Digital technologies in forestry

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Abstract. In Russia today, one of the national development goals is the development of the introduction of digital technologies in the economy and social sphere. The national program "Digital Economy of the Russian Federation", as well as the introduction of digital technologies as a national development priority, raised the relevance of these issues to a high political level. This is an example of a national goal implemented on the basis of the principle of project management and requiring a significant investment of budgetary funds. In this article, the process of introducing digital technologies in the forestry industry is considered on the basis of the application of N Venkatraman's model, and their effectiveness is proved. The main result presented in this article is the evidence base for the need to introduce digital technologies at enterprises for the further development of the industry; examples of the use of new achievements, both in forestry and in the forest industry, are considered, and some difficulties in their application are shown.

1. Introduction

In accordance with the Decree of the President of the Russian Federation of May 7, 2018 No. 204 "On National Goals and Strategic Objectives of the Development of the Russian Federation for the Period up to 2024", the main tasks of the development of the Russian Federation have been determined: increasing expenses on the development of digital technologies; creation of a secure information and telecommunications infrastructure; accessibility of the digital environment for all organizations and individuals; use of domestic software [1].

Digital technologies are breaking into our lives, while transforming the economies of industries around the world. Economic growth is happening thanks to the automation of the existing processes and the introduction of breakthrough business models and technologies, such as digital platforms, digital ecosystems, data sets, 3D modeling, robotization, digital twins, the Internet of things, Industry 4.0 technologies. The availability, quality and convenience of services in such areas as education, medicine, government services, and culture are increasing. Digital platforms create new job opportunities and help to improve one's workmanship and to develop extra skills. Thanks to the development of digital technologies and the availability of specialists in the field of artificial intelligence and machine learning, the task of ensuring the safety of people, companies and the state is being solved. New technologies are revolutionizing industrial manufacturing.

According to Global Finance, countries such as Norway, Sweden and the Netherlands (the index is 3.68) are in first place in the countries’ technological index. Russia ranks 46th in this list with an index of 2.68.

By 2024, it is planned to create in the Russian Federation digital platforms for the main sectors of the economy and to provide households with the access to broadband Internet.
The globalization of the economy poses a task for Russia to introduce innovative technologies as soon as possible. And the forestry industry is no exception. Unfortunately, it has lagged behind most industries in the use of these technologies. But, artificial intelligence and machine learning are gradually finding their application in industrial enterprises of the industry.

For the innovative digital manufacturing to work, manufacturers need to gradually integrate all chains within the process of production, from sourcing raw materials and materials for production to the moment the finished product is shipped to consumers. At the same time, it is necessary to implement all stages of the product life cycle. Manufacturers need to tie together all management functions, such as marketing research, product planning and development, manufacturing and logistics. It cannot be done without the creation of "smart industries" and a single "ecosystem" [2]. The latter is the interaction of all system events into a single whole and allows you to simulate various scenarios of what an enterprise can expect in the future.

2. Methods and Materials
The main research methods in the field of application of digital technologies are such theoretical scientific methods as analysis, synthesis, modeling and generalization. In the work, the use of these methods is based on the application of N Venkatraman’s model [3]. It allows the entire process of introducing digital technologies to be considered as separate elements of the system, while distinguishing them according to different levels of internal transformations. As a result of this, there is a transformation and redefinition of all elements and the system itself in order to reorient existing processes aimed at introducing digital technologies.

3. Results and Discussion
Using the above theoretical research methods, we will analyze the elements of the production process using digital technologies on the example of one of the enterprises of the forestry industry, using N. Venkatraman’s model. This model implies the division of business processes taking place in the enterprise into elements, the interaction between which leads to their internal transformation and their subsequent redefinition (figure 1).

![Venkatraman’s model](image)

Figure 1. Venkatraman’s model.

With the help of modeling, it was agreed that the wood processing enterprise creates specialized products for individual orders. The buyer places his order for products over the Internet (Level 1). Immediately after that, the data begins to be processed in a specialized order processing program. This data is sent to the workshop where the order will be manufactured. At the same time, the system already gives a command to prepare the machines for operation and, if necessary, orders materials
from suppliers. Further, with the help of another program, automatically, using generative design technologies, a product design is created. Drawings of the product itself are automatically converted into machine codes for subsequent work on machine tools. Smart hardware keeps track of all the parts you need to assemble so that they arrive at the right place at the right time. For this, electronic identifiers of materials and parts can be used. When all the necessary parts for assembly arrive at the workshop, the robots automatically start performing this operation. In some situations, additive processes can be used, such as 3-D printing. But, as a rule, they are best used for making small batches to order (Level 2).

The data of all production processes and equipment operation are monitored and recorded by sensors of the industrial Internet of things built into the equipment (Level 3). The required speed and quality level are optimized by automatic or semi-automatic artificial intelligence systems. This is achieved by changing the relevant operating parameters and processes (Level 4). The quality of products is checked automatically before shipment using measuring instruments (sensors) and artificial intelligence. The client is constantly informed about the status of the order through the tracking device.

What could be the result of the introduction of such smart technologies in production? This is, first of all, saving time, energy, increasing efficiency and productivity [4]. If anything slows down the production process, then the data reports will show it and, immediately, artificial intelligence systems will look for solutions to this problem. Production downtime is reduced and flexibility increases (Level 5). This gives grounds to completely redefine production for the use of digital technologies in the enterprise.

It is obvious from a specific example that the economy of the forestry industry cannot function without digital technologies, which, in turn, develop according to N Venkatraman’s model.

Digital technologies used in the forestry industry consist of software products and applications that facilitate the operation of the “smart production” system, work with large amounts of data, technical devices (drones, etc.), and developed robotic systems.

Currently, one of the world leaders in the supply of woodworking equipment for "smart production" is the Hexagon group of companies. The group of companies in general integration with their software solutions and other applications help in the operation of the entire system of "smart factories".

The WoodEye scanning systems are one of the developments used in the field of optimization and quality control of products of woodworking enterprises. They work in a variety of industries, from sorting all types of boards and other wood components on sawing, planing lines to flooring, veneer, furniture board, CLT and other products. The scanner works with both treated and untreated lumber, as well as a variety of hard and soft wood species. It gives a complete picture of the quality of the cut, allows you to adjust the sawing and drying technology. Thanks to its application, it has become possible to use the most complex raw materials. The coefficient of output of a structural beam from sawn timber will be 1.45 against the previously obtained 1.6. In this case, the coefficient for laminated veneer lumber is 1.25.

If we move from the field of forest industry to the field of forestry, then the concept of "digital forestry" primarily includes the processing and modeling of data sets [5]. When planning logging, it is necessary to carry out modeling (third level of N Venkatraman's model) in order to determine the volume of logging and the quality of wood. A system of end-to-end forest accounting has already been developed and is undergoing experimental testing, which will allow tracking timber from the place of harvesting to the release of finished products from it. Such digitalization will not only improve the accuracy of all measurements, but will also allow us to fight illegal logging.

4. Conclusion

Innovative strategies applied in the forestry complex are more and more associated with the introduction of digital technologies into production activities. The main tasks solved by the
implementation of such technologies are shown in figure 2. These are, first of all, the integrated use of raw materials, an increase in capacity and a decrease in the energy intensity of production.

![Figure 2](image)

**Figure 2.** The main tasks of introducing digital technologies.

However, there are still some difficulties in the application of digital technologies, both in the forest industry and in forestry. The high cost of implementation and the technological complexity of smart production systems are the main disadvantages of smart technologies and their application in the forest industry [6]. Quite large investments scare off business representatives. The technological complexity of systems puts forward a number of additional requirements, such as the availability of qualified personnel with the appropriate competencies, but over time this will be an interconnected and flexible production environment.

As far as forestry is concerned, the main difficulties are related to forest protection. Losses of forest resources from fires and the system of forest protection and protection indicate the need to digitize data on forest management. With the help of drones, a system for monitoring forest areas was launched, which collects data on deforestation [7]. But, due to the lack of coverage by operators of certain territories, problems arise with the possibility of diagnosing the equipment used. The same problem arises for logistics, when a significant proportion of traffic is carried out on forest roads, where there is no GSM coverage.

Based on the above examples, we can state that the forest industry has formed the prerequisites for organizational transformation inherent in the fourth and fifth levels of the digitalization development model. It provides the forestry sector with many new opportunities to improve productivity, efficiency and create new competitive advantages. Based on the identified levels of development of digital technologies at enterprises, a redefinition of the main processes towards their transformation is being created.

By 2030, it is planned to significantly increase the industry's contribution to the country's economy. There are prospects for combining information flows into a single chain of participants in timber logistics, increasing capacities for the production of cellulose, developing wooden housing construction and processing wood waste into biofuel [8, 9]. In this regard, projects related to the introduction of digital technologies are special [10, 11]. They will make it possible to comply with global trends in the field of industrial innovation, using unmanned aerial vehicles to monitor the state of forests, big data technologies, creating "smart industries". The preconditions for the transformation of the industry have been created.

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