Digitalization as a tool for increasing business process efficiency in logging

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Abstract. The article considers digitalization as the main factor in optimizing business processes in logging. Analyzed the main trends that affect the digitalization of the industry and arising issues in this process. This article discusses the role and criteria of data and information reliability and how you can use them to create better products. The author proceeds from an understanding of the important role of data in the modern logging process and creating a working production platform on its basis. The results outline the main factors that will contribute to the successful development of digital technologies in logging.

1. Introduction
Digitalization is fundamentally transforming value chains and fully redefining value channels. The key resource is data, based on which (collection, storage, analysis, and visualization) a new value chain and competitive advantage are formed [1].

In the early days of mechanized harvesting, the focus was on innovation in mechanical and hydraulic systems [2]. The development of communication technologies and information systems soon came, but they were given secondary importance in logging operations. The role of data and information in forestry has gradually grown, and thanks to digital transformation, we are now on the cusp of a completely new era for this type of digital activity. Mechanical and hydraulic innovations are still needed and valuable, but they are now inevitably accompanied by data, information, and digital services.

2. Methods and Materials
The research method used in the article is mostly qualitative. An analysis of the problem is based on the multidisciplinary principles. Methods of comparative analysis were also applied.

3. Results and Discussion
Today, it can be said for sure that digital technologies most actively influence the established structure of economic relations. This is the reason for all the changes associated with the development of human resources, changing needs, the transformation of logistics, financial and other processes, and, as a result, a change in the paradigm of the relationship between the supplier and the consumer of digital services.
The culmination of the Third Industrial Revolution was globalization and the emergence of transnational corporations. However, in the reality of the Fourth Industrial Revolution (Industry 4.0), a real presence around the world is not required. It often goes to the detriment of both the business and the products and services provided by this business. As the core of Industry 4.0 digital platforms, and companies’ platforms are coming, being more mobile and adaptable to current realities, replacing multinational companies with their huge bureaucratic systems. In the dynamics of 5 years (2011-2016), the capitalization of companies implementing and using digital platforms has grown significantly, which allowed such tech companies as Apple, Facebook or Amazon to oust such giants as General Electric, ExxonMobile, Shell, etc from the first positions. Furthermore, since 2019, The Big Tech Era begins [3].

Similar trends are observed in the global logging market. In the markets of China, Russia, Latin America, the emergence, and formation of large national corporations is observed. It is possible to assume that the next stage will be the formation of international corporations, which will lead to the creation of uniform industry standards applicable to all markets. The situation with the development of digital technologies in different markets is very different. This will certainly lead to unified conceptual approaches to assessing the efficiency of loggers’ work.

Digital applications, which are developed by almost all logging companies worldwide, will play an important role in forming a single information field in global logging. Now the approaches and principles of working with data differ in the developments available on the market, but, of course, forming standardization and the transition to unified principles of working with data will soon become very important for the entire market [4].

Competition in logging technologies will affect the demand for digital technologies and the specifics of working with data. For example, now two technologies are actively operating on the logging market: the cut-to-length or Scandinavian method, as well as the whip. Recently, a shift in favor of cut-to-length logging has been more and more noticeable. For example, according to Ponsse Plc research, from 1990 to 2014 the share of cut-to-length timber on the Canadian market increased from 5% to 48%, and this share continue to grow. The popularity of the method of cut-to-length logging is growing rapidly in all over the world. Today, two thirds of the world’s mechanized industrial timber harvesting is done by cut-to-length machinery.

Nearly all new timber harvesting projects and tree plantations throughout the world are based on cut-to-length solutions. In the cut-to-length method, timber is processed in the forest in accordance with its intended use. Each timber grade is transported directly from the roadside to its destination: logs to sawmills, pulpwod to pulp mills.

In the cut-to-length method, the need for assessing the quality of assortments, their value, and tracking their further path to the processing plant increases significantly. It is worth noting that this involves processing a large, accumulated stream of data on national requirements, which differ depending on local legislation and the characteristics of the tree species growing in the forests. It is easy to assume that the digital applications installed on each machine will generate data to assess the effectiveness of business processes soon. It is worth noting that thanks to digital technologies, we can already assess the effectiveness of not only one single machine but the entire fleet of forestry equipment as a whole. Also, the development of artificial intelligence programs will definitely be in demand, based on which the management of logging companies will be able to make effective decisions [5].

An advanced cut-to-length harvester’s automation system maximizes yield and minimizes waste. These diverse machines are at home in challenging conditions and excel in every harvesting requirement—regardless of the weather, season, or terrain. Unlike other mechanised timber-harvesting methods, cut-to-length enables responsible and high-quality forest management by selective thinning [6].

Currently on the pace of digitalization of the timber industry lags behind many industries. But how it is known that any modernization is just a matter time. Lack of proper network infrastructure is one of the main problems that need to be decided soon. It allowed unleashing the full potential of modern
equipment and technologies. Geographic information systems will move to a new stage of development and will be the main tool to meet the challenge of sustainable forestry management. A major trend often describes a more global change or direction in the industry. Today, the following major trends are identified in the logging industry [7].

1. Digitization in the logging industry may be understood as an increase in the share of information systems and digital services, such as forest management, fleet management and maintenance, performance reporting, visualization of measurement and calibration data.

2. Sustainable development – research and development and understand, for example, the impact of harvesting practices, emissions, and soil compaction on the environment, and how to take this information into account at all stages of activity. Machine electrification represents a major technological shift towards greener and more sustainable solutions.

3. Development of data transmission technologies – the study of the best ways to use different data transmission methods (wired and wireless) and the development of solutions for optimizing communication channels to obtain and manage data on different plots and in conditions of different infrastructure.

4. Automation – The use of sensors, sensing technology and processing techniques for advanced operator assistance systems and semi-automated or fully automated operations. Major trends encourage industry operators to put more effort into these areas and create a technological push that brings new technologies into the market. The offering of the future is a balance between customer appeal and technological push.

Information in the technical context can be defined as a sensory stimulus generated by an event or a process. The information can be used as inputs for a system, which processes the signals based on predefined mathematical rules and produces an output information, which presents the state of the event or the process. Data is often used as a synonym for information, but it is actually more like a simplified breakdown of information (e.g. bits and bytes) that computers can process. Data is required for computer-generated information. An algorithm is used as a mathematical guideline for processing or interpreting data. The main method used, which will be the main one for obtaining data for analysis and processing of the obtained data, will be mainly qualitative [8].

The methods for processing information and data can vary from basic logical rules to more advanced tools based on machine learning (ML) and neural networks (NN), for example. The more sophisticated methods such as ML and NN fall under the umbrella of artificial intelligence (AI), which can be described as the family of methods for maximizing the probability of achieving set goals based on the perceived environment. This means, for example, that certain patterns can be recognized, and processes learned by processing a pool of data, which is formed from the abovementioned sensory stimulus.

However, theory and practice are two different entities, and the challenge is to put theory into practice. The forest environment and the machines working could be a better test for digital applications.

When data is generated by sensors and control systems in a forest machine, there tends to be considerable variance in values and possible errors or static, which affects the reliability of the information produced. Generating data should be an agreed quality-controlled process, which generates outputs based on a known method. We can, therefore, assume that the information can be analyzed reliably. If the data generation process is unknown or has ambiguous rules, the information cannot be reliable and ready for further processing.

When the data generation process is known and always the same, at least within the analyzed dataset, we can begin to draw actual conclusions and identify required decision-making characteristics. We can thus also identify anomalies and possibly even determine unreliable phases in data generation. Without a known data generation process, data is unreliable and cannot track changes or draw conclusions that can help make decisions. The generation and analysis of data are ultimately performed to solve challenges and improve decision-making speed and reliability [9].
If we think about how forestry data can help us make good products and become more productive and efficient, we should start with the big picture: in which parts of the wood procurement chain is data generated, where is it stored, and how can it be extracted for useful outcomes?

Having recognized our customers' and stakeholders' requirements, we should establish the requirements for the outcomes that data should provide. This can be a better method for controlling the harvester head based on sensor data, log piles' location based on coordinate information or productivity reports in a cloud-based service. Whatever the required outcome should be, we should recognize the demand, investigate what data is required, and process it. The result should be a better feature or a product that meets the initial requirements.

Now that making better products is somewhat known, the difficult part is defining what is actually a better product or more efficient operation. To define this, data used to help to identify efficiency in operation from the wood procurement level all the way to a single phase in stem processing. To put this in numbers, well-justified incremental improvements with operator training can be estimated to increase machine operating efficiency by 1-5%. Larger system or platform changes can contribute to a more than 10% increase in efficiency at the machine fleet level [10].

Connectivity is a wider term to describe methods and technologies used for data transfer to and from assets and infrastructures. The forest machine context often describes the hardware and software used to transfer operational data to the machine (e.g. bucking instructions and SW updates) and from the machine (e.g. production data, diagnostics and location).

Most solutions today are purely for monitoring key performance indicators (KPI) and the condition of a fleet of machines. Some solutions also offer remote real-time connection possibilities, which produce an entirely new dimension to machines' management. Different connectivity solutions often also provide different data rates. For example, a solution that transfers data via WLAN and mobile networks offer relatively good data rates. It is fast, but in remote places where satellite connection is required, the data rates and transfer speed are often restricted.

Much of the data received and sent by a forest machine today is standardized and comprises predefined data content. This ensures that different forest machine OEMs have onboard information systems that work with other software solutions in the value chain. This also helps entrepreneurs who own a machine fleet consisting of several OEMs' products.

In the coming years, connectivity solutions will develop rapidly. With 5G technology, the mobile network coverage will expand to new regions, but there will also be some places where satellite connection is still the only means of communication [11].

Data mules are an option if no possible connection is available. Datasets can be transferred to and from a machine with an external hard drive or a mobile phone, which acts as data storage between a network hub and the machine. Data transfer to an external hard drive is often via a USB bus and a mobile phone via wireless proximity technology such as Bluetooth or WLAN.

The environmental awareness of a forest machine is increasingly important in sensing the locations of obstacles, sinkholes or steep hills and identifying which trees are optimal for felling and which are not. Additionally, a perception system enables an analysis of the best places to plant saplings to maximize growth or which locations should be fertilized.

Forests are becoming digital step-by-step, and at some point, it will be possible for data markers or digital fingerprints from each tree to be created to help the mapping of forest stem counts, lengths, and diameters. After felling, each stem with a unique set of parameters will also enable it to be traced at any point in its lifecycle [12].

In addition to observing the environment, it is increasingly important to sense the machine's condition and operational actions. For example, information on system health and routine sequences changes can be used to determine upcoming maintenance and calibration requirements. Tools for analyzing sensor data can also help create virtual sensors. Instead of adding new physical sensing components, a virtual sensor can be created based on other onboard sensors' data.

When a fleet management solution shows numerical data or visualizes trends based on data points, it is a data-based solution. When data shapes and directs solutions or generates new solutions, it is a
data-driven solution. With increasing amounts of data and analyzing tools, we are starting to shift from data-based to data-driven solutions. This shift in data architecture enables generating new digital services and solutions that benefit each party in the value chain. Features such as preventive maintenance, component lifetime prognostications and production forecasts will be enhanced and dynamically updated when data and tools to analyze them are in place.

The market demand for offering solutions, not merely products, has been prevalent in many industries and is also emerging in the forest machine industry. Data-driven solutions are built on physically decentralized platforms in which data generated from machines, systems and other processes can be used in every solution where it is required. The dataflow is facilitated by agreed interfaces, which also enable data extraction to external solutions. When data is available on-demand, reporting improves significantly and can be easily customized for different requirements. Business intelligence (BI) reports are a good example of reports with a selected focus of metrics and key performance indicators (KPI), which offer overall situational information briefly.

In addition to cloud-based computing, more computing capacity will also be placed onboard machines and partly in local edge-computing facilities on site. This is to increase data availability, decrease latencies in processing critical data and save bandwidth. Pertinent operational information will also be shared directly between machines on-site without rerouting it via cloud-based storage. This is referred to as machine-to-machine communication (M2M).

4. Conclusions

The systematic acquisition of data and information-based services has been around for decades. Thanks to advances in technologies and data-processing tools, they have enabled wider use of scalable digital services.

Information from sensors and perception systems offer large amounts of data for cloud-based processing and analysis, which can be used as inputs for reporting, decision-making, and expanding the overall information. Improvements in machine onboard systems also enhance the data-handling and operating decisions made by a machine when processing logs or scanning the environment. The future depends on increasing amounts of data-driven services and operating models, direct organizations, and stakeholders in making business decisions more rapidly, partly automatically with pre-analyzed data and solution suggestions. All this is enhanced by success probabilities and prognostications of component lifetimes or productivity and monetary metrics.

Future data architectures and artificial intelligence will direct the digitalization of the entire wood supply value chain. Data and intelligent products and services will become part of everyday work in forest machines and associated processes.

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