Towards intelligent and sovereign use of data – Optimising wood-based panel production via data exchange along the supply chain

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Abstract

The idea of Industry 4.0 is now 16 years old, yet looking at several industrial sectors, many of its promises are still in their infancy [Da Silva, 2020]. While European industries have slowly modernised their legacy systems, cloud computing has seen rapid growth, and sensors have become ubiquitous. This trend has led to dramatic shifts in the power structure of several industries, where hyperscalers are cementing their superior position through sheer size. Companies such as Amazon, Google and Microsoft can offer their services particularly cost-effectively and are thus gaining more and more market power. Although the benefits of their offers are enticing, many companies refuse to use them, because they fear losing sovereignty over their data. Building on top of the developing European Gaia-X infrastructure [Braud, 2021], the German-Austrian lighthouse project champI4.0ns seeks to establish methods and tools to use production-relevant data (e.g., order, process, machine, raw material and laboratory data) effectively and efficiently along the supply chain while maintaining data sovereignty. The project focuses on the wood industry as it is a prime example of an industry characterised by raw materials with variable properties and global supply chains with a high degree of heterogeneity in terms of company sizes and digital maturity levels. Therefore, the wood industry is a perfect sandbox to develop and test the technologies that enable European production to move towards a future defined not by hyperscalers but by a diversity of service providers and users working together to turn data into value. In the champI4.0ns project, the developed methods and tools are applied in various use cases. One of these use cases concerns wood-based panel production and addresses a range of issues from traceability of wood along the supply chain to model-based process control and quality data exchange.

The wood industry is already very highly automated throughout. Process-control systems and process-optimisation systems have been used in production for many years [Bernardy, 2019]. Comprehensive online measurement technology is used to control and monitor plants and is standard in most installations. But a marked lack of measurement technology and information, especially where the

properties of raw materials and particles are concerned, still exists. The systems and metering components are also often realised as stand-alone solutions with few interconnection points. Individual production sub-processes, such as raw-panel production, have been employing systems like Siempelkamp's Prod-IQ® or Dieffenbacher's Prodacon to optimise and model processes for years. The sophistication concerning data availability that these systems deliver has meant that they have already been used in the past as the basis for research work [Andre, 2013; Riegler, 2013; Roeßler,2020; Thoemen, 2003]. Due to the variable properties of wood as a natural raw material and the complexity of interlinked manufacturing processes, setting manufacturing process parameters to optimise quality and efficiency remains challenging, especially concerning the often-lengthy start-up processes. Varying material properties and process malfunctions still require the intervention of plant operators despite the availability of recipe and machine parameters that experts have defined. Therefore, the settings used differ widely depending on the experience and qualification of those making the adjustments. The different material properties do not only affect the production of raw panels, they also have a knock-on effect on all downstream processes. The requirement to produce in an energy- and resource-efficient and consequently sustainable manner, for example, by increasing the recycled wood content, further complicates how processes are controlled. In addition, the known data collected internally and externally during the different stages of production, e.g., glue properties and laboratory results for intermediate products, are these days rarely linked across the process chain or used for process control. Other relevant data is not even consistently collected, as, e.g., wood-supply data or particle dimensions. Furthermore, customers of wood-based material manufacturers like the furniture industry involved in further processing are hardly ever informed about product-specific properties, which they could then use to optimise their production. But, even if more data were available, the sheer volume in conjunction with the limited capacity of employees to analyse the data and derive information from it presents hurdles that would make proper improvements to manufacturing processes and more sustainable, efficient production increasingly difficult or impossible to achieve in the future.

The entire supply chain, commencing with raw material suppliers, through the production of raw panels and their coating, to the manufacturers of the finished products, such as the furniture industry, must be involved in the project to meet these challenges. The core task is to link various data sources and derive relevant information. Suitable technologies are being investigated and employed to track products and materials along the entire supply chain. One particular goal is to collect relevant measurement data that is not available yet, (e.g., glue properties, particle dimensions) and to communicate data about finished products with minor quality flaws to downstream processors. With this information panel customers can optimise their own cutting patterns and avoid scrap. For example, data from upstream processes could be used to optimise direct coating. Additionally, by merging and analysing data from across the process chain, panel properties otherwise only determined through destructive methods can be inferred. Furthermore, the understanding of interdependencies between process steps is enhanced. And, in addition to all that, the project will also be pursuing the next logical step for artificial intelligence applications in the wood industry. Intelligent dashboards will enable plant operators to make better and more consistent decisions by presenting recommendations for action based on model-based process predictions. These models will be continuously improved to reduce necessary manual inputs and to

ultimately realise self-adapting automatic control loops. One of the approaches used to enable faster learning while maintaining data sovereignty is federated learning. This approach lets machines at multiple sites learn collaboratively without sharing raw data.

The presented advances are enabled by recording and linking production-relevant data from the entire production ecosystem across plant and company boundaries. Consequently, the process of manufacturing (coated) wood-based panels or products made from wood-based panels is tracked comprehensively. However, particular emphasis is paid to the sovereign use and the secure transfer and storage of data to ensure that specific know-how remains with the manufacturer while still allowing relevant data to be exchanged and used for the purposes of adding value. The champI4.0ns project is not starting from scratch where the sovereign use of data along the supply chain is concerned, it builds on the foundations laid by Gaia-X. The described use case is flanked by several other use cases in the wood industry, creating a comprehensive picture of the industrial requirements for an intelligent and sovereign use of production-relevant data. A project advisory board with perspectives from industry and academia is being established to ensure the applicability and transferability of project results. The project consortium invites other companies from the wood industry and beyond to discuss perspectives, ensure the relevance of results and thereby advance data use across plant and company boundaries.

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