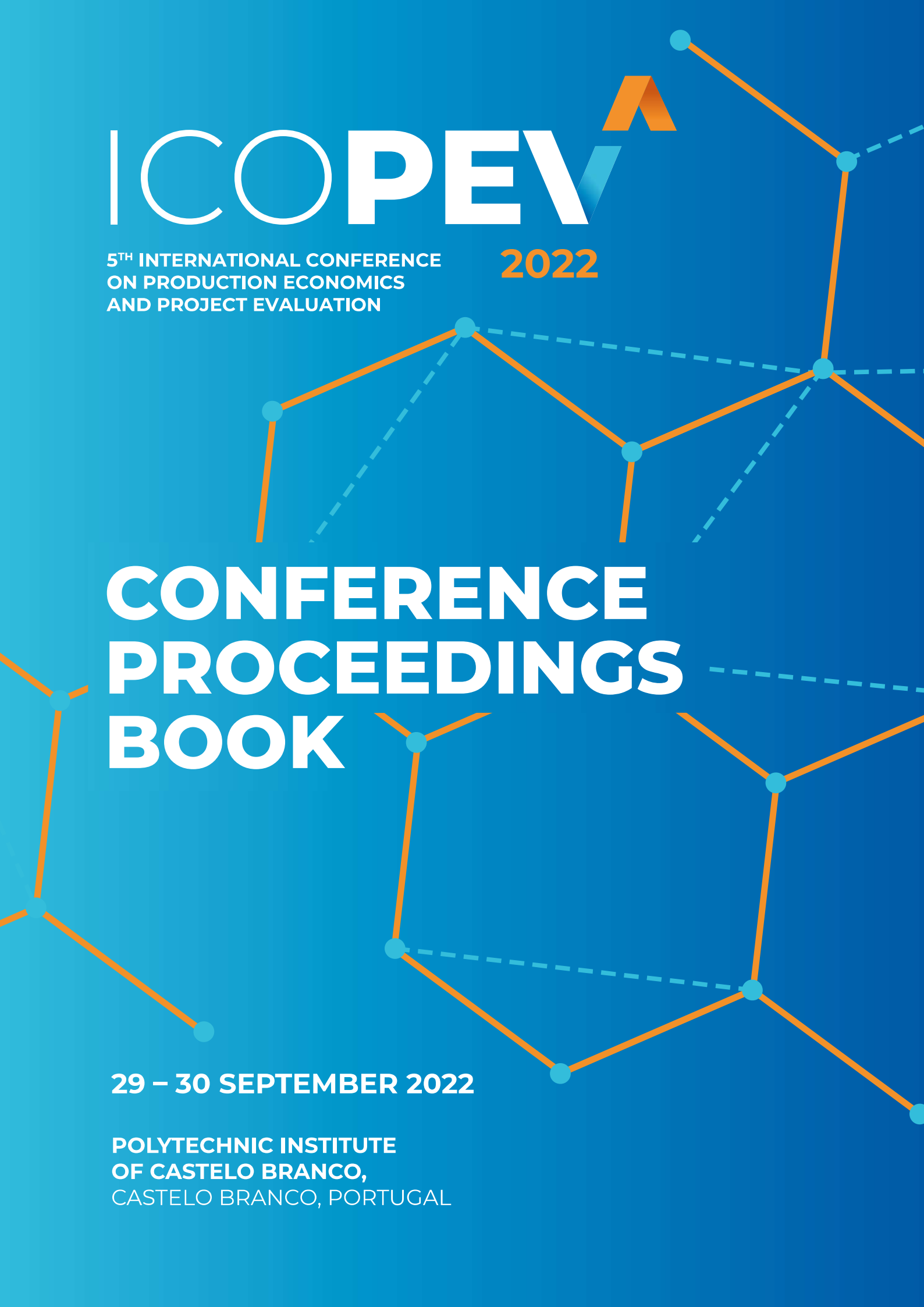




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INDUSTRY DIGITALIZATION, TECHNOLOGICAL DEVELOPMENTS IN FOREST MACHINES TOWARDS FORESTRY 4.0

Keywords:

Entrepreneurship, University Technology Transfer and Commercialization, Digital Entrepreneurship, Industry Digitalization.

Abstract:

This paper describes a case study, where the applicability of digital tools helps an SME to implement the concepts of Industry Digitization, reinforcing its entrepreneurial activity. We adopted a qualitative research methodology, through a case study, involving a research project for the digitization of the industry and technological developments in forest machines towards forestry 4.0. The case study reveals an example of technological improvements that solve a concrete problem and open the doors of a product to new markets, new customer demands, opening new market horizons through digitally based entrepreneurial practices.

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INTRODUCTION

According to Schumpeter (1934), entrepreneurship implies carrying out new combinations of a firm organization to produce new products and services, including using new sources of raw materials, new production methods, markets, and forms of organization, ultimately introducing innovations. Departing from this definition, the entrepreneurial process requires planning, investing, producing, and providing markets with innovative products and services, to create superior value to customers, and fulfil present and latent customer needs.

Entrepreneurship is critical in sustaining economic growth and development. Through the entrepreneurial process, new innovative companies are born and produce new products and services targeting customer desires, many times creating new needs. During this process, jobs are created, inequalities are reduced, people are empowered leading to positive outcomes in several social fields as well as economic growth. Therefore, is common to see governments, across the world, seeking to create the right conditions and implementing friendly conditions towards entrepreneurship (World Economic Forum, 2021).

Digital entrepreneurship is generally defined as the pursuit for opportunities based on the use of digital media, as well as other information, and communication technologies (Davidson & Vaast, 2010). Digitalization is the process by which digital technologies and infrastructures get woven into the fabric of the economy and society (Autio et al., 2019; Yoo et al., 2010). This process has been led through the miniaturization of hardware, increasingly powerful microprocessors, inexpensive and reliable memory, broadband communications, efficient power management, which enabled a digitalization of key functions and capabilities of industrial-age products, such as cars, phones, televisions, cameras, and books (Yoo et al., 2010).

This digital transformation had a transformative impact on innovation and entrepreneurship. Digital technologies and infrastructures are general-purpose technologies, once they can be applied in almost every sector in a wide range of functions and activities. On the other hand, they open new ways to organize business operations. Therefore, both, combined, make digital technologies and infrastructures an enabler of business model innovation (Autio et al., 2019) to ensure that the new productivity potential is fully deployed to the benefits of economic growth and societal welfare, policymakers need adequate metrics to monitor digital entrepreneurship. The measurement challenge of the digital entrepreneurship lays in the pervasive nature of the phenomenon itself that cannot be captured by count-based measures of individual-level entrepreneurial action. Therefore it becomes important to monitor the conditions which set the business context of entrepreneurs in the different EU countries. The European Index of Digital Entrepreneurship Systems (EIDES). Over the years, the process of digital transformation led to the emergence of start-ups that are currently among the major worldwide companies. Companies such as Amazon, Alphabet, Meta Platforms show the power of digital technologies in fostering entrepreneurship.

Therefore, the digital transformation and the emergence of new ways of doing business using digital technologies present a critical opportunity to foster new ventures. According to the European Commission (2015), three-quarters of the value of the digital economy will come from increased productivity, competitiveness, and job-creating ability of the existing industry and enterprises. Therefore, the advance of digital technologies and their transformational opportunities present a significant role in providing further jobs and the development of technology-rich businesses, enterprises, and public services enabling organizations that use these types of technologies to scale up at unimaginable rates and perform much better than their peers.

Departing from this background, this study uses a case study methodologic approach to depict a digital entrepreneurial venture. The use of this approach was found the most suitable for the study's objective, i.e., to describe and explore a digital entrepreneurship venture in its real-life context in which it occurred (Yin, 2009), nevertheless also to produce a framework for academics and practitioners and provide insights regarding the digital entrepreneurial process and the entrepreneur mindset. Therefore, departing from this objective, the used approach, can also be seen as instrumental (Stake, 1995), once it provides a real-life roadmap into building a digital entrepreneurial venturing.

This study is organized as follows: section 1 contains the introduction, section 2 is reserved for literature review, section 3 explains the case study, and section 4 contains the final remarks.

LITERATURE REVIEW

Traditionally, entrepreneurship implied some sort of new combination of resources or new types of organizations to introduce innovation, radical or incremental. However, the increasing adoption of digital technologies and their functionalities reshaped business strategies and competitive environments, structures, and processes (Bharadwaj et al., 2013; Zhao & Collier, 2016), fostered changes in the entrepreneurial processes and the emergence of digital entrepreneurship. Therefore, understanding the facilitators of digital entrepreneurship became critical to enhancing the entrepreneurial process. Moreover, these facilitators have been focused on two main ideas, namely, how digitalization transforms entrepreneurship and new ventures creation process and, the entrepreneurial opportunities generated throughout digital technologic innovation (Sahut et al., 2021).

The adoption of digital technologies put forward significant changes in entrepreneurship in the overall economic sectors. The emergence and development of digital technologies enabled and fostered new ways of collaborating, the redesigning of the entrepreneurial process, changing traditional business models to new ones (Steininger, 2019). Moreover, they powered the digital economy, enabling the emergence of new opportunities with higher business value potential and reduced entry costs for new companies (Zhao et al., 2015).

As digital technology develops, new ways of doing business emerge, fostering economic development through the emergence of start-ups. Yet, understanding the context and reasons within digital entrepreneurship becomes of critical relevance for the overall participants in the economic process, particularly for governments, as they put their efforts into fostering the digital economy to support job creation and economic growth. Departing from this stance, recommendations to accelerate digital transformation implies the need for building genuine generators of innovation and to inspire and mobilize partners towards an overall environment focused on facilitating the creation of value. Setting up this process requires providing leadership education, with relevant senior-level training and talent development, to motivate exchange and towards industry leadership (European Commission, 2016), and to embrace new ventures and transform the existing ones. Therefore, digital entrepreneurship and consequently, digital enterprises use novel digital technologies intensively, including big data, mobile and cloud solutions, and social media to, ultimately, enhance business performance, by means of improvements in business operations, new business models, and sharpen business intelligence in their relationships with the overall stakeholders (European Commission, 2014).

Therefore, unsurprisingly, scientific literature on entrepreneurship gained an increasing focus on digital entrepreneurship, at the same pace as digital technology develops. Nevertheless, the

emphasis on digital entrepreneurship has been transversal to all economic players, including practitioners, such business executives as well as governments. For instance, according to the European Commission, 81% of the managers say that platform-based business models will be core to their growth strategy, and 90% of chief executives, in sectors such as the automotive and healthcare industries, identify data analytics as having high-value prospects. On the other hand, 54% of European jobs are at risk due to key technological advances, 77% of companies consider missing digital skills as the key hurdle to their digital transformation, and only 4% of companies ensure that their training efforts are aligned with their overall objectives (European Commission, 2016).

Despite the changes that the evolving of digital technologies brought to entrepreneurship, some aspects continue to be at the centre of entrepreneurial activities, such as opportunity identification and exploitation (Shane & Venkataraman, 2000; Short et al., 2010; Steininger et al., 2022; Zahra & Dess, 2001). However, the emergence and development of digital technologies provided entrepreneurs with additional tools towards increasing business performance and, despite the growing competitiveness, additional instruments to increase the rate of survival of new ventures have emerged. Moreover, in this process, aspects such as the digitalization of services and products allowed profound changes in the ways that companies organize for innovation (Yoo et al., 2010) and helped the emergence of greater levels of unpredictability as well as to break new ground of growth and innovation (Huang et al., 2017; Nambisan, 2017)

Moreover, the process of new technologies adoption in the entrepreneurial process led to digitalization which brought an increasingly, broader, diverse, and evolving number of partners in the entrepreneurial process, including a dynamic set of agents with a set of varied goals, objectives, and competences (Nambisan, 2017), including a set of types of digital infrastructures, which includes digital services and products (Lyytinen et al., 2016), digital marketplaces (Rayna et al., 2015; Smith et al., 2016), digital marketing tools (Dabas et al., 2021), digital platforms (Tiwana et al., 2010), crowdfunding systems (Aldrich, 2014; Mollick, 2014), digital artifacts (Ekbja, 2009), or social media platforms (Fischer & Reuber, 2011). These changes and additional tools brought up new opportunities as well as new threats for entrepreneurs. The production, distribution, and consumption of digital information enabled new types of interactions and exchanges of information, which led to the emergence of new opportunities and, consequently new ventures (Sahut et al., 2021; Song, 2019) as well as new ways to generate value for sellers and consumers.

Departing from the above framework, the introduction of digital technologies in the entrepreneurial process have led to a reshaping of the overall entrepreneurship environment. Digital tools enabled the generation, processing, and sharing of information regarding the markets and the overall business context, which made the process of designing, creating, producing, promoting, and selling new and innovative products and services become much more expedited and targeted on the customer. These changes enabled the emergence of non-traditional business models that reshaped the entrepreneurial landscape, increased wealth creation, with positive effects on economic and social development.

CASE STUDY – INDUSTRY DIGITALIZATION, TECHNOLOGICAL DEVELOPMENTS IN FOREST MACHINES TOWARDS FORESTRY 4.0

This section describes a case study where the applicability of digital tools aids a SME to implement the concepts of Industry Digitalization (Industry 4.0) in their products, contributing not only for technical improvements but also improves its entrepreneurial activity.

The SME in analysis is a forestry machines manufacturing, that produces harvesters and wood processors heads for the Iberian, Brazil, and Indonesia regions. One of the pillars of the company is the internationalization, however, needs to overcome some barriers such as the technical support and maintenance outside its headquarters. For this, a research project (SMARTCUT¹) is in progress that allows the development of technologies that support telemaintenance and remote support tasks to machines that work in the forest in different regions of the globe. This is perfectly aligned with the concept of Forestry 4.0, where all interveniens in the forest ecosystem are connected.

As illustrated in Figure 1, nowadays connectivity and cooperation between all agents is important for a smarter management of processes and natural resources, where there is knowledge of the status of the entire production chain, from the forest to the final consumer. All this is only possible due to the existence of intelligent sensors, inside the forest and the machines, the automation of processes, the edge computing that can bring the works of artificial intelligence closer to the products, the concept of all connected devices provided by IoT, the importance of low latency and high bitrates provided by 5G, cybersecurity to ensure infrastructure resilience and integrity, cloud computing among other emerging technologies.



Figure 1
Forestry 4.0 concept.

One of the activities to enhance the technological capabilities of forest machines produced by this SME is the development of new hardware modules that allow communication with intelligent sensors and actuators through a CAN Bus network, a protocol used for vehicle communications. On Figure 2 is shown an electronic board, named as Electronic Control Unit (ECU) for remote connections over CAN Bus communication protocol, between machine controller and sensors/actuators on the end tool. This small ECU allows communication with only 4 wires, signals, and power, between devices instead of dedicated cables, typically with 24 pairs of wires. It is a

1. SMARTCUT—Remote Diagnosis, Maintenance and Simulators for Operation Training and Maintenance of Forest Machines, financed by Portuguese funds through the program COMPETE 2020, under the grant number POCI-01-0247-FEDER-048183.

demonstration of technological improvements but also of innovation that ensures competitiveness with other brands and allows the company into new markets.

Another ECU is shown in Figure 3, this one dedicated to the operator's joysticks, to enable standardized communications with the controller, ensuring robustness, reliability, and safety in operations.

Both ECUs will be a new product marketed by the company, which overcomes an existing limitation in terms of connectivity and responds to the requirements of Industry 4.0. The modules provide new technological capabilities to forest machines, improving connectivity within the machines, but also with the outside via CAN Bus gateways – mobile networks such as the LTE. The deployment of ECUs is just one example of technological improvements that solve a concrete problem and open the doors of a product to new markets, new customer requirements and, of course, increase the company's visibility.

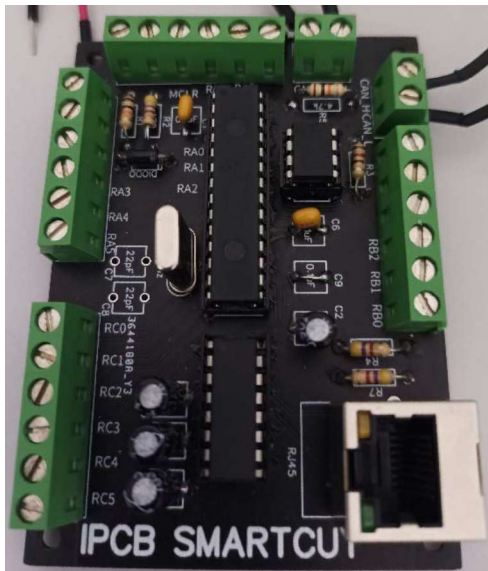
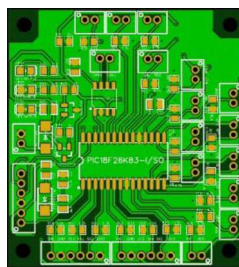


Figure 2

CAN-Bus Electronic Control Unit for Input/Output remote interfaces.



a)



b)

Figure 3

CAN-Bus Electronic Control Unit for Joystick interfaces. a) Joystick with ECU, b) PCB design.

FINAL REMARKS

Digital entrepreneurship is generally associated with the identification of opportunities in the context of ICT technologies (Davidson & Vaast, 2010). However, digitization needs to be understood as a broader process through which digital technologies and infrastructures connect interactively with the economic fabric and society itself (Autio et al., 2019; Yoo et al., 2010). In an industry 4.0 logic, this process encompasses hardware miniaturization, the development of increasingly powerful microprocessors, associated with a broadband communication system, allowing the digitization of the main functions and capabilities of industrial-age products (Yoo et al., 2010)

The case study presented explores the digitalization process in Industry, through new technological development processes in Forestry Machinery and Equipment. It is also the applicability of digital tools associated with tradable products in an SME, allowing it to improve its entrepreneurial capacity and competitiveness in the market.

Providing new technological capabilities to forest machines, improving their connectivity (internal, but also with the exterior through CAN Bus gateways – mobile networks such as LTE), the case study reveals an example of technological improvements that solve a concrete problem and open the doors of a product to new markets, new customer requirements and, of course, increase the company's visibility.

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