Mistra Digital Forest

Digital Transformation of the Swedish Forestry Value chain: Key Bottlenecks and Pathways Forward

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Abstract

The purpose of this report is to investigate the dynamics of digitalizing the Swedish forestry value chain. Specifically, we investigate the information flows in the Swedish forestry value chain, and the new value creation opportunities associated with an integrated end-to-end digital information flow across the value chain. While the digital transformation of traditional forestry value chain processes towards a digital value chain may enable firms to establish a competitive market position, digital transformation is also associated with a series of challenges. Based on an interview study with 16 respondents from firms across the forestry value chain, we posit that while the traditional value chain works well, the digital value chain is fragmented. The results also demonstrate how the interest in digitalization and AI is huge, but the digital transformation processes have barely begun. A key concern among all respondents is that the data sets used by each firm are limited and not shared between the firms throughout the value chain. Specifically, the results illustrate four major bottlenecks the forestry industry is facing: 1. The level of digital maturity is varied, 2. the supply/demand chain is broken, 3. The level of digital competence is low, and 4. The level of service innovation is low. Moreover, we identify four key areas with respect to possible pathways forward: 1. strategies for boosting digital maturity, 2. from supply chains to ecosystems, 3. programs for improving digital competence, and 4. approaches for identifying opportunities for service innovation.

Introduction

Organizations in all industries find themselves at a transition point because of the rapid emergence of disruptive digital technologies (see e.g. Yoo et al., 2012; Jonsson et al., 2018; Westergren et al., 2019). As a consequence, business models and organizing models are challenged or fundamentally changed by the nature of digital innovation (Nambisan et al., 2017; Holmström, 2018) and there is widespread recognition that investing in digitization in general and artificial intelligence (AI) in particular drives transformation in today's organizations (Brynjolfsson and McAfee, 2014). But while contemporary firms are increasingly dependent on digital technologies, digital transformation is a challenging venture as it requires both technical knowledge combined with contextual knowledge of the business environment (Nylen and Holmström, 2019). Contemporary firms typically fall into the trap of assessing digital technologies too narrowly and are thus unable to see its impact on business goals (Nylen and Holmström, 2015). Recent research suggests how only a small minority of all firms manage to fully embrace digital technologies to better pursue business goals (Kane, 2016; Bughin et al., 2018). As such, while firms in most industries see digitalization as a priority in their operations, it is often a challenge to embrace digital technologies and it is therefore critical to explore what bottlenecks there are in digital transformation efforts.

It is well established that digital technologies may enable firms to become more responsive and agile by leveraging today's fluid forms of information (Kallinikos et al., 2013). But while digitizing value chains provide new ways of reaching goals, only a small fraction of the interactions in value chains are digitized (Nylen and Holmström, 2011). As such, more must be made to help firms to embrace the new logics associated with digital technologies (Markovitch & Willmott, 2014). The major bottlenecks do not seem to be associated with digital technology per se but rather the knowledge of how to navigate in the new business environment using digital technology (Manyika & McAfee, 2014).

Successful use of digital technologies and AI demands active attention to digital transformation. The forestry industry is lagging behind in digital transformation but changes to the traditional value chain triggered by emerging digital technology have started to emerge recently (Nylen and Holmström, 2011; Borz et al., 2017). Indeed, the forestry industry has unique challenges to overcome as forests are typically located in remote places and spans across of huge land masses. Digital transformation in the forestry industry is hampered by a lack of understanding of how to extract value from digitalization, and while there are examples of digitally empowered processes they are few, and in-house digital competence is often lacking (Nylen and Holmström, 2011).

To make informed decisions, managers require access to real-time data on their supply chain; however, the limitations of legacy technologies typically hinder end-to-end transparency (Borz et al., 2017; Lyall et al., 2018). New digital technologies, including AI, have the potential to disrupt traditional value chains and change how firms in the forestry industry collaborate. Against this backdrop this research aims to explore what bottlenecks exist in the Swedish forestry industry and what can be done to address these bottlenecks. This report aims to answer the research question: *What characterizes the current information flows in the Swedish forestry value chain, and what are the new value creation opportunities associated with an integrated end-to-end digital information flow across the value chain?*

The remainder of the report is as follows: We begin by presenting insights from the literature, specifically the key challenges and opportunities associated with digitalization of value chains, with a particular emphasis on the enabling role of digital technologies. After presenting the research method behind the report we present evidence from the case study of how firms in the forestry value chain are working towards digitalization of the value chain. In the discussion section we articulate the major bottlenecks the forestry industry is facing, and we point at pathways forward to address these bottlenecks.

Digitalizing Value Chains: State of the art

It is widely accepted that a firm must continuously innovate to develop new capabilities without jeopardizing existing processes (Svahn et al., 2017). However, organizational structures can prevent innovation by causing frustration through efforts to transform the firm (Gharajedaghi, 2011). As such, firms in all industries invest heavily in digital

resources to create a strategic competitive advantage (Alavi & Leidner, 2001; Sambamurthy et al., 2003). Consistent with the notion that transformation leads to increased strategic business performance (Fiol & Lyles, 1985), firms need to develop transformational capabilities that go beyond implementing processes that are sufficient to facilitate digital strategies (Arvidsson et al., 2014).

The management of digital technologies in large firms often involves managers facing complex challenges, including responding to dynamic environments, designing performance measures that reflect time-to-market pressures, synchronizing and stabilizing development, and improving software processes (Napier et al., 2011). A dominant way in framing the value creation of any organizational transformation is to frame the organizing processes as a value chain. According to Porter (2008), one important purpose of a strategic analysis is to better manage linkages between buyers and suppliers in the value chain. A value chain is defined as "the linked set of value-creating activities all the way from basic raw material sources for component suppliers through the ultimate end-use product delivered into the final customers' hands" (Shank, 1989, p. 50). As such, different types of linkages can be distinguished in a value chain: relationships between activities, relationships between units of the firm, and relationships between the firm and its buyers and suppliers (Porter, 2008). This last type of relationship, referred to as 'vertical linkages' in the supply chain, deals with how a firm's internal value chain is related to those of its buyers and suppliers. A linkage exists when there is a certain degree of interdependence between activities, something which needs to be managed by coordination mechanisms in order to achieve efficient and effective outcomes.

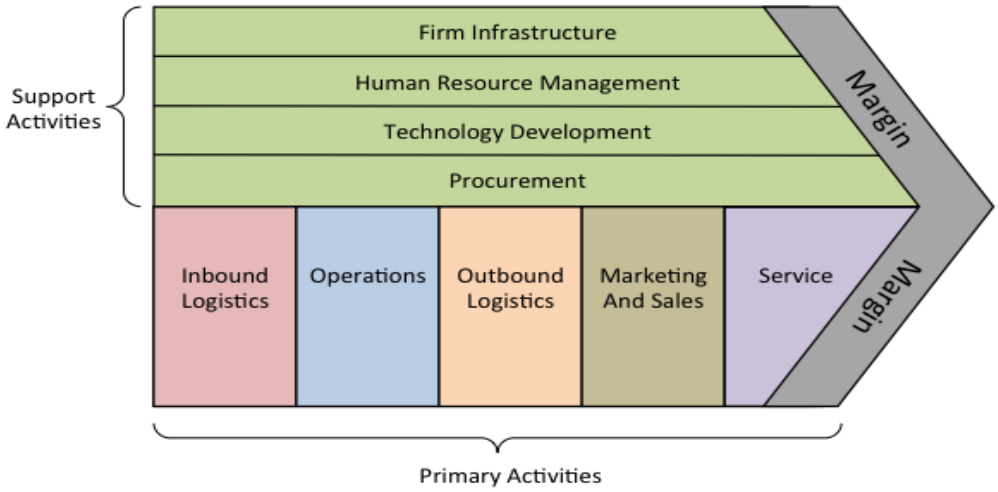

Figure 1: Value chain components

However, there is little research that explicates how a firm can tackle the digitization of value chains. Existing research mainly focus on the benefits of creating such a composition or technologies that can enable more digital communication. Digitization often transcends

organizational lines and changes thus typically transcends into several business operations (Bharadwaj et al., 2013) which creates a complex environment for managers to navigate in. There is a gap in the literature as it fails to provide firms with solid advice of how to start engaging in digital transformation. It is therefore important to gain knowledge of digital transformation, how firms should engage in digital transformation and also how to overcome challenges associated with digital transformation.

Research Method

In this study, a qualitative case study design was used to investigate the digitization of the Swedish forestry value chain. Qualitative methods are widely used to comprehend people's actions and dialogs as well as the contexts in which critical decisions are made (Myers, 2009). This research was designed as an embedded case study that was conducted together with the participating firms. The case study method has proven effective in researching complex social phenomena, including distinct life cycles, actions by small groups, and organizational processes (Yin, 2003). The case-study method allows us to capture complexity, and the engaged scholarship model provides rich insights into the design, data collection, and analysis of the cases being examined (Van de Ven, 2007). Case studies are ideally suited to explore complex changes such as the disruptive changes caused by digital innovations. Hence, the case study is an ideal methodology for studying the phenomenon of disruption facilitated by IT (Besson & Rowe, 2012).

The case study method creates the opportunity to understand the complexity and dynamic nature of the context within which the events occur (Van de Ven, 2007). The continuous access to the research setting and participants, facilitated by Mistra Digital Forest, provided the researcher with extensive data on key events. The research utilized a qualitative case study approach in which semi-structured interviews served as the primary sources of data. A total of 16 Interviews (with respondents named as respondent A-P in the report) were conducted with individuals in varying roles and at varied hierarchical levels in a number of firms in the forestry industry. The diversity of the participants provided several important perspectives. A case study protocol that contained an interview guide, procedures, and general rules (Yin, 2003) was developed. The literature on value chains guided the development of questions that were designed to reveal how the learning process was manifested in the organization. As recommended by Yin (2003), the data collection plan was drawn from multiple sources, including archival data, project progress reports, process documentation, and interviews with project team members and leaders. Interviews were audio recorded for data collection and referenced during the data analysis.

The data analysis was an iterative process of theoretical interpretation and data examination. In alignment with Klein and Myers (1999), the data analysis utilized dialogical reasoning combined with the prior research literature. The identification of key

concepts, organizational processes, and relationships was the focus of the data analysis. The utilization of dialogical reasoning facilitated the emergence of new insights and themes.

It is recommended that in qualitative research, the data analysis be executed in parallel with the data collection (Mason, 2002). As such, the data analysis occurred in multiple iterations, resulting in numerous opportunities to evaluate the plausibility of the results. During the initial iteration, the goal of the data analysis was to understand the experiences of the participants, define relationships, and uncover pattern sequences in the data. The subsequent phase involved multiple reviews of the consistency of the findings that emerged from the iterations of the data analysis.

Digitalization of the Swedish forestry value chain: Key Bottlenecks

The study of digitization in the Swedish forestry industry led to the identification of four key bottlenecks: 1. The level of digital maturity is varied; 2. the supply/demand chain is broken, 3. the level of digital competence is low; and 4. the level of service innovation is low. In what follows each bottleneck will be discussed in detail.

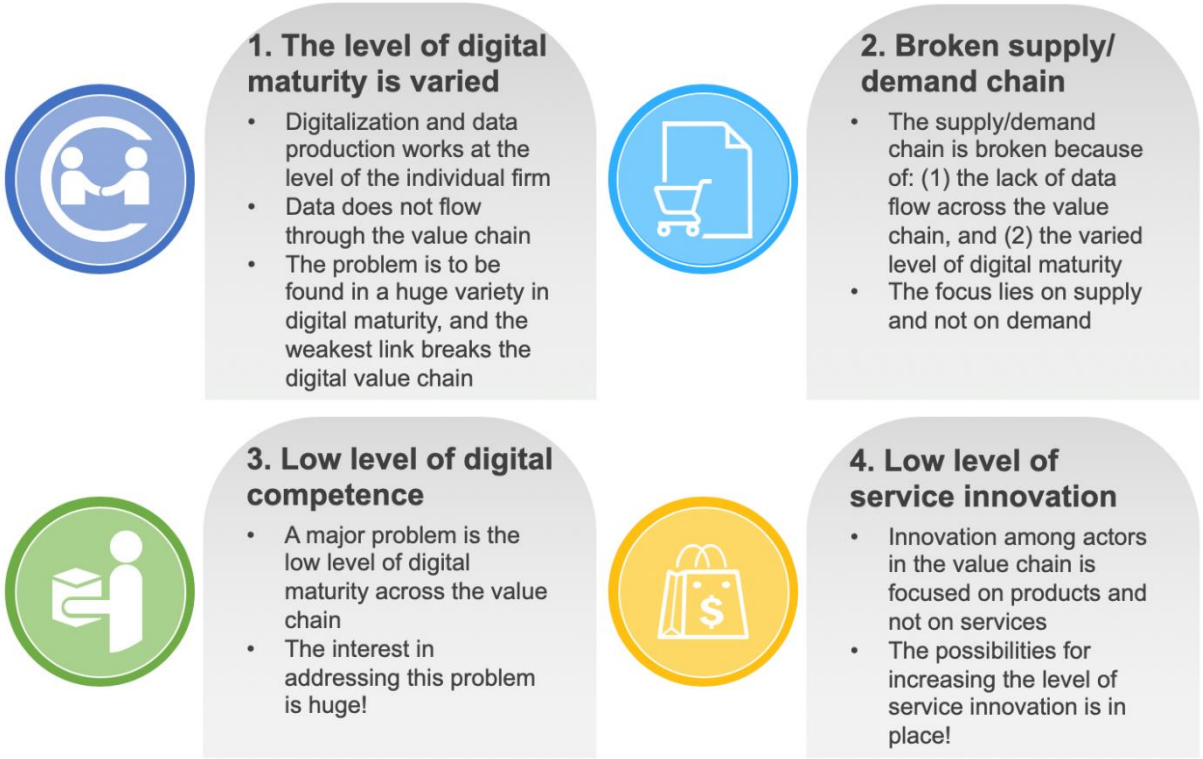

Figure 2: Four key bottlenecks in the digitization of the Swedish forestry value chain

Bottleneck 1: The Level of Digital Maturity is Varied

The first bottleneck identified in the study is that the level of digital maturity is varied. The variety is problematic since the weakest link inevitably will break the digital value chain. Our interviews found that there are good examples of digitization at the level of the individual firm, but the flow of data throughout the digital value chain is "nobody's responsibility and everybody's problem" as respondent E phrased it.

The use of digital technologies is seen as highly important for all respondents and the respondents express how they are all actively on the lookout for new technological breakthroughs through assessing a broad array of emerging digital technologies. For instance, the respondents expressed that an exciting opportunity lies in increasing the quality of forest scans. This particular opportunity is seen as an important step in the digitalization by the harvesting companies. The value from such digitization would come from being able to build on digital data instead of continuously controlling data through manual processes, and thus creating a clearer picture of details in their respective forests by the digital representation of what they can offer to their customers. The most prominent change associated with the increased quality of forest scans is how the stakeholders involved in the process will be able to trust the digital information, making the individual firms less dependent on manual processes in managing their product portfolio, and optimizing the way they can harvest their respective forests towards orders. Many respondents note that other firms in the forest harvesting industry share the same problems, making them interested in similar technologies and solutions.

Our interviews also demonstrate how firms along the value chain in the Swedish forestry industry are positive to airborne laser scans as a data collection method. It in its final steps in developing a working solution, allowing the industry to rely more on digital data that will be continuously updated. The strength of this new method lies in improving the quality of mapping the forests, making it possible to improve the knowledge of what is in their forests such as tree kinds and easier detection of dead trees and of areas where trees do not grow (such as wetlands). However, some respondents note that they will still continue to manually control the data as some destructive elements are not visible in the scans making it dangerous to fully rely on the new data. Furthermore, one respondent note that it is a big step as the industry currently cannot tell if the laser scanned forest data will be updated, making it a worthwhile investment to further development and can be relied on in the long term.

> *"It is not that it measures more precisely than before, it is that you can start depending on it. It means that the industry is turning towards trusting that this data generation will continue."* [Respondent E]

The harvesting respondent explained that many of the opportunities associated with the new data collection method is not fully developed yet and thus firms will have to work with this new format as they did with their previous data collection methods. This includes having manual data gathering processes to ensure the quality, as respondent H note "you cannot fully rely on the digital scanned data from the start." But the respondent also noted that in the future other opportunities may emerge as firms will put effort in making the data collection and processing better.

The firms interviewed for the report found it challenging to get an elaborate view of the forest areas by only using digital information and found it necessary to complement the digital information with manual processes that serve as a backup to the digital information. Having said this, all respondents explained that there are several plans in motion to become less dependent on manual processes in the data gathering phase. The quality of the data from digital technologies is today too low to rely on, but the firms expect continuous improvements in the digital data quality in the years to come.

In some instances, the respondents expressed the need to "not fall behind" when it comes to digitalization as it is seen as an increasingly important cornerstone for firm operations in both increasing customer value and optimizing key processes. Some respondents expressed that their current digital strategy involved exploring possibilities of many different digital technologies as they can prove to be vital for the future. But the respondents also expressed a need to funnel their resources into a smaller number of digital technologies as their resources are to sparsely deployed today. However, this is expressed as a problematic choice to make and requires a high level of expertise on the different opportunities associated with different digital technologies.

Although interests in AI and engagement in digital transformation is a consistent theme in the interviews, the respondents have experienced little direct value in AI, which might result in slowing down the digital transformation process as it requires the organizations to invest in both assimilating critical knowledge as well as adapting current processes with a new and complex type of technology. It is a bottleneck to not see the value propositions following the use of AI, and investing resources right now does not imply a direct value. The firms expressed a need to see real-life value deriving from AI in the digital ventures for commitment and today such understanding is lacking.

In sum, digitalization requires changes in many different areas that has previously been more separate and thus creating a reality where firms need to assimilate new knowledge as to how digital transformation will evolve and how it affects firms in many dimensions.

This boils down to that digital transformation often requires changes of a magnitude that can challenge current structures and operations, and the fact that the digital maturity is varied throughout the value chain is a key bottleneck. The interest in engagement in digital transformation is evident from all interviews, but many respondents imply that the journey is uncertain and we can observe different levels of maturity. The varied digital maturity is observed not only between firms but also within single firms.

Bottleneck 2: Broken Supply/Demand Chain

The second bottleneck found in the study is that the supply/demand chain is broken. The reason for this is twofold: First because the lack of data flow across the value chain, second because of the aforementioned variety in digital maturity. In addition, the focus in the value chain lies on supply and not demand which makes for a high level of rigidity and inflexibility in the value chain.

Our interviews demonstrate how data is collected from single points across the forestry value chain, meaning that individual firms themselves collect the data with the help of their own infrastructure. The respondents we interviewed recognized that the broken supply/demand chain can be mended by sharing data between the nodes in the value chain, but all respondents pointed at data sharing as a risk as well as an opportunity. All firms we interviewed also noted the importance of moving towards relying on digital data rather than manually collected forms to increase the quality and producing more precise measurements. However, it is very clear from our interviews that the digital value chain in the Swedish forestry industry does not currently have a continuous flow of information as a result of single points in the value chain holding onto their data with little or no intent of sharing data. The value chain is currently separated from harvesters and markets, and although this is seen as a valuable connection it is not a priority today.

The harvesting firms are in the front end of the value chain and may provide later stages with material to enhance its value. The goal and value derived from data about raw material represents a huge potential that is currently untapped. The respondents expressed a desire to strengthen the links in the value chain, allowing harvesting processes to be linked with later parts of the value chain such as customer demand.

> *…sensors on train for example that allows you to measure in real-time where they are, wood measurements will be completely automatized within a couple of years, which is partly automated today.* [Respondent D]

The real-time data is described as a means to become closely connected to customer demand and, as a consequence, increasing the value of their services. This is seen by all harvesting respondents as an important step to take as it is described as an emerging need from their customers as well as an optimization of their current service portfolio. The ideal result would be to allow partners downstreams in the value chain to better prepare for the produced goods they are about to receive.

Data standards of how to describe forest data is already in place and all firms we interviewed use the data standard *StanForD.* The standard provides forestry machines with the ability to communicate data that is collected through the harvesting processes. It is stated as a tool that allows communication between different actors to be made smoothly.

> *"…. and then you operate the communication between forestry machines and the offices through the StanForD standard."* [Respondent F]

The respondents note that they are satisfied with the description that the standard provides but some of the data fields still requires manual labor. Some respondents expressed this as problematic because many workers rely too much on past experiences and making estimations that tend to include minor errors. However, Respondent E saw the data fields that require manual labor as not vital for the data quality and argued that the standard works well for describing the most important part of the forest. Respondent E also described that the fields that requires manual labor is not used when analyzing the data. Furthermore, collaborative projects that have used forestry data from different organizations have little problem with combining data from different sources. However, there are more than one way to describe forestry data and some organizations are using multiple methods to describe their forests but overall the most methods follow the StanForD standard. The StanForD standard is under continuous development and the respondents described how they can impact its development as well as believing in its future. The respondents describe this standard as robust and does not see a need to steer away from it.

Bottleneck 3: Low Level of Digital Competence

The third bottleneck found in the study is that the level of digital competence is low. This is a critical problem, and a problem that we found throughout the value chain. All respondents were aware of the problem, expressed a high level of concern over the problem, but did not see any quick solutions for the problem.

Our interviews demonstrate how digitalization is seen as an important cornerstone for all organizations throughout the value chain, and it is becoming an increasingly central part for firm strategies. However, all respondents acknowledge a lack of directions and that they are currently not clearly focused in their digital strategy. The respondents noted that they are lacking necessary competence in digitalization in general and are thus dependent on outside firms' expertise to navigate today's digital landscape. But the outside expertise – often the form of consultants – are seen as problematic sources for competence in that the respondents do not fully trust the consultants' understanding of the forestry context. As such, there are some efforts in place among the bigger firms in the value chain with the goal of building more in-house expertise in areas such as AI and digitalization to be less dependent on outside knowledge in the future.

> *"Clearly competence is key and we need to step up our game. But it is difficult to articulate where we are going when it comes to the digital realm and therefore we are not sure what competence we need and how we can obtain it."* [Respondent P]

In addition, many respondents noted that it is highly problematic to know when/where to invest resources in the digital landscape, and are looking very broadly on opportunities on what to invest further resources in. The problem in fully understanding the implications of the digital opportunities the different ventures presents makes the decision-making challenging and hampers the digital transformation process. It is also noted that many different digital technologies appeared interesting for the respondents but knowing how to implement them successfully into the organizational context appeared as a daunting exercise.

Some respondents expressed an interest in sharing the journey of exploring different opportunities of digitalization with similar firms, although in some cases it has proven to be problematic because a lack of trust between the firms. Many respondents explained that engaging in collaborations with other requires a neutral party to lead the projects to ensure that data and knowledge are not taken advantage of. All respondents think that there are representatives that can fulfill this role in the Swedish forestry industry and projects have been successfully completed in the past with similar setups.

> *"We have participated in many research projects and while we are pleased with the experience we get from these projects they are limited in time. It is too much of starting and stopping whereas our need to build digital competence is an ongoing thing."* [Respondent M]

The firms we interviewed have a history of working in collaborative innovation projects but the projects tend to be focused on the future and will often not result in direct value, but rather serves as a helpful tool to assess the future digital possibilities. There are problems in certain areas to collaborate with competitors and ventures with competitors needs as it is not possible to focus resources on hands-on useful changes when a

competitor is present which complicates the situation when collaborating closely inside the industry. Having said this, every firm we interviewed had been involved in collaboration projects to some degree. Especially in long-term projects focused on research and generating a foundation for future ideas to build on, essentially exploring what value digitalization can bring them. However, the respondent expressed that the most exciting projects tends to be related with present problems and how to gain value from digitalization whereas most projects proposed to them by external partners (such as universities) tend to steer away from those concerns.

It is consistent throughout the interviews that the issue of competence is a key bottleneck for digital transformation in the forestry industry. Research projects and educational programs are seen as important remedies for this. Many respondents described how firms in the forestry industry in Sweden are open to collaborate and that they trust each other as long as a neutral part is handling the research project and the data. Many expressed that this willingness represents an advantage compared to their competition across the globe, and the willingness to collaborate in certain projects makes the Swedish forest industry stronger. However, when collaborating with other competitors it is required to have a clear goal and understanding of how and why the research project is carried out.

Bottleneck 4: Low Level of Service Innovation

The fourth bottleneck found in the study is that the level of service innovation is low. Specifically, the focal concern is on products and not services. Having said this there are several initiatives in place to address this problem even though much more needs to be done.

In our interviews, the respondents recognized that external knowledge exploitation is a key source for realizing opportunities and bringing in knowledge that is missing internally. This contribution was seen as a positive and appreciated by all respondents. In fact, increased innovation by bringing in external ideas in the existing innovation process was seen not only as a positive but also as something critical. As explained by respondent B *"You need to have inspiration or knowledge coming in from other technical areas or new ideas crossing the existing R&Ds".* This process was also perceived as a key aspect to improve the technologies/practices among the firms. Moreover, the external knowledge process is not only the venue of gaining knowledge but also an incentive to get them out of their comfort zone, cross their boundaries and try new creative solutions. As respondent L highlighted "*we need external knowledge to push ourselves outside of our boundaries*" in order to achieve a long-term development. As such, many firms expressed

how they have received external help for scientific tests of their development products and also for broadening the market understanding. However, the respondents stated that the external knowledge is not exploited to the maximum and there is still room for more openness and creativity. Most of respondents underscored the necessity of continuous improvement in terms of technological awareness as a driver for increased efficiency. Respondent J argued that "w*hat we are doing is to improve the technology used for industrial forestry to be more efficient and here the automation plays a key role".* In that case, universities, research institutions and even experts such as consultants can contribute the innovation efforts and technological research. The positive contribution from the researchers and universities was highlighted by the majority of the respondents. This is clarified by respondent O: "We *need to use other partners and the university. There are different companies with relevant expertise, there are different specialists outside the university world, and I don't think we are using those partners as much as we should".*

Many respondents expressed their view on collaboration in digital innovation as a necessity for the future of the forest industry. The motivation is to create a shared and deeper insight throughout the value chain and to gain knowledge from external sources to reach both greater service quality and a better stream of goods from the forest to nodes later in the value chain. Manufacturers of forestry equipment such as harvesting machines and other tools expressed a belief that a closer collaboration in sharing data and needs can provide better solutions for harvesting processes. Respondent G expressed a need to share more data and thoughts to fully reach the opportunities of digitalization, but the closer cooperation is dependent on trust that enables a more fluid form of cooperation.

> *"You have to create stronger and wider cooperation in different areas, and that requires that the different actors are open and honest on how they perceive the future and what problems one might have." [Respondent G]*

We identified this interest in an increased collaboration between firms throughout the value chain. As such, all organizations agreed on the necessity of not operating in a vacuum and on the need to improve their practices to get mutual technological benefits. For instance, respondent D stated that *"more different industries benefit from the same type of cooperation between companies"* while respondent G perceived the collaborations they are engaged with as *"a platform to discuss and have solutions and find opportunities on the problems we are going to face in the next couple years"*. To address these tensions, collaboration mainly occurs in the primary steps of project development, such as testing, and then the firms continue separately with the development of their products.

There exists a collaboration among the firms in the forestry industry that is facilitated through different events such as seminars and workshops. This was appreciated by all firms we interviewed as a beneficial approach for enhancing the knowledge flow.

Moreover, some respondents emphasized the need for increasing the collaboration and openness to external partners in order to go bigger in their productions and achieve sustainability. Respondent H said that "*now that all small projects are done, we are looking more and more into bigger projects and we need to cooperate more in the future".* The respondents embraced the importance of mutual collaboration but the sense of competition is still remaining. This is only logical since forestry is an industry that traditionally worked with patents and thus it is quite competitive in nature. For some respondents, the competition is a manageable tension that does not negatively affect the innovation towards innovation.

The problematic issue of knowledge leakage among the firms in a research project setting is described as a challenge by many respondents, a challenge that may cause an increase in the sense of secrecy and lead to a decline in the sense of trust. This challenge may also hamper the process of idea generation and knowledge exchange between the organizations. Respondent G referred to this by saying "*it is not so easy for the company to share its information with others. I think no company is taking steps too easy [....]. If you try to tell others (your idea) it relates to the issue of trust and who can we share this information with*".

Consequently, as respondent N put it: "*When our product is concerned, we are more likely to have discussions with researchers than with other companies."* This effort to protect their ideas is aligned with the challenge of IP strategy. Our findings demonstrate that most collaboration arrangements do not apply any specific IP strategy but there is a well-established agreement among collaboration partners which attempts at eliminating the issues regarding the ownership of the end products. All companies claimed that they have not experienced IP violation cases in the context of collaboration projects, but they are quite concerned and protective with the ownership of their idea/patent to avoid any possible negative consequences in general. However, while collaboration and openness are highlighted as important drivers for achieving innovation, the level of service innovation is still limited.

Digitization in the Swedish forestry value chain: Action Plan

Following the identification of the four key bottlenecks, this section will address each bottleneck to articulate an action plan for moving forward. The action plan involves the following four key actions: 1. Strategies for boosting digital maturity; 2. from value chains to ecosystems; 3. programs for improving digital competence; and 4. approaches for identifying opportunities for service innovation.

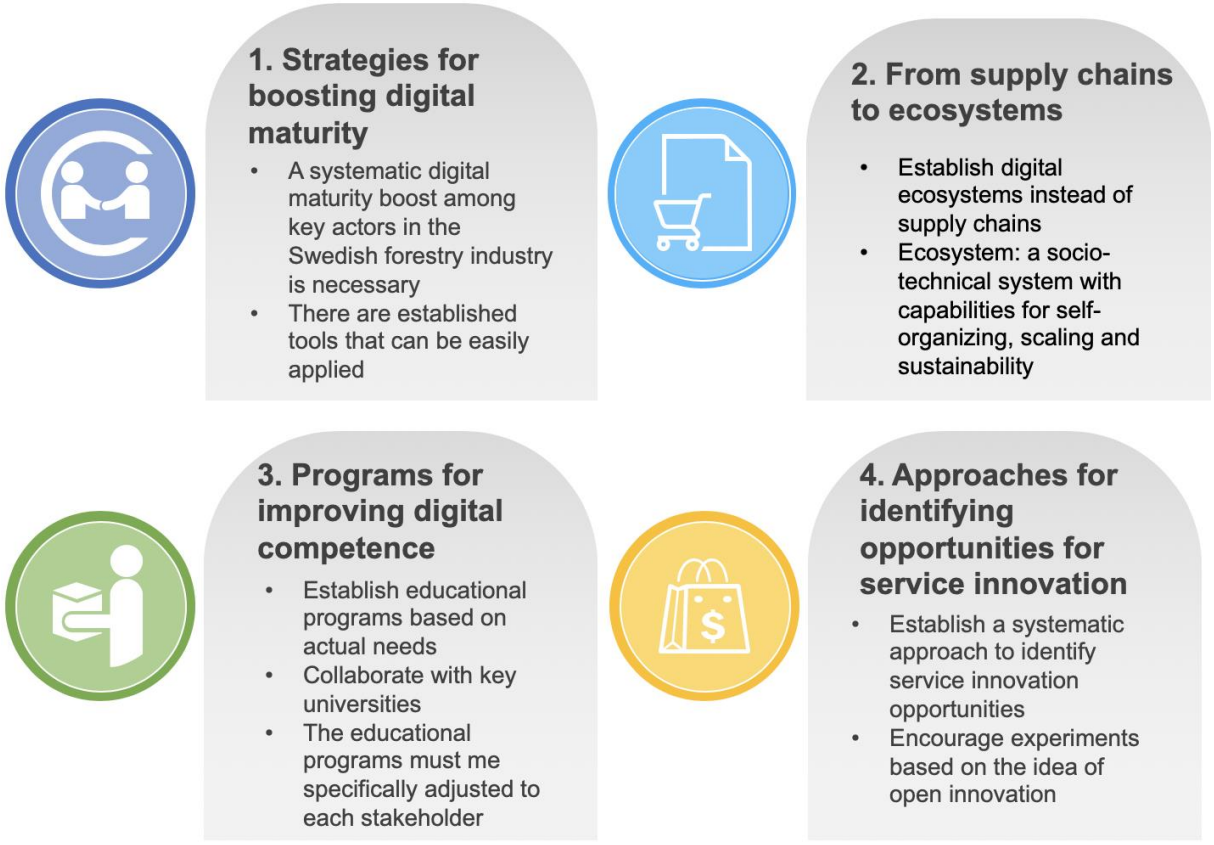

Figure 3: Action plan for digitization in the Swedish forestry industry

Strategies for boosting digital maturity

For a firm to remain competitive, there is a need for having a continuous process of improvement that scrutinizes the company's positioning in terms of its IT capabilities and the quality of its properties and services. Maturity models are according to de Bruin et al. (2005), helpful tools that aim for assisting those specific issues.

Firms in the forestry value chain have already begun to face the challenges of digital transformation by using a variety of strategies. While some companies have started to transform their firm by developing strategies suited to this uncertain environment, many firms still struggle to develop clear and coherent digital strategies and a key problem when striving to develop digital strategies is the low level of digital maturity we find among many of the firms in the forestry industry. A key for boosting the digital maturity

for a firm is to use a reliable tool for measuring digital maturity, and to articulate ways in which to improve the digital maturity. Maturity is described as the levels of development that characterize a specific firm (Andersen & Henriksen, 2005). A maturity model consists of chronological stages that assess the level of maturity for a firm. As for the use of such a model, maturity models are anticipated to reveal current and desirable maturity levels.

Previous research has suggested a large number of maturity models suitable for assessing digital maturity, which can be used as guidance for practitioners to face several distinct issues. Becker et al.'s (2009) approach of developing maturity models consists of eight different requirements. The first requirements emphasize exploring if there is a need for developing a new maturity model or improve an existing one. Therefore, a comparison with existing maturity models has to be done. Requirement two is that maturity models must be developed iteratively in order to refine, evaluate and enhance when necessary. The third requirement when developing a maturity model is to evaluate. Premises, principles, usefulness, quality and effectiveness of the model need to be evaluated iteratively. A multi-methodological procedure is the fourth requirement, which means that the development of a maturity model involves a variation of research methods, and that the usefulness of the research methods needs to be reliable and finely adapted. The fifth requirement states that the developed model must not only be innovative, but also try to answer a relevant problem for either researchers or practitioners. Problem definition is the sixth requirement, closely connected to the requirement of problem relevance. In order to establish relevance, a precise definition of the problem is needed. The purpose of the seventh requirement – implementation of the transfer media – is to present the maturity model and make it accessible in a planned way for the earlier defined user groups. Scientific documentation is the eighth and last requirement, which says that every step of the development process has to be documented (Becker et al., 2009).

A mature digital strategy should guarantee an efficient use of digital technologies to develop those capabilities. A maturity model can be a tool for sensitizing to support this process and managers who work with digital strategies to focus on the right issues. However, to make the tool useful, firms should be proactively engaged in the process and articulate an aim for reaching a specific maturity level.

From supply chains to ecosystems

Our results demonstrated that the trust among the firms in the forestry value chain can be either the enabler or the constrainer of collaboration, knowledge exchange and

network activities. Therefore, limited trust can generate obstacles on managing activities along the value chain. Our results also suggest that the higher the level of trust, the stronger the collaborative culture between firms in the value chain (c.f. Nestle et al., 2019; Westergren et al., 2019).

The collaborative projects that do exist between forestry value chain involves firms that are competitors but attempt at collaborating (Felzensztein et al., 2018). In alignment with Sandberg et al. (2015), our results revealed that the collaboration among competitors with a small or large conflict of interest is challenging. Specifically, it seems that secrecy comes before trust, in order to achieve objectives of the individual firm. Therefore, we argue that limited trust has impeded the process of fully seizing the open innovation opportunities between firms in the forestry value chain. In fact, mutual trust is the cornerstone that facilitates knowledge sharing (Henkel et al., 2014; Westergren and Holmström, 2012) and increased interaction. Similarly, blind trust is a challenge, hiding the risk of being exploited by the collaborators (Wu, 2014). The firms in the forestry value chain should take this risk into consideration, but actions to establish trust should be the main concern. Although there are some examples of firms successfully establishing trust in their inter-firm relationships, the barriers are hindering most efforts at collaboration.

However, most respondents noted that such continuous collaboration is only interesting in an exploring manner, and when it comes to developing solutions for optimizing current processes the firms make use of formal and restricted projects which often results in each firm venturing in such developments by themselves. However, some respondents noted that there are some industries that have similar problems as the forest industry, and thus establishing collaborative projects with actors not connected directly to the forest is possible and interesting. It is noted by some respondents that a lack of continuous collaboration is a reason that hampers the overall progress for an industry-wide digitalization and integrating different nodes of the value chain.

All respondents expressed interest in development of AI technology to help the different firms to optimize processes through automation. However, the firms also expressed a lack of knowledge on digitization and AI which is seen as a big obstacle in further engagement in AI, but some collaborative projects that involve the whole harvesting industry is undergoing to unveil its potential. The respondents perceived AI as a potentially powerful tool, but they cannot explicitly pinpoint what AI solutions to invest in. Respondent F believed that there needs to be hands-on projects that can show the power of AI in the forestry context, and have some collaborative AI projects ongoing as of now that may influence the harvesting industry in the future. The same respondent acknowledged that the industry needs a system for data storage that is suitable for a future of AI development. Some respondents note that AI solutions are often bottlenecked by the amount of data

available but estimates that they have enough data for it to be suitable for AI development. The bigger obstacle is their lack of knowledge and investing in a coherent direction, which makes the ecosystem argument – to cast a wider net to move from the supply chain to an ecosystem view – widely shared among the respondents.

Programs for improving digital competence

In an OECD report from 2010, one of the policy recommendations suggested identifying and fostering the development of 21st-century skills and competences, and pointed out that "most of these competences, if not all, are either supported or enhanced by ICT" (OECD 2010, p. 169). To meet this challenge, the firms we interviewed expressed how they are in constant demand for qualified staff which is considered to possess skills in digitization and AI. While self-motivated creativity is a key driver for firms in most instances (e.g. Carayannis et al 2016), it is perceived that digitization and AI represents a challenge that puts the firms' sustainable success in jeopardy if it is not addressed properly.

Many scholars have pointed out the role of capabilities in sustaining a firm's competitive advantage (e.g., Teece, 1986). The process of developing a firm's internal capabilities is strongly related to its knowledge management practices, which are the capabilities connected to the stock of knowledge that the firm can acquire from different sources through both formal and informal processes. Firm performance is correlated with employees' skills and competences (Whelan and Carcary 2011). Thus, the diversity of labor skills and competencies is a key for sustained competitive organizations advantage (e.g. Ordóñez de Pablos 2004). As such, maintaining sustainable competitive advantage requires cultivated labor skills which in turn need to be embedded in an environment supporting to leverage these potentials (Sharkie 2003). Leveraging individual competences and integrating them into a collective competence pool requires an elaborate strategy.

In our interviews we found empirical evidence that is a significant gap between the competence on digitization and AI among the firms in the forestry value chain, and the competence they perceive they need. It is clear that firms are aware of the importance of digitization and AI competencies and seek to develop them further by establishing an organizational culture which is supportive to innovation and the exchange and sharing between individuals. However, this insight needs to be extended by distinct programs for improving digital competence among the firms.

Approaches for identifying opportunities for service innovation

The link between digital technologies and service innovation is a complex one. Services and digital technologies have a tight relationship, wherein digital technologies are not merely a passive background but a focal point and a facilitator of services (Schlagwein et al., 2017). Our results underscore the importance of digital technologies as an inseparable part for the development and survival on the competitive market for firms, and services were articulated by all organizations as a domain that must be improved. Digital technologies may serve as a mediator for openness and as a facilitator of the heterogeneity among actors, as it is highlighted in the literature (e.g. Yoo et al., 2012; Schlagwein et al., 2017; Sandberg et al., 2020). But this is largely an untapped potential thus far.

Having said this, our study demonstrates how the role of digital technologies has broadened the opportunities for the formation of networks between firms, laying the foundation for a distributed agency (Nambisan et al., 2017) to build new competencies and reach goals. Thus, the role of digital technologies serves as enabler and accelerator of openness between firms. In our case, we identified that the enabling capabilities of digital technologies can allow firms in the forestry value chain to cross their boundaries, expand to new industries, incorporate the whole value chain and assimilate diverse ideas/knowledge. We recognized that the linkage between internal and external actors can create the ground for collaborative communities. Boudreau and Lakhani (2009) characterized these communities as an environment suitable for fostering interaction among members and cultivating collaboration and knowledge exchange.

In addition, we underline limited trust as a barrier that firms should seek to overcome in facilitating service innovation. Based on Westergren and Holmström (2012), we see how the lack of trust is responsible for most cooperative failures and therefore, we suggest the creation of a trustworthy environment that facilitates the management of cooperative tensions. Second, we consider the process of drawing of an IP strategy as a critical. Coupled with Chesbrough's (2006) idea of open innovation, we recognize the advantages of managing the IP property in a way that can improve the business model and increase the profits from competitors, instead of excluding the members from using the technology. Since the potential for knowledge diffusion across the value chain is high (e.g. Holgersson et al., 2018) it seems advisable for firms to design a digitization strategy by considering the potential for rapid diffusion and imitation (Chesbrough, 2006). Building on this, we argue that the firms along the value chain may consider reducing some of their use of IPs in order to facilitate collaborative and innovative activities that are promising in a long-term.

Furthermore, it is well established how heterogeneity of knowledge, actors and industries are of utmost importance for innovation (Sandberg et al., 2015). Technology heterogeneity and the implementation of digital technology solutions from other industries may diminish the risk of unpredictability while improving product development (Enkel et al., 2009). As such, the role of a "triple-helix" of innovation (academia, cluster and government) is crucial, and therefore firms in the forestry value chain should seek to maintain it. Simultaneously, firms in the forestry value chain should also expand its network further from research institutions. As such, we suggest the creation of an ecosystem that will include the whole value chain and broad the network activities. Knowledge and abilities that generate innovation can be discovered anywhere inside (or even outside) the forestry value chain (c.f. Lopes et al., 2016).

The interviews reflect how digital technologies reshape the nature and structure of products and services (e.g. Gawer, 2014; Nambisan et al., 2017). As such, digital technologies may not only increase productivity by developing complementary assets but also may enhance the forest management process (through for instance automation and robotization). Moreover, digital technologies play an important role in helping firms to cope with changing environment (El Sawy et al., 2010), which is appreciated by all organizations we interviewed. There are many opportunities for pursuing service innovation in this landscape, and it is a critical thing to do in order for firms in the forestry industry to remain competitive.

Concluding Comments

To summarize, our empirical findings illustrate the challenges and opportunities for firms in the forestry industry in leveraging the value from digitalization and AI. Specifically, we investigated the information flows in the Swedish forestry value chain, and the new value creation opportunities associated with an integrated end-to-end digital information flow across the value chain. Our findings demonstrate that the traditional value chain works well, but the digital value chain is fragmented. Specifically, the results illustrate four major bottlenecks the forestry industry is facing: 1. The level of digital maturity is varied, 2. the supply/demand chain is broken, 3. The level of digital competence is low, and 4. The level of service innovation is low. To address these bottlenecks, we identified four key areas with respect to possible pathways forward: 1. strategies for boosting digital maturity, 2. from supply chains to ecosystems, 3. programs for improving digital competence, and 4. approaches for identifying opportunities for service innovation.

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