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Transport management – a Swedish case study of organizational processes and performance

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ABSTRACT
Transport represents a critical link for lean supply chains from forests to mills. The management processes developed by individual organizations are often a result of their supply context and mill service demands. The goals of this study were to i) provide a general process map for transport management in cut-to-length supply systems and ii) quantify the effect of varying planning and control cycles on organization performance. The key performance indicator for organizational performance was weekly delivery fulfillment, and the study was limited to the non-winter months when there is greatest variation in road trafficability. The process map documents operational planning and control activities at monthly, weekly, and daily levels. Two main variants of planning activities were found. These had diverging effects on delivery fulfillment as transport distances increased but could also facilitate varying degrees of responsiveness in core supply areas. Regarding the control cycle, the number of follow-up activities used by managers increased with the number of mills/terminals served and their total weekly delivery volume.

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Introduction

Transport management has undergone continuous development during recent decades. As mill consumption has continued to grow, supply areas stretch across more diverse geographies. The main development trends to meet these challenges include increased truck payloads and higher precision in planning and control. This study documents the current state-of-the-art for transport management in an integrated Nordic forest company and identifies the main variants that can be linked to organizational performance and the operating environment.

Earlier studies

Research and development in roundwood transport has included numerous studies on operations research-based decision support for improved planning (Lukka 1994; Karanta et al. 2000; Bergdahl et al. 2003; Forsberg et al. 2005; Andersson et al. 2008). However, existing transport management practices, which are generally developed at the enterprise-level, have received sporadic research attention. These practices are nested within the wood supply context, which in the case of the Nordic countries includes sourcing from both company forests and smaller non-industrial private forests. Mixed sourcing with wood barter extends delivery responsibilities to transport managers within other supply organizations.

While cost at mill gate has been the primary key performance indicator (KPI) for competitive advantage, the need to reduce stocks and meet lead time restrictions has driven development toward increased control over the supply chain (Uusitalo 2005). The general approach to achieving balance in wood supply is presented in numerous sources (Bäckström and Åström 2003; Fjeld et al. 2014). Comprehensive studies mapping frameworks for Swedish wood supply and transport organizations have covered goals, decisions, decision support, and information flow modeling (Andrén 2004; Andrén and Fjeld 2004; Nilsson 2004; Hedlinger et al. 2005). These studies documented gradients of service goals ranging from i) profitability/cost, ii) freshness and delivery precision, to iii) mill stock management. The increase in service levels generally corresponded to external versus internal supply responsibilities. The studies of transport management (Nilsson 2004) covered forest companies, forest owners association, and independent transport organizations. This study also differentiated between central and local managers and noted a dominance of goal-oriented management through the allocation of monthly and weekly delivery quotas to haulers. This was later detailed in terms of transport order specificity ranging from i) monthly/weekly mill quotas to ii) weekly load assignments and iii) daily load assignment with sequencing (Ekstrand and Skutin 2005). However, the reduced opportunity for haulers to cooperate on backhauling with increased transport order specificity may have been a driving factor for the domination of weekly quotas in transport management, at least when the supply situation has permitted this degree of freedom. The development of hauler contracting agreements has also been studied (Landström 2005; Karlsson et al. 2006). These ranged from i) independent hauler-owned transport organizations with fleet manager functions to ii) direct contracting of haulers with decentralized management key area haulers (KAHs) as well as iii) individual hauling companies (HCs) which are contracted and controlled directly by the service buyer transport manager. In a subsequent study of hauler attitudes toward different organizational forms, these differences were interpreted as degrees of decentralization

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designed to reduce the complexity of transport management for the service buyer (Fridén 2009).

The fundamentals of control in logistics systems present transport management as a hierarchy of self-regulating subsystems (Bolin and Hultén 2002). In this perspective, each subsystem consists of planning, execution, and control cycles between the controlling system (planning and control) and the controlled system (responsible for execution). Different degrees of system control are seen in terms of the balance of complexity (requisite variety) between the controlling system and the operating environment (Ashby 1956). Seen in this perspective, the various service buyer/supplier agreements cover a gradient of direct control versus decentralization, as deemed necessary to fulfill mill service requirements. So far, only one Nordic study has empirically shown the effect of transport management processes on service parameters (Lindström 2010; Lindström and Fjeld 2014). The study was limited to service-provider processes (weekly/daily hauler routing). No corresponding empirical studies have been done of the effects of service-buyer processes in monthly and weekly transport management.

Most of the referenced studies were done before the latest waves of flow optimization, real-time monitoring, and (onboard) IT-platforms. **The goals of this study** were therefore to i) provide a general map of state-of-the-art transport management processes and ii) quantify the effect of the main variants on organization performance. The main KPI for organizational performance was weekly delivery fulfillment. The study was limited to the non-winter months when there is greatest variation in road trafficability.

Materials and methods

The case study company was SCA in northern Sweden. SCA currently has 2.6 million ha of forest, 5 sawmills, 2 combined pulp and paper mills, and 1 CTMP pulp mill. The annual mill consumption ranges from 0.6 to 1.1 million m^3 for sawmills and 0.6–4.5 million m^3 for pulp and paper mills. In 2021, their total annual consumption was 11.2 million m^3 of roundwood and chips. Annual harvesting has been 8.1 million m^3 with 4.7 million from their own forests and 3.4 million from private forest owners. Other roundwood sources included 1.5 million from other forest companies and a minor supplement from import. The largest mill consumes approx. 10,000 m^3 daily with a maximum mill stock capacity of 50,000 m^3 (equivalent inventory cover time of 5 days).

Hauling from own harvesting operations is primarily by independent HCs contracted directly by SCA. The supply area for own operations is divided into seven supply balance areas (BAs), each with its respective transport manager. Rail and sea transport is managed by a central industrial logistics group and are outside the scope of this study.

The study was divided into three phases: interview, process mapping, and empirical analysis. The data in each phase identify the respective BA. The interview phase was designed to map general aspects of transport management as well as capture differences in operational context and typical challenges. The ambition for process mapping was to provide one general model covering work elements commonly used in all seven areas/managers, as well as to identify the main variants.

Interviews were done through personal interviews with each area manager, according to a structured questionnaire. The first section covered context control data including the number of demand nodes served (rail terminal, internal vs external mills), number of trucks, contracted hauling contractor companies, and questions about key area haulers (KAHs). Key topics for follow-up questions included i) priorities and practices in transport management as well as questions and ii) factors driving delivery deviations from weekly transport plans. Regarding priorities and practices, these aspects were captured by respondent disagreement/agreement to specific claims. The response was given on a Likert scale from 1 to 5, where $L = 1$ represents complete *disagreement* and $L = 5$ represents complete *agreement*. Regarding the importance of factors, the respondents ranked the importance of the given alternatives where $R = 1$ represents the highest ranked importance, and the lowest ranking can be equal to the number of alternatives ranked. Both are elicitation techniques typically used to capture sensitive information related to attitudes and perceptions (Fishbein and Ajzen 1975).

The process mapping was done using a similar methodology as employed by Lindström (2010). The approach (Ljungberg and Larsson 2001) represents processes as the commonly repeated series of activities where information and resources are used to transform input to output (Figure 1). These activities can represent both planning and control. Resolution of the mapping increases as one progresses from aggregated processes to sub-processes to specific activities. Input objects initiate each activity or set of activities, resources represent the capability necessary to accomplish the transformation, and information supports or controls the activity. The transformed output object represents the result of the activity as well as the input object for the next activity.

The process mapping employed the “virtual walk through” approach (Ljungberg and Larsson 2001) where the respondent leads the interviewer through the typical sequence of activities with the corresponding use of information and resources. The walk-through was structured according to the time horizons typical for transport management (monthly, weekly, and daily) and preceded by the rolling 3-month prognosis cycle, which is typical for wood supply planning. The hierarchy was included in the process mapping with multiple levels or parallel activities within the respective planning and follow-up cycles.

Data for organizational performance were collected for weeks 14 to 43 ($n = 29$ weeks) of 2021 from SCA’s own databases. This period covers the seasons associated with the greatest trafficability challenges in the north: from spring thaw to autumn rain with intermittent dry summer periods. The weekly data were collected from two sources: ordered volumes from SCA’s own transport planning and monitoring system (GATA) and delivered volumes from the sector-wide wood reporting system (VIOL; www.biometria.se). These were supplemented with the corresponding weekly average transport distances per BA and mill assortment.

KPIs were calculated per BA (a), mill assortment (m), and week (w). Transport output (TO in m^3km/week, Equation (1) was calculated as the product of the respective delivered volumes (V) and average transport distances (TD in km).

$$TO_{a,m,w} = V_{a,m,w}(TD_{a,m,w}) \quad (1)$$

Delivery fulfillment (DF %) was defined as the ratio between delivered volume (DV) and ordered volume (OV) per area, mill assortment, and week; see Equation (2).

$$DF_{a,m,w} = 100\,(DV_{a,m,w} \,/\, OV_{a,m,w}) \quad (2)$$

The specification of performance per BA (a) allows connection to the respective process configuration per transport manager for further analysis. Statistical analyses were performed in Minitab version 19.

Results

Operational context and challenges

The operational context in terms of demand nodes served and capacity is presented in Table 1. Each area typically served 10 demand nodes using 40 trucks contracted through 15 HCs. Local responsibility for the allocation of transport orders was typically delegated to five KAHs. With a typical weekly transport volume of approximately 20,000 m^3 over an average transport distance of 100 km, transport output averaged approximately 2,000,000 m^3km per week. Given that the average transport distance varied from 56 to 174 km and the data collection period included summer holidays, the resulting weekly transport output varied considerably (596–5499 thousand m^3km).

Respondent agreement with a number of pre-prepared formulations (Likert scale 1–5) was used to represent general attitudes to priorities and practices in transport management. The formulation that received the highest agreement was *"It is important the demand nodes receive their weekly order/plan"* (L = 4.0). This was closely followed by *"it is important to follow the optimal mill supply area borders"* (L = 3.75). Regarding the approach to transport management, a general agreement was given for *"I support my haulers in their planning"* (L = 3.5). The only formulation that received a general disagreement score was *"I manage the details of my hauler's plans"* (L = 1.5).

Regarding typical challenges for transport managers, three aspects were mapped: i) flow-related risks, ii) impact of common disturbances and iii) factors typical of challenging periods. For flow-related risks for reduced delivery fulfillment, the top three ranked factors were assortment surplus/deficit ($R = 1$ for both), transport capacity ($R = 3$), and receiving capacity at the demand node ($R = 4$). Regarding the impact of disturbances, the top three ranked events were mill process breakdown or demand reduction ($R = 1$ for both), reduced road trafficability ($R = 3$), and assortment surplus/deficit or increased mill demand ($R = 4$ for both). Regarding the factors associated with increased (manager) work intensity, the three top drivers were difficult weather ($R = 1$), high meeting frequency ($R = 1$ and 2), and assortment deficit or insufficient transport work ($R = 2$ for both).

General process configuration

The transport management process consisted of two sub-processes: planning and follow-up. For each sub-process, Figure 2 shows the common set of activities repeated monthly, weekly, and daily by all managers, with the input/output that initiates and ends each set of activities. Planning resolution increased as activities progress downward and decreased as follow-up is aggregated upward.

Table 1. Summary table of demand and capacity per balance area (7) with weekly transport output ($n = 29$ weeks).

Capacity per balance area	Average	Range
No. demand nodes	11.3	8–15
No. trucks	37.9	26–44
No. shifts	60.5	40–79
No. hauling companies (HCs)	15.7	11–24
No. key area haulers (KAHs)	5.3	3–8
Transported volume per week (m^3/week)	19 738	5840–37,481
Average transport distance (km)	104	56–174
Transport output (1 000 m^3km/week)	2 097	596–5499

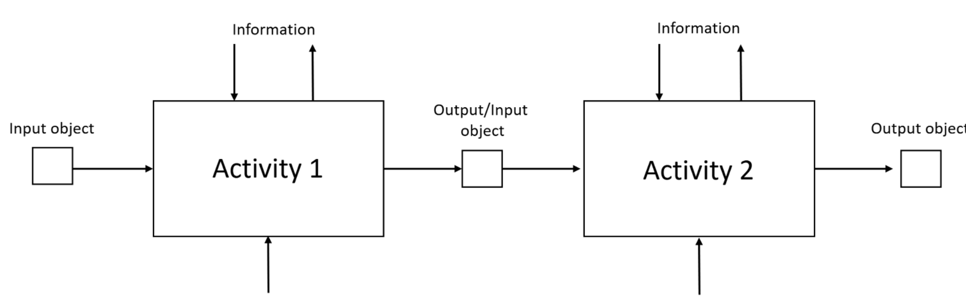

Figure 1. Process mapping format showing a sequence of activities transforming input to output using the necessary resources (below) with information supporting the activity (above). After Ljungberg and Larsson (2001).

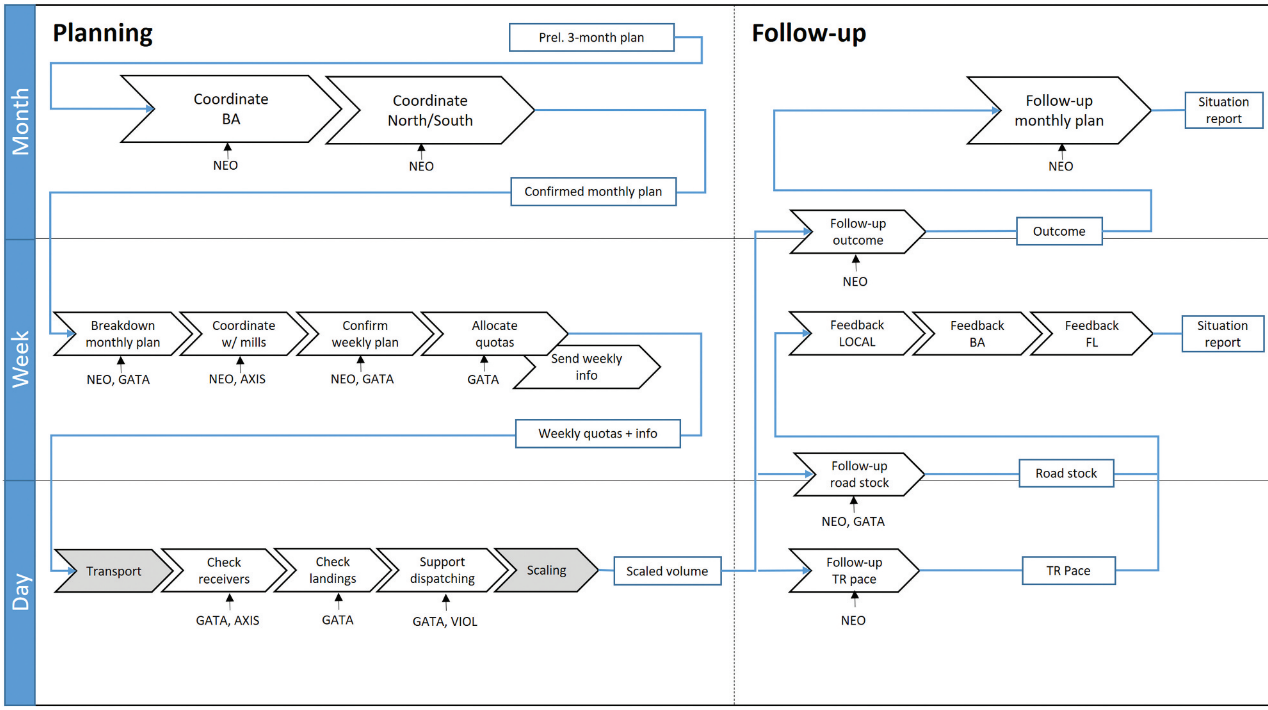

Figure 2. Process map for planning (left) and follow-up (right) activities at monthly, weekly, and daily levels.

Planning

Planning at the monthly level was initiated by the preliminary 3-month plan. After coordination between BAs and between mill groups (northern/southern) a confirmed monthly delivery plan per BA initiated weekly planning. Weekly delivery planning started with breaking down the monthly plan to weekly volumes per mill and assortment. After coordination with the mills for acceptance/adjustment, the weekly plan was confirmed and the transport manager allocated weekly quotas (goals for mill assortment deliveries) to the key area haulers (KAHs), often including distribution of a weekly information update. After distribution of the weekly quotas, the manager continued with daily monitoring of receiver (mills/terminals) and landing status to support the haulers in fulfilling their assigned quotas.

Follow-up

Follow-up at the daily level was initiated with receipt of mill/terminal delivery volumes (scaled). Transport pace was subsequently analyzed in relation to fulfilling weekly quotas, and remaining road stock volumes were updated. This enabled weekly feedback to other functions (purchase and production) both at local area levels and BA levels as well as to the other transport managers (FL, forest logistics staff). The final weekly activity was the monthly summation/follow-up of delivery outcomes, which initiated the follow-up of monthly plan fulfillment. Both weekly and monthly follow-up provided situation reports.

Figure 2 links each activity to the information system resource used (NEO, GATA, AXIS, or VIOL). The information used to support each activity is presented in Table 2. NEO, GATA, and AXIS are the acronyms for the respective SCA systems for wood supply, transport, and mill functions. While NEO tracks primarily tactical wood flows, GATA and AXIS enable real-time monitoring of truck arrivals (GPS-tracking) and mill stock status (webcams). VIOL is the flow monitoring function of the sector-wide business solution for wood sales (www.Biometria.se).

Main variants of the general process map

Two main variants were registered during the process mapping; one in weekly planning and one in delivery follow-up. Regarding weekly planning, quota allocation could be done in two different ways. Four transport managers allocated all quotas to KAHs alone. The three remaining managers, in addition to allocating quotas to key area haulers, chose to manage deliveries from selected transport areas through direct contact with the corresponding individual HCs. This represented an increased degree of centralized management, in contrast to the decentralized approach with KAHs.

Regarding the follow-up cycle, the combinations of activities varied. All managers followed-up delivery pace, road stocks, and delivery outcomes. However, up to four additional activities were noted. These could include i) a review of the latest situation report, ii) a review of the previous week's deliveries, iii) daily monitoring of the current week, and iv) daily follow-up of transport messages. In this context, transport messages refer to PapiNet mobile messaging indicating the approximate assortment volume en route to the mill and the subsequent reduction of available roadside stocks. In principle, these additional activities are expected to be linked to varying degrees of system precision and control.

Table 2. Information and systems supporting planning and follow-up activities at monthly, weekly, and daily levels (black cells). The orange cells rely on real-time stock monitoring via AXIS.

		Information used														Information system used			
		Confirmed monthly plan	Delivery pace, outcome	Road stock status	Need for re-planning	Info from other functions	Significant deviations from	Situation report	Receiver status	Available capacity	Rail terminal departures	Mill stock status (webcam)	Alternative flow solutions	Info from KAH/drivers	Production reporting	NEO	GATA	AXIS	VIOL
Monthly																			
Planning	Coordinate BA	■	■	■	■	■										■			
	Coordinate North/South	■	■	■	■	■										■			
Follow-up	Follow-up monthly plan	■				■	■									■			
Weekly																			
Planning	Break-down monthly plan		■	■												■	■		
	Coordinate with mills		■	■		■		■	▨							■		▨	
	Conform weekly plan		■	■												■	■		
	Allocate quotas		■	■						■							■		
	Send weekly info							■			■								
Follow-up	Feedback LOCAL					■		■											
	Feedback BA					■		■											
	Feedback FL					■		■											
	Follow-up outcome	■														■			
Daily																			
Planning	Check receivers		■			■						▨					■	▨	
	Check landings			■		■											■		
	Support dispatching					■				■			■	■			■		■
Follow-up	Follow-up TR pace	■														■			
	Follow-up road stock														■	■	■		

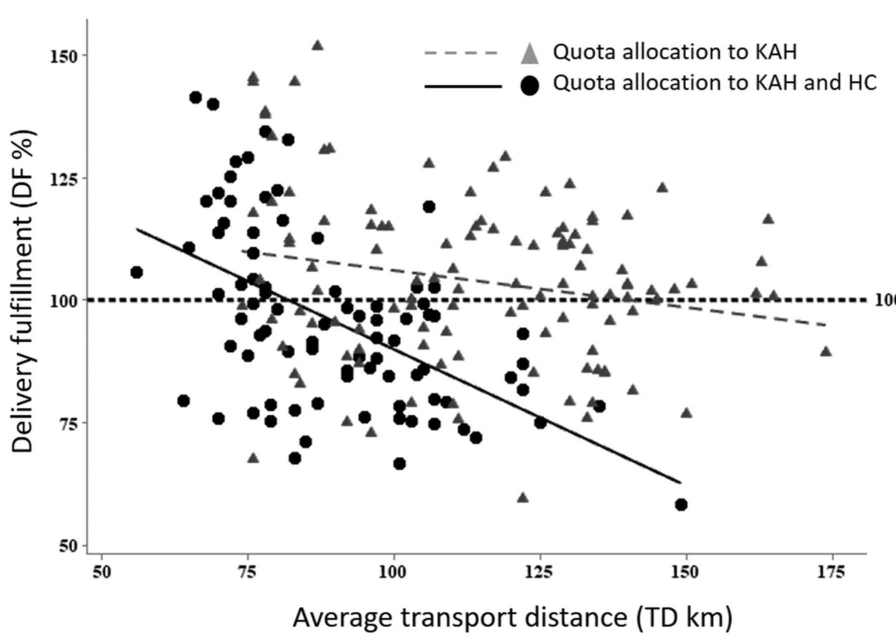

Figure 3. Scatter plot of weekly delivery fulfillment (y-axis) and average transport distance (x-axis) for two different variants of weekly quota allocation. Grey triangles; key area haulers (KAH) alone, black circles; combined KAH and individual hauling companies (HC).

Analysis of management processes

Planning

According to the interview results, the highest ranked goal for transport managers was *"It is important the demand nodes receive their weekly order/plan."* This motivated focus on delivery fulfillment for empirical analysis. An initial overview of weekly delivery fulfillment showed that the widest range (60–140%) was found at lower levels of transport output (1,000,000 m^3km/week), gradually narrowing toward higher levels of transport output (75–125% at 3,000,000 m^3km/

Table 3. Average values for weekly transport output and delivery deviation for three groups of balance areas (no. demand nodes).

No. demand nodes	Delivered volume (m^3/week)	Transport distance (km)	Transport output (m^3km/week)	Absolute deviation from weekly plan (%)	n
8–9	20,693	89	1,848,522	6	2
10–13	16,755	93	1,547,983	5	3
14–15	23,465	134	3,165,667	4	2

week). The same pattern was present when plotted against the average transport distance but in neither case was there any visible trend with respect to transport output or distance.

Figure 3 shows a plot of weekly delivery fulfillment versus average transport distance when the observations are identified by the variant of weekly quota allocation; i) KAHs only, versus ii) a combination of KAH and direct management of individual HCs (KAH and HC).

When seen individually, the scatter plot shows trends toward reduced delivery fulfillment when operating over longer distances for both quota allocation variants. Both variants appear to have similar delivery fulfillment at the shortest transport distances (110–115% at TD ≈60 km) with increasing divergence as distances increase. Because of the considerable variation at a weekly level, regression analysis (Equation (3)) only explained 19% of the variation in delivery fulfillment; however, the effects of all variables were significant ($p < 0.001$).

$$DF = 114 - 0.177\,(TD - 60) - 0.442\,(TD - 60)\,QA \qquad (3)$$

Where

TD = average weekly transport distance (km)

QA = quota allocation variant (0 = KAH alone; 1 = KAH and HC combined)

With the subtraction of the lowest frontier value for distance (TD ≈60 km) there remained no significant effect of the quota allocation (QA) alone, only for the interaction between QA and transport distance (TD).

Follow-up

Regarding the additional activities for delivery follow-up, the number of activities initially appeared to vary with the number of demand nodes (mills/terminals) served per BA. Table 3 presents the average transport output and absolute deviation from planned/ordered volumes for three corresponding groups of BAs.

With respect to the number of demand nodes, both absolute delivery deviation and transport distances appeared to follow a consistent trend. The trend was not consistent with respect to transport output because of the lower weekly volume of the middle group (10–13 nodes). Principal component analysis (PCA, Figure 4) was used to find the main factors driving the manager's use of follow-up activities (1 = activity in use; 0 = activity not in use). The strength of the associations is indicated by their respective loading coefficients (loading).

The first principal component (PC1 explaining 42% of the variation, loading = 0.57 for the number of demand nodes) was associated with daily follow-up of transport messaging (loading = 0.52), daily follow-up of deliveries during the current week (loading = 0.41), and follow-up of deliveries during the previous week (loading = 0.39). The second principal component (PC2 explaining 30% of the variation, loading = 0.63 for weekly transport volume) was also associated with daily follow-

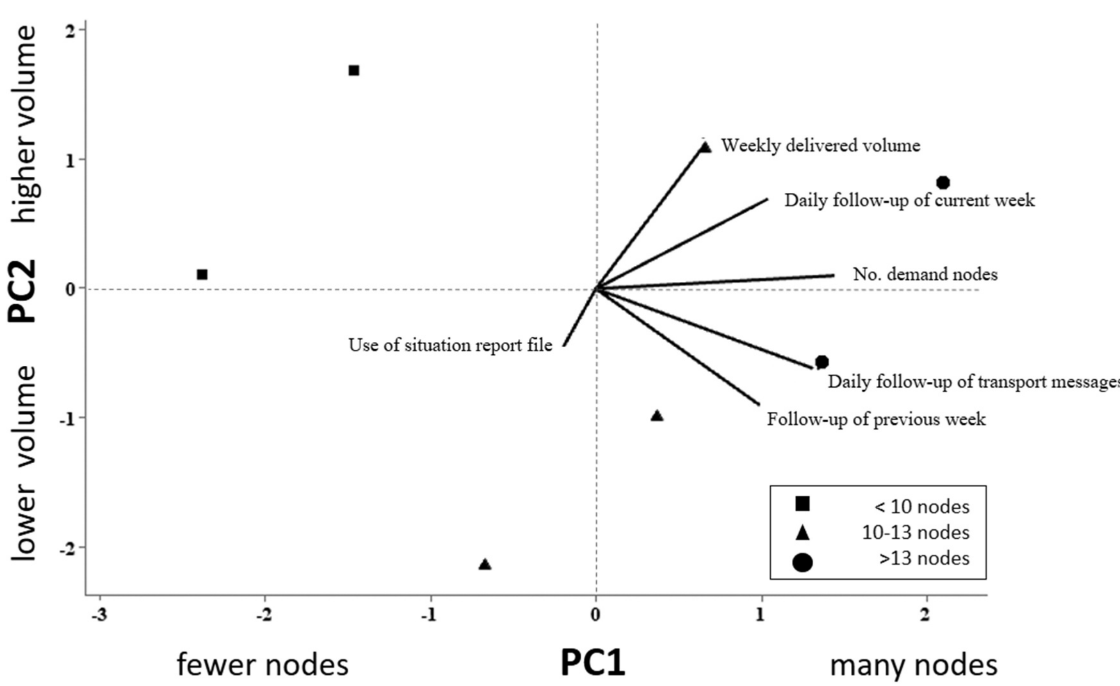

Figure 4. Principal component analysis biplot showing the distribution of the respective balance areas and association of follow-up activities in relation to two principal components of variation (PC1; no. demand nodes, PC2; weekly delivery volume).

up of the current week (loading = 0.39) but associated with reduced use of previous weeks follow-up (loading = −0.51) and daily follow-up of transport messaging (loading = −0.35). In summary, as the number of demand nodes (PC1) and delivery volumes (PC2) increased (counter-clockwise from bottom-left in Figure 4), so does the progression toward a higher frequency of follow-up activities.

Discussion

Earlier empirical studies of the influence of work processes on transport service levels were limited to how haulers solve the timber transport routing problem (TTVRP) in practice (Lindström and Fjeld 2014). While the practice of weekly quota allocation is dominant in practice and a typical student exercise in forest logistics courses (Fjeld et al. 2014), few empirical analyses have been made of its effects. This study provided an updated general process map for planning and control cycles where variants of planning activities were linked to delivery fulfillment (Figure 3). Variants of follow-up were also linked to the varying complexity of the operating environment (Figure 4).

In relation to earlier studies of management practices for wood supply (Andrén 2004; Andrén and Fjeld 2004) and transport (Nilsson 2004; Hedlinger et al. 2005), the research host is positioned in the upper levels of customer service ambitions, focusing on high delivery precision and mill stock management. However, since the previous studies, sector demands to delivery fulfillment have been increasing. Earlier, monthly deliveries within 10% of the planned volumes represented common criteria for monthly delivery bonuses for external suppliers. In contrast, the current study showed an average weekly deviation closer to 5% (Table 3).

Planning

The two variants of weekly quota allocation had diverging trends with respect to delivery fulfillment and transport distances (Figure 3; KAH alone versus combined KAH and HC). The interpretations of cause and effect, however, are not immediately clear. Logically, increasing transport distances (56–174 km) reduces the volume feasible to deliver with a given transport capacity (40–70 shifts/week). At the same time, wider geographies and volumes under the same transport administrator should facilitate increased backhauling and higher capacity utilization, partially compensating for the effects of increasing transport distance. The organizational solution of using KAHs to coordinate local HCs transfers operational responsibility to those with the best knowledge of local trafficability and road stock status. In principle, this development should support improved delivery precision. Assuming that KAHs also have the necessary overview of wood flows to support backhauling, the KAH-alone solution could be expected to maintain high delivery fulfillment even at longer transport distances.

The definition of delivery fulfillment used in this study compares the delivered volume to a planned or agreed monthly volume. While this KPI is commonly used, the highest level of mill service ambitions (mill inventory management) can also define delivery fulfillment as delivery volume in relation to the actual volume consumed *with adjustment for planned changes in mill stock levels* (e.g. seasonal trends for supply or demand; Fjeld and Dahlin 2017). In this study, transport managers had on-line access to mill stock levels via AXIS webcams and were expected to maintain sufficient mill stocks regardless of agreed orders or plans. These higher demands may be the driver for the mixed quota allocation practiced in three of the studied BAs. In principle, maintaining direct control of hauling capacity in areas closest to mills or terminals should facilitate a more rapid response to varying mill/terminal stock levels. The organizational capability to quickly re-allocate HC capacity within the core supply areas could then enable a greater range of daily delivery rates. Such short-term dynamics may not be captured or reflected by the delivery fulfillment KPI used in this study but would help explain the greater variation in delivery fulfillment at the shorter transport distances. According to this line of reasoning, the average delivery fulfillment for both variants could be expected to converge at shorter transport distances, while responsiveness and capacity utilization for the mixed quota allocation model (KAH and HC) could be expected to decline as operations extend outside of the core supply areas.

Control

Exploiting the advantages of an improved planning cycle requires a corresponding high precision in the follow-up cycle. The PCA analysis (Figure 4) showed how the BAs with a higher number of demand nodes and volumes utilized a progressively higher frequency of follow-up (Figure 4; i) previous weeks follow-up, ii) daily follow-up during the current week, and iii) daily monitoring of loads enroute via PapiNet delivery messaging). The highest loading in PC1 for on-board delivery messaging implies that the advanced knowledge of deliveries “in the pipeline” is advantageous when handling the most complex operational contexts. This knowledge also provides an earlier update of the remaining road stock for subsequent deliveries.

The observed differences in follow-up activities can be related to control theory for logistics systems. Control describes the capability of the controlling system to meet the different states of the controlled system in its operating environment. The requisite variety describes this balance, where the system regulator has the necessary variety of responses to compensate for any variation appearing in the controlled system (Ashby 1956). In transport systems, the two general approaches for achieving the requisite variety include i) increasing the variety of management through more advanced planning and control functions and ii) reducing the variety of the controlled system through increased buffer volumes or decentralization of management (Bolin and Hultén 2002). This is consistent with practice where decentralization through goal management has been used to reduce the variation imposed on the transport manager (Fridén 2009) and weekly quota allocation has become the dominant practice for ensuring smooth weekly flows (Nilsson 2004).

While optimization solutions for wood flow planning solutions have been implemented for wood supply organizations in Finland (Savola et al. 2004) and Sweden (Forsberg et al. 2005), the high complexity of the operating environment has prevented widespread operational optimization of truck routing and scheduling. In the SCA case, transport planning is based on wood flow plans, which are optimized with commercial software (WoodFlow, https://Creativeoptimization.se). The documented planning and control cycles can then be interpreted as providing the operational requisite variety to fulfill ambitions for mill stock management, given the real-time monitoring of truck deliveries and mill-yard stocks with GATA and AXIS (Table 2).

Conclusions

This study extends current knowledge with an updated process map for operational planning and control of roundwood transport in cut-to-length supply systems. Two main variants of planning activities were noted: decentralized planning (quota allocation to KAHs alone) and partially centralized planning (quota allocation to both KAHs and selected HCs). These had diverging effects on average delivery fulfillment as transport distances increased. They could also facilitate varying degrees of responsiveness in core supply areas. Regarding the control cycle, the number and frequency of follow-up activities increased with the number of mills/terminals served and their total weekly transport volume.

Disclosure statement

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