outdated knowledge is replaced with new updated knowledge. Such updating of knowledge is essential to enable an organization to adapt to new circumstances. Thus, it is important for an organization to be a learning organization and to keep track of the knowledge it possesses (Spender 1996). The organization also needs to ensure that knowledge is accessible within the organization when needed.

The relation between data, information and knowledge can be described in different ways. A common view is to see this relation as a Data-Information-Knowledge relation (Nonaka 1994). This view looks upon data as meaningless numbers, that when given meaning turn into information, that when combined with other information and knowledge finally turns into knowledge. Alavi and Leidner (2001) refer to another argument, which argues that knowledge must be present before information, and that both knowledge and information are necessary before data can be collected. Yet another way to use the term knowledge is that data, information, structured information, insight, judgment and decision are different states of knowledge in decision making (Holsapple 2008).

Alavi and Leidner (2001) summarize five perspectives of knowledge; knowledge as (1) a state of mind, (2) an object, (3) a process, (4) a condition of having access to information, and (5) a capability. In this study knowledge is seen as an object, which means that knowledge as such can be "stored and manipulated". We also include the perspective 'knowledge as a condition of having access to information'. This latter perspective can be seen as an elongation of the object view (Alavi and Leidner 2001).

Two types of strategy for knowledge management can be identified; the company can adopt either a codification strategy (push strategy), where knowledge is coded and made accessible to members of the organization to use when they need it, or a personalization strategy (pull strategy), which involves a web of persons that hold important knowledge. In the latter case, if a member of the organization needs specific knowledge, he or she has to ask a person in the web to share knowledge with him or her (Hansen et al. 1999).

The four basic processes of a KM system, to support creation, storing and retrieval, transfer, and application of knowledge, are central to our analysis. They can be described in terms of different qualifiers, such as the dichotomies of tacit/explicit knowledge and individual/social knowledge (Zack 1999, Alavi and Leidner 2001).

Tacit knowledge is knowledge that is not possible to put in words. This kind of knowledge exists within an individual and is strongly connected to specific actions (Nonaka 1994). Explicit knowledge, on the other hand, can be written or told and transmitted to others in that form. Individual knowledge is the knowledge that a person holds and forms the foundation of social knowledge. Social knowledge is the collective knowledge of a group and is the result of all individual knowledge within the group. Both individual and social knowledge can be either tacit or explicit (Spender 1996). These four knowledge processes can then be described as follows (Alavi and Leidner 2001):

Knowledge creation: According to Nonaka (1994), the knowledge creation process within an organization is related to learning and is based upon both tacit and explicit knowledge. This process is described by four modes in the "Spiral of Organizational Knowledge Creation". When people interact, they create new tacit knowledge out of the tacit knowledge they already possess (socialization), new explicit knowledge is created from tacit knowledge (externalization), and new explicit knowledge can also be created from explicit sources (combination). Finally, new tacit knowledge can be created based on existing explicit knowledge (mode of internalization). These four modes are dependent on each other, they are always interacting in knowledge creation, and they drive the knowledge creation process. (Nonaka 1994).

Knowledge storing and retrieval: To avoid loss of knowledge and to secure access to knowledge and information, the organization needs a memory. Alavi and Leidner (2001) suggested five possible ways to organize an organizational memory, which covers both tacit and explicit knowledge: written documents, information in data bases, codified human knowledge stored in expert systems, documented organizational procedures and processes, and finally, tacit knowledge acquired by individuals. Alavi and Leidner also distinguished between individual and organizational memory. They propounded that individual memory affects a person's observations, experience and actions, whereas organizational memory influences present organizational activities.

Knowledge transfer: It is important to be able to transfer relevant knowledge possessed by one individual or a group to others. Transfer of knowledge can occur between individuals, from individuals to explicit sources, from individuals to groups, between groups, across groups and from the group to the whole organization (Alavi and Leidner 2001). By considering the basic properties of communication, Gupta and Govindarajan (2000) identified the key elements required for transfer of knowledge to occur: a message, a sender, a coding scheme, a channel, transmission through the channel, a decoding scheme, a receiver, and the assignment of meaning to the decoded message. Based on this framework, they suggested five elements of inter-personal knowledge flow: value of source unit´s knowledge stock; motivational disposition of the source unit; existence and richness of transmission channels; motivational disposition of the target unit; and absorptive capacity of the target unit.

Knowledge application: "…The source of competitive advantage resides in the application of the knowledge rather than in the knowledge itself…" (Alavi and Leidner 2001). Three mechanisms have been proposed that translate knowledge into organizational capability: directives, organizational routines, and self-contained task teams (SCTT) (Grant 1996). Whereas directives are essentially direct instructions, organizational routines involve coordinated action "…that allow individuals to apply and integrate their specialized knowledge without the need to articulate and communicate what they know to others..." (Alavi and Leidner 2001). When neither directives nor routines suffice to perform the task, self-contained teams may be enrolled. Whereas both directives and routines can improve efficiency in an organization, SCTT are groups that meet to share knowledge between different experts. These meetings may not appear efficient at first sight, but they can enable tacit knowledge to be shared between group members (Grant 1996).

2 Materials and Methods

The company Sveaskog owns forests with a total area of 4.3 million hectares, of which 3.3 million hectares is productive forest land, corresponding to 14 % of the total productive forest land in

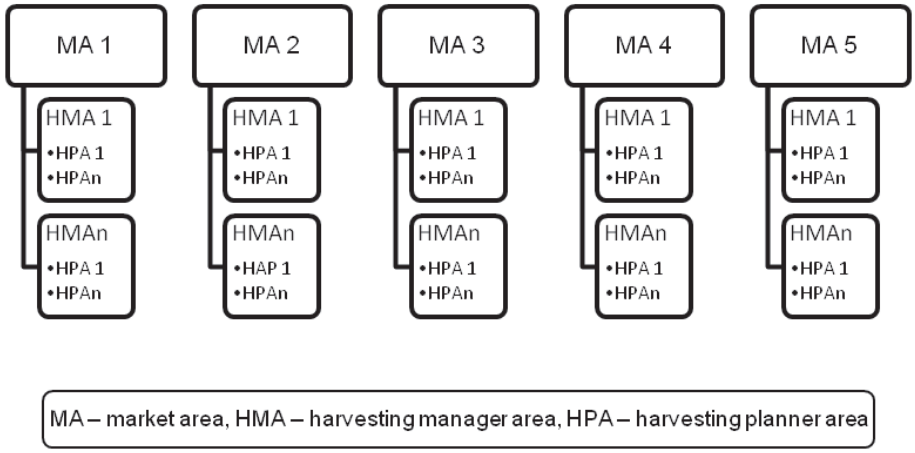

Fig. 1. The relationship between the geographical areas in the company organization.

Sweden. The holdings are distributed over the whole country, with the majority located in the northern part of Sweden. Sveaskog had at the time of the interviews, a process-oriented organization, consisting of three central processes: Forest, Production and Market (Sveaskog 2011). All three processes are represented in each of five geographic market areas (MA). Each MA consists of approximately 4–6 harvesting manager areas (HMA). These in turn are divided into a number of harvesting planner areas (HPA) (Fig. 1).

We conducted a case study based on qualitative data obtained from interviews (Eisenhardt 1989). Yin (1981) has defined the purpose of case studies: "As a research strategy, the distinguishing characteristic of the case study is that it attempts to examine: (a) a contemporary phenomenon in its real-life context, especially when (b) the boundaries between phenomenon and context are not clearly evident."

In the present study, interviews were thematically structured according to interview guides (Kvale 1997). The interview guides were adapted for each person depending on the role of that person in the organization. The interview guides were prepared in advance after studying the company's process maps where the different subprocesses of the company could be identified. These interview guides were divided into four main themes: the planning procedure and the plan, the data used in the plans, the communication of the plan, and the follow-up of the plan and instructions. These themes were broken down into subcategories to ensure that the fundamental elements of the main themes, according to the interviewee's role in the organization, were covered. Examples of these elements are; people involved in the plans and when the work with the plans is done, where information used in the planning process comes from, and how the communication of the plans is done. The interviews were conducted on five employees of Sveaskog who were purposely selected for the interview. The interviewees were persons in leading positions involved in forest planning at the long- and medium-term stages. At the headquarters, the Senior Vice President Forestry, the Vice President Planning, and the Register Specialist who worked with forest data and long-term planning systems, were interviewed. At the MA level, two planning managers were interviewed. The interviews took place in 2009.

All participants were briefly informed about the aim and content of the study via an e-mail requesting their cooperation in the study. The participants were thereafter contacted by telephone to arrange a time and place for the interview. At the time of the interview, the interviewee was verbally briefed again about the study's aim and what themes the interview would include. The interviews were recorded on a digital voice recorder, which all interviewees consented to. In addition to verbal

Table 1. The KM model used to analyze data.

Knowledge creation	Knowledge storage	Knowledge transfer				Knowledge application
		Message	Sender	Channel	Receiver	
How is new knowledge created from the knowledge received from the previous step in the planning chain?	How is this knowledge stored?	What knowledge is sent to the next step in the planning chain?	Who owns the knowledge at this step of the planning chain?	How is the knowledge transferred to the next step of the planning chain?	Who is in the next step of the planning chain; who will use the knowledge next?	What type of application is used to perform this step of knowledge management?

questions, the interviewees were given large pieces of white paper and a number of pens in a variety of colors, and encouraged to draw their picture of the planning process. One interview was conducted by telephone, whereas the others were performed in person. One interview was conducted with two interviewees at the same time, whereas the others took place with one person. Each interview lasted approximately 1.5–2 hours, except for the telephone interview which lasted approximately 40 minutes. The majority of the interviews were conducted in conference rooms close to the participant's own office room.

The recorded interviews were first transcribed. Then, these transcripts, together with the drawn material from the interviews, were transferred into mind maps with a focus upon the information and knowledge utilized in the planning processes. These mind maps were combined to create a single mind map for the whole planning process, covering the information and knowledge management processes. From the resulting mind map, a new map was drawn. This last "meta map" tracked the flow of forest knowledge through the organization from the freshly collected stand data to the harvesting tracts in the tract bank. These mind maps was made by one of the authors and then discussed in the author group, where the interview transcriptions where used to evaluate the result. The final mind map was used to analyze the KM processes at each step of the planning process using the analysis model (Table 1). The analysis model was based on the four KM processes. In the model, the process of knowledge creation was documented by assessing the main knowledge creation mode or modes (socialization, externalization, combination, and internalization) that seemed to be in operation. The process of knowledge storage/retrieval was described in terms of how the results of decisions or activities were stored (documents, data bases, expert systems, organizational procedures, and tacit knowledge acquired by individuals). Concerning the process of transfer, 'sender' and 'receiver' essentially corresponded to the start and end points of the step, respectively, the 'channel' to the main form(s) of transmission connecting the endpoints, and the 'message' to the essential outcome of the step. This does not exclude the possibility that other knowledge transfer processes are active within a specific step. Finally, 'Application' refers to the mechanisms of directives, organizational routines and self-contained task teams, and IT-related support tools that were employed to complete the step. Each step in Table 1 can be read from left to right in the following manner: Through the act of knowledge creation, knowledge is obtained that is stored in some format and is sent as a message from a sender through a channel to a receiver, a process that is regulated by modes of application.

3 Results

Sveaskog follows the general forest-planning procedure described above. Fig. 2 shows the flow of forest knowledge through the organization from the acquisition of data for the long-term plan to the tract bank.

Table 2 presents the forest-planning process in terms of the four KM processes identified by

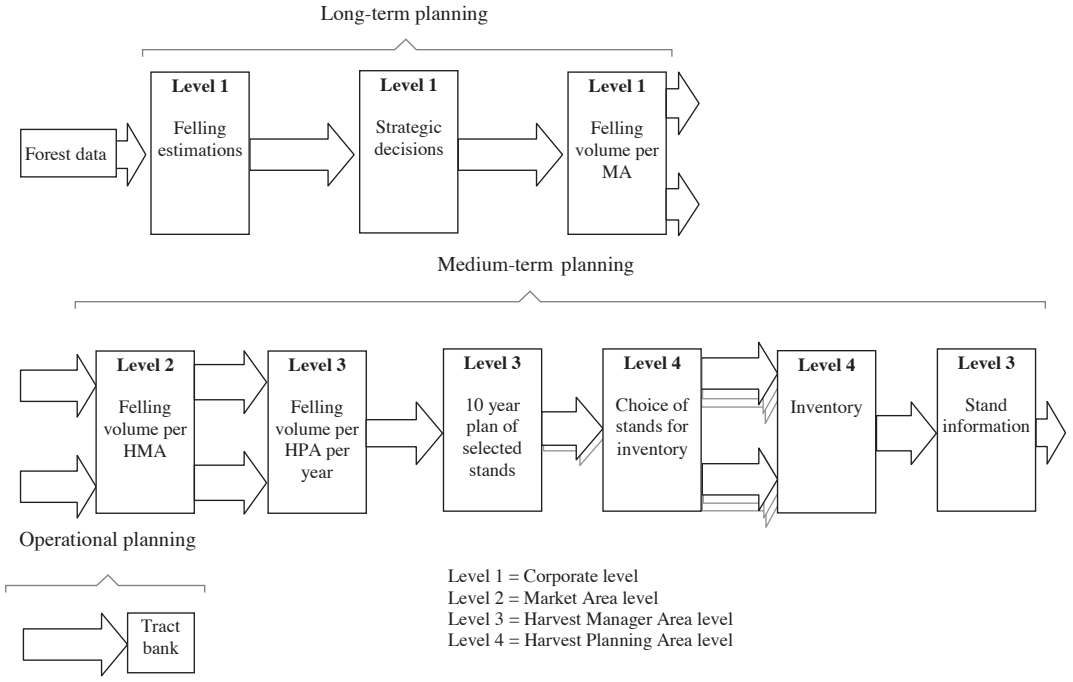

Fig. 2. The flow of forest knowledge through the forest-planning organization and the level at which decisions are made. (Separate multiple arrows denote distribution on different geographical units; overlaid multiple arrows denote repeated activity at the same geographical unit during the long-term planning cycle.)

Alavi and Leidner (2001) – creation, storage/retrieval, transfer, and application. They are analyzed according to the model presented in Table 1. In the study, the forest knowledge is followed from the long-term harvest estimations through a number of steps to the tract bank. Each row in the table corresponds to a decision being made, or specific activities performed that are related to KM, based upon existing knowledge of the forest in combination with other data, information and knowledge. The new decision (activity) creates new knowledge which is subsequently utilized as shown in the following row or rows in the table.

Further details of the various steps shown in Table 2 are as follows:

1) The forest-planning process begins with the calculation of alternative long-term harvest estimations. These estimations are based on inventory data, which are based on data in the existing stand register. The stand register is kept in a GIS database and forms the basis for the sample stand inventory. This inventory is mostly performed by a consulting firm. Information about the forest from the inventory, together with other input information, such as market information, assumptions about interest rates, prices and costs in the future, is used by the FMPP system to create several long-range plans for each analysis area (21 in total). The plans extend over a period of more than 100 years and are based on economic optimization subject to harvest flow constraints. The outcome from the optimization is the allowable cut, distributed on final felling and thinning, where the first three 10-year periods are considered to be the most important. The work involved in this step is mainly conducted by a Forestry Analyst together with other specialists under the supervision of the Senior Vice President Forestry. The Senior Vice President Forestry mentions that, in the process of finding the best plans to present to the board, also some "gut-feeling" is involved.

Table 2. Knowledge management processes involved in long- and medium-term planning.

Step	Knowledge creation	Knowledge storage [a)]	Knowledge transfer				Knowledge application [a)]
			Message [a)]	Sender	Channel [a)]	Receiver	
1	Externalization, combination	Documents	A set of long-term harvest estimations	Senior Vice President Forestry	PM / presentation at board meeting.	The board	OR, SCTT; FMPP, e-mail programs etc.
2	(Externalization, combination)	Documents	The long-term harvesting level to achieve over the next ten years.	The board	Personal meeting and minutes	Senior Vice President Forestry	(OR, SCTT)
3	Combination	Documents	The felling volume over a 10 year period per MA.	Senior Vice President Forestry	Meeting and e-mail	Production manager & Planning manager	OR
4	Combination	Documents	The distribution of the ten year volume for each HMA.	Production manager or Planning manager	Meeting	Planning manager	OR
5	Combination	Documents	Planning volume per year for each HPA.	Planning manager	Meeting	Harvesting planner	OR
6	Combination, externalization	DBMS	Medium-term plan, suggesting the year for attending to each stand.	Planning manager & Harvesting planner	GUI	GIS database	OR; GIS, DBMS, database queries
7	Combination	DBMS	A set of stands for inventory	GIS database	GUI	Harvesting planner	OR; GIS, DBMS, database queries
8	Combination	DBMS	Inventory data	Harvesting planner	GUI	GIS database	OR; DBMS
9	Combination	DBMS	Information about stands, volume etc	GIS database	GUI	Tract bank	OR; DBMS

[a)] GUI = graphical user interface, OR = organizational routines, SCTT = self-contained task team, DBMS = database management system, FMPP = Forest Management Planning Package, MA = Market area, HMA = Harvesting manager area, HPA = Harvesting planner area, GIS = Geographic information system.

The work is supported by reference groups that provide knowledge in their respective specialist areas. These groups include planning managers from the MA's and other members of the Market and Production processes. In Table 2 these groups are referred to as SCTT:s. This economic optimization should in principle be performed every 10th year, but is normally carried out for the whole company approximately every fifth to sixth year due to environmental reasons.

2) A number of felling estimations result from the economic optimization of the analysis areas. Each plan alternative is consolidated by the whole company. The Senior Vice President Forestry presents the plans as a memo and at a board meeting. The board makes a decision on the long-term harvest strategy for Sveaskog based on the optimizations. The decision is entered in the minutes of the meeting.

   As the board meeting is closed, it is difficult to draw any conclusions as to the nature of the knowledge used and created. However, it seems logical that some tacit knowledge contributes to the deliberations. To what extent the board constitutes as a task team is more uncertain.

3) The Senior Vice President Forestry is commissioned to implement the long-term plan decided upon by the board. This long-term plan incorporates a new long-term harvest strategy, which must be applied at the five MAs. The first action is to divide the total volume among the MAs based on the FMPP calculations. The allotted volume is disseminated to each MA through e-mails and by a meeting with the Senior Vice President Forestry and staff of the MA.

4) The long-term harvest strategy for the first period, i.e., the allowable cut in the coming ten years per MA, is then distributed to each HMA. The information is distributed in meetings at the MA, which are attended by the production manager, planning manager, harvesting managers and harvesting planners.

5) The volume to cut during the coming ten years at each specific HMA is subsequently apportioned between each HPA and per year in meetings with the planning manager, harvesting manager and harvesting planner; the production manager can also take part in this task.

Steps 1–5 above are conducted each time a new long-term harvest strategy is decided upon. Step 6 is performed once a year, whereas steps 7–10 can be carried out more frequently, if needed.

6) Based on the estimated volume per year of coming harvests, the medium-term plan is then developed. Medium-term planning involves several sub-processes, including consultations, both internal and external. For example, these consultations may be held with the Sámi people regarding the common use of the land or to plan the construction of new roads. They provide part of the knowledge used in decision-making.

   The medium-term plan, except for the tract bank, is stored as a part of the GIS database. All knowledge about the forests is stored in this database. The forest knowledge is stored by stand and comprises both current and historical information on each individual stand in relation to a computerized map. The work towards the medium-term plan does not involve decision support systems. Some elements are also difficult to program, such as the outcome of the consultations. These two factors, lack of decision support systems and uncertainties associated with consultations, in combination with the complexity of the task, make it likely that some of the knowledge entering this process is tacit.

7) From among the stands marked for inventory in the GIS database (the second category of the medium-term plan; see step 6), encompassing 3 to 3.5 years of harvests, stands are selected to be inventoried. The harvesting planner uses the knowledge stored in the GIS database, local knowledge not available in the GIS database and the composition of the existing tract bank (the final factor determining what needs to be added to the tract bank).

8) The harvesting planners take inventories of the selected stands, i.e., they make field measurements and estimations of the stands, such as the standing volume, ground conditions, and which parts of the stand to leave. Although these inventories are made continuously over the year, they are preferably taken during the vegetation season. After the information is collected, it is transferred from the field computer to the GIS database by the harvesting planner.

9) Following compilation of data in the GIS database, the stand is made available for operational planning. To inform the harvesting manager about this

and to transfer the knowledge about the stand, the stand data is exported to another database which contains the tract bank.

After the tract has been operationally planned, it is ready to be harvested. Harvesting activities follow a three month rolling operational plan and are conducted continuously around the year. These activities belong to the operational planning stage and will not be covered in this article.

It should be noted that this system requires a well-functioning updating system. The plans are based on the stand register, and thus, the stand register should be up-to-date. After harvesting, information about the stand is transferred back to the harvesting planner, who manually updates the stand register. It is expected that these updates are performed following each silvicultural action, e.g., after stand establishment, pre commercial thinning, thinning and final cutting. This aspect of the planning system is not dealt with further in this article.

4 Discussion

The purpose of this study was to analyze the knowledge related processes in forest-planning of a large forest company in terms of knowledge management (KM) and with special attention to knowledge about the forest resource. The analysis below will involve characterization by the four KM processes; creation, retrieval/storage, transfer and application, and also identification of the type of KM strategy in operation (push or pull). Based on these results, an assessment of the KM of the company is attempted and some future research tasks are identified. In the following text, numbers in brackets refer to the steps 1–9 in Table 2.

Following Nonaka (1994), the process of creation can be described in terms of tacit and explicit knowledge. Characterization of the creation process outlined in steps 1–9 revealed that a large amount of knowledge is handled in an explicit form. Plan proposals are delivered (1), memos are written and distributed (2 and 3) and data are inputted into databases (6, 8 and 9). There also appears to be tacit knowledge; it was explicitly referred to as part of the development of the long-term plan proposals (1) and it would be surprising if it was not also involved in the board meeting (2). Another instance where it is probably valuable is in (6), the complex and lengthy planning process concerned with forming the medium-term plan. Otherwise, there are few occasions where the planning process seems to incorporate tacit knowledge.

The process of storage/retrieval operates in all 9 steps, essentially through documents and database systems comprising explicit knowledge. As mentioned above, there are a few instances where tacit knowledge is involved. However, it does not seem to be the main form of storage, as all the steps specify storage in terms of explicit knowledge. Alavi and Leidner (2001) have suggested that organizational procedures and expert systems also can be viewed as forms of storage. Organizational procedures certainly exist here, but it is difficult to interpret them as ways of storing new information. Expert systems were not observed.

The process of transfer took place through meetings in 5 out of 9 instances (1–5), supplemented by e-mails and minutes; a Graphical User Interface (GUI) was employed in the remaining cases. The meetings were associated with revisions of the long-term plan, whereas the GUI was used in the medium-term phase (6–9). It should be noted that groups are involved in all steps of the long-term plan revision, either as the receiver (1, 3–5) or sender (2), but only individuals or explicit sources are involved as senders/receivers in the medium-term planning.

Turning to the process of application, according to Grant (1996), there are three ways to apply knowledge; directives, organizational routines and self-contained task teams. Application almost entirely relies on organizational routines. Certain procedures are followed at each step. The routines are also codified in process maps, although the interviews revealed that they are not always followed to the same degree everywhere. Self-contained task teams are employed in (1), which concerns the development of long-term harvest estimations. To what extent the board constitutes a task team in (2) is uncertain as this meeting could not be observed.

It should be noted that only in (1), is something resembling a decisions support system employed, i.e. the FMPP for long-term planning at forest

level. Information technologies are otherwise employed for communications, primarily e-mail, and for making database queries when stands are selected.

The entire planning process follows a push strategy with only a few observed elements of pull. Knowledge is to a large degree coded and made available to those needing it. This is in line with the top-down nature of the planning process, where it is stipulated what should be delivered in terms of knowledge and when, i.e., planning does not evoke a unique search process every time it is initiated. However, an example of the pull strategy is found in step (1), where the Senior Vice President Forestry seeks out information regarding both when to initiate a new round of planning and what direction to give it, supported by a task team.

Assessment of the KM associated with the planning process of the company should begin with the KM strategy itself. The push strategy and its focus on explicit knowledge would seem to be consistent with the nature of the business that the company belongs to. Hansen et al (1999) found, when comparing two consultancy firms, that the firm offering relatively cheap standardized solutions followed a push strategy, whereas the firm with specialized solutions adopted a pull strategy. This is consistent with the strategy pursued here, since the planning process under study (long- and medium-term planning in which final customer destination is undetermined) focuses on the delivery of volumes of timber and pulpwood rather than specialized products. It is also true that the company operates in an established business where large volumes enter markets for standardized products. The predominant mindset of those involved in the supply chain is on delivery of the required volumes (Hugosson 1999). The business is probably best characterized by several competing firms with price, i.e., efficiency, being important for maintaining competitive advantage (Porter 1985).

The push system is essentially applied through operational procedures, meaning that managers can use their specialized knowledge without direct exchange with others (Alavi and Leidner 2001). We observed a well-established structure for determining when and what knowledge should be stored and retrieved as well as when and how transitions should be conducted. Given the long time that the planning paradigm – with specific tasks assigned to long-term, medium-term and operational planning – has been exercised in Swedish forestry, this result is not surprising.

The planning process was clearly a top-down process, in that knowledge in each step progresses from one level of the organization to the next lower level. Given the centralized nature of the flow of knowledge in the absence of built-in feedback loops, there is a risk that long-term decisions are "diluted" along the process, so that the harvest plan input into the tract bank in (9) does not actually match the long-term plan. Andersson (2005) highlighted the potential risks by describing a sequence of planning steps, where each step introduces new aspects. It is also apparent when investigating the aspects that guide FMPP solutions (Jonsson et al. 1993) in (1) that the extensive knowledge applied in developing the medium-term plan cannot be fully taken into account in the long-term plan. However, the risk of inconsistencies between plans should not be exaggerated, particularly for boreal forest conditions (Andersson and Eriksson 2007).

The centralized top-down process also means that knowledge is transferred in several steps. In a few of the steps, several functionaries participate in meetings (3, 4, and 5). The efficiency of this process is questionable since it involves a large number of meetings whose purpose essentially is to divide a given volume as consistently as possible according to the long-range plan. However, merely distributing directives could reduce the motivational disposition of the receivers and result in a loss of opportunity to enhance their absorptive capacity (Gupta and Govindarajan 2000). Further, if these meetings did not to take place, knowledge would only transfer top-down; instead, knowledge can flow in the opposite direction, which could benefit future decisions.

Another aspect of the meetings that should be considered is their role in the creation of social knowledge. The basis of social knowledge is individual knowledge. People need to meet to in order to share their knowledge and create social knowledge (Nonaka 1994). There should be opportunities to develop social knowledge in the meetings (1, 2, 3, 4, and 5). However, the meetings do normally not take place more than

once each five-six years and their efficacy in this respect may be debatable. As discussed above, there seems to be a common understanding of the planning process, its purpose and the routines it entails; this can also be interpreted as a form of social knowledge.

The planning process may be regarded as inflexible. The part of the long-term plan that is brought down the organization has a horizon of ten years. However, due to unexpected events, the long-term plan tends to only last for five to six years before it needs to be reevaluated. However, in many businesses, this time-frame would be considered exceptionally long; the propensity of a firm to adapt to a turbulent environment could be impaired by fixing the plan for such a lengthy period. From a KM perspective, one potential drawback of the long interval between planning events is that it restricts the bottom-up flow of knowledge. On the other hand, there are also good arguments for keeping the long intervals. From an efficiency point of view, the development of the plans is costly. The process of implementing the plans in the organization could be even more costly (steps (3)-(7)). Costs associated with capacity variations of harvesting resources may also be high. It should also be noted that the business of timber production, which the company belongs to, is comparatively mature, the forest production process is slow (the planned activities do not change the state of the forest significantly over a five year period), and extensive experience has been gained over the years of how the planning system functions.

In conclusion, the planning system relies to a great extent on codified knowledge about the forest resource. The KM strategy is essentially a push strategy, i.e. knowledge is made available to those active in the planning process. The process is top-down and running over many steps before arriving at operational planning. There are few, or infrequent, opportunities for social learning. This does not mean that the strategy and the way forest knowledge is managed do not gain competitive advantage according to the RBV and the VRIO-framework. The approach of Sveskog appears to be what to expect from a company operating in a mature industry with a low valued product. However, to make a more qualified assessment of the potential for improvement of the KM strategy other aspects need to be investigated, for example how accurate the information is, if it is presented in a useful way, and how interested and competent the employees are.

There are many ways of dividing the KM process. Here, we have considered it in terms of how forest data is acted upon. The emphasis on forest information as a defining element of the KM process gives the impression that the planning process is, on the whole, orderly and consistent. Thus, instances of knowledge storage or retrieval can readily be found.

By their nature, interviews reflect what people say they do rather than what they might actually do. Therefore, the data may not be as reliable as if observations of the actual planning had been performed alongside the interviews. With the present method, knowledge processes taking place outside the actual planning process are not considered. The methodology has also meant that the focus was on the form rather than the quality of the forest-planning process and the KM. Thus, the interviews were conducted with the aim of understanding the realized rather than intended strategy (Mintzberg and Waters 1985).

This study represents an initial attempt to analyze the forest planning of large forest owners with a sophisticated planning system, using KM as an analysis tool. It reveals the complexity of getting a planning system working, requiring the design of components that are consistent in terms of messages, senders, channels, receivers to ensure that the quality of knowledge transfer is adequate along the line. Forest planning in theory is often described as a sequence of decisions that smoothly inter-link. If the requirement is to analyze how new forest information sources contribute to company performance, this description is probably overly superficial. New information sources do not automatically translate into better planning. Indeed, several issues need to be addressed if new information sources are to be exploited to their maximum benefit. We need to put questions like, is the information best used in the existing organization or should the organization be upgraded as well; does the planning process need to be changed to better suit both information and organization; how does the forest information fit with other information needed in the planning process; how is this information

and knowledge used and managed; what are the consequences for existing data sources; and how will it affect the capacity of senders and receivers?

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