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Evaluating the impact of wood flow management software on administrative costs and efficiency for wood suppliers in the Southeastern U.S.: a case study of Timber Resource Analytics and Contract Tracking software

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ABSTRACT

The southeastern U.S. forest industry serves as a crucial source of raw materials for construction and paper production for the global economy. However, this industry faces persistent challenges in wood supply chain management, often centered around logistical inefficiencies and administrative burdens. Additionally, increased operational overhead, due to rising costs, has exerted strain on the business success of wood suppliers. Administrative procedures and record keeping have traditionally been a labor-intensive process for this sector of the wood supply chain. However, technological solutions, such as new wood flow and logistics management software, can enhance efficiency and cost-effectiveness of these procedures. This research investigated the impact of wood flow management software on administrative costs for southeastern U.S. wood suppliers. Utilizing a case study approach, we compared administrative time and cost savings of software users and non-software users, to determine potential financial benefits of software adoption. The research design centered on gathering insight from both user groups, through individual interviews, allowing for a comparative analysis of the software's efficiency metrics. Results indicated that wood suppliers who utilized software saved an average of 43 hours per week on administrative tasks, resulting in estimated annual savings of approximately $62,000 United States dollars (USD). The greatest reported time and cost savings were attributed to scheduling jobs and organizing information. Adoption of wood flow logistics software may result in additional monetary savings through increased efficiency in administrative procedures and communications. These research findings will be useful to wood suppliers interested in improving operational efficiency and reducing administrative costs.

Keywords

administration, efficiency, logistics, supply chain, wood supplier

Citation

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INTRODUCTION

The southeastern U.S. forest industry plays a significant role in the global economy, providing resources for and the manufacturing of products such as pulp and paper, wood pellets, construction lumber, and others. The forest industry accounts for 4% of the total U.S. manufacturing gross domestic product (Zhang et al. 2021). The wood supply chain in the U.S. involves many independent but interconnected business units that are essential for supplying timber to mills. As such, a stable and effective wood supply chain plays a key role in the sustainability and growth of the industry. However, the intricacies associated with management of wood supply chains have presented numerous challenges, spanning logistical complexities to administrative time and expense burdens. The southeastern U.S. forest industry utilizes a wood dealer and logging business system for timber procurement (Conrad et al. 2018; Bowman et al. 2023), with the most common and productive harvesting operations being fully mechanized, implementing a whole-tree harvesting system (Barrett et al. 2017; Conrad et al. 2018; Conrad and Dahlen 2019). Logging businesses harvest and deliver timber to wood processing facilities (Barrett et al. 2017; Conrad et al. 2024) and provide a means to monetize forestland investment and biological growth (Mei et al. 2013). Wood dealers are independent businesses that buy standing timber from landowners and contract with logging businesses to harvest and deliver wood to a processing facility (Flick 1985). The wood dealer traditionally assesses the standing timber's value and engages in negotiations for stumpage prices with landowners or places sealed bids for the timber. Furthermore, wood dealers negotiate delivered prices with mills or processing facilities (Conrad et al. 2018, Bowman et al. 2023). Distinguishing between logging businesses and wood dealers can pose challenges due to hybrid business units that function as both a logging business and a timber supplier, commonly referred to as a logger/supplier. A logger/supplier serves as a wood supplier and operates either with company logging crews or a combination of company and contract logging crews. For the purpose of this study, when referring to the businesses themselves, we will refer to these groups collectively as “wood suppliers”.

Administrative procedures

Administrative personnel within wood supplier businesses are responsible for gathering crew production documents, reconciling them with both company and mill data, creating logger and

landowner settlement documents, and facilitating payroll distribution. Monitoring production data primarily relies on two standard paper documents: load and scale tickets. Gate cards, also typically in paper form, serve as crucial documents in the load delivery process, as they inform mills about the individual tract details and location where the load was harvested. In cases where truck drivers deliver loads from multiple tracts, there is a risk of utilizing an incorrect gate card at a mill. This misstep can lead to compensating the wrong landowner, requiring additional administrative efforts to rectify these errors.

Operational challenges

Over the past two decades, numerous technological advances have resulted in increased wood supplier efficiency and productivity. For example, harvest operations exhibited rapid mechanization throughout the 1960's and 1970's (Silversides and Sundberg 1989; LeBel 1993; Conrad et al. 2018), resulting in a transition from a labor-intensive industry to a capital-intensive one. However, challenges with labor, fuel prices, and mill quotas have negatively impacted these wood suppliers' profitability and long-term sustainability (Conrad et al. 2024). Furthermore, the ongoing escalation of hauling costs, influenced by the surge in insurance premiums and fuel prices (Conrad 2022; Conrad et al. 2024), imposes strain on the transportation segment of the supply chain (Knight et al. 2024). These challenges are compounded by substantial capital costs incurred by wood suppliers. On average, a Georgia logging business has invested approximately $2.0 million[1] into their operation, while the corresponding figure in neighboring South Carolina is around $2.2 million (Conrad et al. 2018). Although technologies are available to assist in administrative and operational efficiency, wood suppliers have been slow to adopt them, perhaps due to a limited understanding of potential or perceived benefits or general aversion to technology. Thus, wood suppliers continue to grapple with coordination issues, logistical hurdles, and administrative inefficiencies, resulting in increased operational costs.

Technological innovation

Over the past decade, Georgia wood supplier labor productivity increased at an average annual rate of 1.6% per year (Conrad et al. 2024). This improvement partially offset increases in equipment and labor costs. Nonetheless, a published logging cost index witnessed a steady increase

[1] All monetary values are reported in United States dollars (USD).

from 2008 to 2020, averaging 2.6% annually, to $15.39 per tonne[2] in the 1st Quarter of 2020. However, unforeseen challenges with labor and supply chains, stemming from the COVID-19 pandemic, led to a substantial spike in logging costs. Over the subsequent two and one-half years, costs surged by 25%, reaching $19.18 per tonne in the 3rd Quarter of 2022 (Timber Mart-South 2023). Following this drastic rise, logging costs have returned to their pre-COVID-19 trajectory, growing at an annualized rate of 2.6%, settling at $19.82 per tonne in the 4th Quarter of 2023 (Timber Mart-South 2023).

Traditional administrative procedures have often relied on manual record-keeping, leading to errors, delays, and increased administrative overhead. Recognizing the need for innovative solutions, multiple companies have developed software solutions for the numerous administrative and logistics aspects of wood supplier business operations. Available software packages, appropriate for the southeastern U.S., that can streamline and enhance the management of wood supply chains by providing a comprehensive digital solution include Timber Resource Analytics and Contract Tracking (TRACT), Trimble's Log Inventory and Management System (LIMS), Caribou Software's Logger's Edge, and Legna Software's Angel. By automating key processes and providing real-time insights, these software systems have the potential to not only increase efficiency but also reduce the administrative burden on wood supply chain businesses.

The study

Widespread adoption of these software systems has the potential to reshape administrative processes, enhance operational efficiency, and mitigate challenges faced by logging businesses. Therefore, by implementing a case study to examine the experiences of TRACT (hereafter, the software) users and integrating their feedback, this study provides practical insights that can guide the further development and refinement of technology solutions tailored to the unique challenges of the wood supply chain. The study's primary objectives included documenting administrative procedures and costs among wood suppliers, quantifying the time and cost savings associated with software adoption on administrative and communications procedures, and identifying barriers to adoption for forestry logistics software.

[2] 1 Tonne = 1 Megagram

METHODS AND DATA

We employed an interview-based approach to investigate the dynamics of software utilization among wood suppliers, incorporating the collection and analysis of both quantitative and qualitative research within the questionnaires. Study participants were divided into two distinct groups: software users and non-software users. Each group was interviewed either in-person or over the phone. Independent questionnaires were developed for both groups combining both quantitative and open-ended questions.

Software user group

We obtained a list of 21 businesses actively utilizing the software analyzed in this case study from the owners. The 12 software-using businesses that participated in the study encompassed seven wood suppliers, four logger/suppliers, and one mill. These businesses operated in South Carolina, Georgia, Florida, North Carolina, Texas, Oklahoma, and Minnesota. Each business was solicited by phone for their participation in the study. Businesses that failed to respond following two outreach attempts were considered unresponsive and were subsequently excluded from the interview participation list. Twelve software users participated in the study. Six participants were interviewed in-person, with the remaining six interviews conducted over the telephone.

Non-software user group

To develop a comparative framework, we contacted 133 wood suppliers listed in either the Georgia or South Carolina wood supplier directories. We focused on this geographical region as that was where the majority of surveyed software users operated. Non-software users were defined as wood suppliers that did not use commercial wood flow management software. Ten non-software users participated in the study, with each interview conducted via telephone.

Questionnaire development

The software user questionnaire consisted of 43 questions and focused on detailed operational aspects of each business. This questionnaire included general demographics, administrative procedures, and specific details related to the use of the software and its perceived value to them. The non-software user questionnaire included 27 questions, designed to gather insights into the administrative aspects of businesses that did not use commercial wood flow management software. Twenty-three questions were identical on both the non-software and software user questionnaires.

Questions related to the usability and perceived value of the software were omitted from the non-software user questionnaire. Similarly, questions related to barriers of adoption were omitted from the software user questionnaire. Both questionnaires contained open-ended, closed-ended, and five-point Likert scale questions designed to collect data on the general demographics and administrative procedures of each company.

Data translation and monetary assessments

We translated time savings into monetary equivalents to provide a tangible framework for understanding the implications of software adoption. To do this, we standardized wage metrics, with an average wage of US$21.90 per hour for office and administrative support workers serving as the baseline (Bureau of Labor Statistics 2022). For forester-related time savings, we utilized the same methodology with an assumed annual salary of $70,000, reflecting an hourly rate of $33.65. This rate was determined through personal communication with existing businesses in the region about the compensation structure for foresters within wood supplier organizations. To further contextualize these savings, calculations factored in an average payload of 25.4 tonnes per load, allowing us to estimate cost savings per tonne of wood delivered through the implementation of software systems (Hamsley et al. 2007; Reddish et al. 2011; Conrad 2021).

RESULTS

Software and non-software user demographics

Seven (58%) of the interviewed software users operated in South Carolina or Georgia, with the remaining participants representing Florida, North Carolina, Texas, Oklahoma, or Minnesota. The interviews were conducted with nine administrative personnel, six owners, and six foresters. The reason for the higher number of personnel interviewed is that some companies include multiple participants in the interviews. The primary individual interviewed among the non-software participants was the owner. Of the suppliers contacted via the Georgia and South Carolina wood supplier directories to determine the non-software user group, 82% were either unresponsive, were not wood dealers (independent loggers), or had already used commercial wood flow software. On average, the software users interviewed had been in business for 20 years, while the non-software users had operated for 32 years (Table 1).

Table 1. Demographics of 12 software-using companies and 10 non-software-using companies that were interviewed. (Means did not differ significantly. Students t-test greater than 0.05).

	Software		Non-Software	
	Mean	Range	Mean	Range
Company time in business (yrs)	20	1-53	32	13-73
Number of logging crews	7	0-20	6	1-17
Trucks	25	1-53	19	5-60
Loads per week	353	32-875	260	33-825

Participating software users oversaw an average of seven logging crews and 25 trucks, producing an average of 353 loads per week while non-software-using businesses oversaw six logging crews and 19 trucks, with an average production of 260 loads per week. It appears that higher-production wood suppliers typically utilized wood flow management software, based upon average number of loads produced per week (Table 1). Additionally, companies that utilized fewer personnel tended to not utilize wood flow management software. The average number of employees reported by software-using businesses was 23, with an average estimated administrative cost of $106,591 per year or $0.23 per tonne (Table 2).

Table 2. Percentage of times a task was reported as one of the top three tasks conducted by administrative staff for software users vs non-software users.

Software Users			Non-Software Users		
Rank	Task	% of Responses	Rank	Task	% of Responses
1	Reconciliation	30%	1	Reconciliation	30%
2	Ticket entry	27%	2	Settlements	26%
3	Payroll	17%	3	Contracts	9%
4	Settlements	10%	3	Stumpage	9%
5	Accounting	7%	4	Ticket entry	4%
6	Job status	3%	4	Buying wood	4%
6	Fuel sheets	3%	4	Paying loans	4%
6	Quotas	3%	4	Communication	4%

Non-software-using businesses averaged nine employees and estimated their average administrative cost at $48,438 per year or $0.14 per tonne (Table 2). However, non-software users often relied on the owner or the owner's spouse to perform administrative tasks and did not consider the monetary value of the owner or spouse's time in their estimates. Coverage radius refers to the extent of a wood supplier's reach or boundary within which they can effectively

harvest, transport, and deliver timber products to processing facilities. One of the software-using businesses had an exceptionally large coverage radius. When including this company in the coverage area comparison, software users had an average coverage area of 177 km while non-software user's coverage area was 117.5 km. When excluding the referenced company from the comparison, the average software user coverage area reduced to 137.9 km. Even without this company included, software users had a larger working area than non-software businesses.

Software users participating in the study had utilized the software for an average of 2.3 years. The primary channels through which companies became aware of the software were personal interactions with sales representatives and, to a lesser extent, internet searches (Figure 1).

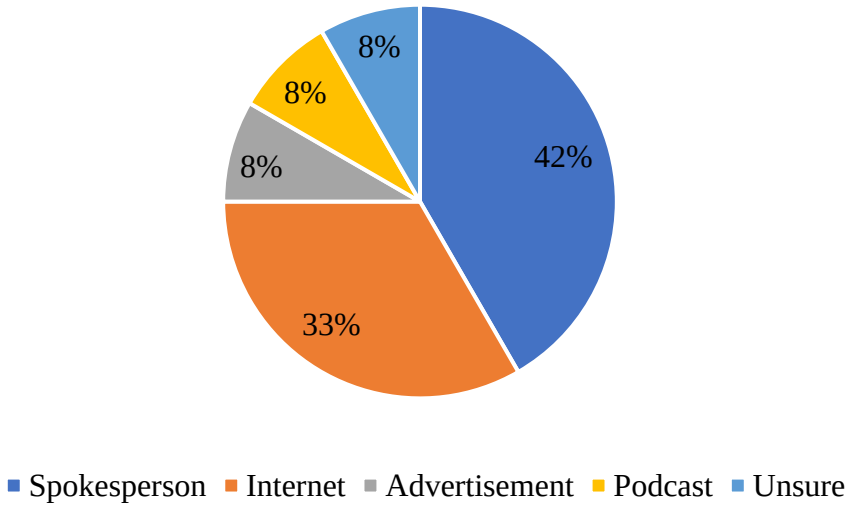

Figure 1. How the 12 software-using companies learned about the software. Note: percentages may not add up to 100% due to rounding.

Adoption drivers varied, with 67% of companies embracing software for streamlined data management and enhanced data sharing. Additionally, 25% of the interviewed companies cited dissatisfaction with their prior wood flow management software as a motivator for adopting the software. Notably, half of the companies reported that the software was predominantly utilized by their administrative personnel.

Non-software users were asked about their awareness of wood flow management software, with 50% acknowledging they were aware of the software studied. However, 30% expressed concerns about the software's perceived expense. Another 30% of non-software users cited age-related concerns, expressing reluctance to learn new software. An additional 20% of respondents did not

see the value in wood flow management software, while the remaining 20% were actively considering the software system studied and other wood flow management software. Surprisingly, 80% of non-software users reported being comfortable with technology, including smartphones, iPads, and web applications, indicating that technological proficiency was not a substantial barrier to adoption. Notably, the two highest production wood suppliers within the non-software user category were considering adoption of wood flow management software.

Data management and administrative procedures

Almost all (95%) study participants reported labor as their largest annual administrative cost. Software users reported that their administrative staff dedicated an average of 3.4 hours per week to relaying harvest-specific information to foresters, while non-software users spent 10.6 hours per week on this task, resulting in a substantial time savings of 7.2 hours per week for software users (Figure 2).

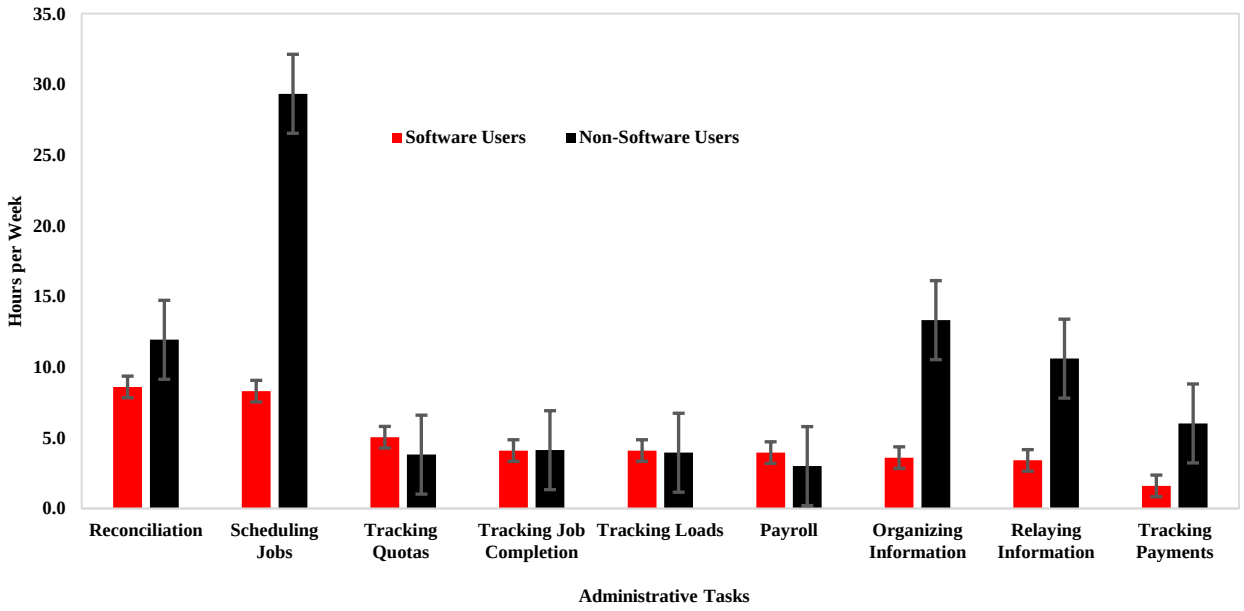

Figure 2. The average time it takes software users compared to non-software users to complete key weekly tasks. Note: some of the companies were unsure of the time it takes to complete some of the tasks, so they were not able to answer the question.

On average, software users allocated 39.3 hours per week to eight administrative tasks, while non-software users spent 75.3 hours per week on those same activities (Figure 2). Thus, software users spend an average of 36 hours less per week on these eight administrative tasks than their non-software counterparts. Assuming an administrative support worker's rate of $21.90 per hour (BLS 2022), software users spend $8,199 less annually on employee time devoted to conveying harvest-specific information to foresters than non-software users (Figure 3). Converting the weekly time spent on administrative tasks into annual monetary values, considering a wage of $33.65 per hour for forester tasks and the Bureau of Labor Statistics (BLS) hourly wage for administrative personnel, reveals that software users spend $54,069 less annually on the eight additional administrative tasks compared to non-software users (Figure 3). The combined time and monetary savings from both relaying information and the administrative tasks culminates in 43.2 fewer hours per week or $62,268 per year.

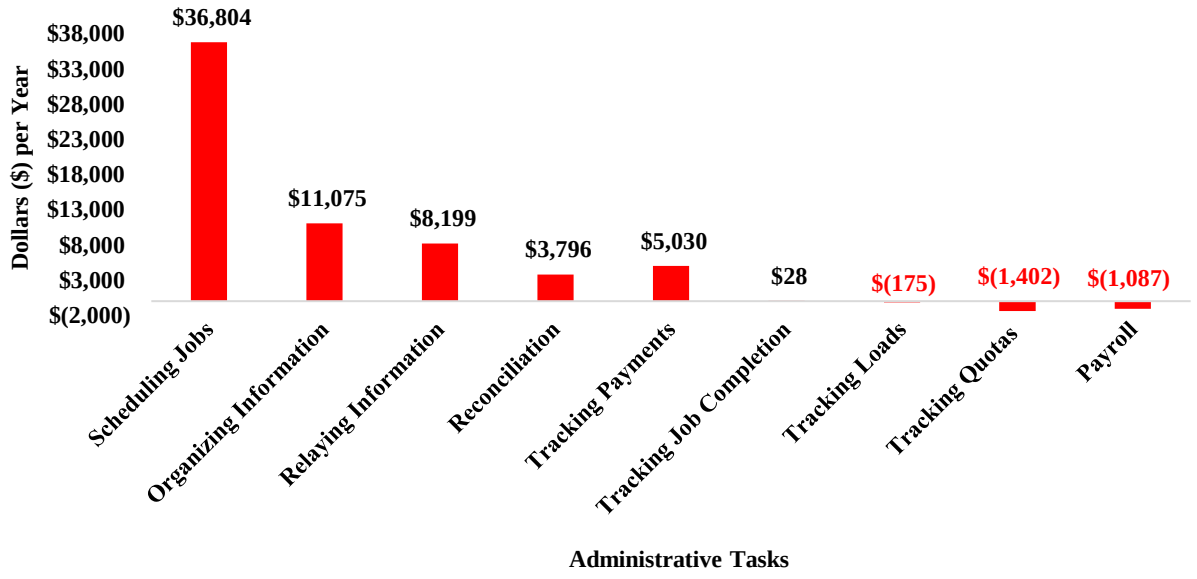

Figure 3. Monetary gains for software users based upon the difference in time reported for key weekly tasks.

A notable strength of software users was the robustness of their system for organizing typical business and job-specific information. This observation aligns with our finding that software users demonstrated significant time savings in scheduling jobs and organizing information (Figure 2). Interestingly, non-software users reported a higher propensity for business and operation management challenges, whereas staffing and labor was the dominant challenge for software users (Figure 4).

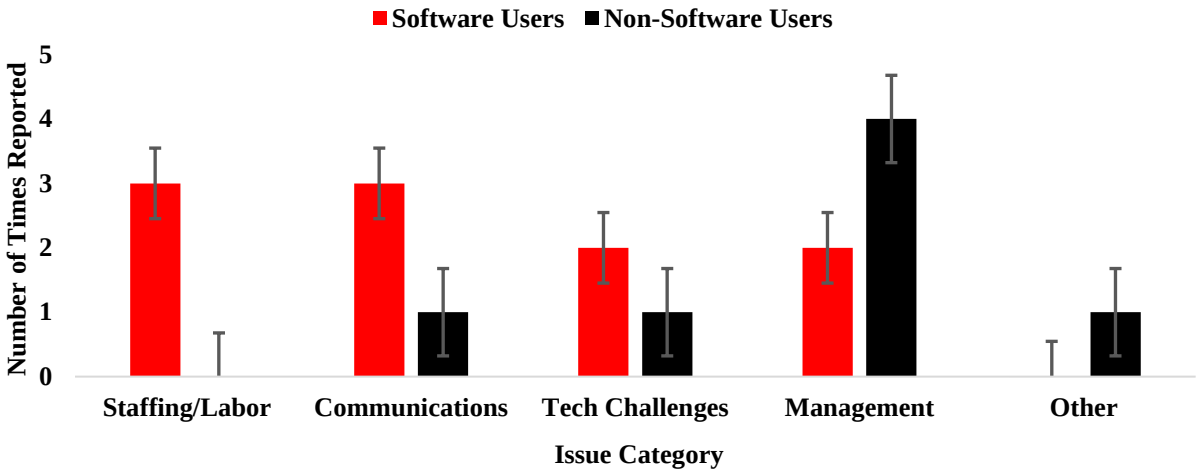

Figure 4. Categorized responses from 10 software-using companies and seven non-software using companies to the question "What is the primary challenge faced by your administrative staff?"

When asked about the top tasks completed weekly by administrative personnel, both software and non-software users cited load and scale ticket reconciliation as a major task (Table 2). Non-software users mentioned additional tasks such as contracts, paying loans, and communication. These tasks can be optimized by using software systems, as these software systems are designed to streamline various administrative tasks.

Despite the software company's introduction of a loader application to reduce reliance on paper load tickets, 66% of software users still utilized paper tickets. This reliance on a physical ticketing system contributes to instances where tickets can be misplaced due to the multistep process involved in delivering them to administrative personnel. Software users reported an average of 1.2 load tickets and 0.5 scale tickets misplaced or lost per thousand loads of timber delivered. By comparison, non-software users reported 0.9 load tickets and 0.5 scale tickets misplaced or lost per thousand loads delivered (Figure 5).

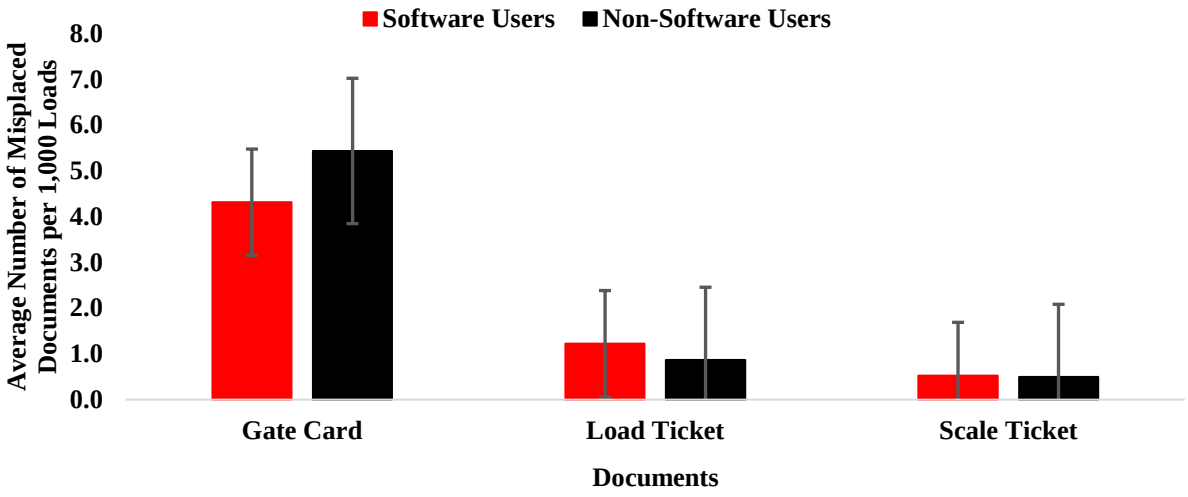

Figure 5. The average number of tickets and gate cards lost, misplaced, or incorrectly used by 12 software and 10 non-software using companies on a per thousand load basis.

Both groups indicated that misplaced or lost tickets were more commonly delayed in delivery rather than permanently lost, as the missing information could usually be recovered by coordinating with the logging crew or the mill. Factors contributing to misplaced or lost tickets included poor data management by the loader operator and departures of truck drivers from the company.

The use of incorrect gate cards at mills is another consequence of the paper system. Software users reported an average of 4.3 incorrect gate card usages per thousand loads delivered, while non-software users reported 5.4 incorrect gate card usages per thousand loads delivered, indicating a 20.4% reduction in gate card issues for software users (Figure 5). Due to the low utilization percentage of the software's loader app, these results, along with the load and scale ticket results, may not be related to the use of the software but may be tied to the use of the paper system. However, the noticeable reduction in gate card issues among software users might be attributed to the software users' enhanced operational and business management organization (Figure 4). As indicated previously, software users exhibited significant time savings relate to job scheduling and information organization (Figure 2), supporting the idea that software systems may increase organizational practices related to harvest sites and corresponding gate cards.

The issue of incorrect gate card usage poses challenges for administrative staff processing load and scale tickets, as using the wrong gate card can result in incorrect information on the scale

ticket, requiring significant administrative time and resources for correction. Software users reported an average of 6.7 hours per incident of administrative time to rectify the use of incorrect gate cards, while non-software users reported 2.5 hours per incident to address errors. However, one of the software-using businesses reported an exceptionally large amount of time to rectify incorrect gate card usage issues, compared to the other respondents. When excluding this company from the comparison, software users had an average reported time of 3.5 hours per incident.

Participants from both software and non-software groups were asked to subjectively rate the cost of various common administrative tasks, considering staff time and associated expenses. A significant percentage of software users indicated that they perceived accounting and settlements as "high" or "very high" in terms of resource intensity (Figure 6).

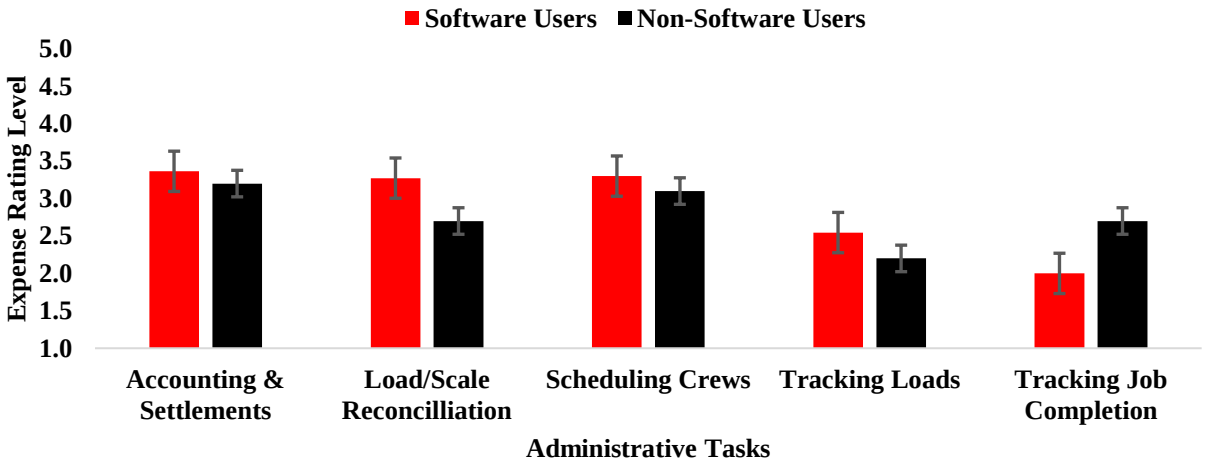

Figure 6. The average perceived expense rating (1 lowest - 5 highest) software and non-software users indicated for administrative tasks (accounting for staff time and associated expenses).

Conversely, more non-software users reported perceiving accounting and settlements as "low" or "very low" in terms of resource intensity, contrasting with the assessments from software users. Non-software users considered several common administrative tasks to be less resource-intensive compared to users. These tasks included accounting and settlements, load and scale ticket reconciliation, scheduling crews, and tracking loads. However, based on our analysis, non-software users were actually spending more time and resources on most of the specific administrative tasks analyzed. This could indicate that the non-software users had a misconception of the costs associated with these tasks. Additionally, as mentioned earlier, non-software

disproportionately utilized owner and spouse time to handle administrative procedures and did not consider the cost of their own time. This may explain the lower perceived resource intensity on administrative tasks for the businesses.

Software usability perceptions

The majority of software users expressed that the software saved them time in completing administrative tasks, enabling more efficient task reallocation. One participant even reported expanding production capabilities due to software use. Companies self-reported an average time savings of 18.5 hours per week on administrative tasks, equivalent to almost half of a full-time administrative personnel position, resulting in a cost reduction of $21,060 per year. Considering the average loads per week produced by each software customer, the savings amount to $0.04 per tonne. A notable 67% of software users reported that the benefits far exceeded the costs (Figure 7).

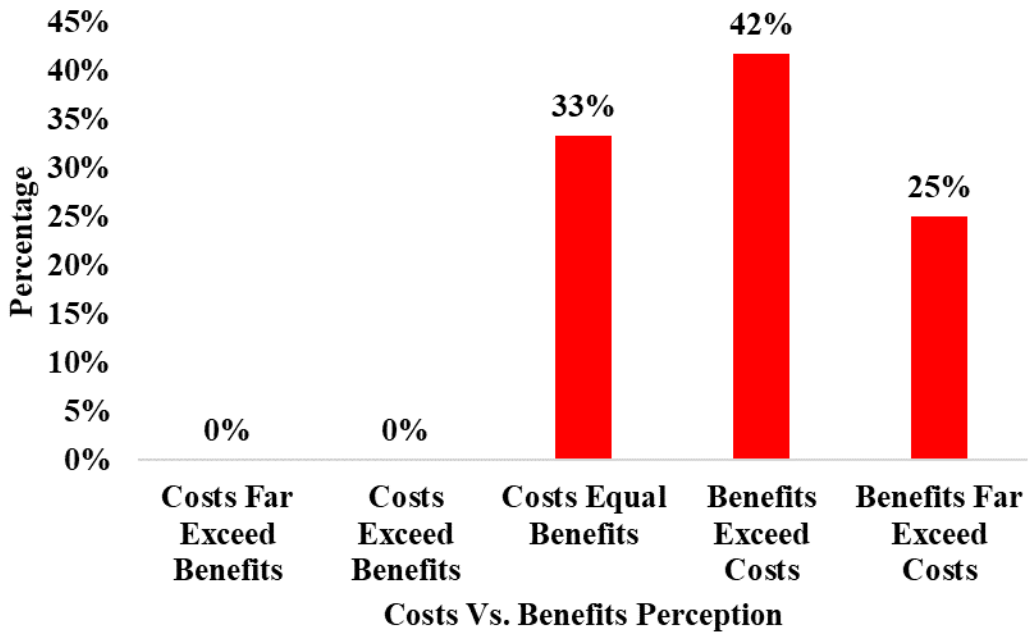

Figure 7. Software users' perception on how the costs and benefits from using the software compare.

Overall, software users perceive it as helpful software that has positively impacted their business. All participants affirmed that software use had made an improvement, with 25% citing enhanced credibility with clients, 25% reporting improved data-driven decision-making, and 17% noting time savings on administrative tasks. When asked if software use allowed for personnel reduction or reassignment, half of participants responded "no," 42% responded "yes," and the rest were

unsure. The majority reported seeing improvement in their business in less than three months, with 33% seeing improvement in less than one month (Figure 8).

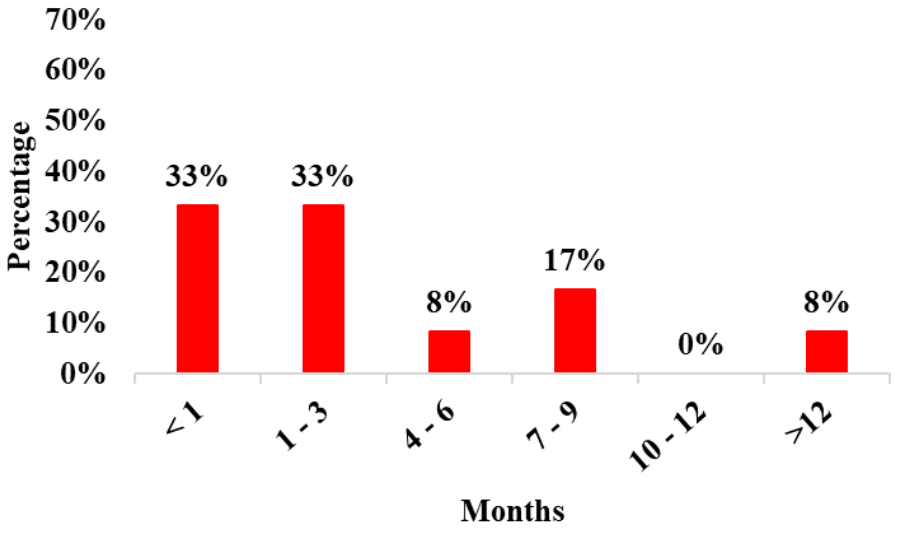

Figure 8. The amount of time (months) it took each software-using company to see improvement. Note: percentages may not add up to 100% due to rounding.

While primarily used by administrative personnel, 25% of companies reported software being utilized by all employee types. Each software-using company reported improved efficiency of all major employee types, except for two companies that reported a decrease in logger efficiency due to challenges in using the loader app. When software users ranked specific features, 64% highlighted that the accounting and settlements feature "significantly increased" their efficiency, and 50% noted the same for the job management feature (Figure 9). During the interview process, non-software users were also asked to provide their reason for not implementing wood flow logistics software. The responses to these questions indicated price and resistance to learning new technology as primary barriers to utilization.

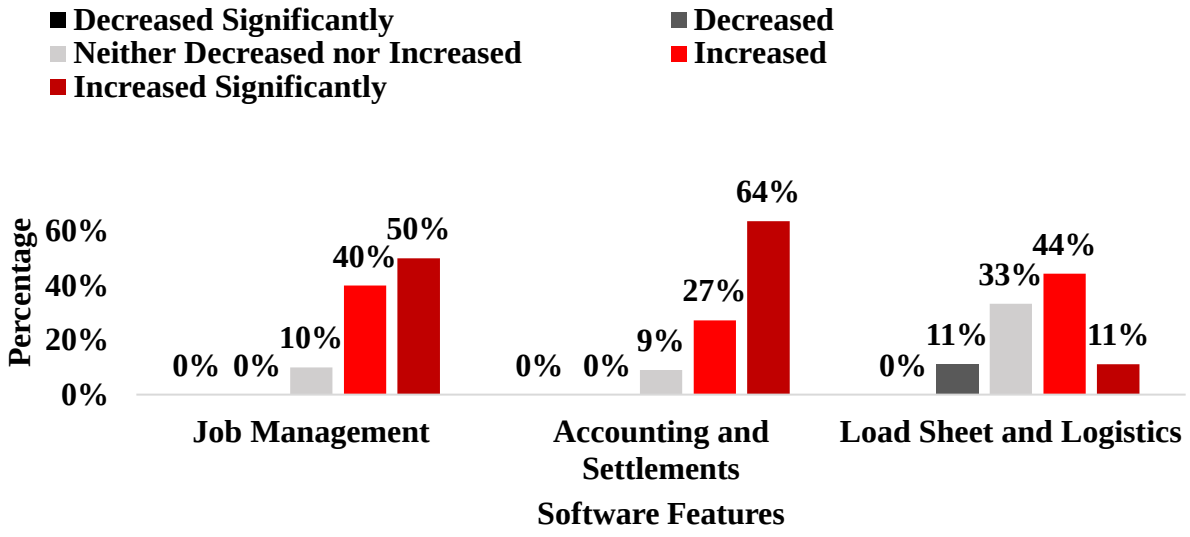

Figure 9. Software users ranking how software features have impacted the efficiency of the company. Note: percentages may not add up to 100% due to rounding.

Participants rated the usability of three software features, with the majority ranking each feature as either "very easy" or "easy" (Figure 10).

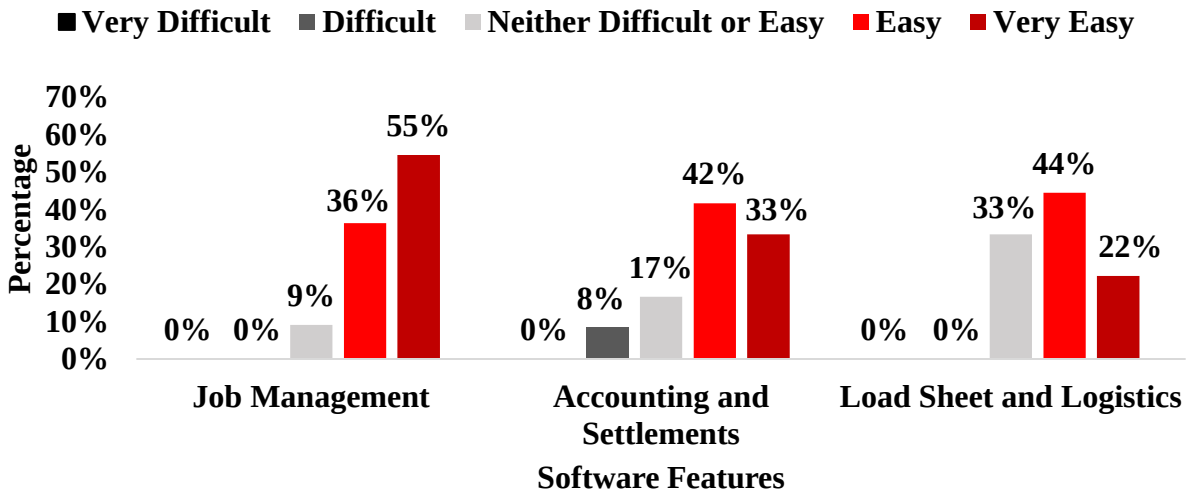

Figure 10. Software users ranking the usability of software features. Note: percentages may not add up to 100% due to rounding.

It took administrative staff an average of 7.5 weeks, foresters 6.1 weeks, and loggers 2.8 weeks to become proficient using the software. However, only four companies reported the time taken for loggers to become proficient. Administrative personnel and foresters took longer, as their tasks were more complex. Issues with loggers' technological savviness were reported by 58% of

companies, causing challenges during software adoption. The authors reiterate that these results are based upon a case study analysis.

DISCUSSION AND CONCLUSIONS

Existing literature indicates that the primary obstacles encountered by the U.S. logging sector over the past two to three decades involve structural deficiencies in logging labor availability and escalating operational expenditures (He et al. 2021). By addressing existing gaps in the literature and building upon previous research on efficiency in wood supply chains, this study contributes to the knowledge base essential for informed decision-making in the sector. Several studies have evaluated operational efficiency among wood supplier businesses (e.g., Greene et al. 2004; Conrad et al. 2017; Francis and Visser 2017); however, these studies have not investigated administrative practices, overhead costs, and the implications of wood flow logistics software.

The primary barriers to implementing wood flow logistics software for non-software users were price and resistance to learning new technology as primary barriers to utilization. These results mirror a broader issue within the forest industry with a general resistance to or slow acceptance of technological adaptation (Bettinger et al. 2023). It is possible that the lack of succession planning in wood supplier businesses could impact businesses' willingness to adopt new technologies. A recent study indicated that 31% of Georgia logging business owners and 38% of Florida logging business owners plan to exit the industry between 2022 and 2027. In both states, logging business owners that planned to continue operating exhibited a 65% higher production level than those who planned to exit (Conrad et al. 2024). Further research may be able to address this hypothesis and identify productive means to encourage adoption of new technology in the logging and wood supplier sectors. Moreover, according to Fleming et al. (2018), larger organizations could be more adept at adopting new digital technologies. This advantage stems from their capability to manage initial acquisition and training costs efficiently, along with having personnel possessing expertise to swiftly integrate novel technologies into their organizational framework. This supports our observation that software-using businesses exhibited higher production levels and had a greater number of employees, on average, compared to non-software users. Additionally, the two highest producing non-software-using companies were the ones considering adopting wood flow

management software to assist with business operations. We hypothesize that this may be due to company complexity. The larger the wood supplier, the more information is generated that needs to be organized, disseminated, and reported to multiple individuals within a company. It is noteworthy that a large percentage of software users indicated that they perceived accounting and settlements as “high” or “very high” in terms of resource intensity, compared to non-software users reported perceiving accounting and settlements as "low" or "very low" in terms of resource intensity. This could indicate that software users place a greater emphasis on accounting and business financials than non-software users. Finally, upfront costs were observed as a significant hinderance from utilization of wood flow logistics software. Participants were reluctant to divert capital to a product where they did not foresee quantitative and tangible value. Developers may be able to address this issue through the implementation of a trial period for evaluating the software before committing to a purchase.

In response to the heightened awareness of ethical and sustainable considerations by customers, an increasing emphasis has been placed on ecological sustainability within production processes (Dabbene et al. 2014; Gualandris et al. 2015). Blockchain technology has emerged as a preferred solution to combat information asymmetry during the tracking of goods across various actors within the supply chain (Francisco and Swanson 2018). Traditionally, traceability in forestry relied on paper-based systems; however, the need to curb illegal logging and deforestation in the face of globalization has spurred the adoption of digital approaches (Stopfer et al. 2024). Existing digital solutions often focus on direct trading partners within the supply chain, but a comprehensive and standardized approach necessitates the entry of a uniquely identifiable wood unit into a tamper-proof database, ensuring that virtual data aligns with the actual flow of goods (Kaulen et al. 2023). The software discussed in this study and its counterparts represent a significant step towards this comprehensive system. This specific software and potentially others have the ability to track and trace all loads processed with a geo-stamp and timestamp from the load’s origination point to the delivery facility. Additionally, the system can geo-fence loads and prevent them from being entered on the incorrect job site, reducing the potential for error and illegal logging. These technologies are crucial for the forest industry’s ability to provide certification data to organizations like the EU’s Deforestation Regulation (Regulation (EU) 2023/1115). While these current software systems do not allow detailed tracking through to finished wood products, they

do provide tracking from the mills back to the point of origin. Additional research is needed to identify means to improve adoption and full implementation of these technologies.

While this research holds significant implications for both the forest industry and the broader field of technology adoption in supply chain management, the study does have some limitations. First, the sample size for the survey was relatively small, encompassing only 21 wood suppliers. Second, the interviews were primarily conducted in two southern states: Georgia and South Carolina. Finally, the interviews only collected data during a short period of time. This can cause variation in data reporting based on several factors such as economic conditions, weather, etc. However, the interviews for both software users and non-users were spread out over a series of weeks. This, along with the geographic variability of the study participants would mitigate the impact of weather, markets, and other factors. We believe it is important to note that non-software users often relied on the owner and the owner's spouse to handle a majority of administrative tasks. During the interviews, owners of non-software-using companies did not seem to consider the monetary value associated with their own or their spouse's time. This contrasts with their evaluation of their employees' time, which might explain the observed disparity between the quantitative time data in Figure 2 and participants' subjective cost estimation ratings. Additional research could address these concerns and help provide an understanding of the tangible benefits of wood flow logistics software, potentially impacting industry practices and improving operational efficiencies. By streamlining workflow management, these software systems can help ensure sustainability and global competitiveness in the evolving timber industry.

CONFLICTS OF INTEREST

The authors confirm there are no conflicts of interest.

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