

EUROPRENEURSHIP & SUSTAINABILITY

Scientific editors

Tomasz Kusio
Alexandra Borges
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Introduction

The monograph “EUropreneurship and Sustainability” follows the 1st International on-line Scientific Conference “EUropreneurship & Sustainability”, organized by J. Retinger Center for European Studies of the Cracow University of Economics in Poland and Polytechnic Institute of Viana do Castelo in Portugal, with the collaboration of the Institute of Entrepreneurship Development in Greece, held on-line on November 28th, 2023.

The purpose of the development of the study was an attempt to present the recognized potential presented by young scholars of courses on entrepreneurship, innovation and sustainable development issues. The potential resulted in the presentation of a brief study, the content of which reflects the scientific interests of these young academics. The specific goal of the creation of the monograph on entrepreneurship and sustainability was to obtain young people’s views on the topics of sustainability and entrepreneurship.

After a theoretical introduction presenting the EUropreneurship concept, the monograph is divided into two sections: the first is related to entrepreneurship and the second one is related to sustainability.

Section I begins by presenting entrepreneurial perspectives in different countries in Europe, moving later to more applied research in the area of entrepreneurship. The first studies present considerations in the field of entrepreneurship in different European countries such as Romania, Georgia, Poland and Portugal. In the case of Romania, considerations are presented on the level of awareness of entrepreneurs in the field of sustainable development, which plays an increasingly important role not only in the direction of future entrepreneurial activities, but also in the existing businesses. In the case of Georgia, entrepreneurship is fundamental in terms of its role in building the country’s prosperity. This decidedly more macroeconomic dimension of taking up the subject of entrepreneurship was compared with the impact and opportunities provided by European Union (EU) funds. On the other hand, the example of Poland, and the textile and fashion industry in particular, inspired the authors to take up the topic of consumer awareness, particularly in the face of the challenges of sustainable development.

In addition, the study gives the prospects for the development of this market given the turbulence caused by the pandemic period. Among the other issues presented in the section on entrepreneurship, is the example of the pharmaceutical industry in Portugal, where authors consider the issues of e-commerce in pharmaceutical products in Portugal. There is also the example of Southeastern Asian case of Indonesia with its impact of digitalization on entrepreneurship. The authors investigate the interplay between technological advancements and entrepreneurial dynamics within the Indonesian context, to offer a nuanced perspective on the country's digital economy and its impact on entrepreneurial ventures, particularly startups, which are a vital and dynamic part of this landscape. Afterwards, the section on entrepreneurship includes chapters that present considerations on the impact of proper human resources management on business development, as well as the management of a specific type of project, such as the organization of an event.

Section II presents generic studies on sustainable development, the energy crisis and health in Europe, as well as specific technical applications related to improving energy efficiency, and the transparency of information to be reported by companies about their actions and contribution to the sustainable development.

The first chapter entitled *Energy Sector Crisis and its Implications for Public Health and Sustainable Development in Europe* aims to scrutinize the challenges confronting Europe in devising sustainable energy strategies and public health sector strategies that can alleviate the impact of the energy crisis, while at the same time promoting sustainable development across all sectors. The study *Promoting energy efficiency in an Eco School Environment* aims to demonstrate the importance and effectiveness of education for sustainable development (ESD) at Instituto Politécnico de Viana do Castelo (IPVC), in Portugal, through the presentation of two projects developed by students, which intend to improve the energy efficiency in the institution. The work *The Role of Microalgae in a Sustainable Development* presents the development of a project of a Photobioreactor from the first design to its tuning and operation. The main idea of this project is to build a photobioreactor that will response to the requisites to produce a specific type of microalgae. The main work activity is to find the right technologies for this project, making a perfect integration and control system. This equipment is important and contribute(s) to environmental sustainability and innovation. The chapter *Produced Energy Storage System at the Braking of a Train* proposes an onboard energy storage system capable of storing the energy generated from its available electrical braking functionality. This stored energy will be used during train's accelerations, thus achieving peak shaving. This innovative idea contributes

to energy sustainability. A study energy storage systems, DC/DC converters, as well as simulation and experimental work. In the chapter *The evolution of Corporate Social Responsibility disclosure and its relationship with the Sustainable Development Goals*, the authors review the main standards and regulatory initiatives that have been undertaken by several international organisations. They also analyse the disclosure of social and environmental indicators by Portuguese-listed companies in the pulp, paper, and paperboard sector, between 2017 and 2019, and their contribution to the implementation of Sustainable Development Goals (SDG). Results reveal a high disclosure of environmental information, which may be associated with the increased social scrutiny that companies in this sector have in these matters, and a strong connection between the indicators disclosed in terms of sustainability reporting and the SDG to which companies commit themselves. In the chapter *The relevance of environmental accounting. An implementation proposal in the automotive sector*, the authors analyse the evolution of environmental accounting over the years and the process of implementation of an environmental accounting system in an automotive company. They also develop a proposal for the implementation of an environmental accounting system with the main procedures to be followed. The results highlight the need of knowing in detail the specificities of the productive activity of the company, the human resources, and the information system. The incorporation of environmental issues in the companies' strategy and their reporting through new formats, provides valuable information on companies' environmental awareness and commitment. The chapter *Sustainability in the client's policy-related activities* explores various strategies for small and medium-sized enterprises (SMEs) to enhance their business operations that are centered on fostering long-term relationships with customers, broadening the overall consumer base, and turning existing customers into clients. It is organized into several main sections that highlight specific tools for overcoming the challenges described: the critical importance of adopting a client-oriented approach, innovation, and eco-friendly practices in the business management. The results obtained from the research indicate that implementing mentioned strategies can significantly contribute to sustainable SME's grow and succeed in today's competitive business world. The study *Industrial use of bioenergy and high-value molecules extracted from winemaking by-products Ecological aspects* was developed to explore the potential applications of winemaking sub-products, known as grape pomace (GP), which have incomplete exploitation and part of which is dumped as biowaste. In European countries, the winemaking industry converts 22 million tonnes annually of grapes into wine, giving rise to 5 million tonnes of GP as a product. The goal of this research was to examine the

antioxidant capabilities of GP polyphenols in order to identify useful industrial uses. When compared to other biomass heating values, the heating value results of GP samples after the fat and polyphenol extraction, which are between 16.9 and 17.2 MJ/kg, show that GP extracted residue has the potential for energy recovery. This by product offers fresh prospects for alternative industrial uses when considering the quantities of GP that are produced each year and its chemical characteristics.

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EUropreneurship for Sustainable Development

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Abstract

The objective behind the creation of a short text on the issue of EUropreneurship is to present considerations on the current understanding of the terms entrepreneurship and sustainable development, especially focusing on the social and economic activities of young people, as well as their environmental awareness. As a result of theoretical considerations, the importance of entrepreneurial activities in a European perspective is highlighted, as well as how problems of sustainable development affect entrepreneurial activity. The short text is an extension of the book's introduction.

Keywords: entrepreneurship, sustainability, innovation, commercialization

1. Entrepreneurship

Entrepreneurship is a significant topic in business management research. The large number of articles and books based on this topic has led to the proliferation of different definitions of entrepreneurship. Ratten (2023) explores these definitions and numerous types of entrepreneurship that differ in the way they are conceptualized and used in practice and in education. According to Ratten (2023), one of the most well-known and cited definitions of entrepreneurship is “how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated and exploited” by Shane and Venkataraman (2000).

Entrepreneurship has an important role in social and economic developments, encouraging society to look for opportunities and take initiatives (O'Brien, and Hamburg, 2019). Regardless of the adopted definition, entrepreneurship has been traditionally recognized as a mechanism to generate economic benefits and stimulate economic development (Segal et al., 2005).

However, in the last decade, society has been subject to growing change due to technology, that has driven globalisation and demographic changes (O'Brien and Hamburg, 2019). Simultaneously, the emergence of sustainable development brought through the adoption of the '2030 Development Agenda' approved in 2015 by the United Nations (UN), has pointed out that entrepreneurship should not be based only on generating wealth, but also on social and environmental aspects (Terán-Yépez et al., 2020).

The recognition of the importance of entrepreneurship for value creation for the society as a whole has led it to become a critical area for policy makers and several policies have been developed at European, national and local level (O'Brien, and Hamburg, 2019). Over the past decades, entrepreneurship policy initiatives have shifted the emphasis from buffering-oriented initiatives (business incubators and science parks) to resource mobilisation (subsidies and grants) and bridging-oriented initiatives (venture investors and accelerators), and then towards high-growth and capability-boosting initiatives (firm-specific efforts to boost firm-level capacity for innovation and growth) (Autio, 2016). After these initial targeted specific policies, holistic entrepreneurship policy approaches are being adopted and the entrepreneurship action plan 2020 incorporates entrepreneurial education, entrepreneurial culture and business creation and growth (O'Brien & Hamburg, 2019). These developments reinforce the importance of strengthening the links between higher education institutions, society and businesses to increase the transfer of knowledge to where it can be applied. Entrepreneurship policy considers that entrepreneurial skills and culture need to be developed in conjunction with education, communities, businesses, and research organisations in order to benefit society as a whole (O'Brien & Hamburg, 2019).

However, entrepreneurship referred to the social dimension is also mentioned when sustainability is discussed (Westman et al., 2023). A new discipline called "sustainable entrepreneurship" has even been developed by combining entrepreneurship and sustainable development (Gupta et al., 2023). With an emphasis on minimizing adverse effects on society, the environment, and the effective use of products and services, circular business models sparked intrapreneurship and entrepreneurial initiatives in the so-called sustainable economy (Schaper, 2016).

Promoting economic growth has been seen as a goal of entrepreneurship, while social and environmental issues have been ignored (Sarango-Lalangui et al., 2018). However, some academics argue that entrepreneurship should not be centered only on generating wealth due to the rising attention that governments, non-governmental organizations, researchers, and enterprises are providing to environmental challenges and the creation of the concept of sustainable development (Aghelie et al., 2011). Additionally, some researchers claim that entrepreneurship is a tool that may guide many sectors of the economy toward environmental sustainability (Shepherd & Patzelt, 2011; Dean & McMullen, 2007). This sustainable entrepreneurship claims sustainable development and is the cornerstone for creating sustainable company models because entrepreneurs can recognize long-term entrepreneurial potential (Sarango-Lalangui et al., 2018). Sustainable entrepreneurship is thus “the investigation of how possibilities to bring prospective products and services into presence are unearthed, formed, taken advantage of, by whom, and with what economic, psychological, and cultural” (Cohen & Winn, 2007). Sustainable development was defined in 1987 in the UN World Commission on the Environment’s Brundlandt Report ‘Our Common Future’ (Larson, 2007) as a development that meets the current needs of society without detracting from the ability of future generations to thrive (Reis, 2011). The concept of sustainable development combines two important goals: (1) ensuring the safe life and well-being of all people – the goal of development, (2) living and working with the biophysical constraints of the environment – the goal of sustainable development (Larson, 2007), which in the long perspective, has the strategic dimension.

2. Sustainable Development

Strategy, according to A. Chandler, defines long-term objectives that correspond to the company’s courses of action and also specifies the resources necessary to achieve the adopted objectives (Burnes, 2004). According to R.S. Kaplan and D.P. Norton (2001), strategy, in addition to vision, values and mission, should evolve over time to meet the changing real world conditions. Strategy refers to how an organisation intends to create value for shareholders, customers, communities (Kaplan & Norton, 2011). A strategy, or in other words a concept of activity (Robert, 2006) is, among other things, sustainable development, which should be integrated into the main strategy of the company. In macroeconomic terms, this is obliged by the state of the environment – e.g. excessive carbon dioxide pollution of the atmosphere (Jaźwińska, 2016). This aspect implies taking steps towards decar-

bonisation (Muradov, 2014) and the use, as an alternative, of renewable energy sources and the use of low- or zero-carbon technologies by companies (Morris et al., 2011). Sustainability is typically more closely related to an organization's all-encompassing strategy. It considers logistics as well as the entire production process (Sreenivasan & Suresh, 2023). For instance, a green product made from recycled materials is more likely to be bought (Jaźwińska, 2016). There is no denying of the impact of climate change on our planet's priceless but limited resources (Haleem et al., 2023).

In the past decades, the concept of sustainable development (SD) came into focus and has increasingly gained attention at all levels. Environmental education programs are seen as instrumental in promoting SD, since the preservation of the environment depends on ecological awareness, which depends on education. Higher Education Institutions (HEIs) play a central role in education for sustainable development (ESD) since they provide the knowledge and skills for students to implement sustainable solutions (Martins et al, 2006; (Caeiro et al., 2020).

Today, climate change is a reality that can change the balance of ecosystems. When talking about sustainability and innovation, it is important to keep in mind that we must have a different vision and find new solutions. The information needs of stakeholders have changed significantly over the years with the growing environmental awareness of society. This led to considerable changes in companies' behaviour due to the information needs of the various stakeholders focused on environmental and social performance. Regulation on corporate social responsibility disclosure, usually designated by non-financial reporting, evolved to promote comparability and relevant information on these matters. The awareness of society about environmental problems has led companies to engage in corporate social responsibility (CSR) strategies worldwide. CSR strategies imply the inclusion of the environmental dimension in decision-making processes. Non-financial reporting and environmental accounting are fundamental in providing information on companies' CSR goals, performance, and strategies. Environmental accounting is a strategic and relevant tool in dealing with environmental issues. In this context, it is important to have comparable information for companies' stakeholders, public opinion, and society. While performing and providing any kind of business, all the leading managers and marketers constantly face a problem on how to increase the number of clients and keep them as long as possible. But to accomplish this, new and modern approaches are needed to bring the business to the next level (Baskentli et al., 2019; Burrit & Schaltegger, 2010).

3. Conclusion

Sustainability, just like entrepreneurship, is undergoing an evolution in meaning and is beginning to go beyond just a term strictly related to environmental protection. Sustainable development is being referred to as balanced development, so that relating the term to strategy is gaining in importance. Long-term, sustained, and multi-directional development relate to the notion of sustainability, thus outlining, as it were, patterns of scalability for startups. In this sense, businesses that are desirable are based precisely on patterns of attention to strategic longevity. Desirable businesses are also those whose growth strategies are sensitive to renewable energy issues, or energy efficiency in general, given resource sustainability.

EUropreneurship is a concept that was generated from the influence of noticing the specificity of the influence of active human attitudes on the changes made in the environment, especially the European one. While the phrase European environment may raise questions about the territorial scope or context in which it is placed in discussions, terms such as European Research Area or European Space already seem to be more common. Influencing and changing reality through active attitudes is a quality of an individual, or more precisely of an enterprising person, often young, open to the new and unknown. Observing how much change has been induced in a global perspective, one can relate the making of these changes to the generation and materialization of ideas of these young talented people, whose education is accompanied by a desire to experience, to put creative ideas into practice. Within this scope, EUropreneurship and Sustainability aims to disseminate to academia and to society in general, the applied research that young researchers with links to different European HEIs have been developing in the areas of entrepreneurship and sustainability, contributing to improving the general well-being, in a context of sustainable development.

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PART I: EUROPRENEURSHIP

Sustainability and Entrepreneurship: Entrepreneurial Attitude of Romanian Start-ups

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Abstract

The study on sustainability and entrepreneurship focuses on the entrepreneurial attitude of Romanian start-ups and the impact on the countries' economic and social sustainability. The main objectives of the research were to evaluate the degree of awareness of Romanian entrepreneurs regarding sustainability, to analyze the sustainable practices implemented by start-ups and to evaluate them on the business environment and local communities. The main results of the study highlighted that a significant number of Romanian start-ups adopted a sustainable entrepreneurial attitude. These companies tend to integrate environmentally friendly practices into their operations, promote social responsibility, and develop innovative solutions to social and environmental problems. In addition, what has been observed is that these sustainable practices led to increased competitiveness of start-ups in the market and the creation of relationships with customers, investors and local communities. However, the study also identified important challenges faced by start-ups in pursuing sustainability and entrepreneurship in Romania. Lack of financial resources, knowledge and adequate infrastructure were identified as the main obstacles to implementing sustainable practices. Also, awareness and education of entrepreneurs on the importance of sustainability and its long-term benefits and other crucial aspect that needs attention. The study emphasizes the importance of promoting a sustainable entrepreneurial attitude among Romanian start-ups and the need for governmental support, non-governmental organizations, and the business community to develop and implement programs and policies that facilitate this process. These efforts can contribute significantly to increasing economic and social sustainability in Romania and to promoting a more responsible business environment and higher awareness of environmental and social issues.

Keywords: entrepreneurship, sustainability, innovation, commercialization

1. Introduction

The entrepreneurial ecosystem in Romania is developing. Although this country has a lot of potential, the dynamics of the changes needed to promote a more innovative economy and the digital society are quite low. The assessment of experts on the current situation of the entrepreneurial ecosystem indicates that the biggest barriers to its development are the lack of trust, predictability and transparency, as well as access to finance and the limited capacity of higher education institutions to play an active role as a stakeholder in the entrepreneurial ecosystem. In addition, inadequate communication between ecosystem stakeholders and poor coordination of government decision-makers slow down the process of ecosystem evolution. Undoubtedly, there are islands of excellence, and access to a pool of talents with a proper education and this is one of Romania's greatest strengths. However, brain migration, insufficient funding opportunities and reduced entrepreneurial culture at university level require radical policy measures to make the current situation change faster.

Current approaches to entrepreneurship have brought to the multidimensional and interdisciplinary perspectives, sometimes united by consensus, sometimes marked by the absence of conceptual convergence. However, beyond a wide spectrum of reporting, the understanding of entrepreneurship, has been directed into a constant of specialized research. According to current research, the emphasis has been made on a referential concept for the business sphere – sustainable entrepreneurship; a phenomenon regarded as exponential for start-ups (Fiore, et al., 2013; Bjerke & Hultman, 2013). At this level, Pascual et al. (2011) emphasized that tangible solutions are not only the work of large organizations, but also of new businesses, insofar as sustainable entrepreneurs manage to identify pertinent answers to problems related to “the environment, social and economic value”. Thus, Romanian entrepreneurs want to appeal and explore entrepreneurial marketing practices that have offered, over time, interesting examples of new business evolution. This current opinion is also supported by Andersson & Tell (2009) who convey the very idea that, in a broader context, relying substantially on the personal traits and values of the entrepreneur, entrepreneurial marketing can be seen as an evolution of new businesses in explaining organizational performance and business sustainability. Moreover, the imperative of a pragmatic and up-to-date approach is brought to the fore by Hockerts and Wustenhagen (2010), which conclude that existing studies are, in particular, theoretical and that, consequently, future research will have to follow up on more applied approaches – “additional information can be obtained through comparative analyses of sustain-

able entrepreneurship initiatives in small and large firms, case studies are, in this respect, a priority”.

Starting from these premises, one can observe the possible links between a wide range of marketing practices used by start-up entrepreneurs and sustainable entrepreneurship. In Romania, the issues of sustainability and sustainable entrepreneurship in the context of start-ups are addressed. It had been pointed out that most of the studies focused on sustainable entrepreneurship focused mainly on sustainable development and corporate social responsibility, in other words on mature organizations.

Small businesses have been much more affected by global dynamics than large companies, especially due to the fact that they are permanently under the constraint of limited human, material, financial and technical resources and are facing a shortage of knowledge and marketing skills. Consequently, in order to adapt to market conditions and from the desire to guide their businesses towards sustainability and competitiveness, Romanian entrepreneurs had to resort to innovative marketing models, to reorganize their promotional efforts and to make the best possible use of their available resources.

In today's competitive environment, innovation is an indispensable concept for economic and social growth, but especially sustainable. The continuous change in economic and market processes now requires an increasingly strong collaboration between universities, research actors, large companies, SMEs, and innovative startups to generate wealth and economic growth (Hakala et al., 2020). It is therefore of fundamental importance to create open and dynamic entrepreneurial centers capable of attracting human capital, where more relationships capable of bringing knowledge and creating values can take place.

Despite being small entities, start-ups differ from small businesses in terms of growth potential and can, in a short time, become very large companies. In a context of crisis and due to the emergence of ICT infrastructures such as open source software, cloud hosting, real-time collaboration, logistics services – which significantly reduced the costs of launching a company – there has never been a better time to become an entrepreneur.

Given the uniqueness of each ecosystem, one can identify few generic factors that determine the birth and growth of an entrepreneurial ecosystem:

- strategy on supporting entrepreneurship,
- market access,
- access to human capital,
- access to financing,
- support and mentorship,

- developing an entrepreneurial culture,
- networking with the economic environment and the market.

Decision-makers developing the strategy on supporting entrepreneurship play an indispensable role for start-up ecosystems; with their role as “modelers” of the legislative framework, they can make the environment more entrepreneurs-friendly (Robson et al., 2009). Regulatory obstacles, administrative practices and environmental restrictions can increase fixed costs and discourage entrepreneurs from starting a start-up. To improve the corporate “context”, reducing regulatory burdens is fundamental. As regulatory adoption increases over time, the latter may represent an increasing and disproportionate cost for start-ups. Simplifying tax and administrative codes, facilitating payment systems is becoming a necessity. In fact, many entrepreneurs consider that the complexity of fiscal and administrative obligations is such an important burden on their activities that it jeopardizes the start of entrepreneurial initiatives. To allow for a greater proliferation of start-up activities, it will be necessary to focus on resizing the time required to register a company, the number of bureaucratic steps and the number of regulations and fees. Removing barriers allows for better market access: entrepreneurial opportunities will be greater in decentralized economies, with markets operating freely, as entrepreneurs will be able to operate more flexibly. The result is a dynamic, attractive, and competitive ecosystem. Moreover, to make the ecosystem attractive, a necessary element is the presence of human capital and the cultivation of its growth. Thus, Romania begins to focus on this principle, as this will determine the greater presence of serial entrepreneurs, an increase in the average level of training, as well as a better degree of specialization in the workforce, which is necessary and desired in Romania. Four phases that startup ecosystems go through have been identified: activation, globalization, expansion, integration (table 1.1).

Table 1.1. Phases characteristic of the life cycle of an entrepreneurial ecosystem

Phases of ecosystem development	Phase 1: Activation	Phase 2: Globalization	Phase 3: Expansion	Phase 4: Integration
Fundamental aspects	Entrepreneurship; education and entrepreneurial culture; financial facilities to initiate business			
Aspects focused on ecosystem development	Creating a local entrepreneurial community; identifying funding opportunities	Connection to start-up hubs globally; import of entrepreneurial know-how	Supporting business scaling through financial mechanisms; removing barriers to growth	Adapting business models to different markets and customer segments

Source: (Empoli, 2021).

2. Literature review

2.1. Sustainability dimensions

The recent theoretical perspective on sustainability has embedded a variety of definitions and research directions that have often resulted in the proliferation of dissenting opinions. However, the lack of consensus in defining the term has not irretrievably affected the emergence of some basic elements explained and developed by researchers, practitioners, and entrepreneurs (Bell & Stellingwerf, 2012). Thus, it was possible to consolidate three main dimensions of sustainability, explicitly highlighted by Elkington (2004), namely: people (people), planet (environment) and profit – the three P's that define the *Triple-Bottom-Line* (TBL) concept.

The term was first proposed by Elkington (1994) and later redefined by researchers who had as an area of interest the sustainable development and reconfiguration of business practices based on value. In Elkington's view, sustainable entrepreneurship must show a combined interest in economic prosperity, the quality of the environment and social justice.

The first element – *people (people)* – marks the special value of the workforce, of the recruitment, selection, employment, and training processes of the most suitable candidates for a particular job, of respect for human rights and of the simultaneous fulfillment of individual and community needs (Koe & Majid, 2014). In Romania, ensuring a positive working climate for employees, a perspective of mutual benefits in achieving common targets and responsible organizational actions is a priority as the country is currently focusing on the development of sustainable entrepreneurship. At the same time, assuming a responsible vision in relation to the reference community must become a fundamental point in the strategic planning of the organization.

The second element – *planet* – integrates environmental aspects that require particular attention, even though 'environmental problems can be very different, including within the same industry' (Schick, et al., 2002). Thus, the role of organizations in sustainable consumption starts from the products and services they offer, from the life cycle and the value chain and equally.

The third element of the model – *profit* – differs, in essence, from the traditional approach that profit is the economic value derived from the 'deduction of the costs of all inputs including the cost of capital' (Bell & Stellingwerf, 2012). TBL operates with another profit understanding that the sustainability of the business is reflected in both the purely economic benefit and the societal benefits.

And in such a perspective, it goes without saying that entrepreneurs cannot operate on the profile market without the necessary financial resources, without being economically viable, this reality being also valid for sustainable entrepreneurs (Shepherd & Patzelt, 2011).

One can therefore consider that the organic integration of respect for the environment, care for people and the logic of profit is a stake in itself, given that the three components are often incompatible in the global economic context. This practice can be questioned being in Romania in its infancy. The possibility of the Romanian entrepreneurs to respond effectively to extra-organizational – often transnational – pressures can be questioned at the same time as preserving the social and environmental requirements, as this practice is still in its infancy.

Despite the quasi-utopian vision that financially viable organizations can unconditionally conform to societal and environmental values, promoters of the “new sustainability paradigm” base their arguments on the same ideational vein (Schwarz-Herion, 2015), who considers that civil society is the key to the new paradigm, playing a key role in changes at the human, ecological and even economic levels. However, the classical perspective is refined by translating the angle of analysis on global interconnectivity, catalyzed by economic ties, intercultural adjustments, networks, and transnational solidarity.

All these elements are grafted on an ambivalent meaning of sustainability: stability, but also change, preservation of the main systems and values, but also flexible adaptation to the new. On this level, Burns (2012) talks about preserving the *Triple-Bottom-Line model*, but within the framework of an emerging paradigm of sustainability, generated by “the diffusion and collective learning of new values, ideas and practices through associations, communities, businesses and political networks”. Among the facilitators of the “sustainability revolution”, the author includes the pressure to develop innovative models, methods, techniques, and technologies to revitalize strategic sectors and make the best use of existing resources (Burns, 2012).

2.2. Sustainable entrepreneurship in start-ups

Start-ups contribute to the attainment of worldwide sustainability goals established in programs such as the United Nations Sustainable Development Goals (SDGs) by implementing ecologically responsible practices. This connection with wider social goals not only improves a start-up’s reputation, but also has a positive influence on the community and the environment. Startups can incorporate sustainability principles into their business models and operations to achieve

both financial viability and a beneficial environmental effect. Entrepreneurial enterprises may play a crucial role in promoting environmental sustainability by concentrating on eco-friendly technologies, green supply chain management, and analyzing customer behavior. Integrating these findings into the larger conversation of entrepreneurship and start-ups broadens knowledge of the various obstacles and possibilities encountered by organizations attempting to reconcile profitability with social responsibility (Terán-Yépez, et al., 2020).

Previously cited theoretical approaches to sustainability have confirmed the conceptual multidimensionality of entrepreneurship centered on social equity, environmental awareness, and economic growth (Shepherd & Patzelt, 2010; Fellnhofer et al., 2014). The reorientation of business initiatives towards non-economic objectives (people and environment) marks, in fact, the emergence of a new category of entrepreneurs able to adapt organically to a flexible but extremely demanding global environment. On this level, Majid and Koe (2012) argue that sustainable entrepreneurship is a counter trend in relation to opportunistic business behavior, focused exclusively on profit and with actions legitimate only by the logic of the business.

Discussing different definitions of sustainable entrepreneurship, Bell and Stellingwerf (2012) concluded that there are four major dimensions or key attributes to be taken into account: “1) the balance between environmental and societal concerns; 2) economic gains; 3) market failures and imbalances and 4) the transformation of sectors towards sustainability”. Therefore, the mission of the sustainable entrepreneur is to seek and find the balance between forces and to direct their combined impact towards the gain of the entire community (Shepherd & Patzelt, 2011; Fellnhofer et al., 2014). Therefore, sustainable entrepreneurs need to innovate, identifying viable solutions to societal problems, to mobilize to strengthen community development and seize opportunities to create social well-being in order to ensure long-term competitiveness (Richomme-Huet & de Freyman, 2011).

At this point, the literature circumvents – in general – another distinctive feature of sustainable entrepreneurs. They assign a special role to cultural factors in creating added value for start-ups. Thus, culture should be treated as a fundamental component alongside socio-economic and natural systems, and sustainability should be described as a process in which the entrepreneur exploits opportunities in an innovative manner to generate economic gains, social equity, environmental quality and cultural continuity in equal measure.

Beyond these considerations, profit is the global motivating factor of any sustainable entrepreneur. In the light of sustainability, profit goes beyond a discrete transaction or short-term operation, its conceptual boundaries being extended

to simultaneously include individual, community, and societal benefits. From the perspective of Hockerts & Wustenhagen (2010), small firms and start-ups are likely to better integrate sustainability imperatives and business goals if they are an organic part of their founding vision. First, start-ups are able to coalesce a specific organizational culture that crystallizes social, ecological, and economic requirements into long-term strategies. Secondly, assuming sustainability as a priority for the operation of start-ups is an advantage in identifying the opportunities created by market failures and imbalances.

Focusing attention on the transformation of industries towards sustainability, start-up entrepreneurs are seen as loyal promoters of a multistadial process (Hockerts & Wustenhagen, 2010). Parrish & Foxon (2009) conclude, reinforcing the idea, that sustainable entrepreneurs act as authentic catalysts for the transition to a sustainable economy, both by promoting innovative products and services from a social and environmental perspective, as well as by implicitly training mature firms.

2.3. Consolidation of a sustainable entrepreneurial ecosystem

To strengthen a sustainable entrepreneurial ecosystem in Romania, it was necessary to undertake entrepreneurs participating in the study and in different stages of their business development. They discussed the resources, needs, and challenges they faced in their effort to develop in the entrepreneurial environment, preserving their values and having a positive impact at a social level. Thus, after some analysis of several profiles of entrepreneurs, some results and conclusions arose from these interviews. An example would be the resources of knowledge and skills needed to start a business in the field of recycling (with a positive impact on society) that were considerable. The effort to collect the information necessary to meet the standards was hampered by the dispersion of information and the lack of direct access to standards and knowledge that should be facilitated primarily by public institutions. The experience of the Romanian entrepreneur reveals that simplifying legislation and increasing access to information are two essential elements for developing the robustness of the ecosystem. This led to the creation of a “one-stop-shop” digital service center to meet the needs of entrepreneurs. It can provide specific integrated e-government services in line with the recommendation received from the P.S.F. report (2017). The second result was to encourage and create the premises for the relevant public institutions to facilitate the development of the entrepreneurial ecosystem; to post on their website “relevant information for entrepreneurs”, standards, case studies and collaboration opportunities.

For the development of sustainable entrepreneurs within the start-ups in Romania, it was recommended and applied that the creation and making available to entrepreneurs of business models that have a positive impact at societal level, such as in education or circular economy, and which include references to case studies, relevant information, time, resources, and money.

The growth of entrepreneurship programs has led to an increase in the demand for business consultancy. However, consultancy was used mainly to cope with fiscal controls and less to develop the business. In Romania, tax audits are aimed at penalizing the entrepreneur, unlike in the European Union, where tax audits serve to inform and assist entrepreneurs. They are trying to implement the tax audits that must have an educational purpose and not a punitive one. This could be pursued by simplifying access to information, training and providing educational materials for entrepreneurs. Another step towards sustainability in Romania is for each public institution, starting with the National Agency for Fiscal Administration (ANAF) and through its regional offices, to provide entrepreneurs with the necessary information and to provide professional assistance in the field.

3. Research methods

A study conducted by the online startup Urbanize Hub places Oradea on the first place in terms of the most efficient cities of the country. Given the efforts of the public authorities, Oradea has managed to invest over 240 million euros in capital investments and various projects in the last eight years, (an investment of 1225 euros per inhabitant). In the case of Cluj-Napoca, which ranks 8th in the same chart, in terms of capital investments, it managed to spend 253 million euros (translated into 781 euros per inhabitant) (Urbanize Hub, 2017).

The research examined a wide range of sources, including scientific articles, research reports, case studies and publications relevant to entrepreneurship and sustainability in the Romanian context. This helped to obtain a complete perspective on the specific issues and trends related to the entrepreneurial ecosystem in Oradea.

The specific case study on start-ups in Oradea was chosen for several reasons. First of all, Oradea is a city located in western Romania, known for its economic potential and its growing entrepreneurial community. The choice of this city allowed the focus on a developing entrepreneurial ecosystem, thus capturing the emerging processes and specific challenges faced by start-ups in a medium-sized urban environment. The entrepreneurial ecosystem has gone

through several characteristic phases of its life cycle in the context of Oradea. In the initiation phase, local start-ups were motivated to start businesses by market opportunities and support from government and academic organizations. In the growth stage, start-ups experienced expansion and diversification, attracting investment and developing strategic partnerships to strengthen their market position. The maturity phase involved consolidating the businesses of successful start-ups and optimizing operations to ensure long-term sustainability. At this stage, start-ups began to pay special attention to sustainability practices, including the implementation of eco-friendly strategies and social responsibility to protect their environment and contribute to the well-being of local communities.

As for the Triple-Bottom-Line (TBL) concept, it refers to the integrated approach to business, considering not only financial profit, but also the social and environmental impact of operations. In the case study on start-ups in Oradea, these principles were used to assess the impact of entrepreneurship on the environment and local communities, as well as to identify the sustainable business practices implemented by these start-ups. By applying these concepts and by investigating the life cycle phases of the entrepreneurial ecosystem in Oradea, the study provided the detailed and comprehensive picture of how the start-ups in this region evolved, adopted sustainable business practices and contributed to economic and social development of their community.

4. Research results based on case study of startups in Oradea

In terms of business infrastructure, Oradea has 4 industrial parks. Since the beginning of the business parks in Oradea, for the municipality have been generated 387 million euros. In terms of employment, various companies in the business parks of Oradea employ a total of 8500 people (Oradea City Hall, 2020). Even if the fully operational companies are active in all industrial parks, the management team of the four industrial parks in Oradea is actively involved in attracting and finding start-ups that promote improvements for the city of Oradea.

Through their BrightNights incubator, on March 12, 2021, the Oradea Local Development Agency and “Make-IT in Oradea” promoted a start-up competition meant to find (and develop) startups that bring improvements (social, economic, cultural, technological, etc.) for Oradea. No upper limit has been set for projects/start-ups. (Oradea Local Development Agency, 2021). As a guide and support for their growth, start-ups will use the knowledge of industrial park managers and the knowledge of representatives of the companies that operate in them.

Such partnerships between the public and private sectors are growing in number and quality. A recently started project resulted in the winning of a grant of 6.5 million euros that will be used to create a technology transfer center. This project will have four laboratories aimed at creating and developing innovative technologies. In addition to laboratories, this technology center will also have co-working spaces, conference rooms, classrooms, and will be of the “smart campus” type. An important area of interest expressed by the local authorities in Oradea is related to the growth of innovations, more precisely, to the development of “locally produced” innovations. The representatives of the local authorities expressed their interest in increasing the production of innovative products and services by 45%, at local level. Another such project aimed at increasing the presence of creative industries in Oradea is the creation of a special business incubator for creative and innovative industries. Oradea Local Development Agency will be at the forefront of this project, as it will manage this incubator.

The value of this project is 3.8 million euros, and the project was financed from European funds (Oradea City Hall, 2018). It will be interesting to see how the projects of this incubator will unfold and what types of startups will feed. Although such projects are at the beginning in Oradea, they represent a vital starting point, and through collective performance (public and private), such efforts can become more frequent and accelerated.

5. Conclusions

The current evolution of the entrepreneurial system shows that valuable resources such as talent, know-how, information, and sources of funding are largely located in large and well-developed metropolitan areas. The exponential growth of such metropolitan areas will attract FDI, which in turn will lead to the spread of knowledge in adjacent regions and contribute to the future development of start-ups. The North-West of Romania has the potential to become one of the most important and vocal innovation centers in Eastern Europe, however, it must go easy, given that, regardless of efforts, synergies and recommendations, the transformation of the country and the North-West region cannot take place overnight. An increase in collaboration between the public and private sectors and the various stakeholders present in the North-West region is vital for a better development of the infrastructure and ecosystem of start-ups.

The study on sustainability and entrepreneurship in the context of the entrepreneurial attitude of Romanian start-ups brings to light significant aspects of how

these new and innovative companies approach the economic and social challenges in Romania. The main objectives of the research concerned the evaluation of the level of awareness of Romanian entrepreneurs regarding sustainability and the analysis of sustainable practices implemented in the business environment.

The main results of the study show that a considerable number of Romanian start-ups adopt a sustainable entrepreneurial attitude, integrating environmentally friendly practices and social responsibility in their daily activities. These practices not only help protect the environment, but also improve relationships with customers, investors and local communities. Start-ups that adopt a sustainable approach become more competitive in the market and are perceived positively by consumers.

Overall, the study underlines the importance of adopting a sustainable entrepreneurial attitude among Romanian start-ups. This not only contributes to protecting the environment and improving the quality of life in communities, but also to strengthening Romania's economic position in the global context. By encouraging and supporting sustainable business practices, the country can progress towards a greener, fairer and more prosperous future.

In recent years, the issue of sustainable entrepreneurship has opened multiple research fronts through the prism of addressing three levels in the field of interest of marketing, namely: human resources management (people); concern for the environment and profit-driven economic efficiency. Against the background of rapid societal and economic transformations, assuming an integrative perspective on the three components is required, as an actional imperative, among companies that want to ensure their viability in relation to the market and the sector of activity. Moreover, the researchers believe that such reporting must be found in the founding vision of nascent businesses that, through innovative products and services and high-performance marketing models, are likely to offer feasible solutions to the syncope's and imperfections of markets.

This scientific approach also involves examining the influences of the type of marketing that must be practiced in start-ups in Romania on the components of sustainable entrepreneurship. This is necessary because the results obtained suggest that the printed pattern of a certain marketing style correlates, in practice, discretionarily with the most important dimension of sustainability – people, which Romania needs.

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Entrepreneurship in Georgia under the funded projects provided by the European Union

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Abstract

Entrepreneurship has great social and economic significance for the development of the economic system in Georgia. The investment and entrepreneurial environment in the country have dramatically improved in the 21st century. Small enterprises have an important socio-economic function, in particular ensuring employment, reducing social inequality, forming a competitive environment, and others. The importance of the research lies in highlighting the role and significance of entrepreneurship in Georgia based on the sources funded by the European Union. It's essential to mention that Georgia has its own characterized direction to associate with the European Union, but there are some obligatory aspects in general that should have been improved; among them is entrepreneurship. The main result of the influence of entrepreneurship on the local, regional and national economy is the economic prosperity. Indeed, there is a literature gap about the tendency of Georgian entrepreneurship in line with European integration. The purpose of this research is to identify the specifics of small entrepreneurs operating in Georgia, determine the influence received from the European Union, and develop recommendations in order to improve the effectiveness of their activities. The fruitful performance of the entrepreneur's activities in collaboration with Georgian governmental organizations is one of the beginning points of integration to EU.

Keywords: Georgian entrepreneurship, funding programs, prosperity

1. Introduction

The overall transformation from the Soviet Union to a democratic market economy has had an essential influence on the economy of Georgia. Despite the efforts and activities conducted in the country during the past two decades,

entrepreneurship is still in its infancy. Conversely, the removal of some administrative barriers and active cooperation with the EU strengthened interest in entrepreneurship. (Grießbach, 2022).

Strong and developed SME sector contributes significantly to promoting exports, innovation and creating a modern entrepreneurial culture and in the meantime, plays a special role in the welfare of the country. In developed countries (including EU ones), small and medium-sized enterprises have a large share of operating businesses, creating more than 50% of the total turnover of the business sector. (Bonanno, 2023).

Secondary data analysis has been used in order to emphasize the characteristics and central components of Georgian entrepreneurship according to European integration. The article is structured as follows, first, we the existing theoretical background about entrepreneurship in Georgia from governmental, educational, and gender (female) perspectives is analyzed. Afterwards there is a provision of secondary data, including national statistics and official reports, and emphasizing the influence of funded projects provided by the European Union. Finally, concluding statements are made.

2. Literature review

Georgia is among the group of developing countries with intense social problems, but simultaneously Georgia has great potential for accelerated development through the growth of entrepreneurship. (Surmanidze, 2022) and Janelidze, (2020) highlighted that the maximum effect of the implementation of social entrepreneurship is possible with accurate analysis of the regulations and developmental features of the country. Government policies and programs are considered positive in the Georgian entrepreneurial environment. Therefore, assessment and monitoring of practices for improvement are advised (Bzhalava et al., 2017). The correlation between the development of entrepreneurship and government can be considered mutually beneficial, as Gigauri et al. (2022) mentioned that new collaborative efforts can be built to solve societal problems.

The role of basic education is essential, but currently, the education system in Georgia isn't oriented toward building strong entrepreneurial skills. Bzhalava et al. (2017) point out that it is vital to develop entrepreneurial educational programs that are oriented to identify business skills and exploit them in a proper way. In line

with this research, Natsvlishvili & Kharaishvili (2019) highlighted that entrepreneurial education should promote the enlargement of young people. The building of a culture of entrepreneurship is directly connected with the improvement of educational systems. (Maridashvili, 2021).

Additionally the role of women in entrepreneurship is being studied. In transition economies, women entrepreneurs still face gender inequalities, however, their active participation in building strong entrepreneurial policies is a great contribution (Rybnikova et al., 2020). Meanwhile, the gap in gender inequality is still an active topic in most of the world's countries, including Georgia. This is consistent with the findings of Griessbach & Ettl (2020), according to whom broadening entrepreneurship should be taken into consideration along with gender equality.

3. Research methods

To reach the aim of the research, data were collected using the major economic and scientific research databases. The literature search was carried out in online scientific databases such as Web of Science, Google Scholar, and Scopus in order to include the relevant literature. Articles written in Georgian and English were included in this research, after which the collected information was processed with qualitative methods of research such as secondary data analysis and content analysis (Roller, 2015). Credible sources and downloadable firsthand information are significant for providing hypotheses and regression analyses. Neuendorf, (2017) has demonstrated the importance of the content analysis method and expanded its acceptance across fields of study.

4. Research results based on the case of Georgia

Assessment of the business environment in international ratings over the past 8 years in Georgia, the government has implemented significant reforms to improve the business environment and develop entrepreneurship. In the Heritage Foundation's 2020 "Index of Economic Freedom" ranking, Georgia ranks 12th place (Gwartney, 2022). The main economic indicators of the entrepreneurial sphere in Georgia are shown in table 2.1.

Table 2.1. Main Economic Indicators in entrepreneurship

Year	2017	2018	2019	2020	2021
Registered Enterprises	628673	671023	712692	748307	792614
Active Enterprises	151831	152261	161426	161303	171565
Turnover, mln. GEL	71740.1	86625.1	109024.3	114348.5	150414.9
Output, mln. GEL	38206.8	41649.2	47494.7	46227.3	57613.8
Value Added, mln. GEL	19036.3	20726.9	23296.0	22263.0	27843.7
Intermediate Consumption, mln. GEL	19170.5	20922.4	24198.8	23964.3	29770.2
Fixed Assets, mln. GEL	34880.5	33754.5	36785.1	38730.8	44737.3
Number of Employees, person	708165	734215	756852	703874	744256
Av. monthly salaries GEL	1019.7	1101.3	1161.7	1222.9	1347.6

Source: (NATIONAL STATISTICS OFFICE OF GEORGIA, 2023).

The steady trend of acceleration is indicative of an improving and prosperous for Georgian entrepreneurial segment. The association agreement and free trade relations with the European Union (DCFTA), signed in 2014, create extensive opportunities for entrepreneurship in Georgia, and local businesses are becoming more and more focused on growth. (Commission E., 2014) According to international experience, the entrepreneurial environment directly connected with economy development. (Audretsch, 2023).

Nowadays, along with the competition and the formation of partnership and business relations, the small number of businesses in Georgia restrain the processes of their active involvement in the European concern. As a developing country, Georgia's economy responds easily to both internal and external turbulence, which is reflected in the level of business productivity. State subsidy programs are the main lever through which the government stimulates small and medium-sized businesses.

Accordingly the European Union supports the development of entrepreneurship in Georgia. EU actively supports the development of new entrepreneurs, especially in regions, often in highland rural areas.

Funding program for agriculture is the European Neighborhood Program for Rural and Agricultural Development, implemented through ENPARD. Since 2013, hundreds of thousands of farmers have benefited from this program, information and advice, and financial assistance provided throughout the whole territory of Georgia (Delegation of the European Union to Georgia, 2018).

EU4Youth's five projects are: Social Enterprise Ecosystem Development (SEED) for Green Growth in Border Regions, Social Entrepreneurship in Georgia and Armenia (SEAG), Say Yes: Work Skills, Supporting Youth Education, Employment, and Participation in Conflict-Affected Areas in Georgia and Ukraine, and Building Capacity to Improve Employment Opportunities by Offering Entrepreneurship Training and Mentoring Projects for Young Women have an essential impact on the development of entrepreneurship in Georgia. The governmental support provided by collaborative activities with the EU is highlighted in the document of the Small and Medium Entrepreneurship Development Strategy of Georgia for 2021–2025. It's important to mention the influence of the OECD, which is oriented to helping governments respond to new challenges in the field of entrepreneurship. The project aims at improving the business environment and suggesting proper support for SME.

Based on the data of the National Statistics Department of Georgia, the total population is 3.73 million people in Georgia, of which 47% are male and 53% are female. In that case, if we look at the distribution of entrepreneurs in Georgia, 56% of enterprises were established by men and only 29% by women. (National Statistics Office of Georgia, 2023) According to gender inequality, women often find it complicated to start a business. Although, in 2019, 919 women entrepreneurs in Georgia received loans worth 76 million euros, and 84 received grants up to a total of 500,000 euros under the European Union's Small and Medium Business Support Program. Between 2018 and 2020, 3361 young women in Georgia participated in training and workshops through EU4Youth grant projects, 296 were interned, and 96 became self-employed after receiving funding assistance. (EU Commission, 2023). Consequently, EU funding programs are focused on improving basic business process skills that are geared toward educational prosperity.

5. Conclusion and recommendations

An important part of the development strategy of countries should be the support of small and medium enterprises. Georgia acts as a kind of guarantor in the international market, which promotes the advertising of products made by

small and medium-sized entrepreneurs in accordance with international standards. Despite European Union cooperation and funding programs, entrepreneurship in Georgia still faces challenges and obstacles. According to the research results the governmental support for entrepreneurship can be evaluated positively, however, there is an inadequately educated workforce with low levels of entrepreneurial intentions. Gender inequality is still challenging for the Caucasian region. Meanwhile, strengthening cooperation with the European Union and active participation in funding programs can be considered unique opportunities for developing strong entrepreneurial policies.

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Homeland entrepreneurship in Polish fashion industry – an overview

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Abstract

Although as for today, sustainability of garments and the respect for the rights of textile workers should be mandatory, the question arises how are they developing from the consumer's point of view? It seems unthinkable that there are still people who are not aware of this issue, or that even if they are, they are not able to change their buying habits. Domestic production, vegan products, reuse, and second-hand shops. It all seems known, but who has really acquired these shopping habits? The new era of misinformation also affects the textile sector. Therefore, the aim of the study is to analyze consumer awareness and action in relation to the textile sector. In the European framework, it will be of vital importance to implement measures and increase financial and promotional support to help raise awareness of responsible consumption.

Keywords: textile sector, misinformation, sustainability, consumer, second hand

1. Introduction

The concept of business has undergone countless variations over the years. We have moved from a utilitarian and rational vision to the one related to values and respect. Although this consumer trend has grown relatively fast in recent years, there is still a large part of the population that continues to consume Fast Fashion. Currently, we have a big problem of awareness, but even more of misinformation. So, we ask ourselves the following question: “How about consumer awareness today? Are consumers really informed about how the fast industry works?” The main aim of the study is to analyze consumer awareness and action in relation to the textile sector. To get to the problem, we will first review the evolution

of the concept of organization. Later, it will be noted that many consumers are still in the early stages due to lack of information and knowledge.

2. Literature review

Theories about the organization and its objectives have evolved over time. We have moved from a functionalist and rational approach of organization to the conception of the company influenced by internal and external agents. Within the more traditional definitions of organization, we can find the economic approach. We can divide this approach into three main theories, ordered by date of appearance. First, the Traditional Economic Theory or Neoclassical Theory. Then, the Transaction Cost Theory and finally the Agency Theory.

The Traditional Economic Theory or Neoclassical Theory is the most restrictive definition of the firm because it only relates the organization to production. In addition to this, this theory assumes perfect competition, which is not possible because information is not usually complete, there is irrationality in decisions and sellers and buyers are not usually price-accepting. (Bermejos, 2019).

Within Marshallian thought, one of his most important reflections stands out. He argues that the increase of labor and capital leads to the improvement of organization (Marshall, 1890). Despite this very classical thinking, Marshall already advanced two important premises in the current era. He attenuates the value of benefits to society as opposed to individual benefits (Marshall, 1890). He does so by means of an example adapted to the times in which he lived, but which may have laid the foundations for later theories. He was also aware of the limitations of the time, pointing out that the work of managers to be done at less cost when society helps the most disadvantaged, when trade secrecy is reduced and when the worst forms of competition are eliminated (Marshall, 1890).

The Transaction Cost Theory develops that an organization has transaction costs and coordination costs (Coase, 1937). There are some fundamental pillars on which the author based the theory. Firstly, he argues that the existence of the organization is related to the saving of transaction costs (Coase, 1937). Secondly, the existence and proper functioning of the firm is also closely related to the saving of production costs by internalizing production (Coase, 1937). Thus, Coase's thinking studies the organization from the point of view of efficiency. It is of vital importance to mention that the unlimited rationality postulated by traditional economic theory is no longer defended, which was a great advance for the development of organizational strategies at the time.

The last approach to be mentioned within the economic approach is the Agency Theory. This approach focuses on the delegation of authority within an organization, thus separating ownership and management (Jensen & Meckling, 1976). But in this case, conflicts of interest often arise. If we add to this the costs of supervision and compensation, we have the so-called agency costs (Jensen & Meckling, 1976). Due to delegation, what they call the agency relationship arises. This theory goes one step further than the Transaction Cost Theory, as it strongly believes that the existence of the organization is related to the minimization of agency problems (Jensen & Meckling, 1976). That is, the reduction of the conflict of interest that still exists between management and ownership.

As a critique of the purely economic approach to organization, new theories emerged that focused more on individuals. They saw that this theory was too mechanical and dehumanized, so new ideas were developed, where rationality and production are no longer the only important pillar within organizations.

Human Relations Theory argues that the moral and mental health of workers is closely linked to the social aspects of work, and therefore encourages managers to be aware of the social repercussions of their activity (Mayo, 1933). This theory is based on the following fundamental pillars:

- the need to humanize management and to establish less rigid and harsh rules for workers,
- the human relations school concentrates almost entirely on the informal aspects of the organization, such as informal groups, employee behaviors and beliefs,
- simple and repetitive jobs tend to become monotonous, which affects negatively on the worker, reducing efficiency and job satisfaction,
- it is necessary to treat workers as members of a group within the organization,
- need to create a pleasant climate for the good functioning of the company (Mayo, 1933).

After the emergence of theories about the conception and evolution of organizations, theories about consumption emerged. It creates the term “cathedrals of consumption”, due to the scenario in which society is hypnotized, created by fast food restaurants, shops, cruises, casinos and all those attractions that make us move away from reality and evade the individual (Ritzer, 1999).

Following this line, Bauman introduces the concept of “consumer society”, decorated by advertising and marketing. It is about making society believe that it needs to consume to feel fulfilled (Bauman, 1998). Despite this, in recent years this consumerist trend is changing. We are moving towards more responsible, sustainable, and quality based consumption. More and more people are focusing their efforts on

reducing their consumption and consuming in organizations whose values respect the care of the environment and the fundamental rights of individuals.

Furthermore, according to Lozano (2002), the organization's activity directly and aggressively influences the environment. Organizations, as well as polluting, have a great capacity for change. For this reason, large companies, together with governmental organizations, are the ones that must promote more sustainable production. Today, sustainability goes beyond respect for the environment. It is therefore necessary to mention the concept of the "Triple Dimension of Corporate Sustainability". It is the union of the economic, social, and environmental dimension (Gil & Barcellos, 2011). It is about the pursuit of economic development without forgetting respect for human rights, the pursuit of racial and gender equality and the protection of fauna and flora. It is vitally important that public organizations demand such compliance from private companies. In February 2022 the European Commission set out a proposal to promote respect for human rights and the environment in global supply chains (European Commission, 2022). The measures would apply directly to organizations with more than 250 employees, excluding small and medium-sized enterprises. Failure to comply with the measures set out in the communiqué could lead to fines.

One sector where governmental organizations have set targets for reducing pollution and respecting labor rights is textiles. European consumption of these products ranks fourth in terms of environmental impact (European Commission, 2022). Therefore, some of the measures imposed on textile organizations are (European Commission, 2022):

- the implementation of new design requirements,
- the implementation of strict eco-laundering controls,
- economic incentives for organizations introducing organic textile products,
- reduction of the release of microplastics.

What can a small or medium-sized enterprise do in this situation? We can distinguish two main options. The first is the creation of vintage shops, where in addition to offering unique garments, clothes can be given a second life. But there is still a group of people who are reluctant to buy used garments, which is why there are companies that take exhaustive care in their entire production process. These are organizations that usually manufacture their production in the same country where they are based, respect human rights and care for the environment.

3. Research methods

The method to find out the current consumer issues in a European framework was quantitative in nature, supported by qualitative tools. Home-grown surveys were carried out with 505 people of different European nationalities. The sample was made up of men and women between the ages of 15 and 65 who are resident and of European nationality. As mentioned above, the survey follows a quantitative methodology to compare these data with each other. In addition to this, the quantitative survey has been supported by qualitative tools due to open-ended questions to allow the respondent to give his/her opinion on a specific topic.

Of the 505 respondents, 26.2% were people between the ages of 15 and 25. 20.2% were between 26 and 35. Between 36 and 45 we surveyed 21.3%. 19.6% were between 46 and 55 years old and 12.7% were between 56 and 65 years old.

4. Research results

First, respondents were asked about their forms of consumption. 82.2% of them answered that they do not pay attention to whether the garment has been produced in an environmentally friendly way. Looking at it by age group, we can conclude the following:

- 15–25 years: 11.70% of them say that they do consider whether the garment is sustainable,
- 26–35 years old: 43.01% do take it into account,
- 36–45 years: 13.79% yes,
- 46–55 years old: 10.12% take environmental friendliness into account,
- 56–65 years: 5.6% do take it into account, while 94.4% do not take into consideration the sustainability of clothing.

Fewer bear in mind whether the organizations in the textile sector where they usually shop offer good working conditions. This is because 85.1% of those surveyed answered that they do not pay attention to workers' rights when buying a garment or accessory.

- 15–25 years: only 10.64% are concerned about workers' rights in the organizations they buy from,
- 26–35 years old: 14.32% do,

- 36–45 years: 10.70% yes,
- 46–55 years: 47.7% are concerned about workers' working conditions, in contrast to the previous age groups,
- 56–65 years: 24.4% yes.

Although it may seem contradictory, 65.3% say they would pay more money for a garment or accessory produced in a developed country without violating workers' rights. Despite this, there are some differences between the age groups surveyed:

- 15–25 years: 70.21% would pay more,
- 26–35 years old: 85.48% would also pay more,
- 36–45 years: 93.48% of this group is willing to spend more money,
- 46–55 years old: 67.7% would pay more, a large reduction in the percentage of the previous age group,
- 56–65 years: 81.2% would invest in clothes that take care of their workers.

As far as respect for animals is concerned, this is an issue that is much less addressed by the population. Only 10.9% of the sample surveyed knew of any company in the textile sector that produces vegan products. Despite this, 78.2% of them would be willing to buy from organizations that follow these values. Slightly more than half of them (53.5%) want the organization to follow the same values as they do. Among them, the most repeated is quality, which is also similar in all the age groups studied. Thus, 65.3% of respondents said that they prefer to buy one quality garment rather than a larger number of garments of a lower quality. Most respondents (71.9%) usually shop in shops belonging to the Inditex group, which outsources most of its production to developed countries and is also one of the largest organizations in the world of Fast Fashion. In addition to this, 64.2% of those surveyed have at some point purchased from organizations such as Shein, a Fast Fashion textile company that operates internationally. There are many rumors of the appalling working conditions of its employees, with long working hours, hardly any breaks or days off, as well as a lack of care for the environment and the appalling quality of the garments, which makes it almost impossible to reuse them. Just over half of the sample surveyed (51.3%) said that if they had greater purchasing power, they would not change their shopping habits. That is, they would continue to shop in shops such as those of the Inditex group or Shein.

The main reasons why many respondents buy products from these textile companies are design, quality, and price. In addition to this, only 21.2% of the sample is aware of textile companies which have their production in developed countries or are domestically produced. Among those who are aware of the existence of such organizations, 81.7% of them are in the 15–25 age group. But also, within the former group, there are those who believe that shops such as Zara, Nike

or Mango are produced in developed countries, respecting workers' rights, and the environment.

Another large group within the textile sector that has emerged in recent years are second-hand shops. 69.1% of the sample would shop in second-hand shops, but only 18.2% do so.

- the main reasons why consumers shop in shops like these are mainly: environment, design, price, and quality,

- on the contrary, those who do not want to shop in this sector do so for the following reasons: they believe that the clothes are dirty and unhygienic.

Despite this, 81.2% believe that quality clothes can be found in second-hand shops at a lower price.

Another large group in the textile sector that is being forgotten due to the rapid growth of multinationals and low prices are the local shops. Although 78.2% would like to shop in these shops to help small shops, only 8.9% do so because of the high prices and because the design does not appeal to a large group of the population.

5. Conclusions

Surprisingly, the 26–35 age group takes sustainability more into account when shopping than the 15–25 age group. This may be since the former group is of working age and can therefore invest in a sustainable shop, as they tend to be more expensive than those who do not contribute to the problem. The 36+ age group is less aware of this criterion, because they have grown up with other values and culture. The age group between 36 and 45 years does not consume as much in Fast Fashion companies, but not because of their awareness, but because they prefer to consume higher quality clothes and a more exclusive design.

As for respect for working conditions, more people seem to take this into account when buying clothes or footwear. Despite this, 71.9% of those surveyed admitted that they regularly shop in shops belonging to the Inditex group, whose production is outsourced to less developed countries.

Respect for wildlife (vegan products) is also gaining importance, raising awareness about the production of vegan garments. Although many of those surveyed would be willing to buy vegan products, the majority do not know of companies that carry out this type of production. In view of the above, it is of vital importance to mention the widespread misinformation of the population in relation to the textile sector and its impact.

One of the main problems is the population's lack of knowledge about shops with national production or production in developed countries. In addition, many of the young people believe that multinationals within the Fast Fashion group, such as Inditex, have national production. As a result, there is a high number of people who are consuming without being aware of the harm that this can cause. Despite this, young people are also the ones who are most aware of shops with national production, although they are a minority. Another important issue is the rejection of second-hand shops by some consumers. There is a twofold problem. Firstly, there are many people who wish to consume second-hand clothes but do not do so. Secondly and more importantly, those who do not do so because of hygiene or because of a rejection of having been worn before, will find it more difficult to convince them. Finally, it is also necessary to mention the reduction of consumers that local textile companies have suffered. The target audience of these organizations is more adult, but they are experiencing a reduction in the number of customers due to high prices and the fact that some people think that the products offered are "old-fashioned". Despite this, they have always been seen as shops with high quality products, which is what most consumers are looking for.

In addition to the above, it is striking that most respondents would not stop shopping at Shein or Inditex even if their purchasing power was higher. Therefore, it is necessary to ask ourselves the following questions: Are we really a conscious society? Do we know the impact of our purchases?

6. Recommendations

As our objective was to observe what human awareness and action is like in relation to the textile sector, after having thoroughly analyzed consumer thinking, it is necessary to highlight the lack of awareness and the dehumanization of the western population. Although society is apparently aware and knows what it is doing, there is still a long way to go, mainly through public institutions. These have sufficient power and criteria to help orient consumption and production towards care for the environment and respect for labor rights.

Within the European context, the following measures could be of interest:

1. Companies producing sustainable products and respecting workers' rights:
 - financial support and incentives to bring production to developed countries,
 - increased sales taxes if production has been carried out in underdeveloped countries or without respecting human and environmental standards,

- financial aid to promote and advertise companies that have produced their outputs in a sustainable way;
- Create awareness campaigns on the consumption of the textile sector;
- finance campaigns to advertise organizations with vegan production, national production, etc.,
- carry out TV and outdoor advertising campaigns to raise awareness of the impact of Fast Fashion among the public,
- funding of an awareness program in high schools and colleges in the European Union to promote this thinking from an early age;

2. Promote second-hand sales:

- incentives for newly created second-hand shops,
 - support for the promotion of second-hand shops, by country and region.
- Importance should be given to the quality of the garments and that they are unique and inexpensive. But above all, it would be of vital importance to create exclusive European standards of hygiene and quality for second-hand shops to increase consumer confidence;

- Promote the exchange of clothes:
- incentives to create shops where clothes can be exchanged for other clothes, paying, if necessary, a corresponding amount for the difference in quality,
- financial aid to create applications where clothes can be exchanged within the same region,
- encourage flea markets where the population of a place can exchange their clothes or can leave their clothes and take another according to certain criteria.

As well as helping to ensure that environmental care is respected, we should be concerned about how companies behave towards their employees. An example of good governance is explained in the Theory of Human Relations, which, although it may seem incredible, many companies today do not meet those requirements.

There are countless measures that can be taken to raise awareness and inform the population about correct consumption in the textile sector. The collaboration of both companies and consumers is necessary, but not without the help of public institutions.

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Chapter 3

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Homeland entrepreneurship in Poland fashion industry – an overview

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Abstract

Poland's clothing market generated revenues of EUR 11.5 billion in 2018 and is expected to grow. The fashion industry in Poland has potential to become even more significant on the internationally as it happened in the Eastern European market. An analysis of the indigenous market, enable to look at the problem holistically. It consists of the summary of the year 2022, that shows current perspective about the industry. An impact of the Covid-19 pandemic, key trends, threats and opportunities that are present when it comes to the Polish fashion industry. Studying three separate, different cases of Polish-based brands – “LPP”, “Local Heroes” and Magda Butrym – that show diversity and give an overview of fashion market in Poland, especially with the focus of Polish brands. How the Polish-based clothing brands are worn by celebrities and people all over the world and how are they prospering abroad of Poland. The goal of the chapter is to get an overview of the Polish fashion industry at the beginning of the 2023 and considering what might happen in the Polish fashion industry in the future. The chapter was prepared based on literature studies, popular science articles and interviews, as well as analysis of the case studies.

Keywords: fashion in Poland, Polish brands, apparel and footwear in Poland, sustainable clothing

1. Introduction

In recent years, the fashion industry is consistently growing and developing. Understood as a whole industry of clothes, garments, shoes, and accessories that are being worn not only to meet the basic needs of the customers, but also to express their personality, show themselves or create a piece of art with the complete outfit, is one of the biggest segments of commerce in the world.

The huge growth of the fashion market was also visible in Poland, where in 2018, the clothing market generated revenues of EUR 11.5 billion. According to forecasts this revenue will still increase even beyond EUR 17.7 billion. This means an average market growth of 9.3% per year according to CAGR (Compound Annual Growth Rate) in years 2010–2023 (Euromonitor International, 2022), which is much higher than the European average. This specific segment of Polish economy has potential to become significant on the international market and gives positive impression for the economy in the perspective. The fashion industry in Poland can be divided into few groups, depending on the criteria: sectors, types of sold items, location, target customers, the scale and a few more.

What are the trends? What are the biggest companies on Polish market? What are the opportunities and threats resulting from the characteristics that this industry works on? How to reach success abroad, independently from the type of the brand (premium or mass production)? To understand all those questions, broader knowledge of the whole fashion industry mechanism is needed, that will be presented based on some charts and articles.

The goal of the chapter is to get an overview of the Polish fashion industry of 2023 and beyond, by analyzing the market, showing three cases, where the Polish brands succeed not only domestically, but also internationally, and considering what might happen in the Polish fashion industry in the future, with the perspective of the garment entrepreneurship.

2. Literature review

To clearly understand the issue, it is needed to describe and analyze the market of clothing in Poland. The fashion industry consists of pieces of clothing, shoes and accessories such as hats, belts, sunglasses etc. To know better what the environment that brands must function in, it would be helpful to see the analysis from the end of 2022 (Euromonitor International, 2022).

The fashion market can be divided into menswear, womenswear and childrenswear. In Poland, the biggest part forms womenswear which was 36% of whole apparel market. Writing about the category of clothing items, the main industries are for years apparel, outerwear, footwear and sportswear.

It is important to mention that 2022 was the year when restrictions related to Covid –19 pandemic were lifted and in effect, the shopping movement in stationary stores was restored, and the sales increased in relation to the previous year. It was also influenced by the Russian invasion of Ukraine, when millions of

refugees had to run away with small amount of clothes. They had to buy those in shops in Poland. On the other hand, the rising inflation rate resulted in disquiet about the future, and it placed downwards pressure on purchasing power.

When it comes to key trends in 2022, it was visible that comfort has become a key factor. Sneakers, tracksuits and oversize clothes have reached bigger popularity. What is more, crucial factor for Poles while buying an item of clothing has become the sustainability of it. This is the reason second-hand stores were a huge part of the industry and this is developing and gaining popularity as a way of purchasing.

Moving on to the distribution channels in retail, 78.5% was shopping at stationary stores and 21.5% is e-commerce, however its number still increases and the first significant stimulus for it was the pandemic of Covid –19 (Piosik, 2022). As for the traditional way of selling goods, discounters have reached the biggest sales of clothing, and this is still rising. Operators of apparel and footwear chains are reducing the number of new stationary stores and focusing on e-commerce. The importance of e-commerce was clearly seen during the pandemic of Covid – 19, where shopping on-line was the only way to purchase clothes, due to closed stationary stores. Apparel and footwear specialist retailers remain cautious about opening new stores found on high streets in city centers, because of due to the weakening range of stationary sales and high rental cost.

Main competitors, that have the biggest shares when it comes to the companies are “LPP” SA (12,8%), Pepco Poland Sp zoo (10,9%), CCC SA (4,8%), Adidas Poland Sp zoo (4,4%) and Zara Polska sp zoo (3,9%). The biggest shares when it comes to brands are Pepco (10,9%), Sinsay (4,9%), Reserved (4,8%), CCC (4,5%) and Adidas (4,1%).

PEST analysis¹ could be an informative source to see what the threats and opportunities are while entering the polish market. Some solid chances are relatively low tax burden at the level of 19%, low unemployment range, large consumer market and constant increase of Polish internet users (in 2022 it was 88%). On the other hand, there are also some significant challenges that the brands may face entering the market: political tension with European partners, War in Ukraine (caused migrations and lower demand for Polish exports), higher inflation leading

¹ PEST analysis (political, economic, social and technological) describes a framework of macro-environmental factors assessed as a strategic tool for environment scanning, understanding risks and opportunities, market growth or decline, business position, and potential and direction for operations, helping companies to become more competitive.

to rate rises, and the fact that Poland still has a significant rural population that accounted for 39.7% of the total in 2021.

To sum up, the economic situation is uncertain, however the apparel industry seems to be growing and the demand is bigger every following year. After years of dynamic development of the clothing and footwear industry, the COVID-19 pandemic, followed by the economic recession and the cost-of-living crisis, put the product area before a serious challenge. From their point of view, it brought popularity, that has been constantly rising to the e-commerce distribution channel.

3. Research results based on examples of Polish success/growing companies

3.1. Biggest mass – production Polish company – “LPP”

Describing Polish homeland fashion industry, it is significant to show an example of extremely successful company which is “LPP”. Within “LPP” we can find one of the most popular fast fashion chain-stores: “Reserved”, “Mohito”, “House”, “Cropp” – that are into moderate price range – and “Sinsay” that is accounted into “affordable fashion” retail. Probably every Polish teenager owns a piece of clothing from those brands. As the company describes itself, their goal is constant development that is achieved by omnichannel model of business, digitalization and sustainability.

They are present on the apparel markets in 3 continents: Europe, Africa and Asia. At the end of 2022, their sales offer was available in 39 markets. The key activities that company is focusing on is the usage of *Fashion Tech* in aim of continuous improvement of the collections to meet the expectations of the customers, expanding the scope of sales and after-sales services in line with global trends in the retail industry, adding the flexibility of the distribution network and full integration of traditional and online channels in the soul of the omnichannel arrangement (Wieczorkowski, 2018).

The digitalization of the company is the trend that not only “LPP” does in the past recent years. Mobile apps, clear and easy to use website, uncomplicated way to purchase in internet, migration online shop to the Google cloud etc. The cooperation established with Google is primarily on advanced equipment, including as an analytical platform or data repository, but also on the implementation of infrastructure innovations in addition to e-commerce and the imple-

mentation of product recommendations based on artificial intelligence algorithms (Jadczyk, 2020).

The last main pillar that the company is building on, is the sustainability of the products, which includes reduction of the plastic usage, checking chemical security and reusing material to create a new garment (“LPP”, 2023). Sustainability refers to diverse areas, including waste, substitution, or consciousness (Murzyn-Kupisz, 2021).

It is important to mention the scale that “LPP” has worked through 30 years of experience on the Polish and international market. Every year it sells more (except for covid year), in 2021 it was 14 billion PLN.

Another crucial strategy of the “LPP”’s activity is the fact that they are “loyal to their roots”. They care about remaining faithful to the principles that guided its founders from the very beginning. 65% of the items are made in Poland what economically strengthens the Polish economy in general. What is more, the projects of products are being made in Poland and the taxes are paid here – in 2021 the amount of it was equal to 1,6 billion PLN. Innovativeness and creativeness of a “LPP” company is noticeable on the international market, which makes the store more popular and successful.

3.2. Premium streetwear – “Local Heroes”

Another successful company that was found in Poland – “Local Heroes” – is producing and selling sporty, comfortable clothes for teenagers and young people. The company was set up in 2013 by two women, that wanted to create the brand that will make people wear comfortable outfits (“Local Heroes”, 2023). The items are produced completely in Poland, however in 2020 there was a rumor, that customers of described brand have been provided with finished product that had changed company patch. This scandal was significant and put the brand in a bad light. Nevertheless, “Local Heroes” issued a statement, that was admission of the guilt (Wojtczak, 2017). They also decided not to switch off the comments below their posts, which is a common tactic in terms of any scandal in social media. The ability to apologize and not avoiding the consequences of activities let the brand get out of the crisis and the trust of the customers has not been violated.

The brand is known worldwide because “Local Heroes” clothes were worn by celebrities such as Justin Bieber, Rihanna and Miley Cyrus. The founders tried to get the celebrities’ attention by sending them PR parcels. Their project was liked by Justin Bieber, and he wore it often. Then, other recognizable celebrities started to wear “Local Heroes” projects.

3.3. The most successful Polish Fashion House – “Magda Butrym”

Magda Butrym’s brand has recently gained huge popularity not only in Poland, but also all around the world. Her projects have been appreciated by many valued fashion critics. Because of the unique, feminine pieces of clothing that are made with precision and with good-quality materials it is perceived as the “taste of luxury” when it comes to fashion. It would not be far-fetched, if someone said that Magda Butrym is Polish Dior – chic, class, and at some point – certain identity.

Did her entrepreneurial skills bring her to this giant success? Undoubtedly, hard work and creativity let her open her own boutique. She was simultaneously working in the fashion industry as a celebrities’ stylist and studying at MSKPU – International School of Costume and Fashion Design (Fusiecka, 2017). Afterwards, she tried with her first clothing brand “Portofino”, however she closed it after releasing the first collection. She joined famous Polish fashion designer – Joanna Przetakiewicz, and her projects were received positively by customers. In 2010 Przetakiewicz established brand “La Mania”, where Butrym was main creator of new – successful – collections. After three years she left this fashion house to open her own. Magda Butrym’s brand has been developing and gaining recognition. In 2023, there will be nine years of existence celebrated. The main strategy that this company has been following is to aim in the international market, instead of focusing on the Polish one. However, what differs Magda Butrym’s brand from the others is the fact that it is meant to be an alternative to street wear, that is popular. Also, the superior quality of the apparel, that enables the piece of clothing to last longer, is the opposite of the main movement in this industry – fast fashion. Another principal factor that decided about the success of the Magda Butrym’s brand is promoting their clothes by celebrities. It all started with Kim Kardashian, who liked the dress from the Butrym’s collection and showed herself in it on her Instagram account, where she was followed by several hundred million people that time. After that, Hollywood stars are often seen in Butrym’s dresses and sets (Czarnota, 2019).

4. Discussion

How will the fashion industry be influenced in the next few years? What will be trendy and what will get mass public attention? Polarization is expected in the apparel and footwear industry, with mid-priced brands bearing the consequences. The rise in the cost of living connected with the rising inflation rate also means that middle-income households will be forced to cut back on spending. As a result,

this means that the economic segment can benefit from the increase in demand for cheaper clothing and footwear. However, charts from Passport GMID shows that in the next few years it is highly possible that sales will increase, and fashion market in Poland will get bigger and bigger.

Moreover, talking about trends there has been already hype for ecological and sustainable fashion (even though the whole industry is built on consumerism), and it is visible, that on the apparel market. The biggest chain stores that sell clothes are now signalling its materials, obtained from used pieces of clothing, to save the world's natural resources and become eco-friendly. Right now, in 2023 a huge part of collections takes pride in it that it is made mainly from recycled polyester and for me, personally, this tendency will be even more noticeable in the near future.

5. Conclusions

Fashion market in Poland is constantly growing and it seems that in the future it will not stop. From the analysis of the market, we know that the main drive in this industry is the womenswear. Due to lifted Covid-19 restrictions and Russian invasion of Ukraine, the fashion shopping movement was restored, sales increased and got back to the state that was before. It was experienced that the most valuable factors for the biggest number of the customers are comfort associated with use and sustainability of the item. A trend that has been seen in the previous few years is the increased popularity of e-commerce. Year by year, the number of its users is rising, and this is not expected to slow down.

Polish based brands keep gaining recognition on the international market, both mass-production fashion as well as luxury one. What was the factor that decided that this brand became successful? There is no simple answer. Studying those three separate, different cases, it is hard to find the pattern that a start-up company can follow to become like "LPP", "Local Heroes" or Magda Butrym. Nevertheless, those examples show that international recognition does not depend on the size or type of the company or brand, but mostly on the marketing, identity and – sometimes – on luck. The most important inference is finding the missing part in the industry - a niche, demand or a need in a target group. Then, it is crucial to make smart advertising moves, that will show potential customers the products, its qualities and other information. Another thing that is worth mentioning is well conducted Public Relations policy in case of any setback or scandal. The example of "Local Heroes" activities that prevented the bigger scandal and boycott of the brand let the brand rise, and be still perceived as the "cool, good quality one".

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Commercial Viability of an Online Pharmacy

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Abstract

The e-commerce market in Portugal was extremely driven by the conjuncture of the Covid 19 Pandemic, leading several sectors of traditional commerce to face the need to reach their customers through online communication channels. In this context, Portuguese pharmacies were no exception, having recognized the importance of electronic commerce for the marketing of their products. Now, this observation led us to think of a commercial viability study with a view to creating an exclusively online pharmacy to operate in Portugal. For this purpose, a market study was carried out, based on secondary sources and a questionnaire survey, with 110 responses having been validated, aiming to understand the impact of online commerce on the lives of the Portuguese, the most sought-after products, and the most valued attributes in customer service. The results of this study allowed us to understand that it would be commercially viable to create an online pharmacy, if it offered a range of products, in the categories of medicines not subject to medical prescription, dermo cosmetics, sunscreen, hygiene products and mom-baby products, as well as competitive pricing and pharmaceutical advice. Based on the results obtained, an online marketing strategy was developed.

Keywords: entrepreneurship, innovation, e-commerce, digital marketing, strategy

1. Introduction

Considering the situation of the pandemic experience and adaptation to the online market, the idea arose to verify the commercial viability of creating

an online pharmacy in the city of Viana do Castelo, Portugal. Traditional commerce, in which pharmacies are inserted, was faced with the need to reach customers through other means, namely online means, which allow a broader visibility, both in terms of the public it can reach, and in terms of the products that can be viewed through digital content. To analyze this viability, it was necessary to carry out a comprehensive and effective market study that would allow a realistic idea of the online market in Portugal, followed by the creation of a digital marketing strategy for the business in question. Digital marketing is an extremely important tool for an online business, as it allows to create a sales development strategy in the online category and at the same time retain a flow of customers who can visit the online store.

According to Faustino (2019), digital marketing is the application of communication and marketing strategies with a view to promoting/marketing products or services, through digital channels (websites, blogs, social networks, mobile applications, etc.) and devices electronics, arguing that “their target audience is constantly connected and online”. In other words, the concept of digital marketing is nothing more than the so-called traditional marketing integrated into the internet. Digital marketing has facilitated the process of buying and selling products and services (Costa et al., 2015). The digital approach has a great influence on the consumer’s decision-making process, as it is through this that sensations, desires and even recognition of the value of the product or service are generated, which will lead the individual to make the purchase (Castro et al., 2015). Digital marketing also allows you to measure the return on investment made, that is, it measures the number of views, people reached, actions and interactions carried out and even allows you to segment communication for a specific target audience (Faustino, 2019). Communication is more assertive and objective, as digital marketing allows you to direct publications to the right people, who are really interested in that product/service, instead of communicating to everyone, hoping that someone will pay attention (Faustino, 2019). To verify the commercial viability of an online pharmacy, a market study was carried out, with the aim of understanding whether the online market is an expanding market, namely in terms of purchases of pharmaceutical products.

This article begins by addressing the main concepts and strategic actions of digital marketing. Next, the pharmaceutical market in Portugal is presented, narrowing down to a characterization of its online context. Subsequently, the research methodology is exposed, as well as the main results obtained. Finally, the conclusions and practical implications of this study are presented.

2. Literature review

2.1. Top digital marketing tools

Marketing aims to identify and satisfy human and social needs through profit generation (de Oliveira Rosa et al., 2017). For this, it is necessary to know the customer well in order to be able to offer a product or service that best suits his personality (Santos et al., 2019).

Digital marketing allows for faster and more effective consumer analysis, as well as segmentation of communication for a specific target audience (Ferreira da Costa et al., 2016), using digital channels (websites, blogs, social networks, mobile applications, etc.) that increase the reach of communication (Faustino, 2019). In addition, digital marketing allows you to measure the return on any investment, such as the number of views, people reached, actions and interactions carried out, conversions, etc. (Faustino, 2019).

According to Marques (2022) and Faustino (2019), creating a digital marketing strategy involves using a set of tools such as the website, social media, content marketing, video marketing, search engine marketing and productivity tools.

2.2.1. Website

The first phase of the digital strategy is the creation of a website. The website is the starting point in this strategy and will link the other points of interest, namely the blog, online store, and landing page. First, we must choose the domain of the website. The “.com” extension is the most well-known and therefore will be the most business friendly. The next step is to register the domain. Finally, the creation of sites can be done through the WordPress platform that allows the creation of sites for free. All pages created through the platform must be configured for tablets and smartphones, an extremely important factor since, nowadays, most internet searches are carried out using smartphones. The aim of the blog is to build trust in the target audience and create a positive perception of the company. Thus, creating interesting and current content marketing related to the company’s products and services is the goal of the blog. Blog posts must have an associated image, to make the content more appealing and some links, either internal (to the online store) or external (to justify what is written on the blog with reliable sources). To publicize the blog, the created contents can be shared through social networks, namely Facebook and Instagram.

The online store is the most important page, which will take more work to build and requires more resources, to provide easy and fast navigation. It should have a link to the blog and the website and contain brief texts explaining what each product contains and how it should be used.

Landing page is a page created associated with a blog or an online store, with information about an offer. For example, the offer of a voucher for a certain amount, with the potential customer providing their name and email in return. The landing page, in addition to generating sales, allows obtaining useful data about customers, namely email, telephone contact, address, among other aspects, which enable the development of new marketing campaigns.

2.2.2. Social Media

Social media are platforms that allow us to interact with the public and thereby boost sales. The main social networks for selling products are Facebook, Instagram, and YouTube. The Facebook account must be a public profile. For identity purposes, the profile image and cover image must match the images used on the company's website. All information about the company, links to the blog, online store and website must be available on the Facebook page. All campaigns created in the online store can be published in this account, with an associated question to generate comments. Titles of blog posts can be shared on this account and through them it will be possible to access the blog. To encourage interaction with the public and, subsequently, lead the customer to purchase, it is advisable to publish a daily image of a product that is for sale in the online store to explain the content and application of the product.

Instagram is the social network that privileges the image. Thus, a good presence on Instagram will be based on sharing product images. A commercial page should be created, with the brand name, profile image, definition of the business, link to access the online store and link to the Facebook page. Creating hobbies on this page allows you to increase followers and, accordingly, collect information about the audience and sales segmentation.

Greater business recognition, increased website visits and better results in the digital strategy can be achieved through a good presence on YouTube. This social network has the advantage of allowing the transmission of content via any computer, smartphone or tablet. However, the results are not quick to achieve. Therefore, the communication to reach the potential client must have an attractive and captivating format.

2.2.3. Content Marketing

Content creation must consider the concept of copywriting, also known as the art of using words to influence and persuade, to trigger an action (sales, for example). As tips for writing online, it is worth mentioning: use of the inverted pyramid (starting from the most important to the least important); knowing the audience, setting goals and using the right words; fall back on typical news questions (Who? What? When? Why?); use the 4Us (useful, urgent, unique and ultra-specific); consider the AIDA model (attention, interest, desire and action); use short sentences; tell stories; avoid time references; apply strong verbs and use good titles. To achieve a strong online presence on social networks, on the blog and on the website, the quality of the photographs that are published and the originality of the images that are created must be valued.

2.2.4. Video Marketing

Creating videos can be useful to introduce the company to the public, as well as to publicize the products that the organization offers. There are tools that easily allow you to create videos, such as Microsoft PowerPoint, Windows Movie Maker and iMovie. However, creating a professional video is always a better option in terms of quality, although it requires investment of money and time. One way to gain an audience in the digital world is through live broadcasting, as it allows interaction with the audience in real time, allowing the audience to stay in touch with the content for longer. There are several social networks that allow live transmission: YouTube, Facebook, Instagram, Twitter, among others. On the other hand, there is some software available to create a good live streaming experience, namely Wirecast Pro, Vmix and OBS Studio.

2.2.5. Search Engine Marketing (SEM)

Search Engine Marketing (SEM) is a digital marketing strategy that aims to increase the online visibility of websites on the search engine results page. The main SEM tools used are Google AdWords and Search Engine Optimization.

Google AdWords allows users to create advertising on the Google search engine and target it to users who are actively looking for information, products or services. Ads can be generated in text, video, shopping and for applications.

Search engine optimization (SEO) allows optimizing the capture of visits taking into account the relevance and semantics of the keywords. Keywords

are the main pillar of SEO. So, there are three important factors when choosing keywords: relevance, volume, and competition. The keyword is considered relevant when it is related to the ad, when the text created for the Landing page is related to the subject and when it is related to the product or service to be promoted. To meet the volume, you must check if it is a keyword with an acceptable search volume, using Google AdWords Keyword Planner. In addition, it is also possible to analyze, in this tool, the existence of competition and check if there are similar contents or products.

2.2.6. Productivity tools

It is increasingly important to use tools that enable organizations to manage customer relationships well, to follow up on commercial proposals or additional information that has an impact on sales and customer satisfaction. These types of tools are called Customer Relationship Management (CRM). Some of them are: Insightly, Prosperworks, Hubspot CRM, Zoho CRM, Sugarcrm, Salesforce, Capsule, Microsoft CRM and Streak.

An organization must also define with its employees simple work processes that everyone understands. Thus, it is important that everyone participates and gives their contribution to the project under development. For this purpose, there are platforms, such as Mind Mapping and Google Docs, which organizations can use, stimulating creativity and the sharing of ideas by employees.

E-mail is considered an excellent tool for disseminating marketing campaigns, due to its universality, popularity, ease, possibility of relationship and regular communication. However, it is necessary to take into account some aspects in an email marketing campaign, namely, always checking that the campaigns comply with the legislation, creating an email list, choosing an email marketing platform, and developing regular and segmented communication.

2.2. The pharmaceutical market in Portugal

In Portugal there are, to date, 2804 pharmacies (Infarmed, 2021) and 1376 non-prescription drug sales outlets (MNSRM) (Infarmed, 2018). Regarding the analysis of the total MNSRM market in over-the-counter establishments, these represent 19.6% of the sales volume of the total MNSRM market, in the period from January to June 2020. In the same period, the value of over the counter MNSRM sales was 15.9% of the total MNSRM market, as can be seen in the table below (Table 5.1).

Table 5.1. Representativeness of MNSRM in the drug market

			PVP value	Representativeness	
		Packaging	€	Volume	Value
	Pharmacies	17 054 638	140 815 776	80%	84%
MNSRM	Outside Pharmacies	4 157 042	26 533 964	20%	16%
	TOTAL	21 211 680	167 349 740	16%	12%
Ambulatory Total Market		131 659 588	1 451 487 645		

Source: (Infarmed, 2020).

The MNSRM market grew both in value and quantity until 2018, with a sharp drop being seen at both levels in 2019, in the period between January and June. Due to this drop both in terms of sales volume and the amount invoiced, the price index has increased in 2019 and 2020 (Infarmed, 2020). Analyzing the distribution of the MNSRM market in mainland Portugal, the districts with the most sales and that earned the most with the MNSRM were Lisbon, Porto and Setúbal. Regarding the price index, the districts with the lowest price indexes and well below the national average were Viana do Castelo, Viseu and Portalegre (Infarmed, 2020).

The pharmaceutical market in Portugal comprises medicines (subject to and non-prescription), as well as Consumer Health – CH products. MNSRM are included both in the category of drugs and in the classification of CH, given the free nature of their dispensation. According to a study carried out by Human Data Science Company Portugal (IQVIA, 2019), in a universe of 1800 pharmacies, the CH category represents 30% of the market in the pharmacy channel in Portugal. The CH category is made up of several subcategories: Over The Counter (OTC) (medicines not subject to medical prescription, but which require specialized technical advice and should not be made available to the user without advice) [MNSRM-EF and MNSRM (11%) and supplements (7%)], which represents 18% of the total CH; Personal Care – PEC (dermo cosmetics, oral hygiene, etc.) represents 7%; Patient Care – PAC (para pharmaceutical products, diagnostic tests and accessories) with a representation of 5% and finally the subcategory Nutrition – NTR (infant nutrition and diet) which corresponds to 1% of sales in the CH category, as shown in the figure below (Figure 5.1).

Chapter 5

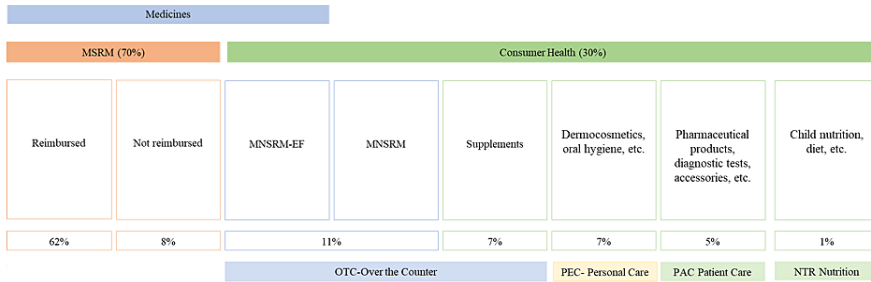


Figure 5.1. Distribution of the medicine and consumer health market in the pharmacy channel

Source: (IQVIA, 2019).

The pharmaceutical industry is one of the most resistant to entering e-commerce, mainly because it is a conservative and highly regulated sector. However, it should be noted that, in 2010, there were only 65 websites of pharmacies authorized to sell medicines in Portugal. Ten years later, there are 2806 pharmacies with an online presence, duly authorized by Infarmed (Digitalks, 2020).

In perfumery and cosmetics, which are not categories of products considered direct competitors, sometimes ranges of these categories can be found in online pharmacies. As can be seen in Table 5.2, these product categories are already part of the online shopping habits of many Portuguese people, thus making it a very competitive market at a national level (Digitalks, 2020).

Table 5.2. Online perfumery and cosmetics stores with the most traffic in Portugal, average visit time and average page views

	Global monthly traffic	Average visit time	Average pages visited
Care to Beauty	1.499M	00:01:58	2.94
Perfumes&Companhia	661.984	00:03:38	4.59
SweetCare	661.259	00:03:07	3.91
Pluricosmética	528.166	00:04:29	6.98
Skin	444.146	00:03:48	4.51
Tulsi Cosmetic	339.342	00:05:26	7.55
Loja do Shampoo	254.516	00:03:09	5.25
Cosmetics	193.541	00:05:16	5.22
Castelbel	43.168	00:01:53	3.13
Claus Porto	34.092	00:02:44	3

Source: (Digitalks, 2020).

3. Methodology

The analysis of results is based on a questionnaire, built on the Google Forms platform, consisting of 26 questions, and entitled “Study of the commercial viability of an online pharmacy”.

One of the peculiarities of a questionnaire is the impossibility of clarifying doubts, therefore it must be extremely well organized in a way that is coherent and logical for the respondents (Carmo & Ferreira, 2008). For the formulation of the questions, it was sought that they were not only clear, concise and unambiguous (Principle of Clarity), but also that they corresponded to the intention of the question itself (Principle of Coherence) and that did not induce an answer (Principle of Neutrality) (Barbosa, 2012). Regarding the type of questions, this questionnaire used completely open questions and closed questions in which the respondent could only select, among the options presented, the one that best suited his opinion. For closed questions, multiple-choice answers and the Likert scale were used, allowing to quantify thoughts, feelings and preferred actions in relation to a given topic (Joshi et al., 2015).

The distribution of the surveys was done through online means, such as email, WhatsApp, and Messenger. Data collection took place between May 20, 2021, and September 15 of the same year, obtaining 110 responses. The results were exported to an Excel file using the platform’s functionalities and the necessary changes were made (response coding) so that the results obtained could be more easily treated and analyzed using the IBM SPSS software.

4. Research results

The main objective of the statistical analysis of the results was to answer the main question of the study and concluding that, if the creation of an online pharmacy was viable, which products/services would make the operation of this pharmacy viable, security aspects on online services and indicators that lead to online purchases. Thus, several questions were introduced in the survey to obtain this information. The analysis started with a descriptive study of the sample and then an inferential study to validate the significance of the results obtained.

4.1. Socio-demographic characterization of the sample

Starting with the descriptive analysis of the sample, most of the 110 participants are young (67.3% are less than 20 years old and between 20 and 29 years old) and 71.8% are female. With regard to marital status, 87.3% are single or married and 84.6% hold a bachelor's or master's degree. Considering the average monthly income earned by pharmacy customers, grouped into the following intervals (<400€, 400€-600€, 600€-800€, 800€-1000€, 1000€-1200€, 1200€-1400€, 1400€-1600€ and >1600€), the analysis show that 57.2% earn between €600-€1400 and 23.6% earn more than €1600. Approximately 50% of respondents go to pharmacy about once a month and 32.7%, between 2 to 4 times a year. About 60% say they spend on average, per purchase at the pharmacy, up to €30 and approximately 30% say they spend between €30 and €60. The results also show that around 32% already shop at online pharmacies and 55.5% say that it is very likely that they will use the services of an online pharmacy. It should be noted that, to facilitate the analysis and interpretation of the results, the participants' ages were grouped into intervals: <20, 20-29, 30-39, 40-49, 50-59 and 60-69.

4.2. Inferential analysis of results

One of the most important aspects to be checked on the study, concerns the frequency of demand for products in a pharmacy. In this sense, the survey considered products such as: general medication, specific medication, dermo cosmetic products, sunscreens, hygiene products, food supplements, products for mom and baby, orthopedic products, ophthalmological products and services. For this set of variables, the Cronbach's alpha value obtained indicates that the internal consistency of the results is good (0.812). General medication, specific medication, dermo cosmetic products, hygiene products and sunscreens are the most frequently sought by respondents. As the internal consistency of the results is good, a factor analysis can be applied. Three factors/groups were extracted using the principal component analysis method, which explain 65% of the variance present in the original variables. Factor analysis proved to be an adequate technique for the data, since the Keiser-Mayer-Olkin test has a value of 0.776. In addition, Bartlett's test confirms the applicability of this technique since it allows rejecting the hypothesis of identity of the correlation matrix (p-value=0.000). The factors obtained were:

Factor 1: Medium turnover products (dermo cosmetic products, sunscreens, hygiene products, mom and baby products);

Factor 2: Low turnover products (dietary supplements, orthopedic products, ophthalmic products and services).

Factor 3: Products with high turnover (general and specific medication);

Also important is to characterize the demand for products by gender and age, in pharmacy. The answers provided by the respondents seem to show the existence of differences in the demand for products when analyzed separately by gender. Using a Chi-square/Fisher test with a significance level of 5%, it is concluded that the demand for dermo cosmetics products, sunscreens, mommy and baby products and orthopedic products depends on the gender of the participant, being more relevant for females. The Kruskal-Wallis test indicates that there are no statistically significant differences in the frequency of demand for products in the pharmacy, based on the participant's age ($p\text{-value} > 0.05$) except for mom and baby products. For this difference, Dunn's post-hoc test was applied, concluding with 5% significance that the age groups [50–59] and [20–29], [20–29] and [40–49] and even between < 20 years old and [20–29] show differences regarding the frequency of demand for mom and baby products.

Next, the search behavior for brands of dermo cosmetics products is analyzed. The existing brands in the Portuguese market pharmacies for this type of product were considered (Avene, La Roche-Posay, Bioderma, Uriage, Lierac, Gálenic, Vichy, Ceravé, Eucerin, Neostrata, Caudalie, Endocare, Isdin, Isdin, Isdin, Martiderm). The reliability/internal consistency of the results is good based on Cronbach's alpha test (0.874) and the distribution of the results shows that there are differences in the frequency of demand for these products. Again, it was considered interesting to verify whether these differences could be associated with the client's gender, age and average monthly income. From the results obtained through the application of the Mann Whitney U test, there is no statistically significant difference only for the Vichy, Endocare and Martiderm brands ($p\text{-value} > 0.05$). This equality of demand for Vichy brand products by individuals of both sexes can be justified because the brand offers quite complete lines of products for women and men. With regard to Endocare and Martiderm, this could be due to the fact that they are fewer commercial brands and often the purchase comes from a medical prescription. For a significance level of 5%, the Kruskal-Wallis test shows that there is no significant difference in demand for brands of dermo cosmetic products, neither between age groups nor between classes of average monthly income ($p\text{-value} > 0.05$).

A more detailed analysis was also carried out for brands of sunscreens. The brands considered in this analysis were Avene, La Roche-Posay, Vichy, Eucerin, Lierac, Pizbuin and Isdin. Cronbach's alpha assesses the internal

consistency of the results obtained as reasonable (0.772) and these show that there are some differences in the demand for these products. Using the Mann Whitney U test at a significance level of 5%, it can be concluded that there is no statistically significant difference in demand for the Vichy and Pizbuin brands assessed by gender ($p\text{-value} > 0.05$). The significant differences found in the other brands are due to the fact that most respondents said they did not know the product. It is concluded, with 5% significance through the Kruskal-Wallis test, that there is no statistically significant difference in the demand for sunscreen brands by age group ($\text{sig} > 0.05$) and by class of average monthly income, the only difference verified refers to the Eucerin brand, which is probably due to the fact that it is the cheapest brand of sunscreen in Portuguese pharmacies.

As mentioned in the previous section, 32% of respondents say they have already made purchases at an online pharmacy and of these 42.9% show that they do it about once a month. It is important to understand, to fill this gap, because the remaining 68% said they had not made purchases at an online pharmacy. The causes are due to worrying security aspects, in particular the possible difficulty with returning the products and the waiting time until the order is received. Factors such as information security and fraudulent transactions are also of concern to consumers. Through a factorial analysis, 3 factors/groups were extracted using the principal component analysis method and that explain 66% of the variance present in the 10 original variables (10 questions related to aspects of safety concern). Factor 1 will be linked to service, factor 2 to security issues and factor 3 to lack of knowledge. The component with the most weight in the respondent's decision to make an online purchase has to do with service issues, followed by security issues. Regarding the indicators that lead to online purchases, price, speed of delivery, discounts and the functionality of the website stand out. Participants were also asked to indicate "products/services" that they consider important to be available in an online pharmacy. The most mentioned was the counseling service. Participants were also asked to indicate "products/services" that they consider important to be available in an online pharmacy. The most mentioned was the counseling service. Within this service, the chat with the health professional and explanation of the product on the website were the most unanimous.

It is also important to know which sources influence the respondent in the online purchase decision-making process. The most mentioned by the respondents was "Online research" but "Information obtained through social networks" and "Opinion from friends" cannot be neglected. These answers offer a reliability/internal consistency of 0.812 which classifies it as good.

5. Conclusions and recommendations

Research carried out on the Portuguese market shows that the online pharmacy market is constantly growing and that there are categories of supply that can be integrated into an online pharmacy concept (eg: personal hygiene products and cosmetics), which are among the most sought after in online shopping, right after clothes and shoes and computer equipment. Moreover, it was found that the cosmetics and MNSRM market is still a little widespread online market, lacking greater investment on the part of e-commerce companies. By the way, of the large online sales chains, only *Continente* and *Auchan* offer products like the ones we intend to make available. However, they do not have a very diversified offer, nor do they offer a wide range of brands of cosmetic products.

Through population surveys, we realized that a significant number of respondents (around 32%) already shop at online pharmacies and approximately 50% of respondents go to the pharmacy at least once a month and look for, in addition to medication, dermo cosmetic products, sunscreens and hygiene products. However, the biggest obstacles to buying from an online pharmacy are related to security issues in the service provided and on the website. Thus, the creation of an online pharmacy should provide a wide range of non-prescription drug sales outlets and dermo cosmetic products, sunscreens and hygiene products at competitive prices. In addition, it will be essential to combine a personalized technical advice service, as well as a commitment to a fast, user-friendly and secure website. Indeed, it will be crucial to create partnerships with the main dermo cosmetics laboratories, as well as with a network of pharmacies throughout the country, to guarantee the existence of product stock and speed of delivery.

As for the sources of information that most influence the purchase decision, we have online research, followed by social networks and the opinion of friends. Thus, it will be fundamental to promote the presence in online search engines in an organic and paid way (e.g. through a CEO and investment in Google Ads), to guarantee a regular presence, with interesting content on social networks, investing in paid advertising in Facebook and Instagram.

Regarding the limitations of this study, it should be noted that the sample is limited both by the size of the sample and by the geographic areas of data collection, making it difficult to obtain a representative sample of the Portuguese population. After verifying all the legal, technological and initial investment requirements for the creation of an online pharmacy, it will be essential to carry out an economic and financial viability study, in order to understand more concretely the potential financial return of the potential business.

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Digitalization and Entrepreneurship: The Case of Indonesia

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Abstract

This chapter explores the dynamic interplay between digitalization and entrepreneurship in Indonesia, a burgeoning hub in the Southeast Asian digital landscape. With a focus on the startup ecosystem, it delves into how the country's unique demographic, characterized by a young, tech-savvy population, and governmental support, has fueled a digital revolution. The analysis covers key aspects such as the rapid growth of internet penetration, the burgeoning e-commerce, fintech, and healthtech sectors, and the rise of Indonesian unicorns. It also examines challenges like the digital divide, infrastructure gaps, and regulatory shifts, offering insights into how Indonesia is navigating these hurdles. The chapter underscores the country's potential in harnessing digital technologies for economic growth and highlights opportunities for future development in the digital sector.

Keywords: digitalization, entrepreneurship, startup, Indonesia

1. Introduction

Indonesia's journey towards digitalization has been nothing short of remarkable. With over 270 million people, it stands as the fourth most populous country globally, underpinning its vast potential as a digital market. The country has witnessed an exponential rise in internet usage, with more than 73% of its population now having access to the internet. This digital boom has been fueled by widespread smartphone adoption, creating a fertile ground for digital entrepreneurship. The Indonesian populace's growing comfort with digital technologies,

propelled by a youthful, tech-savvy demographic, has catalyzed a burgeoning digital economy (Hutasuhut et al., 2023). As of 2023, the digital sector in Indonesia is poised to contribute significantly to the nation's GDP, reflecting the rapid integration of digital technologies in various aspects of life and business.

The rise of digitalization in Indonesia has created a conducive environment for entrepreneurship, particularly in the tech sector. Startups have been at the forefront of this digital revolution, capitalizing on the increasing digital literacy and internet penetration across the archipelago. Indonesia's startup ecosystem is vibrant and diverse, with around 2,483 startups recorded in 2023. This boom is not confined to mere numbers; it represents a deeper shift towards innovation and technological adoption across various sectors, from e-commerce and fintech to healthcare and education.

Significantly, Indonesia has birthed several unicorn startups - a term denoting privately held startups valued at over \$1 billion. These unicorns, like Gojek, Tokopedia, and Traveloka, are not just reshaping the Indonesian economy but also setting benchmarks for entrepreneurship in the region. Their success stories epitomize the potential of digitalization in propelling entrepreneurial ventures to unprecedented heights.

The symbiotic relationship between digitalization and entrepreneurship is further evident in the funding landscape. Indonesian startups attracted a staggering US\$6.7 billion in funding in 2022 (Bachtiar et al., 2022), a clear indicator of investor confidence in the country's digital market. This infusion of capital has been instrumental in driving growth, innovation, and scaling up operations for numerous startups, fostering a more vibrant and competitive ecosystem.

The Global Startup Ecosystem Index (GSER) 2023 has ranked Indonesia 39th globally, indicating a significant improvement from its previous position at 41st in 2022. This positive trend highlights the rapid growth and increased maturity of Indonesia's startup ecosystem, attracting a growing pool of investors and entrepreneurs seeking business opportunities (Startup Genome, 2023).

Indonesia has become a significant player in the global digital economy, with a rapidly growing startup landscape. The country is home to several unicorn startups, which have revolutionized their respective industries, attracting global investor attention. The diversity in the types of startups in Indonesia is particularly noteworthy, with an increasing diversification into other areas, such as healthcare, education, and logistics, driven by the country's unique challenges and opportunities.

Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities (Westerman et al., 2014).

Digitalization can be seen as the adoption of digital technologies to transform services or businesses, through replacing non-digital or manual processes with digital processes or replacing older digital technology with newer digital technology (Rogers, 2016). Also, it represents the integration of digital technology into all areas of a business, fundamentally changing how businesses operate and deliver value to customers (Siebel, 2019).

Entrepreneurship encompasses the process of creating, initiating, and managing a new business, characterized by its core focus on generating new value. This involves identifying and capitalizing on opportunities to innovate and provide new products, services, or business models. While commonly associated with the start-up of new ventures, entrepreneurship also extends to driving innovation and fostering growth within existing enterprises (Kraus et al., 2019). Figure 6.1 shows the evolution of the number of entrepreneurs in Indonesia from 2013 to 2023.

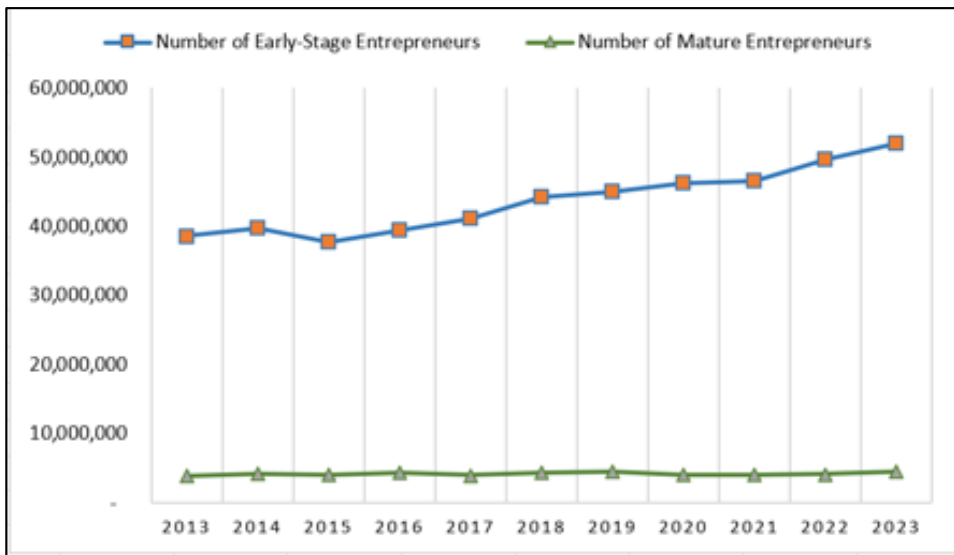


Figure 6.1. The number of entrepreneurs in Indonesia in 2013-2023

Source: (Ahdia, 2023).

In the digitalization era, entrepreneurs are presented with unprecedented opportunities: technological progress fosters sustainable innovation, allowing entrepreneurs to innovate and differentiate themselves using digital platforms continuously. This digital ecosystem not only opens new avenues for traditional entrepreneurial ventures but also promotes social digital entrepreneurship, blending commercial

and social impact. Additionally, the increasing digitization of assets and operations offers fertile ground for female entrepreneurs, though this area still requires further exploration to address online inequality and resource constraints. On the other hand, these opportunities are counterbalanced by significant challenges. Entrepreneurs must navigate the rapid pace of technological change, a task that can be daunting in maintaining a competitive edge. Establishing trust in the digital marketplace emerges as a crucial challenge, compounded by the dynamic and ever-evolving nature of the digital entrepreneurship environment. This rapid evolution creates a gap in academic research, which struggles to keep pace with the latest developments, indicating a need for ongoing, adaptive research. Furthermore, evolving technological infrastructures present diverse challenges, including the low diffusion rates of specific technologies and the necessity for entrepreneurs to adapt to new tech opportunities (Kraus et al., 2019).

Indonesia is making significant strides in digitalization and entrepreneurship. However, there is a notable cognitive gap both domestically and internationally, particularly in the startup sector. This gap is evident in the underestimation of the Indonesian market's potential and a limited understanding of the local context by foreign investors and companies. Furthermore, disparities in digital literacy and access within Indonesia highlight a significant divide. This cognitive gap has substantial implications for policy formulation, investment decisions, and the trajectory of the Indonesian digital ecosystem, especially concerning the burgeoning startup landscape (Hutasuhut et al., 2023).

The purpose of this chapter is to provide a thorough analysis of how digitalization has impacted entrepreneurship in Indonesia, with a specific emphasis on the startup ecosystem. By investigating the interplay between technological advancements and entrepreneurial dynamics within the Indonesian context, this chapter aims to offer a nuanced perspective on the country's digital economy and its impact on entrepreneurial ventures, particularly startups, which are a vital and dynamic part of this landscape. Through this exploration, we aim to provide a comprehensive narrative that sheds light on the distinct features of Indonesia's digital economy.

2. Literature Review

The Southeast Asia digital economy is expected to generate \$100 billion in revenue in 2023, primarily driven by sectors like e-commerce, travel, transport, and media. The adoption of digital financial services (DFS) is accelerating, with

digital payments now constituting over 50% of the region's transactions. Sustainable business models are emerging among fintech companies, and traditional financial institutions are digitalizing to retain users. Digital inclusion has advanced significantly in Southeast Asia, but a digital economic divide is emerging, particularly for consumers outside metro cities. Indonesia is the largest digital economy in Southeast Asia, with its digital economy generating US\$74 billion in revenue in 2023, accounting for over half of the total digital economy in Southeast Asia. Indonesia has emerged as an exciting hub for digital innovation, fueled by its dynamic economy, growing middle class, and tech-savvy population. The country's digital economy is booming, with e-commerce, fintech, and digital content leading the charge. Indonesia's digital economy is estimated to reach US\$124 billion by 2025, making it the largest in Southeast Asia. Mobile penetration is staggering, with over 96% of internet users accessing the internet via their mobile devices. This high level of mobile usage has created a fertile ground for mobile-first businesses and startups. Indonesia has the potential to become a global leader in digital innovation, and businesses that can harness the power of digital technology will be well-positioned to succeed in this dynamic market (Google et al., 2023).

Indonesia's digital economy and startup ecosystem are currently witnessing a period of rapid growth and transformation (see Figure 6.2), fueled by the widespread adoption of the internet, a thriving middle class, and strategic government initiatives. The country's startup landscape is characterized by a diverse community of entrepreneurs who are leveraging digital technology to address local and global challenges across various sectors (Pramono et al., 2021).

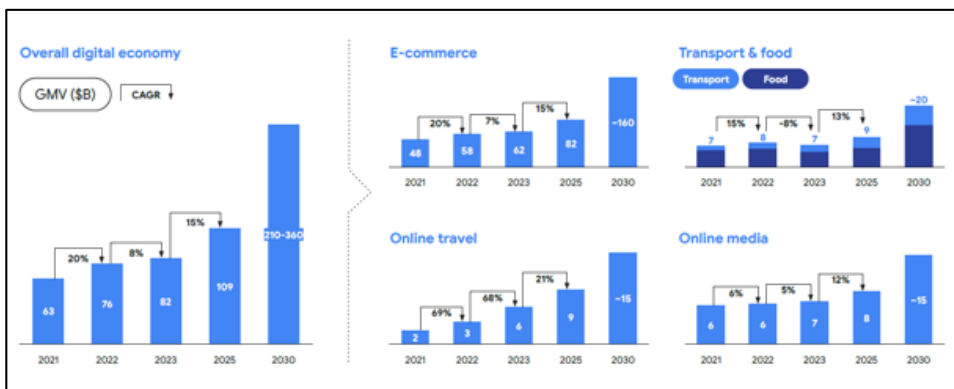


Figure 6.2. Indonesia's digital economy profile in 2023

Source: (Google et al., 2023).

The digital economy in Indonesia is expanding at an impressive pace, with a current valuation of \$70 billion projected to reach \$337 billion by 2030. One of the major contributing factors to this upward trajectory is the substantial surge in funding, with Indonesian startups receiving a remarkable 27% increase in funding in 2022, amounting to a staggering US\$6.7 billion. This marks the highest annual increase in funding for Indonesian startups in history. Although e-commerce and fintech remain the dominant sectors, a notable trend has emerged, with startups diversifying into various domains, including healthcare, education, and logistics. International investors are increasingly recognizing the immense potential of Indonesia's startup scene, with foreign investors accounting for 57% of the total funding to Indonesian startups in 2022. The Indonesian government has also played a significant role by extending its support through funding programs and tax breaks, recognizing the crucial role of startups in driving economic growth. Moreover, Indonesia's demographics, boasting a youthful population with over 70% under the age of 35, provide a vast reservoir of potential entrepreneurs and talent for the startup ecosystem. However, challenges remain, notably limited access to skilled talent, particularly in technology and engineering, which can hinder startups' growth. Furthermore, underdeveloped infrastructure in rural areas can impede startups' ability to reach customers and expand their operations. Regulatory uncertainty can also pose a hurdle to foreign investors and complicate startups' navigation of the legal system. Despite the challenges, the future of Indonesia's startup ecosystem looks promising. The country's vast and growing population, coupled with its young and entrepreneurial workforce, provides a solid foundation for innovation (Startup Genome, 2023).

Innovations like super apps are blurring traditional sector lines, leading to platform convergence and redefining customer engagement through social commerce and omnichannel experiences. The ecosystem's focus is shifting towards sustainability and impact investing, reflecting a corporate responsibility towards societal and environmental issues. Additionally, technological advancements in artificial intelligence, augmented reality, and blockchain are expected to disrupt various industries further.

The growth of Indonesia's digital economy is supported by significant investments from venture capitalists, angel investors, and government funding. This influx of capital allows startups to scale and expand, contributing to the digital economy's overall growth. While e-commerce once dominated investments, fintech is now emerging as a focal point for investors. However, there are challenges such as uneven infrastructure distribution that leads to a digital divide and

a talent gap in technological skills that require innovative solutions (Gayatri et al., 2022).

The Indonesian government is playing a crucial role in shaping a favorable ecosystem for startups. Initiatives like tax incentives for tech-based businesses and the establishment of innovation hubs are driving the development of the startup ecosystem. These efforts, combined with the entrepreneurial spirit within the startup community, have led to the emergence of co-working spaces, incubators, and accelerators, providing resources and mentorship essential for the success of new ventures. This collaborative environment facilitates knowledge sharing and fosters a sense of solidarity among startups, encouraging growth and sustainability (Wahyuni & Noviaristanti, 2022).

As Indonesia's digital economy continues to flourish, the startup ecosystem is poised to play a pivotal role in driving innovation, creating employment opportunities, and contributing to the nation's economic development. The country's vibrant and dynamic startup landscape promises to be a key driver of Indonesia's overall economic growth and development, backed by a supportive government and a tech-savvy population. The dynamic interplay of challenges and opportunities is not only a reflection of Indonesia's current achievements but also a harbinger of the profound economic transformation that awaits (Kartini & Callista, 2021).

In 2023, Indonesia's significant market size in Southeast Asia, combined with a young, talented, and internet-savvy workforce, positions it as a fertile ground for substantial startup growth and the creation of unicorns primarily serving its expansive domestic economy. The country's public sector has prioritized enhancing connectivity, directly benefiting the tech and IT startup landscape. Initiatives like the government-run Startup Studio Indonesia, aimed at bolstering the startup ecosystem, complement efforts to attract investment, streamline business establishment processes, and tackle bureaucratic impediments. This supportive environment has established Indonesia as a Southeast Asian leader in tech investment, with Jakarta emerging as a key hub of entrepreneurial activity, home to successful startups like J&T Express, Ovo, and Traveloka. The growth in digital infrastructure, accelerated by the COVID-19 pandemic, positions Indonesia as an increasingly attractive destination for digital nomads, particularly with initiatives like the digital nomad visa, enhancing its appeal as a hub for foreign talent and startup development (Startup Genome, 2023).

Indonesia has emerged as a vibrant and dynamic startup ecosystem, ranking 39th globally according to the Global Startup Ecosystem Index 2023. This meteoric rise is attributed to a confluence of factors, including a young and tech-savvy population, a burgeoning middle class, supportive government policies, and

a growing demand for digital services. E-commerce and fintech reign supreme in Indonesia's startup landscape, accounting for over 70% of all startups. Jakarta stands as the epicenter of this entrepreneurial hub, followed by Bandung and Denpasar. International investors have increasingly recognized Indonesia's potential, pouring in a significant portion of funding in recent years. The Indonesian government has further fueled the ecosystem's growth through initiatives like funding programs, tax breaks, and incubators. Despite these promising developments, challenges remain, such as a shortage of skilled talent, underdeveloped infrastructure, and regulatory uncertainty. Addressing these challenges and capitalizing on its strengths positions Indonesia to become a global leader in the startup ecosystem. By investing in education and training, infrastructure development, streamlining regulations, and creating a supportive environment, Indonesia can foster innovation and entrepreneurship, transforming itself into a hub of digital disruption (Startupblink, 2023).

Table 6.1. List of unicorn startups in Indonesia in 2024

No.	Startup	Category	Valuation (Billion USD)
1	GoTo (Gojek & Tokopedia)	Super app and E-commerce	30
2	J&T Express	Logistics/Delivery	7.8
3	Bukalapak	E-commerce	7.5
4	OVO	Fintech	2.9
5	Traveloka	Online travel	2.75
6	Kredivo	Fintech	2.5
7	Tiket.com	Online travel	2.0
8	Akulaku	Fintech	2.0
9	eFishery	Aqua-Tech	1.3
10	DANA	Fintech	1.2
11	Xendit	Fintech	1.0
12	Blibli	E-commerce	1.0
13	Ajaib	Fintech	1.0
14	Kopi Kenangan	Food & Beverage	1.0

Source: (Bizhare.id, 2024).

In the rapidly evolving digital landscape of Indonesia's startup scene, opportunity recognition is a complex journey that demands cognitive agility, astute pattern recognition, and the ability to learn and adapt swiftly. Entrepreneurs in Indonesia need to align their resources with emerging possibilities, reflecting a deep under-

standing of their local environment. To unlock sustainable success in this terrain, it is crucial to comprehend the cognitive processes that underpin opportunity recognition, especially within the unique digital landscape of Indonesia (Feriady et al., 2021).

Cognitive models offer insights into how Indonesian entrepreneurs process information and frame their mental models to identify and evaluate potential ventures. Meanwhile, behavioral models provide insights into the heuristics and biases that impact decision-making in uncertain situations—a common scenario in Indonesia’s dynamic digital market. Central to these processes is pattern recognition, enabling entrepreneurs to discern significant trends in market data, user behavior, and technological advancements (Panjaitan et al., 2023).

In Indonesia’s digital market, pattern recognition is particularly relevant since it is characterized by rapid growth and diverse consumer behaviors. Entrepreneurs must transform challenges into opportunities by adopting creative problem-solving skills and creating solutions that resonate within Indonesia’s unique digital ecosystem. Decision-making under uncertainty is an art that Indonesian entrepreneurs must master, balancing risks and rewards in a context-rich with data but subject to constant change. Learning and adaptation are imperative, ensuring responsiveness to market shifts and consumer feedback (Shahzad et al., 2021).

Cognitive agility, the ability to process information rapidly and adjust mental models accordingly, is vital in Indonesia’s continuously evolving digital landscape. Teamwork and collaboration, drawing on diverse perspectives, enhance the ability to identify and assess opportunities. The digital environment intensifies these cognitive processes, and entrepreneurs must efficiently filter and analyze vast data streams due to information overload. Swift adaptation to technological advancements and evolving market dynamics is imperative (Pramono et al., 2021).

Entrepreneurial traits such as risk-taking, proactiveness, and visionary thinking drive the pursuit of new ventures in Indonesia. Cognitive skills like problem-solving, critical thinking, and creativity are essential for navigating the complexities of opportunity recognition. Deep domain knowledge of Indonesia’s digital landscape and relevant sectors provides context and understanding. Team diversity, encompassing various cultural, educational, and experiential backgrounds, fosters innovative solutions. Effective communication, collaboration, and trust within teams create a fertile environment for collective exploration and decision-making (Feriady et al., 2021).

To nurture opportunity recognition in Indonesian digital startups, practical steps include fostering a culture of experimentation and learning and embracing the inherent uncertainty of the digital world. Encouraging team diversity and

collaboration taps into collective intelligence and varied perspectives. Leveraging data analytics and technological tools transforms data into actionable insights. Developing cognitive skills and entrepreneurial mindsets enables teams to think critically, creatively, and strategically. Staying informed about emerging trends and technologies is crucial to keep the opportunity radar attuned to the dynamic digital landscape (Zaidi et al., 2023).

3. The Case of Indonesia

3.1. Fueling the Engine: Key Drivers of Success

Indonesia's demographic landscape plays a pivotal role in shaping its digital economy. With a population exceeding 270 million, a significant proportion of which is young, the country benefits from a substantial demographic dividend. This young population is not only tech-savvy but also increasingly affluent, leading to a growing disposable income that fuels digital consumption (see Figure 6.3). The rise of a new generation of Indonesians, who are digitally connected and entrepreneurial by nature, is reshaping the business landscape. This demographic shift is a crucial factor in the burgeoning e-commerce sector, as well as in the broader digital services market. The enthusiasm and adaptability of this young populace are instrumental in driving innovation and embracing new digital trends, making Indonesia a hotbed for digital entrepreneurship and technological advancements (Muafi et al., 2021).

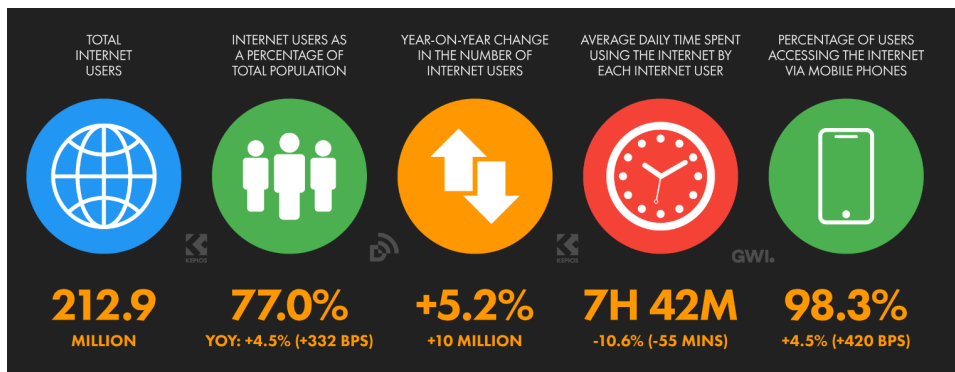


Figure 6.3. Overview of internet use in Indonesia in 2023

Source: (We Are Social, 2023).

The surge in internet penetration and mobile adoption across Indonesia's archipelago has been nothing short of remarkable. From major cities to remote islands, the expansion of digital connectivity is revolutionizing access to information and services. A key factor in this expansion has been the availability of affordable data plans, making internet access more accessible to a broader population segment. Government initiatives to bridge the digital divide have further accelerated this trend, encompassing infrastructure development and policies that encourage digital adoption. The impact of improved connectivity on the economy is profound, particularly in sectors like e-commerce, where it has catalyzed growth by enabling access to online markets for millions of consumers and businesses. This widespread connectivity is also fostering the development of other digital services, transforming the way Indonesians live, work, and interact (Hutasuhut et al., 2023).

The Indonesian government actively supports the startup ecosystem and its development through various initiatives. The BKPM (Indonesia Investment Coordinating Board) focuses on aiding foreign investors and facilitating their interaction with the government. The Indonesian Startup Database, developed by MIKTI and BEKRAF, is a central resource for policy-making and attracting investments. The "Making Indonesia 4.0 Strategy" is geared towards embracing automation and technologies of the Fourth Industrial Revolution (see Figure 6.4). The Palapa Ring project is significant for enhancing internet access in rural areas, aiding digital economy players like OVO and Tokopedia in expanding their reach. Additionally, the Super Deductible Tax offers fiscal incentives for industries investing in vocational activities and R&D, providing substantial tax relief. Collectively, these measures create a nurturing environment for startups, fostering growth and innovation within Indonesia's digital economy (Startup Universal, 2023).

Public-private partnerships have become increasingly common, bridging gaps that the government or private sector could not address independently. These collaborations have been instrumental in various sectors, from fintech to health-tech, driving both innovation and scalability. However, there is still room for improvement, particularly in areas such as regulatory clarity and further incentives for foreign investment, which could accelerate the growth trajectory of Indonesia's digital economy (Abidin et al., 2022).

In addition to these factors, several other elements contribute to the success of Indonesia's digital landscape. The country boasts a vibrant and evolving digital talent pool nurtured by both local educational institutions and international collaborations. This talent pool is essential in driving innovation and sustaining the digital ecosystem. Venture capital investments in Indonesia have been growing,

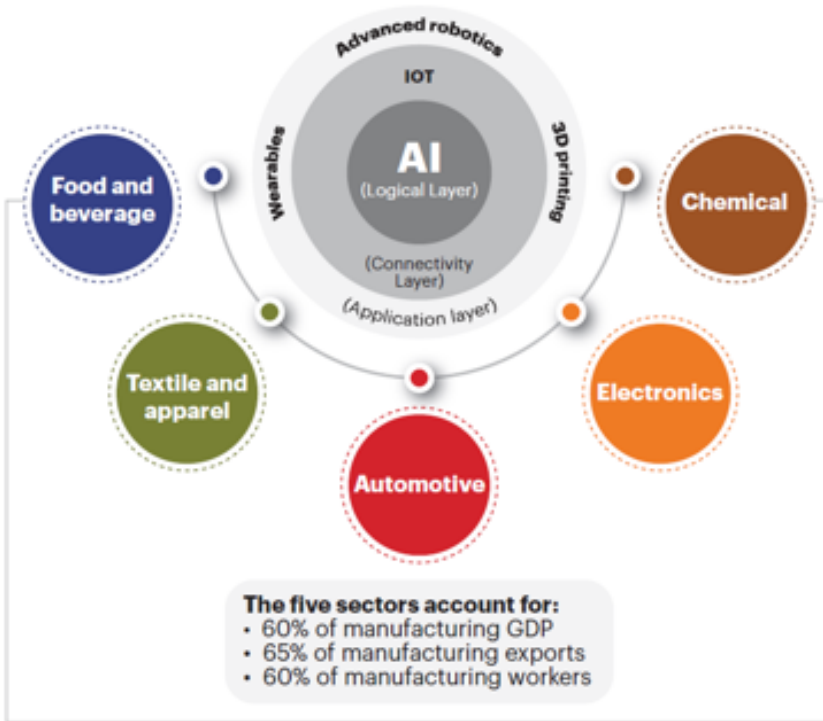


Figure 6.4. Top five sectors in "Making Indonesia 4.0 Strategy"

Source: (Ministry of Industry of Indonesia, 2018).

indicating a maturing funding ecosystem. This influx of capital has enabled startups to scale and innovate, thereby contributing to the dynamic growth of the digital economy. Cultural factors, too, play a significant role. The widespread adoption of social media has transformed communication and marketing strategies, while the growing acceptance of digital payments has facilitated the transition to a more digital-centric economy. These cultural shifts, coupled with technological advancements, are creating a fertile ground for digital innovations and entrepreneurship.

3.2. Lessons Learned: Insights for All from Indonesia's Digital Journey

Indonesia's digital transformation highlights several critical aspects that are instrumental in building a thriving digital economy. One of the most crucial factors is the need to tailor digital solutions to meet the specific requirements and expectations of its young and tech-savvy population. This demographic, which constitutes the majority of Indonesia's population, is highly receptive to innovative and convenient digital solutions and expects the latest technologies to be integrated with user-friendly interfaces that address local challenges and opportunities (Prasetio et al., 2023).

Another significant aspect of Indonesia's digital transformation is the need for educational initiatives that promote digital literacy and entrepreneurial mind-sets among the youth. This approach prepares future generations for the digital economy and equips them with the necessary skills to innovate and succeed. Such initiatives can take various forms, including integrating digital skills into the national curriculum and offering specialized training programs and workshops (Setiadi et al., 2023).

Indonesia's digital transformation also underscores the importance of affordable internet access and infrastructure development in bridging the digital divide. Despite the challenges posed by Indonesia's archipelagic nature, the country has made commendable efforts to expand its digital infrastructure to remote areas, offering valuable insights into innovative solutions such as low-orbit satellites and community networks that can provide affordable and reliable internet access to underserved communities (Lynn, 2023).

Furthermore, Indonesia's commitment to connecting the unconnected highlights the transformative power of digital inclusion. By ensuring that all segments of society have access to the Internet, Indonesia is unlocking new economic opportunities and enhancing its citizens' quality of life. These efforts also contribute to achieving more equitable and inclusive economic growth, enabling rural and underserved communities to participate in the digital economy (Hosan et al., 2022).

Indonesia's digital landscape also emphasizes the importance of supportive government policies and regulations in fostering a thriving digital economy. Policies encouraging innovation and competition are essential for creating a dynamic and competitive digital market. Indonesia's approach to implementing regulatory reforms and providing incentives for digital startups sets an example of how governments can effectively support the digital economy, striking a balance

between encouraging innovation and ensuring consumer protection and fair market practices.

Finally, Indonesia's digital ecosystem teaches the importance of building a comprehensive ecosystem that extends beyond mere access to capital. While funding is crucial for startups, other factors such as mentorship, networking opportunities, and access to technology and talent play a crucial role in their growth and success. Incubators, accelerators, and co-working spaces that provide the necessary capital and create an environment where entrepreneurs can learn, collaborate, and thrive are essential for building a dynamic and competitive digital ecosystem (Malau et al., 2020).

3.3. Future Horizons: Challenges and Opportunities

Indonesia's digital landscape is characterized by a significant digital divide, particularly in rural areas. The gap in internet access and digital literacy between affluent and less affluent populations, as well as urban and rural areas, remains a significant challenge to achieving comprehensive digital inclusivity. This disparity limits the reach of digital services and solutions, hindering equitable economic growth (Rumata & Sastrosubroto, 2020).

Public-private partnerships can facilitate extending digital infrastructure to remote areas, making the Internet more accessible and affordable. Targeted educational initiatives, focusing on enhancing digital literacy across all levels of society, are also vital. By prioritizing digital inclusivity, Indonesia can ensure that its digital transformation benefits all segments of its diverse population (Ismail et al., 2023).

As Indonesia's digital economy grows, it faces the challenge of navigating evolving regulations related to data privacy, cybersecurity, and competition (Muzykant et al., 2023). These regulatory shifts are critical in ensuring a safe and fair digital environment but can pose challenges for startups that must continually adapt to remain compliant.

Startups should proactively engage with regulatory bodies, contributing their insights and expertise to shape regulations that support innovation while protecting consumer interests. Adaptability is key, as startups must be able to quickly adjust their operations in response to new laws and regulations. Collaboration between startups and policymakers can lead to a regulatory environment that is conducive to growth and innovation while safeguarding fundamental ethical and security standards (Oliva et al., 2022).

Sustainable business practices are critical for startups in Indonesia's digital ecosystem. Startups should integrate social impact initiatives into their business models, aligning profitability with societal and environmental benefits. Responsible data use is also essential, ensuring that data is used ethically and responsibly, respecting privacy, and promoting trust. Startups must consider their environmental footprint and adopt eco-friendly practices. By prioritizing sustainability, Indonesian startups can contribute to a more resilient and responsible digital economy (Aldianto et al., 2021).

Indonesia's digital landscape presents vast opportunities for growth in emerging sectors such as aggrotech, which holds significant potential in enhancing agricultural productivity and sustainability (Tsurayyal et al., 2023). Fintech can revolutionize financial services beyond just payments, such as lending, insurance, and wealth management, particularly for underserved populations (Setiawan et al., 2021). Edtech offers immense possibilities in bridging educational gaps and providing accessible and quality educational resources, especially for marginalized communities (Bhardwaj et al., 2020).

Greater regional integration and collaboration within Southeast Asia can foster cross-border trade, knowledge sharing, and innovation, enabling Indonesian startups to expand their reach and impact. By tapping into these emerging sectors and fostering regional collaboration, Indonesia can further solidify its position as a leader in the digital economy of Southeast Asia.

4. Conclusion and recommendations

This chapter offers a comprehensive exploration of Indonesia's rapidly evolving digital and entrepreneurial landscape, highlighting its remarkable journey towards becoming a Southeast Asian digital hub. Central to this transformation has been the symbiotic relationship between digitalization and entrepreneurship, propelled by the nation's unique demographic, strategic government support, and a vibrant startup ecosystem.

Firstly, the chapter underscores the critical role of Indonesia's young, tech-savvy population in driving digital adoption and innovation. The demographic dividend, characterized by a vast young workforce, has catalyzed the digital boom, especially in sectors like e-commerce, fintech, and healthtech. This demographic trend presents opportunities for further digital growth but also necessitates continued investment in digital literacy and skills development to maintain momentum.

Secondly, the rise of digital connectivity across the archipelago, supported by affordable internet access and government initiatives, has been instrumental in bridging the digital divide. However, persistent gaps, particularly in rural areas, call for innovative solutions like public-private partnerships and targeted educational programs to ensure inclusive digital growth.

The evolving regulatory landscape in Indonesia presents both challenges and opportunities. As the chapter highlights, navigating these changes requires adaptability and close collaboration between startups and policymakers. A regulatory environment that supports innovation while ensuring consumer protection and fair competition is essential for sustainable digital growth.

Sustainable business practices and social impact initiatives emerge as vital considerations for the future. The chapter advocates for responsible data use and environmental consciousness within the startup ecosystem, emphasizing the importance of aligning profitability with societal and environmental benefits.

The untapped potential in emerging sectors such as aggrotech, fintech beyond payments, and edtech for marginalized communities, is significant. These sectors offer opportunities for innovation and growth, but their development requires greater regional integration and collaboration within Southeast Asia.

To capitalize on these opportunities and address the challenges, the chapter recommends several strategies. Continued investment in digital infrastructure and literacy programs is crucial for bridging the remaining gaps in internet access and skills. Fostering an environment that encourages innovation and entrepreneurship through supportive policies and incentives will be key to sustaining the growth of the digital economy. Promoting sustainable business practices and encouraging startups to adopt socially responsible models will enhance the long-term impact of digital transformation.

To enhance entrepreneurship and digitalization in Indonesia, a comprehensive approach is needed. This approach encompasses a trio of strategies: digital upskilling, regulatory agility, and streamlined funding access. By focusing on digital literacy and skills development, Indonesia can leverage its young demographic across both rural and urban areas through public-private partnerships. Adopting a regulatory sandbox approach similar to that of Singapore allows startups to test innovations in a controlled environment while enabling regulation to evolve responsively. Additionally, establishing dedicated micro-venture capital funds targeting early-stage startups in emerging sectors will alleviate funding constraints and support diverse entrepreneurship.

The European context can glean significant lessons from Indonesia's digital journey. Adapting the model of public-private partnerships, Europe can address

its own connectivity disparities, particularly in rural regions. By mirroring Indonesia's commitment to a diverse and inclusive startup ecosystem, Europe can enhance innovation and participation among underrepresented groups. Additionally, fostering regional collaboration akin to Indonesia's role in Southeast Asian digital initiatives can promote knowledge exchange and joint ventures across European nations.

Sustainable growth remains a pivotal goal, emphasizing the importance of impact investing and responsible data practices. Integrating environmental, social, and governance (ESG) principles within the startup ecosystem aligns business models with sustainability and social impact. Data privacy regulations, paralleling the European Union's General Data Protection Regulation (GDPR), can balance consumer protection with innovation. Investing in sustainable technology, particularly in cleantech solutions, and advocating for responsible resource management in the digital sector are crucial steps toward this goal.

Implementing these strategies will not only strengthen Indonesia's position in Southeast Asia's digital landscape but also offer valuable insights for Europe and other developing economies. This journey requires ongoing adaptability, strategic interventions, and collaborative efforts to ensure a digital future that is inclusive and sustainable for all.

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Sustainable Human Resources Management

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Abstract

Human resource management (HRM) encloses the various processes and activities involved in the recruitment, selection, deployment, and management of an organization's workforce. It is often referred to as simply human resources (HR). The HR department is responsible for developing, implementing, and overseeing policies that cope with employee relations and the organization's relationship with its workforce. The term "human resources" was first introduced in the early 1900s but became more widely used in the 1960s to describe the collective individuals who make up a company or organization's workforce. (Chai, W. and Sutner, S. 2020). In this chapter, the three main themes will be discussed: firstly, I will focus on the essence and origins of human resources in organization. Next, I will examine new approaches to the sustainable human resource management. Last but not least, i will bring our attention to the essential attributes of a leader within sustainable HR management model. This work's main objective is to discuss the sustainable way of understanding HR, its managing in the institution and also to engage readers in a compelling discussion about the sustainable and evolving nature of HR management within organizations.

Keywords: Human Resource Management, leadership, sustainability

1. Introduction

Human resources management is one of the most crucial elements in every organization. It may play a significant role in the overall success of organization and operational efficiency only if carried out wisely. In recent years, advancements in technology and globalization have significantly impacted organizations and altered the landscape of Human Resource Management. These changes have had a significant influence on HR strategy and decision-making (Barkema et al. 2002). The pressure for competitiveness and flexibility in both internal and

external factors of organizations is affecting HR practices and strategies. Nowadays, companies and corporations more frequently recognize the need to use a balanced approach to managing their human resources. The aim of this approach is to ensure both the development and satisfaction of employees, as well as the achievement of business goals by the organization.

In this dynamic and evolving environment, characterized by the unceasing push for competitiveness and adaptability, both internal and external factors have thrust HR practices and strategies into the spotlight. As organizations grapple with the imperative to maintain a firm competitive edge, they are recognizing the need for a more nuanced and sustainable approach to human resource management. This approach strives to harmonize two pivotal dimensions: the holistic development and contentment of employees and the attainment of organizational objectives. Sustainability emerges as the apt and resonant term to characterize this evolving facet of HRM. It encapsulates the essence of not just managing resources, but doing so in a manner that nurtures and endures, much like the delicate balance in nature that ensures life's ongoing vitality.

2. Literature review

2.1. The essence and origins of human resources in organization

The essence of sustainable human resource management in an organization consists of striving to achieve business goals and ensuring a good environment for workers (Bombiak, 2019). This means that the organization should try to develop and meet the needs of its employees and achieve success on the market at the same time. Sustainable HRM can be implemented through several different but related activities. Some of the most important are, among others: active recruitment, motivating and evaluating, as well as dismissing employees. Many corporations use such methods (Zajac, 2007) and, depending on the effectiveness of a given method, achieve proportional results.

The increase in the importance of HRM for organizations in the strategic sense dates back to the 1980s. It was then when people began to realize that it has a real impact on successes and profits (Zajac, 2007). HR departments began to be created and expanded. Different approaches to human resource management have been developed. First of them, the Michigan model, i.e., the hard approach, assumes treating human capital as any other resource in each organization. Zajac (2007) points out that this model is directly focused on achieving benefits (profit,

company position). The second most popular approach is the soft approach, i.e., according to the Harvard model. The organization focuses on the “humane” treatment of people. Harvard model tends to put the unit in a high place. The benefit should still be achieved, but never at the expense of workers. What is important is self-fulfillment, involvement in the company community and the work performed.

2.2. Sustainable human resources management – new approach features

At present times, due to the spread of the Internet and other means of information transfer, newer and newer HR standards are being elaborated and implemented. People are aware of the scale of the impact of sustainable human resource management on the profit and well-being of the organization. As a result, the work and goals of HR departments are different than in the 1980s. Human capital is treated not only as a resource, but also as a company value. It is used to create financial comparisons and balances (Czerniachowicz, 2013). It can be referred to on a macroeconomic scale, where we consider several, tens of millions of organizations. We can also talk about human resources on a microeconomic scale, considering only a single company or even an individual unit. It is worth noting that they are closely related, one influences the other and vice versa. That is why a common, balanced, and unified approach to an employee or organization is so important. The appropriate approach of companies results in a quick, stable, and direct impact on the development of the country's economy. Thanks to investing in the development of HR departments, decisions regarding the recruitment or dismissal of employees can be made faster (Czerniachowicz, 2013). It is also a very sensible response to the labour market that is not going to slowdown. Thanks to the sustainable management of human resources, it is possible to meet the expectations of potential employees and, equally important for the company, customers. Today, it is standard to take care of the mental and physical health of each employee. Even in teams of several people, weekly feedback sessions are organized. Everyone can say what they are happy with and what bothers them or what they would like to change. Organizations reach out to their employees, enabling them to pass on and implement such proposals thanks to HR departments (Stosik & Leśniewska, 2015). In order to properly provide the feedback supervisors should try to conduct a job evaluation. Job evaluation ensures the way of getting the most accurate outcome of their workers performance, because it focuses not only on the achieved results but also on the whole person, including their skills

and abilities, knowledge and personal characteristics. After analyzing the person as a whole, you can easily give a right feedback.

Currently, a noticeably big challenge for sustainable human resource management is the employment and maintenance of units belonging to the so-called “generation Z”. Generation “Z” are young people born after 1990. According to research, they are the most demanding and self-confident group on the labor market (Żarczyńska-Dobiesz & Chomątowska, 2014). On the other hand, they are afraid that a potential employer will look at them through the prism of age, not skills and experience. Generation “Z” is characterized by a high awareness of its value, high self-confidence, and a desire to develop and expand knowledge or qualifications (Żarczyńska-Dobiesz & Chomątowska, 2014). The youngest generation on the labor market sets its own conditions and adapts employers to suit them. That is why HR departments must constantly take on the challenge of hiring and retaining employees. And they must do it at an ever higher level and with an increasingly modern approach.

Some of the characteristics of “generation Z” are highly desirable in organizations, while others are not. Generation of young people was born in the era of computers and elevated level of education. Language, geographical or technological barriers often cease to exist for such a social group. Employers want to hire people who will want to constantly develop, and today’s labor and technology market is moving forward with double strength (Żarczyńska-Dobiesz & Chomątowska, 2014). Young people want to be educated because they realize that they can achieve something in life that the previous generation never thought of. Nowadays, a twenty- year-old can often drive a new car, run a company, or hold a senior position in an international organization. This shows that these people can make a lot of money. As a result, they can use the acquired knowledge and skills. They are a valuable human resource in the 21st century labor market.

Hiring “Generation Z” representatives is highly desirable in organizations. However, it is necessary to undertake the task of reaching a compromise in the management of human resources. It is worth remembering that the labor market is also the Baby Boomers, “X” and “Y” generations. Representatives of the older generations are often an equally important pillar on the market. A pillar which has extensive experience and niche knowledge on critical topics. Organizations must take care of every employee. Generation “X” cannot be more important than generation “Z” (Żarczyńska-Dobiesz & Chomątowska, 2014). That is why sustainable human resource management plays a vital role in the organization. It is essential to talk to employees and agree on solutions that are satisfactory for all parties. A good example of such a compromise is working in hybrid mode.

Corporations often offer such an employment format, where you work three days a week in the office, and two days in the so-called home office. There is nothing strange about this. Young people are used to the fact that they can do everything online, on a computer or on a phone. While “Generation Z” has the option to work from their own home, older generations can come to the office every day. It is the proper management of the organization that allows to achieve such changes and is extremely important for every employee.

2.3. Features of a leader in sustainable HR management model

A particularly important aspect for the well-being and development of the organization is the appropriate selection of managerial staff. This is especially important in terms of sustainable management. Such a leader makes sure that the company’s human and financial resources are not overused. He respects the needs of the employees entrusted to him and tries to avoid tensions or misunderstandings. Hargreaves and Fink (2012) describe seven main principles of sustainable leadership. Depth – being a leader matters; is designed to protect what already exists and give the opportunity to develop. Length – Sustainable leadership continues year after year, leader after leader. Width – is not the responsibility of one person; it extends to others and develops. Justice – does not harm anyone in the environment, tries to solve the problems of the organization. Diversity – avoids standardization; cares about diversity in the environment; they try to combine what makes up their environment. Using resources – does not exhaust the resources available to him; they try to make everyone feel important and unworked. Preservation of tradition – respects and learns from previous experiences of the organization; tries to plan and build a future based on traditions.

It is important that the leader in a sustainable organization is a person not only with extensive professional experience, but also with the characteristics that define a good leader. Thanks to such a selection of management staff, stability and development are ensured. In addition, it supports the work of the human resources department, which can manage the organization more effectively. Joining their forces motivates all employees and positively affects them. When talking about leader development we can ensure some kind of training to make sure that the needs of employees and customers are being met. Every organization should provide a possibility of courses for leaders to take to expand their knowledge and experience in sustainably managing the employees.

3. Conclusions

The main objective of this work has been to explore the sustainable way of understanding HR management within organizations. Sustainable human resource management emerges as an imperative element for organizations seeking to operate efficiently and profitably in today's dynamic landscape. This approach entails continuous development and investment not only in HR departments but also in the management staff. A pivotal aspect of this process is fostering open and transparent communication across all departments and between employees.

In the ever-evolving realm of HR management, leaders must possess the requisite qualifications and skills to navigate the challenges and opportunities that arise. The landscape of company resource management has transformed dramatically over several decades, necessitating a willingness to embrace novel solutions and adapt to changing perspectives on all matters related to organizational governance. What is considered standard today was unimaginable in the past, and conversely, what was once commonplace is now obsolete. Just like ubiquitous technology, HR is in a perpetual state of advancement.

To ensure sustainable HR management, it is paramount to invest in training courses for leaders, enabling them to augment their skills and abilities in effectively managing their staff. This conclusion underscores the crucial role of sustainable HR management, aligning with the main objective of this work, which aims to not only shed light on the sustainable understanding of HR management but also to engage readers in a compelling discussion about the dynamic and evolving nature of HR management within organizations. In doing so, we pave the way for a more resilient and adaptable approach to managing human resources in the institutions of tomorrow.

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Managerial background of sustainable event organization process

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Abstract

This work presents the significance of project-, change-, risk- and human resource management in the area of sustainable event organizing. In other words, the application of their combined specialty knowledge creates the base for environmentally responsible event management. These four management fields are not only their own profound studies but are also used as professional components of successful organizational structure. By gathering numerous theories from previously conducted research studies, it is possible to formulate a clear and defined usage for event management components in the context of direct implication, as well as innovative methods. Starting point of deliberations is defining what an event is, its types, and its societal importance based on Durkheim's "collective consciousness" theory. Diving deeper into the process itself, it is discussed the practical division of roles and phases of event organization, as well as details of the indicated management components including the event project life cycle, technological methods, EMBOK model, importance of innovation, organizational climate dimensions, business ethics, and sustainability. Using this paper for the conversance of the managerial background of event organization and sustainability practices within its processes, may provide the reader with the necessary topics in the modern event industry. The objective of the study was to discuss the idea of sustainable event organization and the method used was the literature review.

Keywords: event management, project management, change management, human resource management

1. Introduction

People come together to work and create – an essential combination of the necessary and the desired activities. It is a beneficial sense of balance between the duty to maintain our lifestyle and the experience itself. Enhanced by the feeling of mutual engagement in something outside our mundane work routine, we seek to explore our knowledge, interests and impressions. There are countless ways to be involved in activities for this particular purpose, namely through discussion, celebration, or honor – all being a social gathering of what we call an event. It allows us to convene and express ourselves. There is a variety of events, some events are conducted for entertainment, such as parades, festivals, sports events, concerts, exhibitions, historical reenactments, and performance competitions. They fall under the category of special events, which according to Goldblatt (2002), defines a unique moment in time celebrated with ceremony and ritual to satisfy specific needs. “To the customer or guest, a special event is an opportunity for a leisure, social, or cultural experience outside the normal range of choices or beyond everyday experience” (Getz, 1997). These require lots of preparation along with a team of specialists, in comparison to private events like birthday parties, family holidays or weddings that are intended for a much smaller list of people and are often excluded from the public viewpoint. Business events, on the other hand, refer to organization-level professional gatherings that function as discussion or deal-oriented forums. Arguably, they are suitable for being carried out in a hybrid type of both public and private executive mode. Conferences, tradeshow, conventions, incentives, product launch events, congresses, corporation, and association events are the most distinctive types. According to Deery and Jago (2010), core motives for business events are the development of ideas, education, promotion, networking, a shift in behavior/attitudes, increased sales, and performance improvement. In the external environment, they aim to be a place for business communication opportunities, sharing information, presenting or releasing new products, trading, discussing possible cooperation, as well as celebrating important milestones or achievements. In fact, organizing such events is an effective tool for building long-term relationships with customers and improving a company’s reputation – there is every chance to make useful business acquaintances.

In the 21st century, events play a significant role in connecting people to foster creativity and innovation. They guide us through intellectual and social understanding since the earliest days of mankind’s communication. One of the major principles in our incredible evolutionary progress as a species has been

the human drive to assemble for the purpose of conferring and exchanging. (Davidson, 2018). Proneness to concerted change and development is what makes a great contribution to our highly interconnected and globalized modern world. According to E. Durkheim society is a unity, where collective consciousness binds individuals together and creates social integration through the internal nature of people being a social organism. He perceived individuals as neither a mere plurality nor a simple mechanical juxtaposition, but as an organization – a system of association and interaction. Although Durkheim indicates the risk of social solidarity weakening due to modern economic relations, our close-knit traditional bonds prove the everlasting existence of cooperation. Because of increased moral density and division of labor, modernization is becoming an obstacle for people to remain self-sufficient. That is why we have no choice but to rely on specialists, which is inherently unsuitable for humans, but from a contemporary point of view is conversely convenient. With each decade people are adapting to more and more comfort in their everyday life because efficiency is most valued. Even if there is a possibility of societal disintegration, organic solidarity is what brings us together. Almost every job includes teamwork nowadays, as it has been confirmed to maximize efficiency through natural interdependence. As a primary discipline of events, they function by subconsciously maintaining our bonds.

To address the core structure of event management, the motivation and philosophy behind people's need to experience social gatherings have been studied. The main research method was literature review in order to shape a detailed explanation of event organization process, followed by the section presenting components of events' managerial background, and conclusively finishing with relevance and importance of sustainable practices throughout all previously mentioned processes.

2. Literature review

Participating in the creation of an event is another level of brought-forth cooperation. It is an exceptional aspect of internal processes that assemble individual artistry into one joint purpose. Event management is what gives us an opportunity for such insight. Practically, the application of mutual contribution toward creating an event is what helps them come into reality. With combined knowledge and division of specific tasks, there are a variety of roles in the event planning procedure. As defined by Matthews (2008), the first and most important one is the event manager, who is responsible for the event as a whole. It can be the owner

(a company, city, non-profit organization) or an individual. They plan and organize the whole process, as well as delegate specialists for each area needed to accomplish the goal. Tum et al., (2006) propose that there are three key objectives for the event manager: to achieve the strategic objectives; to satisfy customers' wants; and to achieve efficient use of resources. Using the four management capabilities mentioned before, and a diverse range of personal skills is the key to success. Depending on the size of the event, they can take up the majority of organizational tasks, as long as they have enough time to operate resources. The type of event also influences their area of responsibility because business meetings for discussing the product and the product launch itself differ in the scope of preparation. Therefore, if the amount of work needed to be done is exceeding the amount of work the event manager is able to do, then they may assign an event planner. Sometimes these two roles are seen interchangeably, as their duties are mostly identical. In a company environment event planner is responsible for small meetings that do not require lots of preparation or division into specialty areas. When they are operating independently, their job is to plan small and private events such as festive dinners, weddings, reunions, or birthday parties. The main difference between these two roles is the level of professional position.

When it comes to putting the theoretical plan into action a need for an event coordinator arises, who is often called the "middle person". Their job consists of bringing all event participants together to ensure they are efficiently working toward the completion of a successful outcome. Some of their tasks include administering pre-agreed-upon arrangements, controlling performance and convergence in time, as well as overseeing the follow-up of each step according to the pre-made plan. This means the event coordinator is linking theory to practice so that the process of transformation happens gradually in order to prevent any inconsistencies in the next phase, which is carried out by an event producer.

The last but not the least challenging part of event organization is the creation itself. It covers around half of the preparation process but is not complicated if the previous steps left no troublesome partialness, so when executed correctly it can even simplify the final plan assembling. The event producer is in charge of practical matters, such as technical issues (staging, sound, lights, A-V), design and scheduling, décor and furnishing of the venue, as well as hiring assisting staff. There is a myriad of details that pile up faster than the event producer can catch up with, which is why they are required to have not only a creative but a logical and apprehensive side of thought process. Besides their organizational abilities, it is expected they have a basic understanding of financial affairs to exclude the possibility of budget discrepancies. They must be committed to effectuating the most

productive result that matches the initially predetermined aim, as do all people involved.

2.1. Phases of the event organization process

Now that the roles are arranged, it is subsequent to delve into the event organization process and analyze the details of its creation. There are five distinct phases: concept and proposal, marketing and sales, coordination, execution, and follow-up. (Matthews, 2008)

The first phase starts with preliminary research, during which the idea is created and then analyzed to determine if the concept is worth pursuing. Matthews (2008) suggests a SWOT analysis to identify internal (strengths, weaknesses) and external factors (opportunities, threats). With the help of this method, we are able to create a list of dos and don'ts, as well as understand our priorities most relevant to the successful result. But for the research to be maximally effective we can also incorporate SMART criteria into this process, as proposed by the studies of J.R. Silvers (2012) and A. Shone & B. Parry (2013). This model aids in defining our goals and objectives by guiding us through the necessary qualities of a pertinent plan of action. It must be specific in targeting aspects of the particular event; measurable in terms of indicating progress; attainable so that the people are capable of accomplishing their tasks; realistic within your amount of resources; and time-bound to a determined duration period in the course of which you are able to finish the preparations. With both these techniques working hand in hand, you are able to formulate the proposal during the real first step, which is the initial event design. It usually starts with the provision of approximate costs, which after agreeing with suppliers, transforms into a formal budget. Then it ends when the first creative proposal is written together with the coordinated ideas of the whole event team, including staff.

The second phase is brought into the picture by taking this theoretical part to the affirmative start-off decision. Its main purpose is to sell tickets or sponsorships in order to cover expenses, as well as profit from it. Primary tasks are the creation of marketing materials based on the initial proposal and the execution of advertising activities that you came up with. However, depending on the type of event, this phase may be completely skipped. If it is a non-profit, private, or business meeting-like gathering, there is no need to include this stage.

The beginning of actual setup starts with the third, coordination phase. As mentioned before, this is the connection procedure between theory and action – a complex step of process allocation. All components of event management

become involved subsequently in this phase, as well as risk and human resource management. The coordination process consists of recruiting or organizing the already functioning staff; contracting suppliers and the catering team; scheduling transportation; accepting registrations/reservations; and obtaining necessary licenses and permits. This job belongs to the event coordinator.

Starting with the next, execution phase, we proceed to hands-on implementation of pre-organized arrangements into the event formation. It is the most time-consuming and stressful stage during which anything can go wrong, which is why the specialist accountable for this part of the event organization, must be able to work under pressure. The aforesaid situations are the reason why risk management implementation is considered in advance. With proper control, the event should take place in time after installing the final equipment and touch-ups. Under the supervision of the event producer, a number of assigned responsibilities are carried out before and during the event, such as suppliers, volunteers, and staff payments; receiving transportation, catering, and production services; onsite registration or ticketing; and monitoring safety. Most importantly, the event organizer has a legal, ethical, and financial responsibility to make sure the event and its operations maintain the highest standards of safety possible, otherwise, they may be held negligently liable for any harm that occurs. (Silvers, 2012).

The follow-up is the last phase in the organization process which begins once all guests leave, and the venue is returned to its pre-event condition. Cleaning is not the only event wrap-up responsibility, as the period that comes afterward involves finalizing payments; thanking participants/guests; conducting a review meeting to analyze the event's success; and making last adjustments to contracts and budget reports. So even though all events differ in type, purpose, size, time spent on preparation, and the number of people working on it or attending, the organization plan is still the same regardless of all these factors. It is not about why or how, but what and when it happens – the key is to understand the process.

2.2. Components and management of event management

Understanding the event organization process is fundamental in the event management structure because all four event management components complement each other during the event creation. Project-, change-, risk-, and human resource management go hand-in-hand when it comes to realizing plans, as well as long-term objectives. With this in mind, it is therefore important to see the connection of these four components within event management (references?)

For the purpose of understanding the correlation between event management and project management, it is substantial to consider three objectives of what a project is, as offered by K. Kerzner (1994): it should be completed on time, within budget, and at the desired level of quality. Along with two more objectives (customer satisfaction and acceptance of the outcome; and customers allowing to use them as a reference), added after the introduction of Total Quality Management (TQM), a clear picture of comprehension is outlined. With this connection, according to J. Tum & P. Norton (2006), an event can be defined as a project since it has a start and an endpoint. And because it has a life expectancy, the time from its inception to completion can be termed as 'the event project life cycle'. But to be even more precise, with the TQM perspective put together with project management, a new interpretation was defined: "each event that is staged can be considered as a quality project, which requires the skills of a project manager to keep it on time and within budget while satisfying the expectations of clients and customers." (Tum & Norton 2006)

"The life cycle of a project in event management revolves around the ability to make decisions in a changing environment" (Gardiner, 2017) Thus, performing well in a volatile environment is based on the capability of quickly deciding optimal alternatives and having a pervasive culture of urgency to make these decisions come into force (O'Toole, 2000). As defined by A. Jaafari (2001): project conceptualization, planning, and implementation is a complex, dynamic, and advancing process, that should be managed on a fully fluid and flexible basis of strategic objectives, which themselves are prone to change in response to the project's shifting environment. Because of such close correspondence, change management simultaneously works with project management, especially with its Critical Chain Project Management (CCPM) method, which unifies both the human side and the algorithmic methodology in a non-traditional discipline. This significant approach was introduced by E. Goldratt (1997) in his business novel "Critical Chain". It is usually implemented after the initial project schedule is prepared, in order to monitor uncertainties and interruptions by identifying the critical path, which essentially is the sequence of steps taken toward project completion. Because of this, CCPM is able not only to save time but also to fix the imprecise execution of distributed tasks together with any contingencies.

The event organization analysis proves our theory of interaction between divisive labor and iterative processes. With each introduced method of work optimization, arises the need for a more paperless office, where companies rely on software collection, storage, and retrieval of data. (Goldblatt, 2010) Since business processes are becoming more modernized in comparison to previous decades,

and new trends are coming in, it is important to consider two more strategically useful technologies that are usually implemented with or instead of CCPM. One of the most promising concepts for gaining insight into business processes that supports decision-making on an operative level is Complex Event Processing (CEP). It is used to concomitantly monitor, steer, and optimize business processes with minimal latency. Typical application areas of CEP are for discovering exceptional situations or business opportunities, namely financial and market analysis, trading, security, fraud detection, logistics like tracking shipments, compliance checks, and customer relationship management. (Suntinger et al., 2008) Another approach, called Self-Organizing Map (SOM), is similar in application simplicity, which also makes it possible for top managers to understand the project condition, potential risks, or opportunities. (Parvizian et al., 2006) It is usually used hand-in-hand with the project management component of event organizing. This interactive visualization method leads to revealing more information about project conditions and tendencies that assist the project monitoring task. The SOM network was proposed by T. Kohonen (1995), as one of the most popular data mining tools that are capable of finding business knowledge from enterprise databases in support of making more optimal decisions.

These outstanding technologies, created by humans and now used in assisting them, once again confirm that human interaction, especially face-to-face, drives innovation and inspiration. As stated by L. Harry (2009), “accidental connections between leading thinkers studying different topics can unlock seemingly intractable challenges and insoluble puzzles.” Getting higher up the ladder of knowledge creation from individuals to companies to countries, M. Deery and L. K. Jago (2010) argue that they must be seen as innovative, and it is crucial that governments provide the necessary support to foster innovation and capitalize on the outcomes. Most funds are allocated toward research and development (R&D) for that matter, thus increasing competitive interest. Following their thought, business events have yet another opportunistic perspective, as they are determined to be key tools in the knowledge creation and dissemination processes, which are fundamental to underpinning innovation. A “mind shift” is expected not only from event managers but from the government side as well, so that the business events sector reaches its full potential. Such concentration must be on the primary objectives of business events: reciprocity, integration, and change. With strategic mindset application, internal and external organizational benefits can then be maximized.

2.3. Risk management

The focus of these innovative methods also belongs to risk management – “the art and science of planning, assessing, and handling future events to ensure favorable outcomes” (Simpleman et al., 1998) because “events can comprise both planned staging elements and unplanned spontaneity” (Bladen et al., 2012). It is helpful in optimizing event organizing strategy by using a coordinated and comprehensive, iterative approach for identifying and assessing potential risk, as well as provision of amendment options. Assessments should be undertaken as early in the life cycle as possible to enhance preventative efforts and guarantee that technical, schedule, and financial risks are addressed with mitigation measures incorporated into event planning and budget estimates. This iterative approach is used not only for systematic analyses in a risk management context but also provides a sequential aspect into functional areas of the Event Management Body of Knowledge (EMBOK), which consist of domains (administration, design, marketing, operations, and risk) that are divided into numerous classes (e.g., human resources). In this model, there are also three scopes of event management: core values (creativity, strategic thinking, continuous improvement, ethics, and integration), processes (assessment, selection, monitoring, communication, and documentation), and phases (initiation, planning, implementation, event, and closure). Even though all these factors may seem too much to grasp, they are imperceptibly integrated into each level of the event organization process since the earliest days of its systematic development. Furthermore, EMBOK is considered to be the foundation that led the event management industry from an “emerging” profession into a “legitimate” one, recognized as an expertise requiring specialized knowledge. (Silvers, 2005).

2.4. Human resource management

Despite all these precautionary methods, the likelihood of unforeseen situations in event management is still high as ever. Sometimes there is a need for the involvement of directly related practices, for example at the risk of personnel loss, human resource management (HRM) implication is considered. If this component of event management is overlooked, the rest of the organizational process is destined for failure. Nowadays, a company’s success is largely dependent on the compliance of employees with their supervisors. According to M. Armstrong (2006), a constructive way to accomplish organizational goals is to create a high-performance culture in which teams and individuals take accountability

for their own talents and skills, while also contributing to the ongoing improvement of business processes within a framework provided by an effective leadership structure. Fostering a positive workplace mentality, and insinuating the “empowering, motivating, and rewarding” strategy bring out employees’ intrinsic motivation, which can immensely affect overall productivity while working on a project and lead to satisfying results. Companies that have an edge over the competitors through their performance, and innovative human resource programs are able to attract and retain good employees (Copeland, 2000).

“Innovation – the perception that change and creativity are encouraged, including risk-taking into new areas where the member has little or no prior experience” (Koys & DeCotiis, 1991) It was captured to be one of the eight organizational climate dimensions (autonomy, cohesion, trust, resource, support, recognition, fairness, and innovation). The researchers suggested that organizational climate perception: summarizes the individual’s description, rather than the evaluative reaction of their organizational experience; is relatively stable over time; and is widely shared by the members of the organizational unit. Such knowledge is important because it allows supervisors to individually understand an employee’s behavior so that they can be managed effectively and efficiently. (Tustin, 1993) Managers’ leadership style quality and their manner of managing the above dimensions influence the organizational climate. It is confirmed by numerous studies, that if the support provided by managers in their role as leaders is based on a positive, constructive, and helpful attitude toward their subordinates, people become fully active in a complex environment by gaining motivation to invent and handle new methods. (Klem and Schlechter, 2008) By focusing on the emotional state of employees, strong management relationships are able to greatly facilitate the event organization process.

J. M. George (1990) describes a group’s shared sense of motivation as an ‘affective group tone’ and argues that this construct is meaningful if group members experience equal kinds of treatment. The conceptually similar, organizational climate also depends on group members having shared experiences. (Anderson & West, 1998) To prevent workplace disputes and staff feeling neglected, managers often rectify potential oversights of importance division with a mindset of all-level inclusion. This part of the intrinsic approach belongs to human resource management, previously mentioned as one of the four event management components. Even though companies have technology and capital, HRM is vital in helping them face the challenges of business globalization. (Yılmaz & Bulut, 2015) This practice explains how individual contributions can work in synergy and why

a company cannot achieve successful results without the strategic implementation of amplified personnel organization methods.

While there is a normative approach to working with people, managers sometimes forget to consider the probability that there may be exceptional problems caused by human factors. At that moment, they are expected to make an ethical decision, even if it is complicated. Clegg et al. (2007) emphasized that such decisions emerge out of dilemmas that cannot be predicted or managed in advance through rules, which is why it is substantial for managers to act with an honest and fair sense of responsibility, that is individually fitted to specific matters. General HRM ethical guidelines issue upon supervisors: to recognize that the organization's strategic goals should embrace the rights and needs of both employees and business; to treat employees as full human beings considering their personal hopes and anxieties, not as mere factors of production; as well as relating to employees justly with respect. (Armstrong, 2006) Such practice results in equal opportunities, reduction of disciplinary matters, as well as employee confidence and well-being in the work environment. Likewise personal principles, but on the corporate level: "professional ethics refer to the code of conduct that a person must adhere to in respect of all aspects of their interactions and business dealings." (Davidson, 2018) They are of compulsory nature and are imposed upon all members of the company, not only managers. Professional ethics represent a combination of prudent and imperative devoir.

2.5. Event management and sustainability

Taking a step further, professional ethics find their way into the external, social environment. This level is not about the relations between people within the company, but about the relation of the company with the people outside of it. Rooted in the acknowledgment that businesses have obligations toward society that go beyond their economic contributions, Corporate Social Responsibility (CSR) was defined. It represents the type of sustainability practice focused on public relations, and an improved image with stakeholders – this is where an event obtains its social conscience. (Jones, 2017) In CSR, impact is preferred over outcome in the context of sustainability, as it focuses on change and legacy left behind, not on the results of business activity. "Under a theory of environmental ethics, humanity may have a duty of care to the planet, and hence corporate responsibility practices should be guided by that duty." (Blowfield & Murray, 2011). Whether it is an event, project, or collaboration initiative, the main idea is to address global/environmental issues, rather than profit off of fabricated agenda behind the false face

of charity. Unfortunately, because the issues where companies take advantage of CSR opportunities for promoting purposes are recurrent in the event industry, such matters are closely monitored for any policy violations. Therefore, CSR is used separately in some events and is usually not incorporated in all operations of event planning companies, unless they are non-profit organizations (NGOs).

But firstly, we need to understand the meaning of word “sustainability” and the importance of its integration with event management. In 1987, the United Nations Brundtland Commission defined sustainability as “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” In simple understanding, sustainability practices are needed so that future generations are able to enjoy events just as we do today – our goal is to sustain the level of quality that is required for the organization process. This is where money and morals oppose, where profit and resource use battle our rationality and responsibility as a society. Introducing a more sustainable approach to event organizing may decrease the satisfaction that people are used to getting from events. Instead of thinking of ways to prevent negative consequences and for future generations to experience what we now have a privilege of, most people turn a blind eye to the depth of the situation and choose selfish ways of action. This can be prevented if we take a step back and realize that “events have the potential to be model examples of harmonious balance between human activity, resource use and environmental impact, rather than hedonistic, resource-gulping and garbage-producing.” (Jones, 2017, p 6) With little to no effort we can follow already-existing sustainability practices or even create ones ourselves.

While talking about a sustainable event, first description that comes in mind, is an environmentally friendly, “green” and socially responsible one, which is not far from truth, but should not be mixed up into the meaning of what sustainability is. As previously deduced in explanation, we are to understand that a sustainable event is one that takes on a wider view of both “product” and “process” aspects; an event that is enjoyable for the audience, while also being responsible during set-up; an event where sustainability is concerned not only with commercial activity, but primarily with the planning and organizational process. (Henderson, 2011). And as we observe the misuse of “eco-friendly” buzz words over the years in the context of labelling events as sustainable, such promotion might be harmful to the collective understanding of a sustainable event, if its organization process does not follow sustainable practices. In doing so, ethical questions to the promoting side of the event may arise, such as “greenwashing”, which according to United Nations (Greenwashing..., 2023) is a misleading promotion or false credible action of a company or other entity, that is used for public to believe that they are doing

more to protect the environment that actually are. There are many tactics that manifest greenwashing, but in this part of research we would like to focus on ones that could be applied in the event management industry.

What catches our eye when we see an advertisement of an event? Title, agenda, cost, or what they do in order to be environmentally friendly? Most can agree that the latter is often not mentioned. Depending on the type of the event, this topic is raised and most likely labelled with “eco-friendly” buzz words that we are used to seeing everywhere. If such labels are untrue to the event and are used as a part of false marketing – it is one of the most-known greenwashing tactics. To make sure that these labels in fact reflect sustainable practices of the event, we must pay close attention if such practices are specified. Companies and organizers should always specify what exactly was implemented or optimized and materials used during the event, otherwise, their actions can be easily misinterpreted. For the impact to be seen by public, companies are to start with internal changes toward sustainable event management, such as change in attitude; an increase in supply chain pressure and in the awareness of the true cost of waste; as well as transparency of product life cycle. (Raj & Musgrave, 2009).

Whether it is a school event or a concert of a popular artist – the scale does not matter in the world of pro-sustainability. The key is to start small, step-by-step, however big or important the event may be to the public’s judgement. For us to make a change in the sustainable organization of one of the biggest events in the world, we have to start from ourselves, no matter how cliché it may sound. There has to be a shift in our mindset, starting from choosing to use our own coffee cups instead of one-use paper ones, reducing waste during our family’s barbecue, and remembering to turn off the water while brushing our teeth. These seemingly small and insignificant habits in our everyday lives will eventually grow together and reflect on the habits that we bring to work and the mindset that we start our projects with. It is no time for a bystander effect, waiting for someone else to bring the idea to the table, not if we all share the same perspective. As a part of organizational climate philosophy, company is set of put-together people with a shared vision and mission. Every corporation makes a difference if we put our morals and personal motivations as a priority to give back to society – our customers and consumers. That is why we have to treat the work that we do (output) and someone else’s work we consume (input) as equally valuable for society.

3. Conclusions

Owing to the fact that our thoroughly detailed examination of all event industry nuances covered the extensive understanding behind the event creation process, there is a place for the conclusive definition of its managerial components. Project management is the foundation of event organizing, because “an event is a project” (Tum & Norton, 2006) that needs proper organization and control of the management figures. It has to be planned out, coordinated and monitored throughout the assembling. During the preparation process, we implement many technological methods that arose because of change management. They are important for work optimization, successful results, as well as prevention of risks and disruptions. They are mutually implemented with risk management strategies to avoid future contingencies. With these new innovations not only do companies grow internally within the organizational climate, but also externally integrate with new social connections. That is why human resource management is so crucial in aiding such changes. Its professional implementation has never been narrowed down only to personnel supervising – it has always been perceived in a bigger view of business ethics and the company’s social responsibility, which are greatly important in the modern event industry. Together with a clear understanding of what sustainability is, and how to differentiate harmful practices from useful ones, companies are able to create progressive change in environmental and social aspects. This analysis, therefore, proves that with the understanding of the strong interconnection between sustainability and project-, change-, risk-, and human resource management, “the future of the event management profession is ripe with promise” (Goldblatt, 2002). Add a small sentence concerning event management and sustainability.

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PART II: SUSTAINABILITY

Energy Sector Crisis and its Implications for Public Health and Sustainable Development in Europe

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Abstract

The energy crisis represents a significant challenge for sustainable development in Europe and exerts far-reaching impacts across diverse sectors. Given the close relationship between human health and the public health sector, the latter is particularly affected by the energy crisis. Recent global events, such as the COVID-19 pandemic, have further underscored the critical importance of the public health sector and the daunting challenges it faces in addressing the energy crisis. In this context, this chapter aims to scrutinize the challenges confronting Europe in devising sustainable energy strategies and public health sector strategies that can alleviate the impact of the energy crisis, while at the same time promoting sustainable development across all sectors. Entrepreneurship, characterized by innovative ideas and novel business models, can play a crucial role in addressing the energy crisis and propelling sustainable development in Europe. In particular, entrepreneurial activities can facilitate the development of sustainable energy sources, enhance energy efficiency, and curb carbon emissions, thereby contributing to economic growth and job creation, especially in the renewable energy sector, and aligning with sustainable development goals. The chapter also explores how the energy crisis and the global pandemic can impact other sectors beyond public health, and how entrepreneurship can offer ways to fix to these issues. By providing valuable insights into the challenges and opportunities associated with the energy crisis, this study emphasizes the necessity for coordinated action in Europe to ensure sustainable development across all sectors, including public health.

Keywords: Energy sector, Public Health, Global Challenges, Sustainable Development

1. Introduction

The current challenges in Europe and specifically in the various sectors of the EU have a strong impact on the domestic situation of the EU member states and candidate countries which, in turn, is caused by the Russia's war in Ukraine, as well as other factors. (Think Tank European Parliament., 2023). Nowadays, almost all the countries of the world are ready to agree on the effective utilization of the energy sector, although the world was faced with such critical challenges, such as, for example, the global pandemic of Covid-19 and the Russia-Ukraine war. These world-scale crisis, which are directly related to human life and health, take a different form in different regions and countries. In this work, we will look specifically at the European example and discuss the role of entrepreneurship in the energy crisis, as well as how these factors can affect the public health sector. For all EU member states, including strategic neighboring states that will soon join the EU, such as the Balkan countries and the associated trio (Ukraine, Georgia and Moldova), energy security, independence and reliable connection are very important, which will help the countries to maintain the pace of sustainable development goals. Strategic cooperation, helping each other not only in healthcare, energy and sustainable development in general, but also in any other noteworthy challenge is on the agenda of all democratic countries built on European principles. In all of this, the Institute of Entrepreneurship should play a big role, and it should maintain its effectiveness especially during such a crisis that we are facing today. For the growth of peace and security on the European continent and more specifically in the European Union, it is necessary that both bilateral and multilateral negotiations on the above-mentioned issues are ongoing, which in itself should be the reason for raising the level of information among the population in relation to these issues. (is there something missing in this sentence?). Sustainable development of the United Nations is what not only European culture strives for but the whole world. However, there are some challenges facing this goal. Such are the above-mentioned energy crisis (this time intensified in Europe) and the protection of people's health and lives. These are the important issues that are relevant and are affected by the Sustainable Development Goals. It was the energy and public health issues that became complicated as a result of the war in Eastern Europe, which is quite alarming for us. It is indeed essential to address and confront the current challenges to safeguard the development of the European Union and its member states. This includes acting on critical issues such as energy, healthcare, and sustainable development. By proactively working on these challenges, the EU

can enhance its resilience and contribute to the well-being of its citizens and the overall sustainability of the region. That helps the country a lot and brings it closer to fulfilling the sustainable development goals set by the United Nations, as well, which is basically a main thing in the agenda of each country. Therefore, we should consider the consent of the importance of each sector in Europe, especially when it comes to the public health and the energy sectors, which are the two areas that have come under the greatest influence and pressure in the last two years.

To address this subject, the chapter is structured as follows: first section reviews literature about the energy crisis in Europe during the COVID-19 pandemic, next section presents the influence of the Russia-Ukraine war on the field of energy, still next section discusses the impact of the Russia-Ukraine war and energy crisis on the health sector, still next section is about meeting sustainable development goals in the field of energy. Chapter 7 describes the renewable energy sector in different regions and its influence on Entrepreneurship. Chapter 8 clarifies the public health sector and its influence on Entrepreneurship. Finally summarizing section draws some conclusions regarding the state of the energy crisis and public health, followed by its relationship with sustainable development.

As research methods, a literature review was first carried out in the main academic databases and then a case study was presented, based on the information obtained through content analysis.

2. Research methodology

As research methods, a literature review was first carried out in the main academic databases and then a case study was presented, based on the information obtained through content analysis. To examine the topic as broadly as feasible in this article, it was required to discover and investigate theoretical material that is based on empirical methods; so, we used qualitative research methods, specifically case studies and analysis of secondary and tertiary sources. The study of specific cases allowed us to analyze in depth specific aspects of the issue, such as the study of the immediate causes that led to Europe's energy crisis and the disruption of the public health sector, which in turn is reflected in putting the UN Sustainable Development Goals in Europe at risk. Furthermore, we used statistical data released by the European Commission as well as polls conducted by them in the paper. In order to answer the research question - "What was the cause of the energy crisis, the direct connection of the health sector with it and what impact does it have on the UN

Sustainable Development Goals?” - in the paper, we used various articles and studies based on the assessments of scientists, analysts and politicians.

3. Literature review

3.1. Energy crisis in Europe during Pandemic

The COVID-19 pandemic profoundly impacted Europe’s energy sector. Restrictions on economic activities and travel led to a significant decrease in energy consumption, especially in sectors like transportation, tourism, and industry. This reduction in demand resulted in an energy surplus, particularly in the oil market, leading to a drop-in energy price. This price decrease had a negative impact on the industry’s profitability and financial stability. Also, the pandemic disrupted energy supply chains, reduced workforces, and caused delays in maintenance and upgrades, further challenging the goal of ensuring a reliable and secure energy supply. Despite these challenges, the pandemic underscored the importance of renewable energy sources and investments in energy infrastructure. According to the International Energy Agency, renewables were the only energy source that experienced growth in 2020 (IEA, 2021). While Asia experienced varying impacts on energy supply and demand due to changes in economic activities and behaviors, Europe and North America faced significant disruptions. Supply chain issues, reduced workforces, and maintenance delays led to a notable decrease in energy demand in some cases. In Europe, the energy crisis during the pandemic primarily resulted from reduced demand in sectors like transportation and industry, causing an oversupply of energy, particularly in the oil market. Countries heavily reliant on tourism and industry, such as Spain and Italy, were especially affected, whereas nations with strong renewable energy sectors, like Germany and Denmark, were relatively less impacted. The pandemic’s challenges in ensuring a reliable and secure energy supply highlight the need for investments in renewable energy sources and energy infrastructure (OECD, 2020).

Entrepreneurship has played a significant role in addressing Europe’s energy crisis. In recent years, entrepreneurs and startups have developed innovative and sustainable solutions to the region’s energy challenges. These solutions include renewable energy technologies such as solar panels, wind turbines, and biomass generators, as well as energy storage solutions like batteries and energy management systems. Entrepreneurship has also focused on enhancing energy efficiency

in industries and buildings through technologies like smart building systems and industrial automation.

This entrepreneurial spirit has fostered innovation, increased competition, and accelerated the transition towards a more sustainable energy system. In summary, entrepreneurship has been crucial in addressing the energy crisis in Europe by introducing innovative and sustainable solutions that provide a reliable, secure, and affordable energy source for the region.

3.2. The influence of the Russia-Ukraine war on the field of energy

The conflict between Russia and Ukraine has had a tremendous influence on the energy sector, particularly in Europe. This is due to Europe's reliance on Russian natural gas, with Russia accounting for roughly 40% of European gas consumption. The Russian-Ukrainian conflict has caused multiple disruptions in the transit of natural gas to Europe, raising concerns about energy security (Ritchie et al., 2022). One of the primary fears is that the conflict could completely disrupt gas supplies if Russia chooses to use its gas exports as leverage in the fight. This could cause a severe energy crisis in Europe, as the region struggles to locate other gas suppliers. In addition to concerns about supply delays, the battle has caused an increase in European gas prices. Some changes occurred on the European continent in 2022, most notably those caused by the Russia-Ukraine war. As a result of this tragic conflict, the European continent's energy crisis began, particularly for those whose energy sectors were depended on Russia. Many countries' energy sector modifications have resulted in a variety of changes in other areas. This was replicated, for example, in the finances of EU member states; in 2022, the inflation rate in EU countries was high (Bruegel, 2023). This conflict also had an impact on people's health and life, both physically and metaphorically. This dispute had an impact on the health-care system. Because of the region's unpredictability and volatility, traders and energy companies have hedged their bets by purchasing more gas than they need, causing prices to rise. The war has highlighted the significance of diversifying Europe's energy sources and lessening its reliance on Russian gas (EU Science Hub, 2022).

The contents included in the figure explains further information the energy crisis can have various causes, included. It is important to note that the causes of the energy crisis can be interrelated and complex and addressing the energy crisis requires a multifaceted approach that includes investment in renewable energy sources, energy efficiency measures, and sustainable infrastructure development. Process of prioritization of immediate security concerns and limited resources

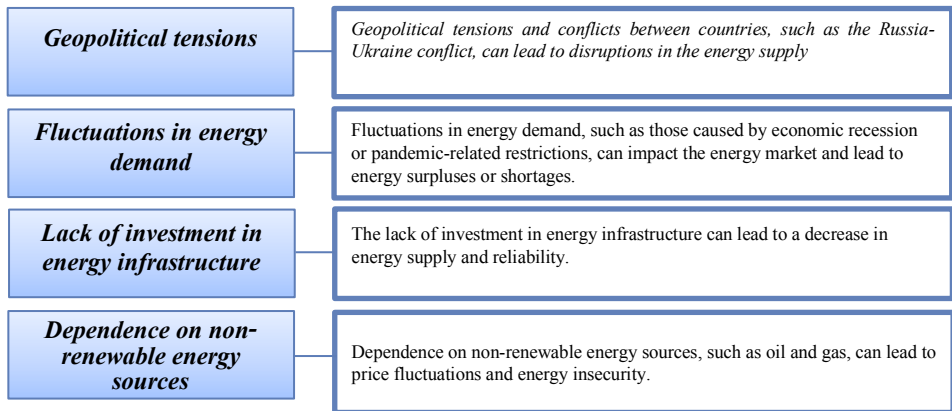


Figure 9.1. Causes of energy crisis

Source: (IEA, 2023).

during wartime affect the allocation of funds and attention towards renewable energy projects which is what probably has happened in 2022 during the start of war and during the period where the process of promoting renewable energy started. In fact, it may delay in promoting and actually implementing renewable energy projects with the same intensively as it was planned to in EU (IEA, 2022).

3.3. Impact of the Russia-Ukraine war and energy crisis on the health sector

The impact of the energy crisis on the health sector in Europe is a significant concern, with hospitals and healthcare facilities being one of the largest energy consumers. In 2018, the healthcare sector in the EU consumed around 372 TWh of energy, accounting for about 7% of the EU's total energy consumption. This figure is expected to rise to 464 TWh by 2030 if no measures are taken to increase energy efficiency and promote sustainable practices in the sector. (EC European Commission, 2023) follow the citation rules). The energy crisis can have adverse effects on the financial stability and quality of health care services. Energy shortages and increased energy costs can lead to higher operating expenses for healthcare facilities, resulting in a reduction in the availability of medical equipment and services. According to a report by the European Commission, energy costs for hospitals in the EU increased by around 30% between 2005 and 2015, and energy accounts for up to 10% of a hospital's operating budget. This increase in energy costs can impact the financial stability of healthcare facilities, which may result in

a decline in the quality of services and accessibility to healthcare. Also, vulnerable populations, such as the elderly and those with chronic diseases, are particularly affected by energy shortages and increased energy costs. During the energy crisis, some hospitals and health care facilities may have to limit their operating hours, reduce the number of available medical equipment, and increase waiting times for appointments, leading to inadequate care for vulnerable populations. Studies have shown that exposure to low temperatures and poor indoor air quality due to energy shortages can exacerbate chronic conditions such as respiratory diseases, cardiovascular diseases, and mental health issues. ((World Health Organization, 2021)citation rules). To address the energy crisis and promote sustainable development, the EU has set ambitious targets for reducing greenhouse gas emissions and increasing the share of renewable energy in the energy mix. The EU's aim is to reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels and achieve climate neutrality by 2050. The Renewable Energy Directive, which is part of the EU's Clean Energy Package, aims to increase the share of renewable energy in the EU's final energy consumption to at least 32% by 2030. The EU also provides funding for projects that promote energy efficiency and renewable energy in the health sector through programs such as the Horizon 2020 research and innovation program. (Source: (Climate Action, 2020) citation rules)

3.4. Meeting sustainable development goals in the field of energy

The global energy crisis poses a severe threat to sustainable development and has far-reaching consequences for the environment, public health, and economic stability. Sustainable development in the energy sector requires the adoption of various strategies and actions that can be taken at the national and international levels. In this essay, we will examine some of the key strategies and actions (International Energy Agency, 2022) references??"that can be taken to meet sustainable development goals in the field of energy.

Energy Efficiency Measures

Improving energy efficiency in buildings, transportation, and industrial processes can significantly reduce energy consumption and greenhouse gas emissions. Energy-efficient buildings and appliances, efficient public transport, and smart mobility systems are some examples of energy efficiency measures that can be implemented. Governments can promote energy efficiency through the adoption of building codes and standards, appliance standards, and energy management systems.

Research and Development

Investing in research and development can lead to the development of new technologies and innovative solutions that can help promote sustainable energy use. Governments and the private sector can invest in research and development to find ways to make renewable energy sources more affordable and efficient. Research and development can also help identify opportunities for energy efficiency improvements.

Meeting Sustainable Development Goals

Meeting sustainable development goals in the field of energy is crucial for ensuring a sustainable future for the planet. The United Nations' Sustainable Development Goal 7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030. Achieving this goal requires significant efforts from governments, the private sector, and individuals to transition to sustainable energy systems.

3.5. Renewable energy sector in different regions and its influence on Entrepreneurship

To emphasize clearly, the prospects for innovative business endeavors within the renewable energy sector are what connect entrepreneurship and renewables. Entrepreneurs may generate sustainable and ecologically beneficial solutions by developing and investing in renewable energy technologies such as solar, wind, and biofuels. These businesses may help both economic growth and environmental conservation, making renewable energy entrepreneurship a crucial driver of green and sustainable development. This issue is important not only in Europe but also in other areas as well. In comparison to EU, other countries have had significant changes in energy sectors. Europe is a leader in renewable energy and smart energy systems, with countries such as Denmark, Germany, and Sweden leading the way. The European Union has set ambitious targets for renewable energy and aims to have 32% of its energy consumption come from renewable sources by 2030. As for the Asia, China is the world's largest investor in renewable energy and has made significant progress in developing its renewable energy industry. The country has set a target of having 20% of its energy consumption come from renewable sources by 2025. As for the continent of America, the United States is the second-largest investor in renewable energy and has seen significant growth in its renewable energy industry in recent years. States such as California and Texas are leaders in renewable energy, with California aiming to reach 100% renewable

energy by 2045. (Filip et al., 2022) citation rules) As for the developing continent, Africa, it has enormous potential for renewable energy due to its abundance of natural resources such as sunlight and wind. Countries such as South Africa and Morocco have made significant progress in developing their renewable energy industries, which makes them stand out in Africa. To clarify the impact, the benefits of renewable energy and smart energy systems include reducing greenhouse gas emissions, improving energy security, and creating jobs in the renewable energy industry. However, there are also challenges, such as the intermittency of some renewable energy sources and the need for significant investment in infrastructure. As Europreneurship is an integral part of Europe's economic and social environment, it is crucial that energy sector and entrepreneurship have connection in EU for the development of the energy sector itself and promoting renewable energy sector not only in EU but other countries, as well.

3.6. Public health sector and its influence on Europreneurship

By fostering an atmosphere favourable to innovation and long-term development, the public health sector plays an important role in shaping entrepreneurship in Europe. The sector's emphasis on promoting health and well-being gives chances for entrepreneurs to create new solutions to unmet requirements in health-care services, medical technologies, digital health, telemedicine, preventative healthcare, and wellness goods. Furthermore, the public health sector provides numerous sorts of assistance, such as funding, subsidies, and collaborations, all of which have a significant impact on the growth and success of health-focused enterprises. Supporting the public health sector becomes even more critical and challenging during times of war. Entrepreneurs can identify holes in the public health sector and establish business models that meet unmet needs. This promotes the expansion of health-focused entrepreneurship and adds to the sector's overall development. Furthermore, the sector provides funding and assistance to entrepreneurs through government agencies, research institutes, and public health organizations, allowing them to develop solutions that are aligned with public health priorities. During times of war, however, the public health sector faces enormous problems, such as the loss of healthcare infrastructure and limited access to critical resources. Aiding the public health sector during times of war necessitates collaboration and coordination among numerous parties. It is critical to provide medical supplies, equipment, and resources to help acute healthcare needs in war-torn areas. Established organizations such as the Red Cross and Médecins Sans Frontières (Doctors Without Borders) play an important role in providing

life-saving medical care in crisis zones. Furthermore, aiding with the reconstruction and restoration of healthcare infrastructure, such as the construction of hospitals or clinics, is critical to improving access to healthcare in war-torn countries.

The public health sector is connected to European entrepreneurship, providing possibilities for improving the process of digital transformation, benefiting EU citizens' health, developing sustainability by providing healthy diet ideas, and most importantly, bringing more innovation. Considering that the public health sector is also affected by the energy crisis, the need to use effective tools, such as entrepreneurship, is vital. The sector suffered not only due to Russia's war in Ukraine but also because it was under pressure back to 2020, and just after almost finishing fighting the coronavirus, the war started, which had a bad effect on the eastern European countries. (??? Clarify). The production of modern technologies in the medical sector, their correct operation and the introduction of innovative treatments will have a positive effect on the patient's condition and the results of his treatment. Therefore, in this process, it is necessary to prevent the provision of electrical energy in medical institutions, which can become a challenge in Eastern Europe. Irregular voltage can damage biomedical equipment and also interfere with the process of making and then producing drugs, which means treating the patient with an inappropriate protocol. This poses a great danger to the patient's life. Despite the fact that some hospitals have secondary energy generators, the question arises: how does it help those patients who are undergoing treatment at home? Their problem can be, for example, power outages and disconnection of energy supply due to debt to energy providers. Supporting the public health sector becomes even more important during times of war and crisis. Donations of medical supplies and resources, as well as initiatives to reconstruct healthcare infrastructure, can assist lessen the impact of conflict on healthcare systems. Collaboration with established organizations, as well as obtaining advice from specialists in public health and humanitarian help, are critical to providing effective and impactful assistance and that's why entrepreneurship has to play a major role in improving such practices in the sector of health. That being said, entrepreneurship in the field of public health can assist to post-conflict recovery and the overall well-being of affected populations by addressing the problems and complexities of supporting the public health sector during times of war. (Urbano & Guerrero, 2013) citation rules

4. Conclusion and recommendations

To summarize, achieving feasible development objectives in the field of vitality necessitates the application of various techniques and activities, including the expanded utilization of the extremely critical thing known as renewable vitality, the execution of vitality effectiveness measures, venture in research and development, cultivating global participation, and securing adequate financing.

We know (you must put the reference from where you got this information) that the EU has emerged as a leader in advocating renewable vitality and has set ambitious targets for its member states to increase the share of renewable vitality in their vitality portfolios. According to Eurostat data, renewable energy represented for 19.7% of the EU's net last vitality usage in 2019, a huge increase from 9.7% in 2004 (Eurostat, 2019). As part of its efforts to reduce greenhouse gas emissions and address climate change, it has committed to increasing the share of renewable energy to at least 32% by 2030. Moreover, the EU points to realize climate lack of bias by 2050, requiring a critical upsurge within the appropriation of renewable vitality sources. Whereas a few EU part states have made vital advance in expanding their dependence on renewable vitality, there are still incongruities among nations. For occurrence, in 2019, Sweden bragged the most elevated share of renewable vitality in its net last vitality utilization at 56.4%, taken after by Finland at 43.1%. Nations such as Luxembourg, the Netherlands, and Malta recorded lower offers of renewable vitality at 8.1%, 8.9%, and 9.6% separately (European Environment Agency, 2023). As we can see, energy, healthcare, and other sectors on our continent are experiencing a very interesting era, and paying attention to them, whether through entrepreneurship or other mechanisms with the same strength, would have a mutually beneficial influence on each area of the country. Taking into account the regulatory mechanisms of EU institutions, surveys and studies reveal that these sectors face specific challenges, and it is recommended that the population be engaged in various ways, with the appropriate campaigns, to become ambassadors of peace, security, and green transition.

In the end, the EU is making progress towards its renewable energy goals, but it is necessary to continue efforts to ensure a sustainable future across the continent. By cooperating towards enhancing renewable energy, Europe can significantly contribute to sustainable development, minimize climate change, and promote a greener and more resilient future. For the next generation. As for public health, the improvement of it in the energy crisis has challenges, but it is also an opportunity to prioritize and improve public medical measures. In times of energy crises, public health faces significant challenges. But, taking proactive

measures such as preparing for emergencies, constructing infrastructure capable of effectively restoring and allocating resources, improving communications, implementing sustainable energy solutions, and cooperating can help to reduce the impact and improve public health outcomes. Public health systems can play a significant role in properly controlling and responding to health problems that occur around the world by prioritizing the health and well-being of individuals and communities. We must also remember that conflict has a negative impact on the energy system and on public health, increasing the issues associated with the energy crisis. Entrepreneurship during a conflict is a complicated endeavor that necessitates thorough evaluation of the challenges and hazards involved. Entrepreneurs, on the other hand, have the power to have a positive impact on public health and improve the well-being of communities afflicted by the virus through new ideas, unwavering commitment, and collaborative efforts. Despite the challenges posed by war, entrepreneurs can develop solutions that address immediate needs, promote economic stability, provide humanitarian help, focus on social impact, and positively contribute to the rehabilitation of critical infrastructure.

These initiatives must be undertaken at both the national and global levels in order to ensure a viable future for our planet. Collaboration between governments, the corporate sector, and people is critical to successfully transitioning to economic vitality frameworks and attaining the vitality sector's long-term improvement goals. Renewable energy is critical to long-term development because it provides an alternative to traditional fossil fuels, which contribute significantly to climate change and natural degradation. Sustainable development aims can be advanced in various ways by improving the utilization of renewable vitality sources such as solar, wind, hydro, and geothermal control. Well-designed commercials can persuade people to reduce their energy consumption. In the United States, for example, some estimates suggest that behavioral changes in the residential sector might save up to 20% of household energy use. One estimate puts India's potential for energy savings through behavioral changes at 3.4 to 10.2 TWh per year by 2030 (IEA, 2023). Many lessons on how to create effective awareness and behavior change programs have been learned. It goes without saying that proper design is critical; just conveying information will not change behavior, and poorly planned campaigns typically fail to achieve the desired impact. That's why we should take into consideration that it is necessary to implement the projects that will raise awareness regarding the challenges we are currently facing and how people themselves can fight against them.

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Promoting energy efficiency in an eco-school environment

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Abstract

In the past decades, the concept of sustainable development (SD) came into focus and has increasingly gained attention at all levels. Environmental education programs are seen as instrumental in promoting SD, since the preservation of the environment depends on ecological awareness, which depends on education. Higher Education Institutions (HEIs) play a central role in education for sustainable development (ESD) since they provide the knowledge and skills for students to implement sustainable solutions. Polytechnic Institute of Viana do Castelo (IPVC) is a Portuguese HEI eco-school, which promotes, among its community, the search for ideas for sustainable practices. This study aims to demonstrate the importance and effectiveness of ESD at IPVC, through the presentation of two projects developed by students, which intend to improve the energy efficiency in the institution. In the first project, a piezoelectric energy collection system was developed, taking advantage of the movement of people to produce energy. In the second project, a remotely controlled low-cost device was developed, to monitor and control the electrical networks of the school buildings. Despite the need for advanced engineering to optimize performance, first experiments showed very satisfactory results. Both projects are imbued with the spirit of SD and confirm the central role of HEIs in ESD and its practical effectiveness at IPVC.

Keywords: Education for sustainable development, Eco-Schools, energy efficiency

1. Introduction

Since the publication of the Brundtland Report *Our Common Future*, in 1987, the concept of sustainable development (SD) came into focus and has increasingly gained attention at international, national, local, public, and private levels. It became clear that the present consumption and production patterns of developed countries, also aspired by those in developing countries, is recognised as unsustainable (Martins *et al.*, 2006). Civilisation is facing difficulties in ensuring sufficient resources for all population to enjoy a life within the contemporary lifestyles, which requires an urgent change in behaviours and life patterns (López-Alcarria *et al.*, 2021). It is recognized that ESD can help change the attitudes and behaviour of people in their role as consumers, producers, and citizens to carry out their collective responsibilities and duties (Martins *et al.*, 2006). Therefore, environmental education programmes might be seen as instrumental in promoting the deliberation aspects of sustainability, since they help students to develop knowledge, attitudes, and skills that are important for responsible environmental behaviour (Cincera & Krajhanzl, 2013). HEIs play a central role in the development of knowledge (Martins *et al.*, 2006). Therefore, they have a critical responsibility in ESD since they provide the knowledge and skills for students to start to create sustainable development (SD) initiatives. (Caeiro *et al.*, 2020). Moreover, HEIs can help achieving the international 2030 SD agenda, ensuring that by 2030 all learners acquire the knowledge and skills needed to promote SD. Therefore, HEIs should integrate SD concepts into their day-to-day practices (Elmassah *et al.*, 2021).

Eco-schools is a global ESD programme, developed in 1992 as a response to the United Nations Conference on Environment and Development, where environmental concerns are addressed in the school curriculum and are also reflected in everyday learning practices. In 2003, the United Nations Environment Programme (UNEP) identified eco-schools as a model initiative for ESD, recognising the impact of its methodology on building sustainable communities. It has brought environmental problems closer to students and has encouraged them to identify them themselves (Andreou, 2020). Students increase environmental awareness by being involved in class, school, and community-based events. Students, working together with their teachers, participate in the process of improving environmental school management (Cincera & Krajhanzl, 2013). European Blue Flag Association (ABAE) is responsible for Eco School Program implementation in Portugal and aims to recognize the work carried out by the schools for the benefit of the environment. IPVC is a Portuguese HEI which has implemented the program in its six

schools, aiming at applying concepts and ideas of education and environmental management to the daily life of the institution. The concrete actions developed by the students and by the entire educational community make themselves aware that simple individual attitudes can improve the global environment. Students are challenged to participate in decision-making processes, being active and becoming aware of the importance of the environment in their daily personal, family, and community life.

In this context, this work aims to demonstrate the importance of ESD and its effectiveness at IPVC practices, through the presentation of two projects developed by students within the scope of the eco-school programme, in a classroom setting and with the support of teachers. The first (Project A) related with energy generation and the second (Project B) related with the efficient use of energy. Project A intends to produce energy by taking advantage of the movements of people who attend the Higher School of Technology and Management of the Polytechnic Institute of Viana do Castelo (ESTG-IPVC). These displacements cause a vertical pressure on the surface, resulting from its weight and speed. After being pressed, the energy generator transforms this pressure into energy, which is in turn (after being duly rectified), transmitted to batteries. This technology allows the supply of stored energy for the school's emergency lighting. Project B aims to create a simple, low-cost device that allows remote monitoring of an electrical lighting network, promoting energy efficiency. The implementation of a device that can automatically control the lighting of all the building's installations will allow financial and energy savings, not only by reducing consumption, but also by increasing the useful time of the resources used.

Both projects are imbued with the spirit of environmental responsibility widely promoted by the Eco-Schools program and confirm the importance of the role of HEIs in education for sustainable development. Thus, this work should be particularly inspiring to scholar community that intend to motivate, promote, and implement SD actions through the evolvment of students in the development of these sustainable solutions.

This book chapter is structured as follows: chapters 2 and 3 present, respectively, projects A and B, a proposal for its implementation at ESTG-IPVC, and a discussion of results. The main conclusions are outlined in chapter 4.

2. Project A: energy generation

As already mentioned, Project A aims to develop a system for collecting and producing energy through the appropriation of the movements of the population that attends ESTG-IPVC. The chapter begins with a brief literature review that clarifies the basic theoretical concepts related to piezoelectric phenomena, namely the piezoelectric effect and its operation, followed by the calculations and procedures related with the association of piezoelectric components. The final configuration proposal and its implementation is then explained, and results are discussed.

2.1. Piezoelectric concepts

Piezoelectricity is a property that only a few groups of materials have, which was discovered by the brothers Jacques and Pierre Curie in 1880 during a systematic study on the effect that pressure had on the generation of electrical charges by crystals such as quartz. Thus, piezoelectricity is said to consist in the generation of electricity resulting from mechanical pressure. It is also defined as the electrical polarization produced by mechanical stress in crystals of certain classes, and the polarization is proportional to the stress and changes sign with it (Haertling, 1999). Piezoelectric materials are those materials that contract and expand according to the electrical polarization developed by tension efforts. As shown in Figure 10.1, if a piezoelectric disc polarized in the direction indicated by P carries electrodes on both faces, then upon receiving a compression effort it will generate a current external to the circuit. If the effort is traction, the current is directed in the opposite direction (Figure 10.1a). In Figure 10.1b, an electric field is applied to the crystal, which produces a negative strain; if the field is opposite, the strain is positive; The dashed lines indicate the original dimensions (Moulson and Herbert, 2003).

2.2. Piezoelectric system proposal and prototype

In a set of piezoelectric, one of the variables that has a great influence on the system is the number of connected piezoelectric components, since it increases the contact surface of the converter material. Another variable with great influence on the system is the type of association made between them, which results in an increase in the generation capacity of voltage (when associated in series) and electric current (when associated in parallel). To analyse the influence of these characteristics on the response obtained from the system, five connection configurations were proposed, as showed in Figure 10.2.

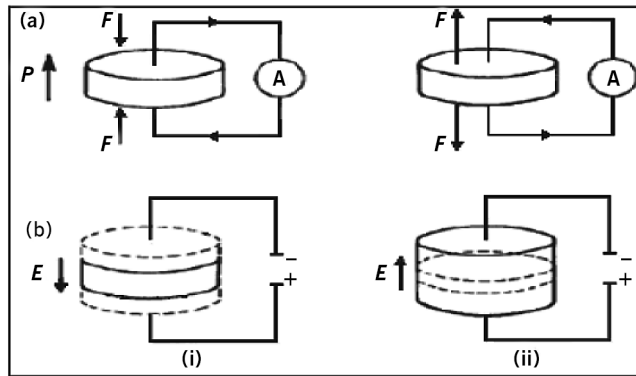


Figure 10.1. (a) the direct piezoelectric effect and (b) the indirect effect: (i) contraction; (ii) expansion. The dashed lines indicate the original dimensions

Source: Moulson and Herbert (2003).

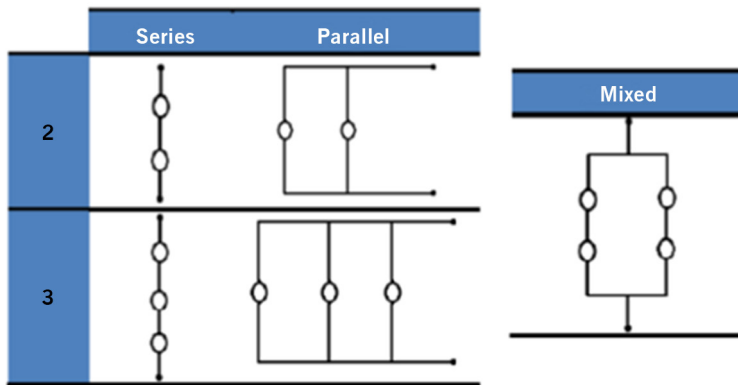


Figure 10.2. Connection configurations with 2 and 3 piezoelectric components

Source: own elaboration.

Using the knowledge of works previously developed at ESTG (Leiras *et al.*, 2014) and consulting other developments of similar structures, it was verified that there is a topology, more or less optimized of the construction of this plate. Considering these experimental issues made with low voltage, it was decided to connect 12 piezoelectric chips, 2 in series connected in parallel with another 2 in series, 6 times, as shown in Figure 10.3.

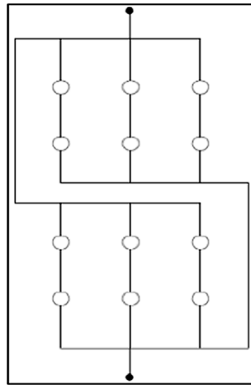


Figure 10.3. Arrangement of piezoelectric

Source: own elaboration.

Figure 10.4 illustrates how the prototype looked after its assembly on a $24 \times 20 \times 2$ cm Styrofoam plate.

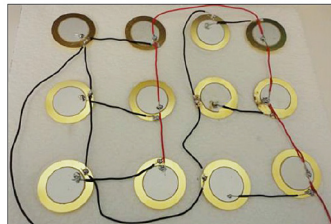


Figure 10.4. Final configuration

Source: Leiras *et al.*, 2014.

After having the final configuration of the piezoelectric, the same will be placed on a carpet, composed of a layer of vulcanized natural rubber, a layer of elastic springs, a layer of piezoelectric and again a layer of natural rubber (Figure 10.5).

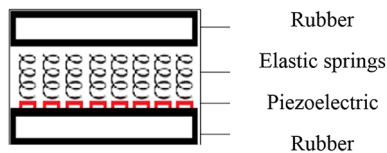


Figure 10.5. Carpet scheme

Source: Leiras *et al.*, 2014.



Figure 10.6. ESTG-IPVC's main entrance: a) location of the carpet with the respective piezoelectric; b) location of emergency exit lighting

Source: Leiras *et al.*, 2014.

The carpet it will be placed at the main entrance of the ESTG-IPVC (Figure 10.6). The movement of people will cause a vertical pressure on the carpet surface, resulting from their weight and speed. Once pressed, the power generator converts that pressure into energy, which in turn, after being duly rectified to direct current, is transmitted to some batteries. This stored energy will be distributed and applied to the school's emergency lighting.

3. Research results

Through the analyses carried out during the tests, it was verified that there are many, and with great sensitivity, the variables that influence the performance of the system. In general, a lot of difficulties were found in working with piezoelectric, mainly because there was little familiarity with this material. Finally, with the appropriate piezoelectric, it was possible to perform the tests satisfactorily and consistent results appeared. However, advanced engineering is required to optimize circuit performance. This may be one of the reasons why this type of application is not so widespread. Additionally, the low performance of the system makes the return-on-investment period high. It is also evident that the way of assembling the circuit for capturing energy becomes impractical regarding loads of considerable sizes, given its low efficiency. The piezoelectric material already has several applications, but much research is still needed so that its use as a converter of mechanical energy into electrical energy becomes commercially viable.

3.1. Project B

Project B consists of the development of a remotely controlled device, whose function is to monitor and control the electrical networks of ESTG-IPVC buildings. The chapter begins by exploring the concepts of Domotics and the Internet of Things (IoT), followed by a description of the proposed system operation and prototype. At the end the results are discussed.

Domotics and IoT

The term Domotics came from the junction of the word “Domus” which means house, with “Robotics” which performs actions automatically. The term emerged in the 1980s in France, during the construction of the first buildings, when man felt the need to look for new solutions for carrying out his daily and routine activities, aiming at quality of life, comfort, safety, and communication. The term is also known as: “Smart House”, “Smart Building”, “Smart Environment”, among others. Home automation has been used more and more in recent years due to the advantages that the associated technology offers. It is worth emphasizing that with the arrival of IoT (new and improved devices such as relays, microprocessors, and sensors), home automation underwent significant changes in terms of equipment quality, as they did not require large and reserved spaces, they began to be able to interact with other equipment and did not need constant maintenance by technicians. It allows and facilitates efficient management of installations and equipment; an automatic thermal control; information on the state of the installations; better energy efficiency; increased security in homes; lighting control with automatic adjustment scenarios depending on ambient light intensity. The objective of home automation is that, through an integrated system, it is possible to control and automate the functions of all the electronic and electrical equipment in the house (Pimparel, 2017).

The term Internet of Things (IoT) emerged in 1999, when British specialist Kevin Ashton from the Massachusetts Institute of Technology (MIT) went to lecture at Procter & Gamble (P&G). Initially, he proposed that if connected objects were able to perform tasks without human intervention, it would be possible to optimize various activities. IoT emerged from advances in various scientific areas such as microelectronics, telecommunication, and information technologies. The main characteristic of the IoT is the presence of a set of objects, sensors and electronic devices and communication that allow interaction between them through communication. IoT can still be applied in several areas and one of

them is home automation, in which one of the main factors is the communication between devices inside the house (Nascimento, 2018).

System proposal and prototype

The control device installed in the electrical network is composed of an ESP8266-01 (Figure 10.7), which is responsible for all the processing of the device, through its integrated microcontroller. This microcontroller is responsible for controlling the sensors and actuators of the circuit, as well as the Wi-Fi connection. As actuators, the ESP8266-01 is integrated in a Relay module, which allows switching on or off the electrical lighting in the building's division. The device has an ACS712 as sensor. Its function is to check the status of the electrical lighting in the building, that is, whether it is on or off. The remote-control application used in this project is Blynk, which is responsible for the user interface. Through this application, for example, a building security guard can obtain real-time information on his mobile device about the status of the electrical lighting in each room of the building, as well as remotely control it.

The ESP8266-01 (Figure 10.7) is a low-cost module with good performance, being widely used in remote motorization, sensor network, robotics, home automation, among other applications (Nascimento, 2018).

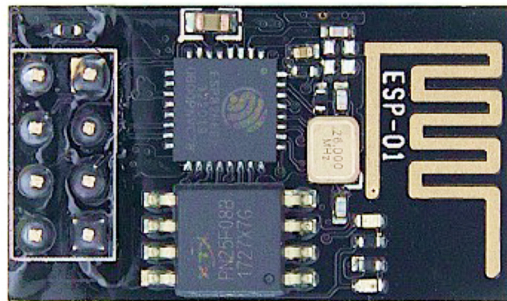


Figure 10.7. ESP8266-01 microcontroller

Source: own elaboration.

The Relay Module (Figure 10.8) is an electrically operated switch that allows switching on or off a circuit through voltage, supporting loads up to 250VAC and 10A, like a mechanical switch. The general supply of the module is 5V. A common regulator AMS1117 makes the regulation for 3.3V, for feeding the ESP8266-01. The Relay activates when the input reaches 5v and turns off when the input is 0v.

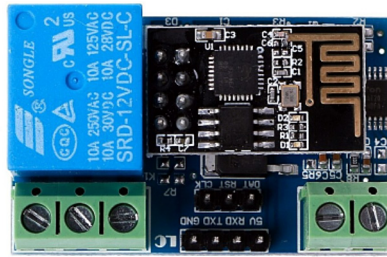


Figure 10.8. Relay Module with ESP8266-01 integrated

Source: own elaboration.

The ACS712 sensor (Figure 10.9) uses the hall effect to identify the magnetic field produced by a current passing through the circuit. It has an analogical output that varies linearly with current. It needs to be powered by 5V input voltage. Its voltage output signal will have the same frequency as the current it is measuring. This measurement makes it possible to calculate the value of electrical consumption in the network.



Figure 10.9. ACS712

Source: own elaboration.

Blynk is an application available for Android and iOS that allows the user to create applications that interact with the hardware. Through a specific space for each project, the user can insert Widgets that implement control functions (such as buttons, sliders, and keys), notification, and reading of hardware data. Communication between the application and the user's hardware is carried out through the Blynk cloud. The server is responsible for transmitting data to

the hardware, storing application and hardware states, and storing sensor data read by the hardware even if the application is turned off (Introdução ao Blynk App, 2018).

The operation of the system is illustrated in Figure 10.10. The control device is installed at the entrance to the electrical supply for lighting in the building's room. The device is powered through a 230v to 5v transformer. Because the power supply of the Relay Module, like the ACS712 sensor, is 5V. The relay module has an integrated voltage regulator from 5V to 3.3V that supplies the ESP8266-01. Communication to the Wi-Fi Network is performed by the ESP8266-01. The network connection parameters are installed in the microcontroller, such as: the Wi-Fi network name, the network access word and the "AuthToken" (pairing code between the ESP8266-01 and the project created in the Blynk application). The lighting remote control is carried out through the Blynk virtual button, which initializes with the value "0" and when the user activates that button, it changes to the value "1". This information is sent through a virtual port to the ESP8266-01 and according to the value received (0 or 1), it gives the order to the Relay to activate or deactivate, sending the corresponding matrix with the hexadecimal codes. The Relay is installed in parallel with the division's mechanical switches, allowing the order to turn the lighting on or off both mechanically and remotely, without either of the two blocking the operation of the other. Monitoring the status of the lighting is done by the ACS712 current sensor, which identifies the magnetic field produced by the current passing through the circuit. As the sensor output signal varies between 0.5V and 5V and the ADC port of the ESP8266-01 only allows voltages up to 1V, it was necessary to install a voltage divider. The signal sent to the ESP8266-01 varies between very close values if the sensor does not verify current flow, and more distant values if there is current flow. The signal reading can be viewed graphically in the Blynk application, and this information is stored in the Blynk cloud, allowing the entire history of the behaviour of the electrical network to be viewed over time. The ESP8266-01 reads this signal for 5 seconds and records the maximum and minimum value verified during each sampling period and calculates the Delta (variation) between the maximum and minimum value. If the Delta value is 15, it means that the lighting in the room is on and in turn turns on the led.

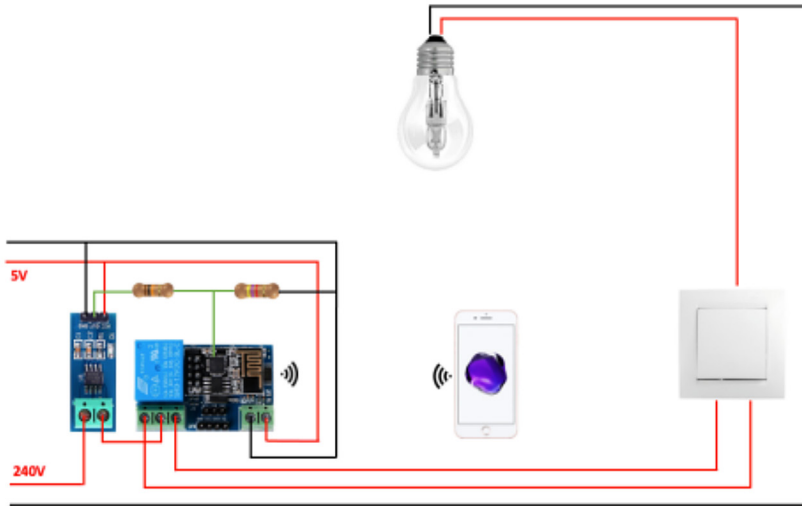


Figure 10.10. Scheme of the system developed

Source: own elaboration.

In Figure 10.11 we can see the prototype developed with this project. The prototype consists of the following components: 1 – 230v power supply; 2 – Power supply 5V; 3 – ESP8266-01 4 – Relay Module; 4 – Sensor ACS712 (20A); 5 – Breadboard with voltage divider; 6 – Mechanical switch; 7 – Lamp; and 8 – Smartphone with Blynk application.

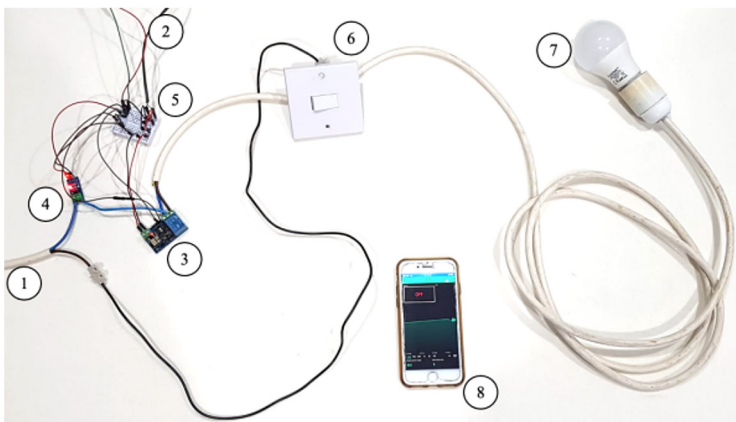


Figure 10.11. Prototype

Source: own elaboration.

In Figure 10.12 we can see that the circuit has the lamp turned off. If we look at the Blynk application, we can see that the state of the led is off, because the Delta value calculated by the microcontroller is 7, that is, the value is less than 15. We can also see in the graph that the values recorded are very close over time.



Figure 10.12. Result: lighting off

Source: own elaboration.

In Figure 10.13, we see that when we activate the Relay remotely, through Blynk's virtual button, the lamp turns on and automatically the virtual led too. The lamp turns on, because the Delta value calculated by the microcontroller is 22, that is, greater than 15. As we can also see in the application graph that the values recorded over time are more distant from each other.



Figure 10.13. Result: lighting on

Source: own elaboration.

3.2. Results discussion

With this project it was possible to create a device that enables remote monitoring and control of an electrical lighting network, supporting the reduction of electrical consumption in ESTG-IPVC buildings. Being an easy-to-install and low-cost device, it allows a short-term return on investment. However, through the various experiments, it was found that the potential of this device could be improved if the adopted microcontroller provided greater voltage tolerance.

Being a device with a high potential, future work can be developed that includes the measurement of energy consumption, in addition to the monitoring function. By exploiting the available resources of this device, it will be possible to carry out statistical analyses of the consumption and cost of electrical networks in buildings. The management of energy consumption will be more efficient if there is more information available on the electrical networks, as this is the only way to eliminate all waste.

4. Conclusion and recommendations

The present consumption and production patterns of developed countries, also aspired by those in developing countries, is recognised as unsustainable. ESD can help change behaviours and help citizens to carry out their collective environmental responsibilities and duties. HEIs have a critical responsibility in ESD since they provide the knowledge and skills for students to create sustainable development initiatives.

In this context, this study demonstrates the importance of ESD, as well as its effectiveness at IPVC, through the presentation of two projects developed by students from ESTG-IPVC, which intend to improve the energy efficiency in the institution. In the first project, a piezoelectric energy collection system was developed, to be applied on the school floor, taking advantage of the movement of people to produce energy. Despite the many difficulties in working with piezoelectric, mainly because there was little familiarity with this material, after several experiments and with the appropriate piezoelectric consistent results appeared. However, advanced engineering is required to optimize circuit performance before its implementation at ESTG-IPVC. In the second project, a remotely controlled low-cost device was developed, for remote monitoring and control of the electrical networks, enabling the reduction of electrical consumption in ESTG-IPVC buildings. Being an easy-to-install and low-cost device, it allows a short-term return on

investment. However, to install it at ESTG-IPVC the microcontroller needs to be further exploited to include the measurement of energy consumption, in addition to the monitoring function. The management of energy consumption will be more efficient if there is more information available on the electrical networks, as this is the only way to eliminate all waste.

In conclusion, this work shows how students from a HEI with the Eco-School flag, in a classroom context and with the support of teachers, can be taught and motivated to develop sustainable solutions. In addition to environmental sustainability, these two projects simultaneously promote socio-economic sustainability, given the savings of financial resources in electrical energy, which can be applied to promote social welfare.

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The evolution of Corporate Social Responsibility disclosure and its relationship with the Sustainable Development Goals

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Abstract

The information needs of stakeholders have changed significantly over the years with the growing environmental awareness of society. This led to considerable changes in companies' behavior due to the information needs of the various stakeholders focused on environmental and social performance. Regulation on corporate social responsibility disclosure, usually designated by non-financial reporting, evolved to promote comparability and relevant information on these matters. In this book chapter, we review the main standards and regulatory initiatives that have been undertaken by several international organisations. We also analyse the disclosure of social and environmental indicators by Portuguese-listed companies in the pulp, paper, and paper-board sector, between 2017 and 2019, and their contribution to the implementation of Sustainable Development Goals (SDG). Results reveal a high disclosure of environmental information, which may be associated with the increased social scrutiny that companies in this sector have in these matters, and a strong connection between

the indicators disclosed in terms of sustainability reporting and the SDG to which companies commit themselves. This book chapter should be particularly useful to early career economic and management researchers seeking to better understand the evolution of non-financial reporting disclosed by companies and its relationship with SDG.

Keywords: Environmental Indicators, Sustainable Development Goals, Corporate Responsibility, Disclosure, Non-financial information

1. Introduction

In recent decades, a new development model based on the concept of sustainable development has arisen. Because the contribution of companies is fundamental for the achievement of this new development paradigm, the scrutiny of their performance by society in general, and by their stakeholders, has increased. Thus, companies' reporting models have been evolving to meet the need for information that allows the assessment of financial and non-financial performance. The traditional financial report is no longer adequate for the decision-making of the various stakeholders (Abeysekera, 2013). The range of information needed to make an appropriate assessment of organisations' performance, past, present, and future, is much broader. Gradually, there has been a shift in traditional reporting to new formats where information on three key areas of performance is included: financial, environmental, and social (Bonsón & Bednárová, 2015).

Additionally, the United Nations (UN) have established seventeen Sustainable Development Goals (SDG) to promote positive changes for a better future for the planet. These goals encourage companies to preserve natural resources, fight climate change, and adopt more sustainable production and consumption practices. Thus, companies can disclose in Sustainability reports, Integrated Reports, or in other reporting models, information on the implementation of the SDG, as well as the targets and actions they intend to achieve.

This study aims to analyse the evolution of the information disclosed on SDG in the Portuguese paper sector, and to what extent companies are contributing to the development and implementation of SDG. The aim is to understand how companies operate. Are their infrastructures related to sustainability parameters? Are companies seeking to minimise environmental impacts? What protections do companies have regarding terrestrial life? The pulp, paper, and paperboard industry is an environmentally sensitive sector, both because of the public exposure to environmental disasters that are associated with it and because of the odor

that its activity has and that spreads throughout the surrounding area. This results in a high level of scrutiny by society. Therefore, non-financial information is especially relevant in this sector.

2. Literature review

Corporate Social Responsibility (CSR) implies that corporate decisions and actions are greater than economic interests, encompassing all voluntary contributions to sustainable development that go beyond legal requirements (Gamer-schlag et al., 2011). Over the past decades, companies have increasingly invested in disclosing information on their CSR performance (Baskentli et al., 2019; Burrit & Schaltegger, 2010).

In this context, several normative developments that seek to regulate the disclosure of CSR practices have taken place. For several decades, the European Union (EU) has recognized the importance of sustainable development in its policies. In October 2014, the EU published the Directive 2014/95/EU (amending Directive 2013/34/EU) entitled “Disclosure of non-financial information and diversity information by certain large companies and groups”. With this directive, the EU wanted companies in all Member States to disclose transparent information on sustainability, including social and environmental factors. It should be noted that the guidelines proposed in Directive 2014/95/EU have an important contribution to SDG defined in Agenda 2030 of the United Nations (UN), because they comprise all areas and sectors of Member States and require comparable and reliable data on the performance of companies regarding SDG (Monteiro et al., 2020).

In December 2022, Directive 2022/2464 of the European Parliament and of the Council (CSDR – Corporate Sustainability Reporting Directive) was approved to correct deficiencies in non-financial reporting and broaden the range of entities required to report on sustainability issues. This Directive is compulsory for a larger number of companies – large companies, from 2024 onwards, and small and medium-sized listed companies, whose securities are admitted to trading on a regulated market in the Union, from 2026 onwards. It also provides a detailed definition of *sustainability reporting*, by EFRAG standards for sustainability reporting, a term that replaces *non-financial reporting*. The disclosure must be made in the management reports of the companies, compulsorily in digital format, and have a reliability assurance report issued by the statutory auditor.

Among the most widespread standards and guidelines are the GRI guidelines, which are the most widely used in the preparation of sustainability reports (Brown

et al., 2009; KPMG, 2020). Over the years, several versions of the GRI guidelines were published, until the fourth generation called G4 Guidelines, published in 2013. In 2016, GRI evolved from guidelines to global sustainability reporting standards – the GRI Sustainability Reporting Standards. The standards present a modular and interrelated structure, distinguishing more clearly what are requirements, recommendations, and guidance. They are subdivided into three sets of standards, namely the universal standards, applicable to all organisations; sector standards, applicable to specific sectors; and thematic standards organized by theme, with the 200 series for economic aspects, the 300 series for environmental aspects, and the 400 series for social aspects. The GRI Standards continue to change, including new standards on tax (in 2019) and waste (in 2020), and a major update of the universal standards (in 2021). The GRI standards aim to provide guidance to make sustainability reporting comparable and reliable. These standards require that the reporting of the impact on the environment, society, and the economy be done in a balanced way, including the positive and negative contributions of the organisation to the SDG (GRI, 2023).

More recently, in 2021, the International Financial Reporting Foundation announced the creation of the International Sustainability Standards Board (ISSB) with the aim of developing sustainability reporting standards (IFRSF, 2023). Subsequently, the European Financial Reporting Advisory Group (EFRAG) published the first set of sustainability standards adapted to EU policies in November 2022 (EFRAG, 2023).

Simultaneously, over the years, the UN have undertaken several initiatives to promote sustainable development. In the year 2000, at the Millennium Summit, the UN established eight Millennium Development Goals (MDGs) for the years 2000 to 2015 (Unric, 2020). Based on the MDGs for the years 2000 to 2015, the UN drafted a new sustainable development agenda containing the seventeen SDG to be achieved by 2030 (Unric, 2015). The SDG are seventeen goals and one hundred and sixty-nine targets related to environment, society, and economic sustainability and are directed at all countries. The SDG are related to health, education, hunger, global warming, gender equality, water, energy, sanitation, urbanization, environment, and social justice. The 2030 Agenda came into force on 1 January 2016 and aims to improve the living conditions of our planet (Unric, 2015).

The seventeen SDG set out in the 2030 Agenda are presented in Figure 11.1.



Figure 11.1. Sustainability Development Goals

Source: Adapted from Unric (2015).

To encourage companies to apply the SDG and disclose information in sustainability reports, the GRI has developed three business tools. These tools have been developed in partnership with the UN Global Compact and are aligned with the GRI Standards. The first tool is the analysis of goals and targets that help companies understand how they are implementing the SDG and their targets. They provide a list of indicators to make reporting straightforward and simple to execute. The second tool provides a list of potential actions for each SDG goal by integrating them into corporate reporting. The third aims at disclosing the SDG according to GRI standards (GRI, 2021).

This context led to the development of a prolific research area. Several studies have focused on analyzing SDG disclosure and its relevance for investors, share-

holders, managers, and other stakeholders in assessing the organisation's level of SDG integration (e.g., Bose & Khan, 2022; Erin & Bamigboye, 2022; Hatayama, 2022; Hummel & Szekely, 2021; Ike et al., 2019; Izzo et al., 2020; Monteiro et al., 2020; Rosati & Faria, 2019; Wynn & Jones, 2021).

Bose and Khan (2022) examined the extent of SDG disclosure by companies from 30 countries between 2016 and 2019, and analyzed whether institutional factors influence SDG disclosure. The study, based on a sample of 6,941 reports, concluded that only 8.4% disclosed SDG reports. The most commonly reported SDG were SDG 8 (Decent Work and Economic Growth), SDG 5 (Gender Equality), and SDG 3 (Good Health and Well-being), with SDG 2 (Zero Hunger) being the least reported. The authors also found that companies in developing countries disclosed more SDG information than those in developed countries.

In a similar vein, Rosati and Faria (2019) examined the integration of SDG into sustainability reports and the relationship between SDG disclosure and institutional factors in 2016. Based on reports from 2,413 organizations in ninety countries, Rosati and Faria (2019) found that organizations reporting on SDG tend to be located in countries vulnerable to climate change, as well as in places with a more tolerant culture, individualistic tendencies, and weaker employment protection and market coordination laws.

Hummel and Szekely (2021) observed an increase in both the quantity and quality of SDG information disclosure from 2015 to 2018. They analyzed annual reports of companies listed on the STOXX Europe-600 index and found that out of 1,732 reports, 652 included information about SDGs. The most frequently disclosed SDG were SDG 3 (Good Health and Well-being), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

Based on a sample of 134 organizations located in Europe in 2018, Izzo et al. (2020) examined the disclosure practices related to Integrated Reporting and SDG. Through content analysis, they found that 95 organizations provided information on SDG in their Integrated Reports. The most reported SDGs were SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action), while the least reported were SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 14 (Life Below Water).

Erin and Bamigboye (2022) evaluated the extent of SDG reporting in the annual reports of eighty companies located in eight African countries between

2016 and 2018. Twenty-nine companies mentioned SDG in their sustainability reports, with 38% of them referring to priority SDG, and 30% disclosing goals related to SDGs. The most commonly reported SDGs were SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduced Inequalities), SDG 13 (Climate Action), and SDG 15 (Life on Land).

In the context of international business expansion, Ike et al. (2019) concluded that Japanese companies prioritize a set of SDG for establishing or expanding their commercial operations in the countries where they operate, including SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 14 (Life Below Water), and SDG 17 (Partnerships for the Goals).

Wynn and Jones (2021) examined annual and sustainability reports from various companies in eight industrial sectors and found that the most commonly reported SDGs were SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). The least reported SDG were SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 14 (Life Below Water), and SDG 16 (Peace, Justice, and Strong Institutions). Some companies did not explicitly address SDG in their reports, but indicated that they had integrated SDGs into their business or sustainability strategies. The authors argue that companies will face significant challenges if they want to make substantial contributions to the SDGs.

Similarly, Monteiro et al. (2020), when examining sustainability reports and non-financial statements of Portuguese companies listed on the Euronext Lisbon stock exchange in 2017, considered that organizations will encounter substantial challenges in identifying priority SDGs, integrating them into their strategies, setting goals, and reporting on them. In the metallurgical industry, based on reports from sixty-one companies, Hatayama (2022) noted that evaluating the contribution to SDG is a challenging task but allows for the construction of a consolidated framework for sustainable development in which SDG can serve as a common language.

From the analysis of the reviewed studies, one can conclude that there is considerable diversity in the choices that companies make concerning which SDG they provide information about regarding the impact of their activities. However, in general, the SDG most mentioned by companies are SDG 8 and SDG 9.

3. Research methods

This study aims to analyse the disclosure of non-financial information by Portuguese companies in the paper sector and to understand to what extent companies are contributing to the implementation of SDG. This research adopts a qualitative approach. Data collection is carried out through content analysis of sustainability reports disclosed by companies, between 2017 and 2019. The content analysis consists of “a set of techniques of communication analysis that uses systematic and objective procedures to describe the content of messages, indicators (quantitative or not) that allow the inference of knowledge concerning the conditions of production/reception of these messages” (Bardin, 1977, p. 42). The most used method in qualitative research is the collection of information in the analysis of texts and documents. Content analysis helps the researcher to obtain information from all types of documents and texts, which are later transformed into codes according to the objectives of the research (Vieira et al., 2009). Therefore, in this study, the information will be collected in the Sustainability Reports of the years 2017 to 2019 of the sample companies. The reports were collected through the official website of each company. The analysis falls on three companies in the paper sector: Altri, Inapa, and The Navigator Company, within the scope of the application of Decree-Law No. 89/2017, of 28 July. In Portugal, this decree-law transposed Directive 2014/95/EU into domestic law. It establishes that Public Interest Entities, which at the date of closing of their balance sheet exceed an average number of 500 employees during the annual financial year, include in their management report a non-financial statement or prepare a separate report to be disclosed with the management report.

In the first stage, it was verified whether the companies mentioned the implementation of the SDG in their reports. Subsequently, the indicators disclosed by companies over the three years under study are related to the seventeen SDG, according to the disclosure of information in their reports. The indicators studied were Employees, Materials, Water, Energy, Biodiversity, Emissions, Effluents and Waste, Training and Education, Human Rights, Employment and Employability, Employee Health and Safety, Community, Anti-corruption, Customers, and Suppliers.

To understand the priorities of companies, we also analysed the priority SDG companies identified in their reports, more specifically the targets and actions to meet them.

4. Research results – Reporting on the Sustainable Development Goals

Regarding the reference to SGD in the companies' reports, Altri mentions the SDG in the 2018 and 2019 reports, Inapa in the 2019 report and The Navigator Company in the reports of all three years, as displayed in Table 11.1. It should be noted that in the last year studied, all three companies refer to the SDG, which confirms the increase of their relevance in recent years. Hummel & Szekely (2021) analysed annual reports of companies that belonged to the STOXX Europe-600 index and also found that from 2015 to 2018 there was an increase in the disclosure of SDG information in reports and that the quality of information disclosure also increased.

Table 11.1. SDG disclosure in the non-financial report

Companies								
Altri			Inapa			The Navigator Company		
2017	2018	2019	2017	2018	2019	2017	2018	2019
No	Yes	Yes	No	No	Yes	Yes	Yes	Yes

Source: Own elaboration.

The Altri discloses information, mainly, about six SDG, considered priority: Quality Health (SDG 3), Renewable and Affordable Energy (SDG 7), Sustainable Production and Consumption (SDG 12), Climate Action (SDG 13), Protecting Marine Life (SDG 14) and Protecting Earth Life (SDG 15). In Table 11.2, we can see Altri's goals and actions for the achievement of the objectives.

Table 11.2. Altri's SDG Goals and Actions

Objective	Goals	Shares
	Promote health and safety policies to ensure access to quality health services.	The company fully complies with the applicable health and safety legislation, based on international standards such as OHSAS 18001. The health and safety processes implemented go beyond the mandatory requirements, aiming to provide a safe and healthy working environment, thus ensuring the right of people to the protection of their health and integrity.

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Table 11.2 (continued)

Objective	Goals	Shares
	Seek to produce energy from renewable sources, namely through the expansion and modernisation of its biomass plants.	The company is in the renewable energy sector from biomass through Bioelétrica da Foz. It currently has five thermoelectric power stations operating from forest biomass, which produce around 700 GWh annually.
	Seek the integrated prevention and control of pollution, contributing to minimise its adverse impacts on the environment and human health.	The Foz Bioelectric Power Station contributes to the company's energy policy, which aims to reduce external dependence and the greenhouse effect resulting from the use of fossil fuels.
	Integrate climate change measures into national policies, strategies, and planning.	The Forestry Services Suppliers Code of Conduct focuses on Performance, Audits, Ethics, Subcontracting, Health and Safety, Labour, Environment, Equality and Non-discrimination, and Confidentiality.
	Prevent and reduce marine pollution of all types, especially from land-based activities, including marine debris and nutrient pollution.	81% of the water collected in the company's factories is returned to the environment after being properly treated. The remaining 19% accompanies the final product or evaporates into the atmosphere.
	Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains, and drylands, in line with obligations under international agreements. Integrate ecosystem and biodiversity values into national and local planning, development processes and poverty reduction strategies.	The company highlights the importance of creating value in natural areas, for example, through the valuation of ecosystem services and the opportunity that results from an effective sharing of experiences, knowledge, and potential benefits of active and integrated management of production areas and conservation of protected areas, habitats, and species. Altri joined the Mata Bussaco Foundation to value and boost the endogenous potential of the areas covered by the National Forest and the Bussaco Mountains.

Source: Altri Company Reports.

Inapa discloses information on targets and actions for four SDG: Quality Health (SDG 3), Renewable and Accessible Energy (SDG 7), Sustainable Production and Consumption (SDG 12), Climate Action (SDG 13), as can be seen in Table 11.3.

Table 11.3. Inapa's SDG Goals and Actions

Objective	Goals	Shares
 3 GOOD HEALTH AND WELL-BEING	Improve the rate of occupational accidents and diseases for all employees – 10% by 2022.	Improve the occupational health and safety management system. Reduce specific occupational health and safety risks. Increase employee training in the area of health and safety at work. Improve the company's internal health and safety reporting.
 7 AFFORDABLE AND CLEAN ENERGY	Increase the share of renewable energy used in the company from 5% to 20% by 2022.	Change the energy used by the company to „green energy”. Change the use of fossil fuels to biofuels (Diesel). Review the company's heating options for low-emission options, for example, building photo-voltaic panels and converting oil to gas heaters. Reduce energy used in workplaces: more economical use of air conditioning, and smart lights. Reduce the environmental impact related to travel. For example: increase the use of videoconferencing.
 12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Increase the efficiency of the use of natural resources by increasing the use of recycled materials. Increase the percentage of purchasing volume from suppliers with responsible and credible internationally recognised production standards to over 90% by 2022. Reduce waste production by 15% by 2022.	Replace plastic packaging material tapes with bioplastic and/or recycled paper. Develop the company's supply chain monitoring programme, improving the participation of the highest-scoring suppliers. Increase the share of reused materials. More careful and economical handling of materials used in logistics and transport.
 13 CLIMATE ACTION	Increase resilience and adaptive capacity to climate change-related risks by reducing the energy consumption and GHG intensity of the company's business. Set ambitious CO2 reduction targets based on the SBT of the UN's „Business Ambition 1.5°C” programme.	In the coming years, the transport of goods between the company and the customer's premises will be carried out by road due to the high requirements with short delivery times. Rail or ship are not alternatives because there is little local infrastructure required for this purpose.

Source: Inapa Company Reports.

The Navigator Company discloses information on targets and actions on seven SDG: Quality Education (SDG 4), Decent Work and Economic Growth (SDG 8), Industry, Innovation, and Infrastructure (SDG 9), Sustainable Consumption and Production (SDG 12), Protecting Earth Life (SDG 15) and Partnerships for Goal Implementation (SDG 17) (Table 11.4).

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Table 11.4. The Navigator Company SDG Targets and Actions

Objective	Goals	Shares
 4 QUALITY EDUCATION	To substantially increase the number of youth and adults who have relevant qualifications, including technical and vocational skills, for employment, decent work and entrepreneurship.	Promote training actions that ensure the retention of internal <i>know-how</i>. Learning Center <i>online</i> platform. Literacy of workers in Mozambique. School visit programs. The paper produced by the company is a support for learning and literacy.
 8 DECENT WORK AND ECONOMIC GROWTH	Promote development-oriented policies that support productive activities, the creation of decent jobs, entrepreneurship, creativity and innovation, and encourage the formalisation and growth of micro, small and medium-sized enterprises, including through access to financial services. Protect labour rights and promote safe and secure work environments for all workers, including migrant workers, in particular migrant women, and people in precarious employment.	Promotion of workers' safety. Goal Zero Accidents. Cardinal Rules (Code of Conduct) for Employees and Suppliers.
 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Develop quality, reliable, sustainable, and resilient infrastructure, including regional and cross-border infrastructure, to support economic development and human well-being, focusing on equitable and affordable access for all. Modernising infrastructure and rehabilitating industries to make them sustainable, with greater efficiency in the use of resources and greater adoption of clean and environmentally friendly technologies and industrial processes. Strengthen scientific research, improve technological capabilities, encourage innovation, and substantially increase the number of research and development workers per million people and public and private expenditure on research and development.	RAIZ Research Institute: Inpactus Project. Development of bioeconomy projects. Tools for evaluating research projects.

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Objective	Goals	Shares
	Achieve sustainable management and efficient use of natural resources. To substantially reduce waste generation through prevention, reduction, recycling, and reuse. Encourage companies, especially large and transnational ones, to adopt sustainable practices and to integrate sustainability information in their activity reports. Promote sustainable public procurement practices, in accordance with national policies and priorities.	Minimising water and energy use: Corporate Programme for Reducing Water Use and Corporate Programme for Energy Efficiency. Circular economy projects. Programme for the Promotion of Forest Certification.
	By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains, and drylands, in line with obligations under international agreements. By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation efforts globally. Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and avoid the extinction of endangered species.	Sustainable forest management practices. Defence of forests against fires. Practices of biodiversity conservation and protection of natural habitats.
	Strengthen the global partnership for sustainable development, complemented by multi-sectoral partnerships that mobilise and share knowledge, technology, and financial resources to support the achievement of sustainable development goals. Encourage and promote effective public, public-private and civil society partnerships, building on the experience of resource mobilisation strategies of such partnerships.	Promotion of partnerships with various entities to promote compliance with the remaining SDG and stimulate engagement with different stakeholder groups.

Source: The Navigator Company Reports.

Generally, the targets proposed by companies aim to use fewer natural resources in their production, increase the use of renewable resources, use recyclable materials, and improve the working conditions of their employees. The companies hope to achieve these goals in a short period, following the intention of the UN of achieving SDG be achieved by 2030.

The relation between the indicators disclosed by companies and the seventeen SDG is displayed in Table 11.5. In Altri's report all indicators disclosed relate to the SDG. Inapa only disclosed this in its 2019 report information on SDG. So, for Inapa, Table 11.5 refers only to that year. In Inapa's report not all indicators disclosed are related to the SDG, such as Water, Biodiversity, Human Rights, Employment and Employability, Community, Anti-corruption, and Customers. Regarding The Navigator Company, only the Human Rights and Anti-Corruption indicators were not related to the SDG.

Table 11.5. Corporate Indicators Related to the SDG

Altri's indicators	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Staff				×	×			×		×						×	
Materials								×				×					
Water						×		×				×					
Energy							×	×				×	×				
Biodiversity						×								×	×		
Emissions, effluents and waste			×			×						×	×	×	×		
Training and education				×	×			×								×	
Human rights										×							
Employment and employability					×			×									
Employee health and safety			×					×									
Community	×	×															
Anti-Corruption																×	
Customers								×									
Suppliers					×			×				×				×	

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Inapa Indicators	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Staff			×	×													
Materials								×							×		
Water																	
Energy							×					×	×				×
Biodiversity																	
Emissions, effluents and waste							×					×	×				×
Training and education				×													
Human rights																	
Employment and employability																	
Employee health and safety			×														
Community																	
Anti-Corruption																	
Customers																	
Suppliers								×				×					
The Navigator Indicators	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Staff				×					×								×
Materials															×		×
Water						×						×					
Energy							×					×	×				
Biodiversity															×		×
Emissions, effluents and waste												×	×				×
Training and education				×													×
Human rights																	
Employment and employability								×									
Employee health and safety			×					×									
Community				×													×
Anti-Corruption																	
Customers												×					
Suppliers								×				×					×

Source: Own elaboration.

The results show that there is a strong connection between the Indicators and the SDG. This reveals that companies choose to disclose how their actions contribute to achieving certain SDG and that the choice of these SDG is related to the disclosed indicators. This confirms that the evolution of sustainability reporting is compatible with the inclusion of information on the SDG.

According to PWC (2017), most companies choose to prioritize only a small number of SDG, focusing on the goals that can achieve positive results or that can have a greater impact on their business. In companies' reports analysed, the information disclosed on SDG focuses more on positive impacts than negative ones.

SDG 12 is considered the goal most interconnected with the other SDG by PWC (2017), because preserving natural resources, reducing food waste, reducing waste, among other measures related to sustainable consumption, improves people's quality of life, the quality of the subsoil, marine life and decrease the greenhouse effect. In this study, all companies have measures to implement related to this SDG. Hatayama (2022) analysed the relationship of the metalworking industry and the SDG and concluded that one of the most disseminated SDG was SDG 12 – Sustainable Production and Consumption. In our study, we found that all companies mention SDG 12 which may be because this sector is associated with high levels of pollution and some environmental disasters.

SDG 13 – Climate Action is the goal that 89% of Portuguese companies selected as a priority (PWC, 2017) and, according to the study by Salvia et al. (2019), there is a global concern with this SDG. The companies Altri and Inapa also have measures on this SDG.

5. Conclusion and recommendations

Over the years, stakeholders' needs have changed with society's growing environmental awareness. These changes have had repercussions in the business sphere due to the fundamental role that companies have in achieving a sustainable development model. In this context, companies' reporting had to evolve to disclose environmental and social organisational performance. This chapter addressed the normative evolution that occurred in the EU and how international organisations have been promoting and supporting comparable sustainability reporting.

The results of the study carried out in this book chapter reveal that there was an evolution, over the years, in the disclosure of non-financial information by the companies analysed, which evidences their commitment to disclosing more information on their social and environmental performance. Companies disclose more

information on the following categories: Organisation, Environmental Indicators, and Labour. However, it is noteworthy that in all reports there is more information on positive aspects of the company than negative ones. Regarding the SDG, companies disclose in their reports the targets and actions for the implementation of specific SDG, which reveals their commitment to achieving their goals as soon as possible.

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- Directive No. 2014/95/EU of the European Parliament and the Council, of 22 October 2014.
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The relevance of environmental accounting. An implementation proposal in the automotive sector

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Abstract

The awareness of society about environmental problems has led companies to engage in corporate social responsibility (CSR) strategies worldwide. CSR strategies imply the inclusion of the environmental dimension in decision-making processes. Non-financial reporting and environmental accounting are fundamental in providing information on companies' CSR goals, performance, and strategies. Environmental accounting is a strategic and relevant tool in dealing with environmental issues. In this context, it is important to have comparable information for companies' stakeholders, public opinion, and society. In this book chapter, we analyse the evolution of environmental accounting over the years and the process of implementation of an environmental accounting system in an automotive company. We also develop a proposal for the implementation of an environmental accounting system with the main procedures to be followed. Our results highlight the need of knowing in detail the specificities of the productive activity of the company, the human resources, and the information system. The incorporation of environmental issues in the companies' strategy and their reporting through new formats, provides valuable information on companies' environmental awareness and commitment.

Keywords: Environmental Accounting; Corporate social responsibility; Implementation project, Automotive industry

1. Introduction

The growing environmental awareness of society over the last decades required companies to act in accordance with the sustainable development paradigm. This type of development implies a difficult balance between environmental protection and economic development (Jones & Solomon, 2010).

The incorporation of environmental issues into the companies' strategy and their reporting practices either through traditional financial statements or through new forms of reporting, provides useful information on how companies relate to the environment. In this context, the topic of Corporate Social Responsibility (CSR) is particularly relevant. Companies are seen as entities of an economic nature, but also with a social responsibility towards society.

The development of environmental accounting was due to several factors, namely the high demand in the financial markets for companies' environmental information, the increased adoption of sustainability-oriented strategies, and the research effort carried out by academics. This evolution took place alongside the development of a legal framework with increasing requirements in this subject (Aurelia-Aurora & Sorina-Geanina, 2012). Environmental accounting aims to highlight the financial position with an environmental impact and to include environmental performance in the assessment of the company's performance. The main purpose of environmental accounting is to create conditions for information users, internal or external to the organisation, to be able to make predictions regarding its environmental performance. Measurement and disclosure make visible what was previously invisible and allow capturing the hidden attributes of the business activity (Jones & Solomon, 2010). This allows more informed and efficient decision-making (Aurelia-Aurora & Sorina-Geanina, 2012).

Accordingly, this work analyses a company in the automotive sector and presents a proposal for the implementation of an environmental accounting system. This proposal contains a subdivided accounting plan, a Balance Sheet, and an Income Statement with environmental results. The aim is to contribute to a more practical accounting perspective in addressing environmental issues. Much of the work in this area is based on secondary data, adopting a perspective far from the reality of companies (Deegan, 2017). Therefore, this work intends to adopt a perspective close to the business reality, developing a framework for the implementation of an environmental accounting system at the company BorgWarner Emissions Systems Portugal through the definition of guidelines, principles, and procedures, according to the specificities of the automotive industry and

the requirements of the *Norma Contabilística e de Relato Financeiro* (NCRF – Accounting Standard for Financial Reporting) 26 – *Environmental Matters*. It is also intended to contribute to a better understanding of this standard by showing how it can be implemented in a specific company.

This chapter presents a literature review on the evolution of environmental accounting in the next section. Then, we describe the methodology used in this research and present the company BorgWarner Emissions Systems Portugal. In section 4, we present the proposal for the implementation of the environmental accounting system, as well as the Balance Sheet and the Income Statement with environmental information. Finally, the main conclusions, recommendations, and suggestions for future research are outlined in section 5.

2. Literature review

Society has been developing an increasing concern with caring for and preserving the environment. This concern led to the current model of sustainable development. Sustainable development seeks to meet the needs of the current generation without compromising the ability of future generations to meet their own needs (WCED, 1987). Companies (particularly manufacturing companies) have focused on this issue, either because of the imposed regulations or because of the pressure they suffer from environmentalist groups and associations. Numerous scientific areas are involved in this theme, including accounting. Accounting proves to be essential for dealing with environmental problems, as it satisfies the need for quantification, registration, and reporting on the damage caused to the environment, and helps define the necessary preventive or corrective actions (Gomes, 2010).

CSR is profoundly related to environmental accounting. Companies are expected to assume this kind of responsibility and voluntarily integrate social and environmental concerns into their operations and interaction with stakeholders. CSR is understood as the companies' commitment to improving economic, social, and environmental well-being through their business practices. Currently, more than a moral obligation, CSR is a strategic imperative with consumers rewarding socially responsible companies (Baskentli et al., 2019). Social responsibility is increasingly important for organisations, with an impact on their objectives, strategies, and identity of the company (Monteiro & Guzmán, 2009).

Environmental accounting provides useful information for companies fully embrace CSR practices. It aims to provide information on the financial impact

of environmental aspects through the company's annual accounts (Ramos et al., 2007). It constitutes a well-defined research area that has evolved since the 1970s, that explores the relationship between accounting, organisation, and society (Eugénio et al., 2010). In the 1990s, the first environmental reports began to appear. Because of the increasing importance of sustainability, environmental legislation became stricter, and the financial sector began to demand detailed environmental data on companies.

The implementation of environmental accounting allows, for example, to identify, estimate, allocate, and reduce environmental expenses, control of the use and flow of energy and materials, improvement of the efficient use of natural resources, more accurate and detailed information on actual expenses and, even, improve the company image (Kraemer, 2006). However, the elaboration and dissemination of environmental information face several difficulties, due to the lack of standardized definitions.

Portugal, as other European countries, began to address the issue of environmental accounting at the end of the 1990s. Several EU countries adopted the European Commission (EC) Recommendation of 2001, which promoted greater harmonization regarding the disclosure of environmental matters in annual accounts and in the management reports of the companies. In Portugal, due to this recommendation, the *Comissão de Normalização Contabilística* (CNC – Accounting Standards Board) approved, in 2002, the *Diretiva Contabilística* (DC – Accounting Directive) 29 – *Environmental Matters*. In 2010, with the implementation of the *Sistema de Normalização Contabilística* (SNC – Accounting Standardization System), the environmental issue became regulated by the NCRF 26 – *Environmental Matters*.

The NCRF 26 prescribes the criteria for the recognition, measurement, and disclosure of expenditures of environmental nature, environmental assets, liabilities, and risks, resulting from transactions and events that affect, or are likely to affect, the financial position and results of the reporting entity. This standard identifies the type of environmental information that should be disclosed, regarding the entity's attitude towards environmental matters and the entity's environmental performance, insofar as they may have consequences for its financial position. According to NCRF 26, expenditure of an environmental nature includes expenditure on measures taken by an entity to prevent, reduce or repair damage of an environmental nature resulting from its activities and excludes expenditure that may produce beneficial effects on the environment, but whose main objective is to respond to other needs. Regarding environmental expenses, these relate to goods or services used in the production of other goods or services of an environmental

nature. In this context, there are some specific situations in which the expenditure must be considered as a year expense, namely expenses with waste treatment, repairing damage that occurred in previous years, environmental expenses of administrative nature, and expenses with environmental audits.

Environmental assets are all assets and rights owned by companies that have the capacity to generate economic benefits in future periods and that aim at environmental preservation, protection, and recovery (Ribeiro, 2006; Tinoco & Kraemer, 2011). Revenues or benefits of an environmental nature are the “quantifiable economic benefits obtained by the company as a direct and identifiable result of the implementation of measures whose main objective is to avoid, reduce or repair the negative environmental effects of its activities” (Gaspar, 2003, p. 144). Environmental liability is an obligation of the company arising from duties or responsibilities for preservation, recovery, or environmental protection (Ferreira, 2000; Kraemer, 2011).

According to NCRF 26, environmental matters must be disclosed in the Management Report and Notes to the Financial Statements, to the extent that they are materially relevant to the assessment of the financial performance or financial position of the entity. Thus, the Management Report must include a description of all matters relevant to the performance and financial position and prepare an accurate and clear analysis of the evolution of the business and the situation of the company. The Notes should include all qualitative information regarding the amounts included in the Balance Sheet and Income Statement (NCRF 26).

To implement environmental accounting, it is necessary to create a structured process where all the concepts associated with the subject are defined and to adapt the company’s accounting system regarding environmental matters. Therefore, a case study will be carried out with the development of a proposal for an environmental accounting system applied to the automotive sector, specifically at BorgWarner Emissions Systems Portugal.

3. Research methods

The development of this proposal was based on a qualitative investigation using the case study methodology. According to Godoy (1995), the case study methodology defines that the object of this type of research is a unit that undergoes a deep analysis, aiming to obtain a detailed examination of an environment, an individual or a particular situation. According to Scapens (2004) for the elaboration of a study there are several phases: preparation; evidence gathering; evaluation

of the evidence; identifying and explaining patterns; case writing. The collection of evidence resulted from a combination of methods, which included interviews, document analysis and observation, with the aim of triangulating information (Vieira, 2009).

The case study was developed at BorgWarner Emissions Systems Portugal, a subsidiary of BorgWarner Inc Corporation, leader in clean and efficient technological solutions for combustion, hybrid, and electric vehicles. BorgWarner Emissions Systems Portugal, originally known as ENSA is dedicated to the automotive industry since 1967. It underwent a series of successive changes and was acquired by the BorgWarner Inc Group in 2010, with its integration in its Emissions Systems division. BorgWarner Portugal's is located at Lanheses, Viana do Castelo, since 2014, and its industrial activity is focused on the design and manufacture of components and modules for controlling emissions and conducting fluids for the automotive industry. The BorgWarner Group has a sustainability policy focused on the balance between economic progress, environmental quality, and social well-being. BorgWarner Portugal is aware of its responsibilities in terms of the environment and is committed to a proactive approach to promoting continuous improvement in this area.

The first phase of the research was the process of interviews with the accounting supervisor and the health, safety, and environment technician to obtain information about the environmental conditions of the company. The interviews carried out in this work are included in the typology of unstructured interviews because they only had a set of topics to be addressed. In the second phase, documents and archive records were consulted to gather additional information. Document analysis implies the use of content analysis. Additionally, we analysed the reports submitted to several institutions such as, for example, the National Statistical Institute. The third phase consisted of organizing and processing the information collected and, in the fourth phase, already in the proposal development stage, a second moment of interviews took place, with the purpose of presenting the first results.

It should be noted that, regarding the company's accounting system the company had implemented, there was no accounting environmental information in the company's financial statements. However, the company was interested in introducing the necessary changes to its accounting system to generate the environmental information required by the NCRF 26.

4. Proposal for implementing an environmental accounting system at BorgWarner

According to Eugénio (2011), and with the adaptations to the BorgWarner Emissions Systems Portugal conditions, the steps to implement an environmental accounting system are presented in Figure 1.

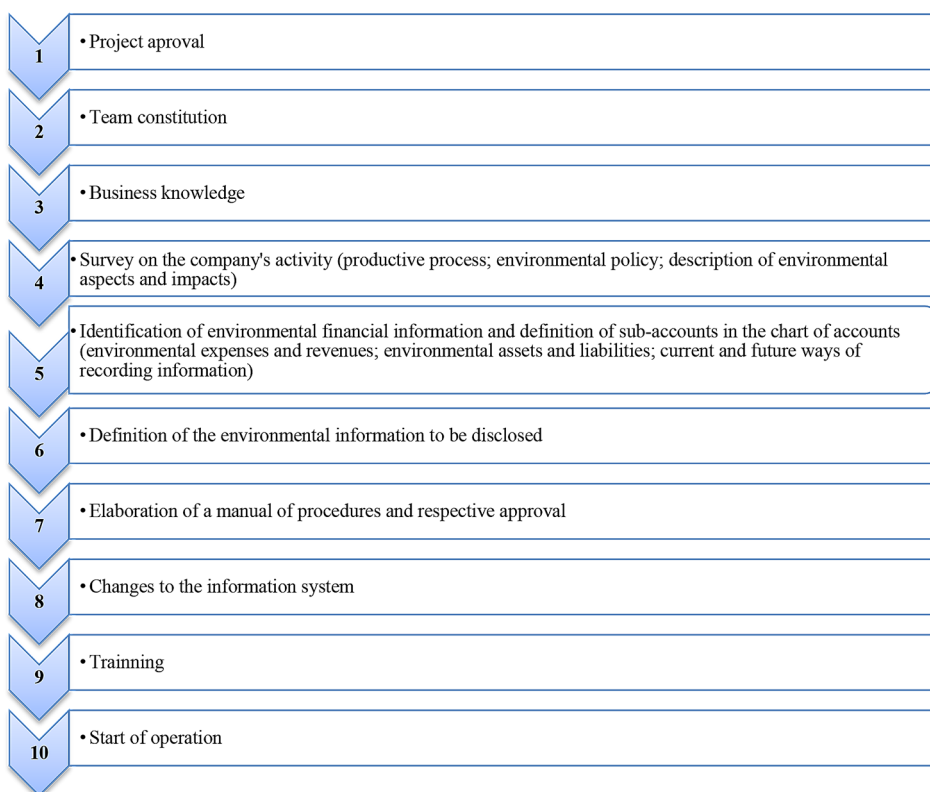


Figure 12.1. Implementation steps of the environmental accounting system at BorgWarner

Source: Based on Eugénio (2011) – Free adaptation.

Considering the aim of this study, the proposal was prepared for structuring environmental reporting accounts for Balance Sheet and Income Statement, with the identification of the environmental sub-accounts. This proposal was defined according to the accounts code used at BorgWarner.

The development of the proposal for the environmental accounting system is consistent with steps 4 and 5 presented in Figure 12.1. The project team with the functional interlocutors were interviewed to acquire knowledge on all the company's environment aspects, namely, environmental expenses and revenues; environmental liabilities and provisions; employees who perform functions related to the environment and current ways of recording each item in the company's information system.

The NCRF 26 recommends that entities consider the definitions of environmental expenses by *environmental domains*. However, the NCRF 26 does not define the content of environmental domains, contrary to the previous DC 29 that fully explained the information to be disclosed by environmental domains. Thus, the characterization of the environmental domains shown in Table 1 is based on the guidelines of DC 29 and on the identification of environmental components as suggested by Gomes (2010).

Based on the information collected in the interviews, the environmental components existing at BorgWarner were identified and classified by each environmental domain into environmental assets, environmental expenses, environmental liabilities, and environmental revenues (see Table 1).

Table 12.1. Classification of environmental components by environmental domain and elements of the Financial Statements

Environmental Domain	Description/Rules of measurement and accounting treatment	Classification by elements of DF
Management of emissions to the atmosphere	• Combustion modifiers to reduce atmospheric emissions • Multi-channel ovens – Simultaneous burning of various fuels • Ovens with preheating system (standby) • Application of photovoltaic panels	Environmental assets
	• Monitoring of the air quality • Traffic monitoring • Maintenance of refrigeration equipment, heat pumps and fire protection systems • Less polluting fuels • Rental of alternative fuel storage equipment	Environmental expenses
Wastewater management	• Wastewater treatment station • Accountants • Water recirculation systems • Construction of the connection to the wastewater collector • More efficient taps and installation of flow meters • Permit for use of water resources for discharge of wastewater	Environmental assets
	• Cleaning of the septic tank	Environmental expenses

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Environmental Domain	Description/Rules of measurement and accounting treatment	Classification by elements of DF
Waste management	• Cover for the waste park • Construction of areas for the collection and temporary storage of waste (waste park) • Containers for Solid and Urban Waste (MSW) • Ecopoints- containers for waste separation	Environmental assets
	• Rate for landfill of waste • Taxes of Waste Management Services • Disposal of harmful equipment and materials, identified or to be identified to comply with environmental legislation	Environmental expenses
	• Waste sales (cardboard, pallets, and scrap)	Environmental revenues
Protection of soil and water (surface and groundwater)	• Construction of spill containment systems (gutters for rain-water collection and soil sealing) • Chemical warehouse • Construction of areas for the collection and temporary storage of waste • Holding basins • Emergency kits • Fuel storage permit • License for use of water resources for abstraction of surface/ groundwater	Environmental assets
	• Contracting of soil decontamination services/ removal of accumulated waste • Monitoring of contaminated soils • Monitoring of the water quality	Environmental expenses
	• Repair of soil and water damage • Cleaning of spills (e.g. fuel and oil)	Liabilities of an environmental nature
Protection against noise and vibrations	• Noise and vibration reduction systems (acoustic barriers, silencers, shock absorbers) • Quieter equipment for noise reduction • Special noise permit	Environmental assets
	• Monitoring of environmental noise	Environmental expenses
Other areas of environmental management and protection	• Environmental monitoring studies • Sponsorships and environmental sponsorship actions • Environmental simulations • Insurance/financial guarantee under the Environmental Liability Directive • External environmental monitoring technician	Environmental expenses
	• Environmental monitoring technician • Cleaning team (related to environmental management) • Preparation of the Environmental Management Plan	Liabilities of an environmental nature
	• Reduction of the value of the environmental taxes paid	Environmental revenues

Source: Own elaboration.

Following the classification by elements of the financial statements, proposals for the Income Statement (Table 12.2) and Balance Sheet (Table 12.3) were prepared, and adjusted to the automotive sector, more precisely to the BorgWarner company.

Certain situations have been defined according to the specificities of the company.

Regarding the classification of expenses, the expenses associated with the Environmental Monitoring Technician were identified, which correspond to expenses with the wages of the company's personnel. Therefore, they are included in the *Personnel wages* account. In turn, the expense of the external Environmental Monitoring Technician must be identified as a specialized external service and must be included in the *Fees* sub-account.

In the Waste Management environmental category, environmental expenses include contracting specialized external services, which fall under the *Specialized work* sub-account. The cleaning of the pit is also carried out by an external service, registered in the sub-account *Cleaning, hygiene, and comfort*. Containers for Urban Solid Waste, Eco points, and Wastewater treatment station, when acquired, are recognized as assets and included in *Other tangible fixed assets* sub-account. If they are rented to external entities, the expense is recorded in the *Specialized work* sub-account. The monitoring identified, which is carried out by external services accredited for the purpose, must also be included in the *Specialized work* sub-account.

According to NCRF 26, recycling activities that respond, firstly, to technical needs or internal requirements of the entity must be excluded from the definition of environmental expenditure. As the purchased Eco points and containers for solid urban waste have waste management as their main objective, they must be considered environmental expenditures.

Regarding the item Insurance/Financial Guarantee, the cost of insurance under the Environmental Responsibility Directive is included in the Income Statement. As it is an expense for contracting an external service, it must be indicated in the *Insurances* sub-account.

Regarding the classification of revenues, in the *By-products, waste, residues and scrap* sub-account is included all revenues from sales of waste, specifically from the sale of certain waste, by type, such as iron, steel, plastic, and cardboard. These are paid by the waste management operator.

There are other revenues, in the form of reduced expenses, such as paper consumption, which are not recognized as revenues but are monitored and considered for management purposes.

It should be noted that the purchased equipment can be sold. If this happens, the value of the gain or loss must be recorded in the *Gains/Losses Disposals* sub-accounts.

A proposal for environmental revenues and gains, and expenses and losses is presented in Table 12.2.

Table 12.2. Proposal for Revenues and Gains and Expenses and Losses sub-accounts – Income statement

Environmental expenses and losses	Environmental revenues and gains
Costs of goods sold and environmental materials consumed	Sales
Raw materials, subsidiaries, and consumption	By-products, waste, waste, and scrap
Raw Materials	Sale of waste for recovery (cardboard, pallets, and scrap)
Environmental materials consumed	Provision of services
Environmental external supplies and services	Secondary services
Specialized work	Environmental services
Environmental specialized work	Operating subsidies
Environmental audits	Operating subsidies for environmental reasons
Environmental Consulting	Reversals of provisions
Environmental projects	Provisions for landscape and environmental recovery
Supervision of environmental projects	Provisions for ongoing legal proceedings concerning the environment
Landscape and environmental recovery	
Environmental monitoring	Supplementary revenues
Ambient noise	Studies, projects, and technological assistance
Environmental vibrations	Environmental studies and projects
Contaminated soils	Royalties
Air quality	Royalties for the use of environmental technology
Water quality (surface water and groundwater)	In subsidies for investments
Traffic	In subsidies for environmental investments
Other environmental specialized work	Gains in inventories
Advertising	Environmental stocks
Advertising and environmental advertising (newspapers/ magazines about the environment)	Others
Fee	Corrections for previous years
Fees to environmental auditors	Corrections to previous exercises for environmental issues

Chapter 12

Table 2 (continued)

Materials	Tax refund
Books and technical documentation	Environmental taxes
Preparation of the Environmental Management Plan	
Insurance	
Insurance Responsibility and Multirisks	
Environmental insurance (under the Environmental Liability Directive)	
Litigation and Notary	
Litigation and notary for environmental issues	
Cleanliness, hygiene, and comfort	
Cleaning for the protection of the environment	
Personnel expenditure	
Staff remuneration	
Personnel assigned to environmental tasks	
Environmental Monitoring Technician	
Cleaning crew	
Other expenditure on personnel	
Personnel assigned to environmental tasks	
Environmental training	
Environmental accessories	
Impairment losses	
Provisions	
Taxes	
Environmental taxes	
Ongoing legal proceedings	
Ongoing legal proceedings due to environmental issues	
Accidents at work and occupational diseases	
Occupational accidents and occupational diseases due to environmental issues	
Other provisions	
For landscape and environmental recovery	
Taxes	

Other taxes	
Green taxes	
Corrections from previous exercises	
Corrections from previous exercises on environmental issues	
Donations	
Donations to environmental protection institutions	
Inventory losses	
Stock losses caused by environmental damage	
Fines and penalties	
Fines and penalties for non-compliance with environmental legislation	
Environmental offenses	
Other extraordinary expenses and losses	
Resulting from environmental claims	

Source: Own elaboration.

The proposal of Table 12.2 had as a starting point the Income Statement used by the company, which follows the SNC principles, with an adaptation, to present the expenses and revenues of environmental nature.

Regarding licenses and authorizations, there are two possibilities for their recognition. They can be considered environmental expenses and be evidenced in the income statement. However, the NCRF 26 defines that when licenses and authorizations are acquired and, in addition, meet the criteria for their recognition as an asset, they must be capitalized and amortized during their expected useful economic lives. In this case, and if they constitute intangible assets, licensing expenses are included in the Balance Sheet, in the *Industrial property* sub-account.

Table 12.3 presents the proposal for accounts for the company's environmental assets and liabilities.

Table 12.3. Proposal for Assets and Liabilities accounts – Balance sheet

Assets
Investments
Financial investments
Other financial investments
Environmental financial investments
Tangible fixed assets

Table 12.3 (continued)

Other tangible fixed assets
Environmental tangible fixed assets
Containers for Municipal Solid Waste
Ecopoints - containers for household waste
Compact WWTP
Emergency kits
Multi-channel ovens
Photovoltaic panels
Water recirculation systems Water recirculation systems
Chemical warehouse
Accumulated depreciation
Accumulated depreciation Environmental tangible fixed assets
Intangible assets
Development projects
Research and development of environmental projects
Permits
Environmental licensing
Special noise permit
Fuel tank licence
Authorization/ License to use Water Resources for water abstraction
Accounts receivable and payable
Other accounts receivable and payable
Other debtors and creditors
Coordinating entity of the licensing
Liabilities
Provisions
Environmental taxes
Environmental matters
Provisions for greenhouse gas emission liabilities
Landscape and environmental recovery

Source: Own elaboration.

The inclusion of the corresponding explanatory notes in the Notes to the Financial Statements results in a financial statement with great informative value and an excellent way of disclosing environmental financial information.

In addition, COM 2017/C215/01 suggests several environmental indicators that can complement the balance sheet information and demonstration of environmental results, namely: energy performance and waste management (e.g. recycling rates). The indicators presented next are calculated based on Sikora & Markiewicz (2021) (Equation 1) and Mendes et al. (2003) (Equation 2).

$$\text{Energy performance} = \frac{\text{Energy consumption}}{\text{Production (units)}} \quad (1)$$

$$\text{Recycling rate (\%)} = \frac{\text{Production of recyclable waste}}{\text{Production of mixed solid waste}} \times 100 \quad (2)$$

5. Conclusion and recommendations

The growing demand for information on environmental business behaviour by society and the incorporation of environmental issues into companies' strategies has led to the development of environmental accounting.

Environmental accounting, either through traditional financial statements or through new forms of reporting, makes it possible to reveal how companies relate to the environment. However, the evidence of the environmental impact in the financial statements has been, until today, a complex process due to the inexistence of norms that clearly guide its implementation. Consequently, there is a need to standardize the information to be published, through an information management system that provides relevant information to investors, public opinion, and society so they can evaluate the situation and the environmental performance of companies (Burrit & Schaltegger, 2010).

In this context, this study aimed to develop a proposal for the application of an environmental accounting system in a company in the automotive sector, adopting a more practical perspective in approaching environmental issues. It should be noted that, for the preparation of environmental accounting, it is essential not only to know in detail the relevant information about the company's operation, but also to reconcile this information with the proposals for components and environmental domains referred to in the literature and in accounting regulation. The proposal includes Income Statement and Balance Sheet sub-accounts, which include the environmental components organised by environmental domains, to comply with the Portuguese standard on environmental matters, the NCRF 26.

The implementation of the proposed solutions is feasible, and it will provide useful information for the company's decision-making. The implementation of the proposal for the environmental accounting system will certainly add value to knowledge in this area.

A limitation of the research is the fact that the proposal is specific to the company analysed. However, this proposal represents a valuable initial step for the company to improve its accounting system in terms of CSR and it can also be a starting point for developing new proposals for other companies. Thus, as recommendations for future work, we suggest the development of proposals for environmental accounting systems in other activity sectors, particularly in environmentally sensitive sectors such as the paper industry, cement, and dyeing industries, and in sectors whose valuation of waste generated represents an important source of the company's revenues.

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Sustainability in the client's policy-related activities

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Abstract

While performing and providing any kind of business, all the leading managers and marketers constantly face a problem on how to increase the number of clients and keep them as long as possible. But to accomplish this, new and modern approaches are needed to bring the business to the next level. So, the essay explores various strategies for small and medium-sized enterprises (SMEs) to enhance their business operations that are centered on fostering long-term relationships with customers, broadening the overall consumer base, and turning existing customers into clients. It is organized into several main sections that highlight specific tools for overcoming the challenges described: the critical importance of adopting a client-oriented approach, innovation, and eco-friendly practices in the business management. The results obtained from the research indicate that implementing mentioned strategies can significantly contribute to sustainable SME's grow and succeed in today's competitive business world. Therefore, term "Sustainability" here will be defined as a business strategy that drives corporate growth and profitability by building strong relationships with customers and expand the client base.

Keywords: sustainability, increasing sales, long-term relationships, competitive advantage, client base

1. Introduction

It is the customer who determines what a business is

(Drucker, 1954)

Nowadays, the business itself may have completely different functions and objectives that it aims to achieve over time. But if we omit such a notion as nonprofit organizations that are created for religious, charitable, scientific, artistic,

literary, or educational purposes, the most important and initial goal of any business is and always will be is to make a profit. Money is the primary objective, as it enables the business to continue operating and grow over time. But as a well-known fact, profit increase, and even existing of any business is literally impossible without customers. For this reason, any manager or SME owner should not neglect the scale and quality of their customer base.

Acquiring new clients and building long-term relationships with them is so essential because it deals with boosting sales, providing fresh revenue streams, increasing customer loyalty and establishing a good reputation for the company. However, attracting new clients can be a challenging task. Businesses must invest in marketing strategies that are effective in reaching their target audience. Over the past couple of years, customers have become increasingly demanding for various reasons, such as increased competition, advancements in technology, and changing customer expectations. Going into detail, in today's highly competitive business world, for almost every product, there are numerous substitutes which means that customers have more options than ever before. Therefore, companies have to work harder to capture and retain customers' attention. Businesses can no longer rely on just having good products or services; they must differentiate themselves from their competitors. As another significant reason, it is extremely important to keep up with the times, follow the new generation and its trends, develop rapidly and effectively. With the technology advancements, customers expect fast and efficient service with a minimal effort on their part. It is all about online 24/7 stores, chat-bots, emails, various communication channels, social media etc. If the company cannot meet these demands, customers will quickly switch to another business that is able to provide all of the above. Last but not least, changing customer expectations have played a significant role in their increased demands. As society evolves and becomes more complex, customers' expectations change with it. For example, customers now value sustainability and ethical business practices, and they expect companies to do the same. Additionally, customers want more personalized experiences and expect businesses to understand their needs and preferences.

To put it all in one piece, the primary purpose of the research is to determine what are the most effective and relevant business strategies for SMEs today, what kind of tools can help SME owners better understand customer needs, and what is needed to be prioritized in order to turn a customer into a long-term client. This essay focuses and highlights business approach, which is called sustainability. In simple words, it is about creating long-term value considering how a particular organization operates in the ecological, social, and economic environments.

Sustainability is built on the assumption that the development of such strategies enhances the company's longevity.

I believe that the principles and strategies provided hereinafter will be useful to anyone choosing to rethink their approach to business and make new contemporary adjustments to the core business processes.

2. Literature review

Many recent studies are focused on the relationships between a business and its ways of development so the relevant literature for the review was easily accessible. Many authors such as Jenkins (2006), Baumann-Pauly and Wickert (2016), Spence and Scherer (2013), Rangan, Chase and Karim (2015) put an afford on researching the impact on SMEs client base that causes implementation of Corporate Social Responsibility. Some authors such as Mouritsen (1997), Varnali (2019), Wirtz and Daiser (2018), Neto and Hirata (2017) have focused their attention on the customer-oriented perspective, while Walsh and Dodds (2017), Turkey & Arslan (2020), on the achievement of competitive advantage. Also, there was much research on innovation management in SME made by Hidalgo and Albors (2008), Sahut and Peris-Ortiz (2014), Ruchkina, Melnichuk, Frumina and Mentel (2017).

3. Research Method

To answer the research questions, the qualitative primary method “content analysis” was chosen as the most appropriate one. It is well-suited for examining and extracting meaningful insights, patterns, and trends from textual data on a wide range of topics, ensuring that the research remains focused and comprehensive. The essay is derived from a complete overview of the above-mentioned literature on the topic of long-term relationships with customers in the SME segment.

3.1. Client-oriented approach

While looking for the sources of competitive advantage, the company must reevaluate and possibly correct or improve its external and internal processes and approaches. Starting with the actual management of the team and ending with the right attitude to its customers. At all levels of business processes the enterprise must have a clear plan of operating and developing. Since we are specifically

focusing on working with clients, it is needed to consider many factors that affect overall customer satisfaction, their desire to stay with this company or even put in a good word about the quality of goods/services to others. The approach for the conducting a business that deals with all the mentioned is called client- or customer-oriented. Client orientation is the type of interaction with the customer that provides additional profit, loyalty, satisfaction, customer flow and long-term relationships due to a deep understanding and satisfaction of their needs. Therefore, in this scenario, not only the needs of the client should be placed over the needs of the company, but also there must be an understanding that the business will not survive without consistent improving of customer focus.

For implementation of customer-oriented approach certain tools are needed, for instance CJM, CSR and increasing employee satisfaction. Starting with the Customer Journey Map (CJM) which is a visual representation of the steps potential customers follow to reach a goal. These maps are useful because they illustrate the different touchpoints customers have with the brand. They consist of the following objects: consumer persona, phases a potential buyer goes through, points of contact, pain points and actions. Making a diagram of the customer journey and covering each of the main elements described above is an important step in the development of any business and a guarantee that customers will not be left behind. Nevertheless, it has quite a lot of advantages, such as increase in income from existing customers, word-of-mouth advertising, building an effective inbound marketing strategy and improved customer service. Similarly, to work with clients, it is a must to receive and record feedback from the services provided. For this, based on current trends and tendencies, CRM systems are used. CRM (customer relationship management) is a program for automation and control of the company's interaction with customers. It maintains and manages information about orders and customers, helps optimize marketing, and improves sales and service quality. CRM-system facilitates the work of employees, controls the efficiency of sales, internal processes, and marketing. Competent implementation of CRM leads to an increase in sales and customer loyalty. And finally, one of the best solutions for improving customer centricity, is to consider employee satisfaction. "Always treat your employees exactly as you want them to treat your best customers," said Stephen Covey. Grateful employees are the best providers of customer-oriented service. That is why managers must take into account the desires of their employees, introduce bonuses and paid holidays, use team management as a way of communicating and managing employees, etc.

3.2. Innovations

Obviously, for a company to develop successfully, it needs to take care of customer service and invest in its development. But the customer needs to be given not only a good product or quality service, but to be offered more than he/she expects. Today's market is limited by fierce competition, making it important for entrepreneurs to find new opportunities and ways to develop. For this very reason, to have good sales and remain in demand businesses need to constantly evolve and keep up with the times. Companies that actively implement innovative methods or technologies will always be at the forefront. Innovation in business is a kind of implemented novelties that can have a powerful impact on the result. In other words, those that can provide a steady increase in output. With its help, an enterprise can reach a completely new level, namely, to increase productivity many times over, to make production technology cheaper or easier, to create a higher quality product or a unique one.

According to Greg Satell, an entrepreneur & innovation expert, innovation in business can be divided by incremental innovation, disruptive innovation, architectural innovation, radical innovation. These 4 types are located on the matrix and differ how well we can determine the problem and how well we can determine the field of knowledge to solve it. Incremental innovations are the most popular and imply small changes and improvements in design or adding new features. Next are disrupting innovations, which are differentiated for creating new technologies or business models that allegedly “disrupt” the existing market. Architectural innovations are used when companies launch their existing products or use their gathered knowledge in new markets. And the most stereotypical but at the same time rare ones are radical innovations. They are about usage of completely new technology or product/service that creates a new market. For business to be more competitive, grow rapidly, integrate new technologies and even build long-term relationships with customers it is crucial to implement all mentioned types of innovations in such fields: product/service, technology, business model, process, marketing and organizational.

Considering SME, the key for creating and introducing novelties is innovation management. It is a way for the implementation of a new organizational method in the firm's business practices, workplace organization or external relations. It can be used for building a prevailing atmosphere of encouragement for new ideas. The creation of any innovative project requires the right approaches to management ensuring a favorable impact on the motivation and creative process of employees. Therefore, it is the innovations in project management that cope with

such a task. The most common approaches to project management are Scrum and Kanban. According to the definition, Scrum is a lightweight framework that helps people, teams and organizations generate value through adaptive solutions for complex problems (The Scrum Guide, 2020). The authors of Scrum declared the following features: easy, understandable, accessible, but at the same time complicated to implement. While the Kanban Method is a means to design, manage, and improve flow systems for knowledge work. The method also allows organizations to start with their existing workflow and drive evolutionary change. They can do this by visualizing their flow of work, limit work in progress (WIP) and stop starting and start finishing. In turn, these two project management practices differ in the process of completing tasks, but they are flexible and focused on results. This is what helps with creation of the right environment to work with any other kind of innovation.

The impact of innovation on the competitiveness of enterprises affects through changes in the nature of competition, increasing the importance of the problem of quality and reliability, the emergence of new products, new technology, the transformation of the production base, increasing impact on market demand, and organizational and managerial aspects of competitiveness.

3.3. Eco-friendly practices

The companies should keep in mind that sustainability has become a requirement; it does not remain as an option

(Charter et al., 2006)

Today if company wants to gain competitive advantage on the market it has a strict obligation to implement the sustainability in its business practices. Overall aim has moved from satisfying intra-personal and inter-personal needs to fulfilling the needs of future generations. Sustainability initiatives such as energy efficiency, waste reduction and alternative sourcing can reduce costs and improve resource utilization. Companies can also use sustainability initiatives to develop new products, better understand customer needs and create innovative services. Finally, businesses can use sustainability as a way to engage customers, cultivate relationships and build trust. It could be explained by the fact that the percentage of clients that do want to follow trends and become more eco-friendly is increasing. Indeed, people began to explore and apply environmental responsibility back in the 1970s but availability of the “green products” was poor as well as average awareness

of importance of sustainability in general. But times have changed, and the term “green consumption” now is widely used in the lives of conscious people.

So, in order to meet the requirements of the customers, companies voluntarily take on the social responsibility to improve society and the world in which people live by their example. Corporate social responsibility sounds like something clumsy, costly, and not always justified, especially for small businesses. But in this area it is possible to borrow some points from the large market players, to adapt and use, even if the business is not yet ready to do it on such a large scale. Moreover, if a small or medium-sized company works in the area where social responsibility is important, it will receive the same benefits from CSR as large companies: increased sales, improved reputation and better life (and hence quality of work) of its employees. Small businesses even have additional advantages: for example, it creates a circle of loyal customers, which a socially responsible business has, making it more resistant to crises.

There can be many manifestations of social responsibility. The authors of *The Truth About CSR* in Harvard Business Review tentatively divide CSR into three broad categories. The first is the emphasis on philanthropy. Programs in this area of CSR are not aimed at gaining profit and do not directly improve business results: usually they consist of donations of funds, equipment or medicines to public organizations. This may also include participation in public initiatives or support of employees’ volunteer initiatives. In the second place, there are operational efficiency improvements. These programs concern the direct operations of the company, improving its efficiency while providing social or environmental benefits. As an example, policies to reduce the use of resources, specific steps toward sustainable development, investments in working conditions for employees, and health or education. And last is the transformation of the business model. Programs from this area of CSR involve finding new business models to address social or environmental issues. For example, a large company may use a standard operating model to reach out to remote areas, or it may engage local residents for its purposes, thereby improving their well-being.

However, the boundaries between these categories are almost erased and initiatives may well move seamlessly from one to the other. Moreover, most companies practice a multifaceted version of CSR, implementing programs from different categories at once, and this is normal, but it is also important that the goals and focus of these programs correspond to the core business of the company, its business goals and values. In general, the development of CSR has a positive effect on the brand image, stimulates consumer loyalty and can help create a community around it.

4. Conclusions

Small and medium-sized enterprises (SMEs) represent 99% of all businesses in the EU. So, it means they not only occupy an impeccably important place in the economic development of any country, but also are extremely popular among all types of businesses. Absolutely, SMEs provide a huge range of benefits for both the country and the business owner and to conduct them successfully, all the managers should simultaneously think about plenty of different business aspects. Based on the foregoing, an integral part of such an enterprise are clients, which is why it is extremely important to sustain the focus and attention precisely on treating them properly. Long-term relationships with customers are critical for building a sustainable and profitable business. By focusing on customer satisfaction and building trust over time, businesses can generate consistent revenue and profits while also creating a loyal customer base.

But obviously, customers have become more demanding for various reasons, including increased competition, advancements in technology, and changing customer expectations. It is important for businesses to understand these reasons and adapt to meet their customers' needs to remain successful in today's market. By providing excellent customer service, embracing innovation, and prioritizing sustainability, enterprises can continue meeting and exceeding their customers' demands. Applying the client-oriented approach is very helpful when it comes to the question of how to build a strategy and where to start. Just as it helps to understand exactly what a potential customer wants to see in you and what kind of attitude they want to have towards themselves. Talking about sustainability, it should play an integral role in any business' long-term strategy. Through careful consideration of sustainability factors, companies can develop a long-term plan that not only boosts profits but also creates lasting value for stakeholders, helps protect the environment, and strengthens the communities in which they operate. Nowadays we can observe a trend about striving to be eco-friendly more than ever before. This applies not only to the companies themselves, but also directly to customers. They increasingly want to participate in eco-campaigns and choose greener brands for their purchases. And finally, regarding the internal processes of the company, it is always necessary to prioritize the task to actively develop, create more and more new approaches to solving problems, product development or even the construction of management as a whole. In order for a business to remain competitive, it must always contain at least a small percentage of innovation. Approaches that were mentioned are definitely sustainable and universal

so with their help all kind of SME can achieve a new level and continue growing more and more.

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The Role of Microalgae in a Sustainable Development

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Abstract

Today, climate change is a reality that can change the balance of ecosystems. When talking about sustainability and innovation, it is important to keep in mind that we must have a different vision and find new solutions. Microalgae are photosynthesizing microscopic organisms that grow rapidly under different environmental conditions due to their simple cellular structure. These organisms are considered fundamental for the maintenance of the life of our planet, since they are responsible for the production of most of the oxygen from the atmosphere, they account for 40% of the total photosynthesis of the planet. These microalgae have a biological, ecological, and economic importance. Biological because, in addition to producing 40% of the planet's photosynthesis, they sustain life in the seas and oceans. Also, it's important to refer that their Ecological importance since microalgae are fundamental in maintaining ecosystems. And, finally, the economic significance is seen in its diversity in commercial application. The use of these microorganisms promises to be an excellent solution to combat global warming and reduce greenhouse gas emissions. This work presents a development of a project of a Photobioreactor from the first design to its tuning and operation. The main idea of this project is to build a Photobioreactor that will response to the requisites to produce a specific type of microalgae. The main work activity is to find the right technologies for this project, making a perfect integration and control system. This equipment is important and contribute(s) to environmental sustainability and innovation.

Keywords: Microalgae, Photobioreactors, Environmental Sustainability, Innovation

1. Introduction

Microalgae are photosynthetic microscopic organisms that grow rapidly in different environmental conditions due to their simple cellular structure. They are found on our planet, on land, in water and in the air. These organisms are considered fundamental for the maintenance of life on our planet, since they are responsible for producing most of the oxygen in the atmosphere, that is, they are responsible for 40% of the total photosynthesis on the planet. There are thousands of species of microalgae, of which only 100 have been studied and about 20 are regularly exploited commercially.

Microalgae have biological, ecological, and economic importance. Biologically, they are important since, they responsible for producing 40% of the planet's photosynthesis, they support life in the seas and oceans. The ecological one is because microalgae are fundamental in the maintenance of ecosystems. Finally, the economic importance is due to its diversity in commercial application. The use of these microorganisms promises to be one of the best solutions accessible to humanity to combat global warming and reduce the greenhouse gas emissions we produce (Trigal, 2021; Aqualgae,2021).

Among the various applications of microalgae, the following can be mentioned (*Cultivo de microalgas*, 2018):

- Aquaculture – microalgae are the main food source used in the nutrition of aquatic organisms in captivity. It is also used as a supplement in the diet of fish or as a means of maintaining water quality, Figure 14.1.



Figure 14.1. The half black angelfish feeds on Spirulina, seaweed, shrimp, among others

Source: (*Cultivo de microalgas*, 2018).

- Water treatment – Microalgae have mechanisms to absorb inorganic and organic compounds dissolved in water as nutrients for their metabolism. The high adaptability of these organisms and their high rate of growth

allow them to be used in the treatment of water from anthropic industries, or aquatic systems that need some type of remediation, Figure 14.2.

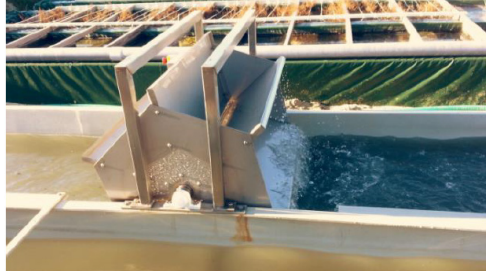


Figure 14.2. Aquatic system

Source: (Cultivo de microalgas, 2018).

- Agriculture – developed fertilizers and bio stimulants based on liquid algae extracts, as they increase crop resistance to pests. Also, they stimulate the growth, volume, and quality of a plant production, Figure 14.3.



Figure 14.3. Production of seedlings (plant) from microalgae

Source: (Cultivo de microalgas, 2018).

- Biomedicine and Pharmacology – Some species are used in weight loss diets and wound treatments; may have antibacterial, antifungal, antitumor and immune system regulatory activity, Figure 14.4.



Figure 14.4. Spirulina Pills

Source: (Cultivo de microalgas, 2018).

- Human and animal food – microalgae have been used as food for centuries. Rich in substances beneficial to health and with great potential in preventing numerous diseases, they are currently used in the form of dry biomass or in the extraction of supplements and natural dyes for food. It is also used as a supplement to animal feed, Figure 14.5.



Figure 14.5. Powder extract, detox juice based on Chlorella and Spirulina microalgae

Source: (Cultivo de microalgas, 2018).

- Chemical and food industry – Microalgae allow the biosynthesis and production of a wide range of substances of commercial interest, such as: vitamins, pigments, amino acids, polysaccharides, glycerol, enzymes, growth promoters in fermentation industries, waxes, phospholipids and lecithins, essential fatty acids and prostaglandins, Figure 14.6.



Figure 14.6. Line of cosmetics that have microalgae as a star ingredient
Source: (Cultivo de microalgas, 2018).

The table 14.1 below provides information on some species of microalgae available for human consumption:

Table 14.1. Main microalgae commercialized in the world for human consumption

Microalgae/Species	Application field	Main feature	Goal
Spirulina sp	Food Supplement	Great diversity of vitamins, minerals, amino acids, and antioxidants	Energize and fight aging
Chlorella sp	Food Supplement	Diversity of nutrients and compounds that help eliminate impurities	Nourish and purify
Haematococcus pluvialis	Antioxidant source	Rich in astaxanthin, nature's strongest antioxidant	Fight aging
Dunaliella Salina	Beta carotene source	Rich in beta-carotene (pro-vitamin A)	Combat aging, promote skin health and anti-inflammatory action
Nannochloropsis sp	EPA and DHA(Omega 3) source	Rich in Omega 3	Protect the nervous system and anti-inflammatory action

Source: (Microalgas – É de comer, 2021)

To produce microalgae, it is necessary to study some requirements, such as: Site selection, Equipment and facilities, Selection of microalgae, Physical-chemical parameters, Culture medium and Mixture. Currently, there are two types of culture systems for microalgae production: open and closed systems. Each of them has several advantages and disadvantages. (Derner, 2021)

2. Research results

2.1. Open Systems

Cultures are developed mainly in tanks (cylindrical, rectangular, with an elliptical bottom or raceway type). They are called open systems because the culture is in contact with the atmosphere. They are less sophisticated, and do not allow the control of environmental parameters (light, pH, temperature, etc.) that have implications for crop growth, because of cultivation under natural conditions. They are more common and more profitable as they can be used for treating wastewater from different sources. Open systems are low cost, easy to build and operate, and highly durable, as seen in Figure 14.7.

2.2. Closed Systems

Closed systems, known as photobioreactors (FBR), in turn, have greater productivity compared to open systems, achieving greater efficiency in the use and fixation of injected CO₂. Different from open systems, the crop does not have contact with the atmospheric air, which allows the control of the environmental parameters that imply in the growth of the cultures. Several types of photobioreactors have been manufactured for the cultivation of microalgae, however, the most common types are vertical columns, vertical or horizontal flat panels (flat panel) and tubular photobioreactors (vertical or horizontal coils), built with tubes plastic, glass, or polycarbonate, as seen in Figure 14.8.

Nowadays, different microalgae production systems of different scales and uses are being studied and developed. Each of the systems has a series of advantages and disadvantages. In the first part, they worked in a more artisanal way, using traditional production systems.



Figure 14.7. Traditional microalgae production system

Source: own elaboration (Aqualgae Company).

Chapter 14

The traditional production system has several disadvantages and some advantages over FBRs, table 14.2.

Table 14.2. Several disadvantages and some advantages of traditional production system over FBRs

Advantages	Disadvantages
• They are cheap systems. • They are simple, you don't need a lot of knowledge to assemble them.	• Low productivity. • The density reached by the cells is 5 to 10 times lower. • It is a disposable plastic material – greater environmental impact. • Area – productivity ratio is low. • High labor force. • No control over crop parameters.

Source: own elaboration (Derner, 2021).



Figure 14.8. Closed system - FBR machine

Source: own elaboration (Aqualgae Company).

Table 14.3. Several disadvantages and some advantages of Closed system – FBR machine

Advantage	Disadvantage:
High productivity. • Greater ease of continuous operation. • Control of culture parameters. • Glass material, sustainable. • 50-year lifetime/durability.	High initial investment.

Source: own elaboration (Derner, 2021).

2.3. Difference between vertical column FBR and tubular FBR

Photobioreactors provide the possibility of cultivating different species of microalgae, since it is possible to change the parameters (temperature, pH level, lighting, CO₂ injection) necessary for the best growth of microalgae. There are some types of photobioreactors but, this analyses will only focus in some differences between the vertical column FBR and the tubular FBR.

The great advantage of the vertical column FBR machine, Figure 14.9, is that all existing species of microalgae can be cultivated, while the tubular FBR machine, Figure 14.10, cannot cultivate all types of microalgae. The tubular FBR has the highest initial investment and higher productivity compared to the vertical column FBR.



Figure 14.9. Airlift type vertical column photobioreactor

Source: own elaboration (Aqualgae Company).

The project begins by studying all of the issues related with the microalgae system, and to define the type of photobioreactor and what technologies to use. This chapter is structured as follows: chapters 2 present the evolution of technical drawing and chapter 3 presents the drawing of vertical column FBR machine and the results achieved with the operation test of the system. The mains conclusions are outlined in chapter 4.

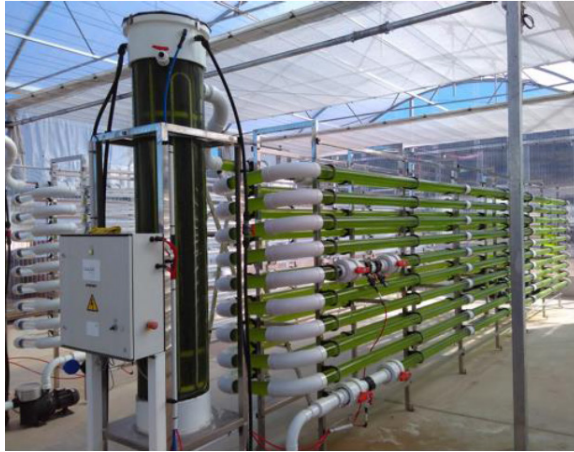


Figure 14.10. Tubular photobioreactor

Source: own elaboration (Aqualgae Company).

3. Evolution of technical drawing

According to the requisites demanded for this project (it means the type of microalgae to produce), the photobioreactor will be design by using a particular software. In the past, engineering drawings were all done by hand, using different types of pencils, erasers and *T-squares*. Even after all the manual work, if a change was necessary, the engineers and manufacturers had to start from scratch and redo the entire sketch. Currently, thanks to technological advances, such as the construction of machinery and equipment, technical drawings have been created. Technical drawing is a type of graphic representation in which it accurately transmits all the characteristics (dimension, type of material, views, cuts, scales, etc.) of the object it represents. Before the emergence of specific CAD (Computer Aided Design) software, there were already programs that facilitated graphic design, but their cost was high, and they were not as understandable as the programs we have today. Currently, there are several software on the market for creating technical drawings, such as: AutoCAD, Revit, DraftSight Free, LibreCAD, QCAD, ArchiCAD and SolidWorks. But AutoCAD and SolidWorks stood out. (Morais, 2012).

In 1982 the company Autodesk had the idea and initiative to create a CAD program that could run on a personal computer. The first version created was MicroCAD, which served as a guide to improve what would become AutoCAD,

which began to evolve and become the most popular CAD software in the world. AutoCAD stood out because it is more versatile, it is used in different sectors, not only for architecture, but also for engineering, textile modeling, etc. It is excellent 2D drawing tool. However, in the 3D resource, its use is more complex, mainly due to the ease of handling and agility of the project. It is a complex program, as it requires memorizing certain command codes.

Therefore, its introduction in the academic world is important, so that the student obtains a broader understanding of the program, having an ease in handling the other programs available on the market, knowing that the vast majority had the influence of AutoCAD, as seen in Figure 14.11. While SolidWorks dispenses with memorizing command codes, as it has a highly developed interface, making it a major competitor within the CAD software market.

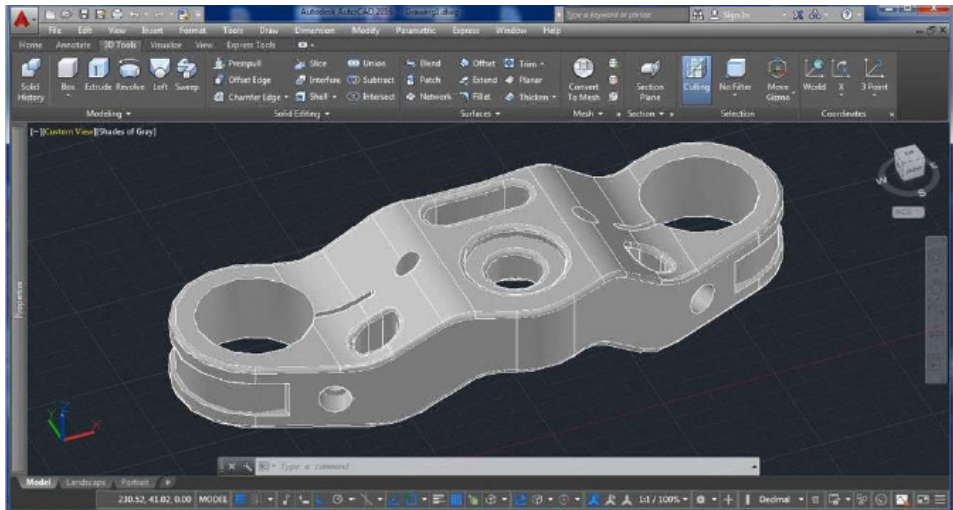


Figure 14.11. Drawing in AutoCAD

Source: own elaboration.

The demand of an easy-to-use program on Microsoft's operating system (Windows), to help building 3D models was required. It began to be developed in 1993, over the years the program evolved to the provision of 3D CAD technology, which allowed its users facilities, with quality tools and high performance, benefiting the development of better resources and products. SolidWorks, Figure 14.12, stood out because it is a program that optimizes work and increases designer productivity (Costa, 2016)

Chapter 14

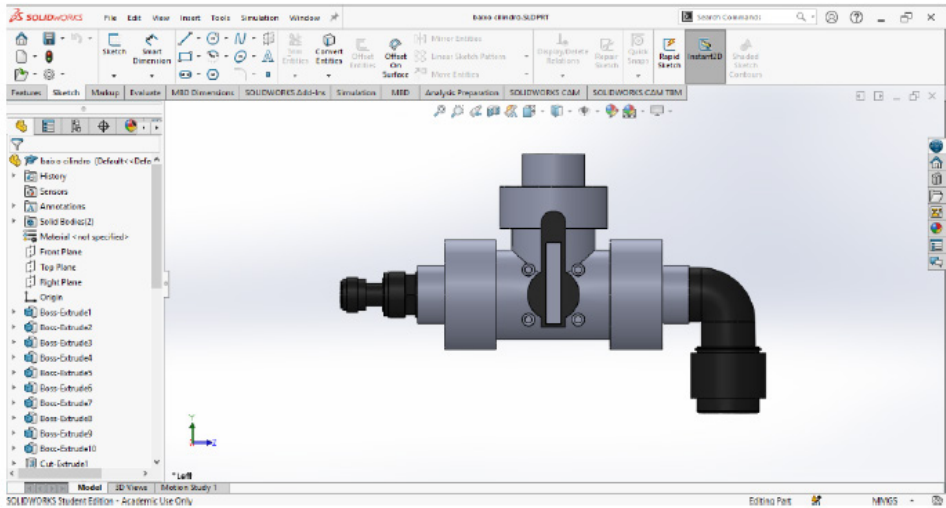


Figure 14.12. Drawing in SolidWorks

Source: own elaboration.

Drawing of vertical column FBR (Photobioreactor) machine

This project will use the photobioreactor machine, with 5 vertical columns serves to produce microalgae, which will then serve as food for shrimp, which will be food for sole or turbot larvae (fish produced in aquaculture). In the next pictures, there are presented some views of the drawn machine, as seen in Figure 14.13 and Figure 14.14:

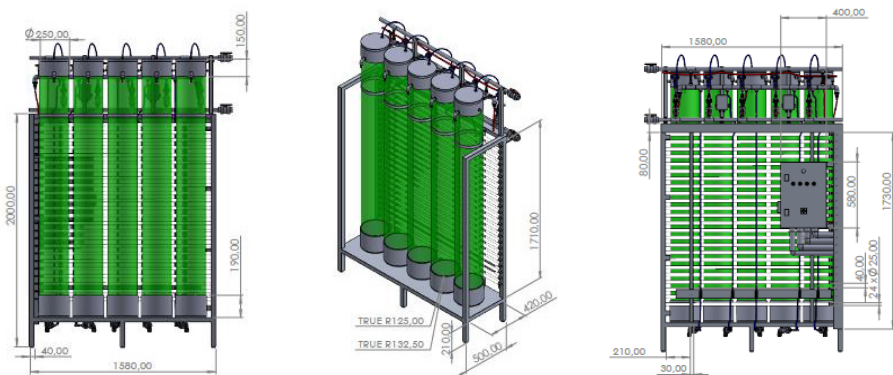


Figure 14.13. FBR machine: front, isometric and Rear views

Source: own elaboration (Aqualgae Company).

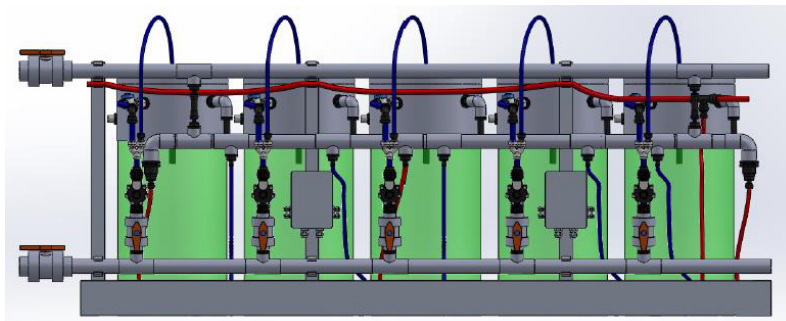


Figure 14.14. View of the connections part of the FBR machine

Source: own elaboration (Aqualgae Company).

3.1. Machine design process

To manufacture the machine, the first thing to do is necessary to purchase materials such as PVC material, acrylic columns, clamps, LEDS, solenoid valves, level sensors, tubes, etc. Then, it's time to make the metal structure, which took two weeks to make. After that, the columns took a week to be assembled. Finally, it was time to build the lighting tubes (LED), the electrical panel, the air pipes, and the water pipes, Figure 14.15. In general, the construction of the machine took about a month.

So, the first part is to build the metal structure (shelf), then the columns, the LED, the electrical panel and so on.

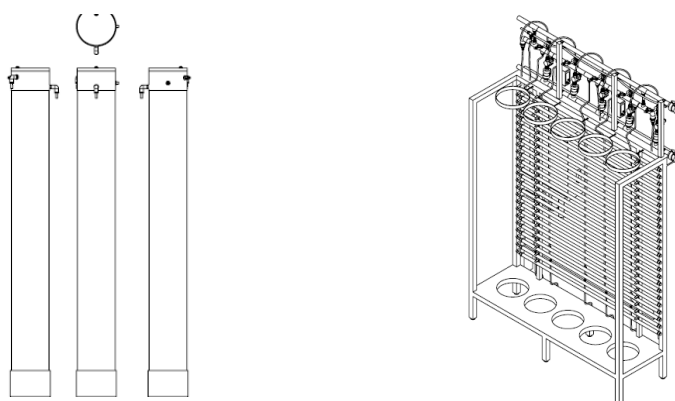


Figure 14.15. FBR machine: Some views of the machine column and metallic structure with the leds and connections

Source: own elaboration (Aqualgae Company).

3.1.1. Machine Operation

First, in a 500 L tank, the sea water is mixed with the nutrients, and through the filters, the water will be filtered, to obtain a water free of impurities, solids, and particles, being conducive to growth of the seaweed. Afterwards, this water will be sent to the columns through the pump. Each column has 100 L and, as there are 5, they take 500 L. They will fill up to 80% with water and the remaining 20% will be 10 L of microalgae. These quantities are controlled by the level sensors, which when it reaches the limit, automatically triggers/cuts the electrovalves, as seen in Figure 14.16.

As for luminosity, you start with low light (at 25%). After 4 days, you can change the light to 100%. Until the 8th day, the microalgae are going to grow with the light at maximum, because the right light conditions are necessary for the multiplication of microalgae. After the 8 days, you can start collecting the culture, removing 25% of the volume and then refill the columns with fresh water and nutrients. The cycle will be always the same, you must remove 25% of the volume and then add 25% of water. The machine works in this cycle. It has photoperiod, that is, the light turns on from 8 am to midnight. Then there's the nocturnal phase, which is where occur the division of microalgae (during night). The pH of the water is also controlled, and the ideal for microalgae is a pH around 8. That's because when microalgae are multiplying, the pH tends to rise to 9 to 10 and this is toxic for them. To solve this problem, CO₂ is injected, since it reacts with water, originating carbonic acid and this acid is what makes it acidic, so it can control the pH, Figure 14.17.



Figure 14.16. Culture appearance on first day
Source: own elaboration (Aqualgae Company).



Figure 14.17. Appearance of the culture on the 8th day.

Source: own elaboration (Aqualgae Company).

So, the machine allows to establish the photoperiod, different lighting levels 25%, 50%, 75% and 100%, pH control through CO₂ injection and automatic filling with the level sensor.

4. Conclusions

In this chapter, we first introduced bioreactor design and different types of bioreactors that can be used for algal growth with high biomass production rates. Then we compared the advantages and disadvantages of these PBRs. We also summarized the computational modeling used in PBR design for algal growth. Microalgae can be cultivated in open-system (such as a raceway pond) and closed-system PBRs (such as tubular, bubble column, airlift, and flat panel). The comparison results indicate that both open and closed systems have advantages and disadvantages and should not be viewed as competing technologies. It is important also to identify optimal working conditions and reasonable costs in open and closed systems for algal growth. Microalgae are part of our lives, and we can only gain from its implementation in our daily lives. Some of these benefits are renewal of body cells and tissue; energy and focus; balance of the nervous system; healthier hair and skin; combating aging; heart health; control of diabetes and hypertension, among others. The objective of the project was achieved. Beginning with

the requisites for a particular system of microalgae produce, a photobioreactor machine was designed and built, including all the sensors and motors needed.

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Industrial use of bioenergy and high-value molecules extracted from winemaking by-products. Ecological aspects

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Abstract

From the concept of circularity, a new industrial revolution is arising where waste as unwanted or unusable material is virtually unknown. In present times, indicators describe the main constraints posed on our world's future development: population growth, carbon dioxide in the atmosphere, energy consumption, overuse of minerals and natural resources, and shortage of water, which leads to a future zero-waste society. In this context, a study was developed to explore the potential applications of winemaking sub-products, known as grape pomace (GP), which have incomplete exploitation and part of which is dumped as biowaste. In European countries, the winemaking industry converts 22 million tonnes annually of grapes into wine, giving rise to 5 million tonnes of GP as a product. The goal of this research was to examine the antioxidant capabilities of GP polyphenols in order to identify useful industrial uses. With a total phenolic content (TPC) of 86 mg GAE/g DM in Loureiro variety seed and only 35.1 mg GAE/g DM in Vinhão variety, with very significant differences ($p < 0.01$), GP can offer a wide range of products with high-value bioactive molecules. In the skin fraction, the TPC value was higher in Vinhão variety than Loureiro variety (120 and

24 mg GAE/g DM, respectively). The findings of TPC and the antioxidant activity as determined by DPPH activity are correlated, with $r = 0.988$ for Vinhão and $r = 0.975$ for Loureiro. From the seeds of the grape types Loureiro and Vinhão, a high-yield edible oil content of 16.5% and 17.7%, respectively, was found. When compared to other biomass heating values, the heating value results of GP samples after the fat and polyphenol extraction, which are between 16.9 and 17.2 MJ/kg, show that GP extracted residue has the potential for energy recovery. This byproduct offers fresh prospects for alternative industrial uses when taking into account the quantities of GP that are produced each year and its chemical characteristics.

Keywords: grape pomace; polyphenol; thermal energy; high heating value

1. Introduction

Sustainability of natural resources in order to maintain the earth environmental system in equilibrium is a demanding action to the humankind present survival. In this context, the wine production industry was the target of this study, in particular the sub-products after the wine making. The aim was to study the chemical composition of grape pomace and to evaluate the best utility for this sub-product, studying the potential use of this biomass for producing high value molecules and energy.

A broader use of renewable resources and the substitution of fossil based materials and products by renewable raw materials, like agriculture by-products will be an important and necessary step. This solution could help to reduce the present environmental problems, since the renewable material is a source to feed other industry raw material needs. The European Commission in its Lead Market Initiative (EC, 2007) identified bio-based products, made from renewable raw materials such as plants and trees, as one of the promising future markets. This is a closed cycle of transformation of matter with full appliance.

Grape is the world's largest fruit crop with an annual production of more than 67 million tons. Grapes and products obtained from them, such as wine, grape juice, jams, and raisins, have then an obvious economic importance. Eighty percent of the worldwide grape production is used in winemaking (Fontana Ariel R., 2013). The wine industry produces millions of tons of by-products that are named grape pomace, GP, which mainly consists of stalks, skins, and seeds and represents a waste management issue both environmentally and economically. Economically because most wineries in Portugal are small enterprises, scattered in the territory, which do not have the tools and the ability to properly manage and dispose them. So, from the ecological point of view, a common practice for

GP is to lay down in the fields, in order to be composted by aerobic decomposition. During this biodegradation process, GP remains exposed and is a source of contamination, mainly because of the volume and many natural products that it contains. The organic load has significant antimicrobial and phytotoxic activity, which significantly limits the action of microorganisms involved in the process of biodegradation. As a result, the process of biodegradation is slowed down. Another problem is the high levels of phenolic compounds that inhibit seed germination. Regarding GP use in livestock feed, some animals show intolerance to certain components, such as condensed tannins and polymeric polyphenols (lignin), which negatively affect digestibility because they inhibit cellulolytic and proteolytic enzymes as well as the growth of rumen bacteria (Fontana Ariel R., 2013).

With the increase of consumers' awareness for the use of additives in foods and the attention that functional foods have acquired in recent years, there is a need for the identification of alternative natural and safer sources of food additives, namely antioxidants, colorants and preserving additives, as well as natural functional foods. Adding to this, modern industries are focused on diminishing the environmental impact of industrial byproducts. Therefore, most attention has been paid to the recovery of bioactive phenolic compounds from grape byproducts from the winemaking industry. Portugal is the fifth largest wine producer in the EU-28 (Table 15.1) with a production estimated at 5,886 khL in 2014.

Table 15.1. Wine production* trend in the EU-28 (khL)

	2011/12	2012/13	2013/14	Rank
Italy	43,072	40,057	44,900	1
Spain	33,397	31,123	44,600	2
France	50,890	40,609	44,100	3
Germany	9,258	9,000	8,500	4
Portugal	5,609	6,140	6,740	5
Romania	4,700	4,100	5,400	6
Greece	2,750	3,150	3,700	7
Hungary	2,822	2,243	2,450	8
Austria	2,814	2,155	2,252	9
Other EU-28 countries	3,214	2,558	4,911	10
EU-28	158,527	141,135	167,553	11

* Volume of product removed from fermenters after the first natural fermentation of the must of fresh grapes (juices and other musts were excluded).

Source: (GAIN-FAS, 2014).

This study was developed with samples from GP of the wine production with appellation of origin “Vinho Verde”. This is obtained from a demarcated region of grape wine cultivated in the northwest of Portugal (Figure 15.1).

Polyphenols are the most important phytochemicals in grapes because they possess many biological activities and health-promoting benefits to the plants. Grape pomace is characterized by high-phenolic contents because of poor extraction during winemaking. The bioactive substances are used worthwhile and thus support sustainable agricultural production (Kammerer Dietmar, 2004). Although, the absolute amount as well as the relative proportion of these beneficial compounds in GP is conditioned by a myriad of factors including genetic load of the separate grape varieties, agro-climatic conditions, fertilization procedures, and soil properties, among others. On the other hand, the specific wine-making processes as well and the time between the generation of by-products and valorization activities, as well as the characteristics of the recycling and recover procedures have a direct impact on the final concentration of phenolic compounds in the GP and, therefore, on the potential use as a source of bioactive phytochemicals.

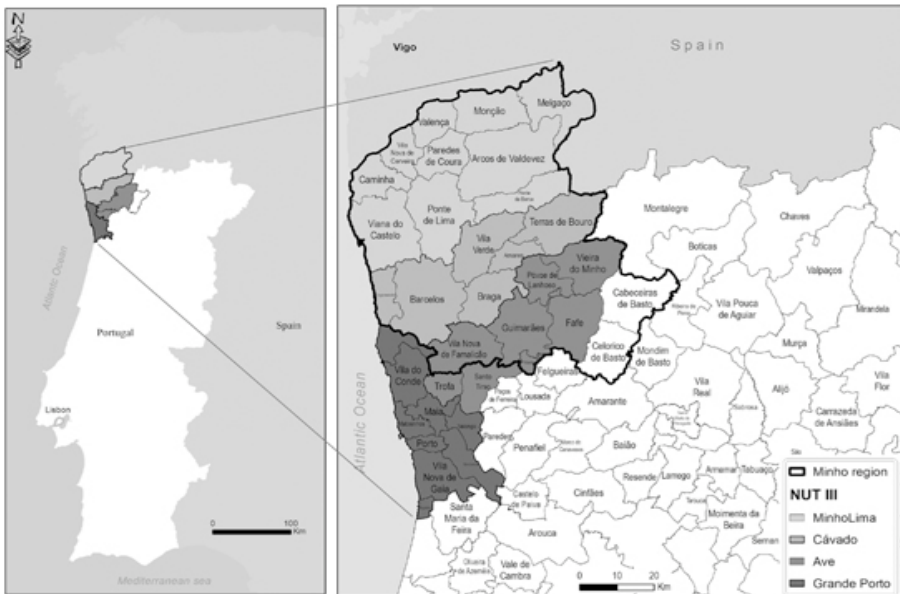


Figure 15.1. Map representing the demarcated region of “Vinho Verde”

Source: (IGP, 2010).

Polyphenols are the most important phytochemicals in grapes because they possess many biological activities and health-promoting benefits to the plants. Grape pomace is characterized by high-phenolic contents because of poor extraction during winemaking. The bioactive substances are used worthwhile and thus support sustainable agricultural production (Kammerer Dietmar, 2004). Although, the absolute amount as well as the relative proportion of these beneficial compounds in GP is conditioned by a myriad of factors including genetic load of the separate grape varieties, agro-climatic conditions, fertilization procedures, and soil properties, among others. On the other hand, the specific wine-making processes as well and the time between the generation of by-products and valorization activities, as well as the characteristics of the recycling and recover procedures have a direct impact on the final concentration of phenolic compounds in the GP and, therefore, on the potential use as a source of bioactive phytochemicals.

The objective of this study was to evaluate the potential application of grape pomace, from Vinhão and Loureiro grape varieties, as bioenergy or as raw material in other industrial processes. To achieve this, two specific goals were established: determine the GP bioactive content, through the assays of total phenolic content (TPC) and antioxidant activity (DPPH); Evaluate the high heating value (HHV) in GP and extracted GP as a form of bioenergy.

2. Experimental development

The study for the by-products recovery after the winemaking process with Loureiro and Vinhão grape varieties was an innovative theme. A general characterization of the grape pomace, including the extraction and quantification of the bioactive compounds and finally the determination of the calorific value of grape pomace and extracted samples was investigated. In the present chapter, reagents, standards and solutions used throughout all the experiments are described. Furthermore, aspects regarding the sample preparation and latter analysis are also explained.

2.1. General experimental conditions

Analytical grade reagents were purchased from different suppliers and used for all experiments. For the preparation of all solutions, water from Barnstead™ E-Pure™ Ultrapure Water Purification Systems was used throughout the work. All the standards and the samples were weighted in a Mettler Toledo analytical

balance (model AE 200) with the accuracy of decimal of miligram. Standard stock solutions were prepared by rigorous weighing the respective reagent, followed by dissolution in the appropriate solvent (water, buffer solution, methanol, or mixture of the previous solvents). All reagents that appear in the experimental procedure, without the reference grade, were pa grade.

2.2. Sampling and transportation

Samples of grape pomace resulting from winemaking with the species *Vitis Vini-fera* L. of the varieties Loureiro and Vinhão cultivated and harvested in the region of Lima, Alto Minho, Portugal were provided by Adega Cooperativa de Ponte da Barca, in September. The GP from the white Loureiro was collected immediately after separation from the must in the step of decantation, before fermentation as a mixture (skin and seed) from big opened air tanks shown in Figure 15.2. The GP from the red grapes Vinhão was collected after the fermentation of the must, as a mixture of skin and seed. The stalks from both varieties were collected in the back of the factory, Figure 15.3, after the staking step. Many authors consider GP consisting of a mixture of all the fractions, stalk, skin and seed, while others consider only the skin and the seed. In this work, GP means the stalks, skin and seed and GP mixture refers to the skin and seed. The sampling for both varieties was done during three different periods of time in September, collecting about 3 kg of GP in each sampling visit, making a total of 9 kg of each variety. All the samples were transported in fully and closed vessels at room temperature for about one hour to the laboratory and then followed the pretreatment.



Figure 15.2. Storage of grape pomace in the factory



Figure 15.3. Storage of stalks in the factory

2.3. Pretreatment and codification of samples

In the lab, fresh grape pomace was divided. Half amount was dried at 30 °C in a drying oven, Heraeus Model UT 6060 for four days. After, it was vacuum packed and stored until analysis. Before analyses, the seeds and skins from each sampling visit were manually separated and the same fraction from the three visits was mixed together and dried at 103°C. The other half amount of each variety was vacuum packed and it was stored at –20°C, after manual separation of the skin and the seed of white Loureiro. The analyses of the heating value were determined on samples dried at 103 °C. The samples stored at –20 °C were lyophilized in a Christ Alpha 1-2 LD Freeze Dryer with a Rotary vane pump RZ 2.5 and used for the studies on polyphenol extraction. For all the analyses the samples were ground in a Taurus blender (Aromatic Model, Type: SP- 7407) until homogenous flour to approximately 8-meshes. Samples were codified by B and T standing for white (“Branco”) and red (“Tinto”) GP, respectively, followed by L for Loureiro and V for Vinhão varieties. Finally the letters E, P and G stands for stalks (“Engaço”), skin (“Película”) and seed (“Grainha”) respectively. Samples of GP with a fourth letter, E, in the beginning stands for extracted samples (Table 15.2).

Table 15.2. Codification of samples from Adega Cooperativa de Ponte da Barca

CODE	PART OF GRAPE	COLOUR	VARIETY
BLE	Stalk	White	Loureiro
BLM	Mixture*		
BLP	Skin		
BLG	Seed		
TVE	Stalk	Red	Vinhão
TVM	Mixture		
TVP	Skin		
TVG	Seed		
Samples after extraction			
EBLE	Extracted Stalk	White	Loureiro
EBLM	Extracted Mixture		
ETVE	Extracted Stalk	Red	Vinhão
ETVM	Extracted Mixture		

* The mixture contains the seed and the skin of the grapes.

2.4. Polyphenols extraction

The extractions were made according to author Shoeb (Shoeb Mohammad, 2005). A Soxhlet extractor JP SELECTA with thimble for Soxhlet extractor, filter paper (QL 100, 185mm Fisher Scientific), n-hexane 95% (J.T. Baker, analytical reagent standards), dichloromethane (J.T. Baker analytical reagent standards) and methanol (Riedel-deHaën, Analytical Reagent and J.T Baker analytical reagent standards, were used.

Lyophilized grape pomace sample, about 20 g, was placed inside a thimble made from thick filter paper, which was loaded into the main chamber of the Soxhlet extractor. The Soxhlet extractor was placed onto a 250 mL glass flask with hexane as the first extraction solvent (220 mL). Dichloromethane and methanol also 220 mL each were used as the second and third extraction solvents by this order. The Soxhlet was then equipped with a condenser. Each solvent was heated to reflux for 6h at the temperature of 60, 40 and 60°C, respectively. After extraction, the solvent was removed, in a rotary evaporator, yielding the extracted compounds. After weighting (m1) the solid residue was re-dissolved immediately in methanol and stored at -20°C until analyses. After the three solvent extractions

the non-soluble portion of the extracted solid remaining in the thimble, was collected for high heating value determination.

$$\% \text{ yield} = \frac{m_{2\text{flask (g)}} - m_{1\text{flask (g)}}}{m_{\text{sample (g)}}} \times 100$$

$m_{1\text{flask}}$ is the initial weight of empty flask in g

$m_{2\text{flask}}$ is the weight of the flask after each solvent extraction (hexane, dichloromethane, methanol) in g

m_{sample} is the weight of dry sample

2.5. Total phenolic content – Folin & Ciocalteu

The total phenolic content in GP was determined by the Folin-Ciocalteu colorimetric method. (Lafka Theodora-Ioanna, 2007). The colorimetric total phenolic assay with Folin & Ciocalteu reagent relies on the transfer of electrons, in alkaline medium, from phenolic compounds to phosphomolybdic/ phosphotungstic acid complexes, which act as oxidant. The products of the metal oxide reduction have a blue color that exhibits a broad light absorption with a maximum at 765 nm. The intensity of light absorption at that wavelength is proportional to the concentration of phenols. The exact chemical composition of the reagent is not known, but the reaction that occurs is the reduction from Mo (VI) to Mo (V) by transfer of one electron. A double-beam ultraviolet– visible spectrophotometer, Hitachi U-3210, Folin & Ciocalteu reagent, 2.0M (Sigma Aldrich), saturated solution of Na_2CO_3 (anhydrous, J.T.BAKER), Gallic acid monohydrate (Sigma Aldrich), methanol (Riedel-deHaën, analytical reagent) were used.

Methanolic GP extract (m_2 in 50 mL) was appropriately diluted (Table 15.3) and 0.5 mL of this solution was transferred to a volumetric flask of 25 mL and it was added 20 mL deionized water and 0.625 mL of Folin–Ciocalteu reagent. After mixing, it was left standing for 3 min and then 2.5 mL of saturated solution of Na_2CO_3 was added. The content was mixed again and diluted to volume with deionized water. After two hours, the absorbance of the sample was measured against a blank by using a spectrophotometer. Gallic acid served as the standard for preparing the calibration curve with the concentrations of 10; 25; 50; 75; 100; 125; 150; 175; 200; 250 and 300 mg/L, following the same procedure as the samples (0.5 mL of standard solutions and blank in a volumetric flask of 25 mL).

Table 15.3. Dilution factor for the TPC determination

Sample	BLE	BLM	BLP	BLG	TVE	TVM	TVP	TVG
d.f	2	20	10	20	4	20	2	2

From concentration (mg/L) formula:

$$C \text{ (mg/L)} = \left[\frac{\text{Abs}_{\text{sample}} - b}{m} \right] \times \text{d.f}$$

the following formula was used to obtain the results in mg gallic acid equivalent/g DM:

$$\text{mg GAE/gDM} = \frac{C \text{ (mg/L)} \times V(\text{L}) \times \left(\frac{m_1(\text{g})}{m_2(\text{g})} \right)}{m_{\text{sample}}(\text{g})}$$

Abs is the absorbance obtained from the spectrophotometer,

m is the slope of the line

C is the concentration in mg/L,

b is the y-intercept of the line,

d.f is the dilution factor

V is the volume in L, for the m_2 dissolution (0.05 L)

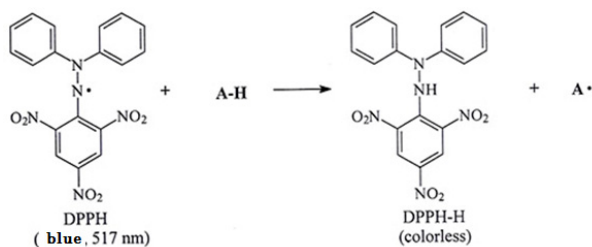
m_1 is the mass of the extraction, in g

m_2 is the mass of the sampling, in g

m_{sample} is the mass of the GP lyophilized sample in g, used in the extraction

2.6. Antioxidant activity – DPPH assay

The free radical scavenging activity of the GP fractions was measured in vitro by 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay according to the method described below (Qian Deng, 2011). The method is based on the molecular absorption of the radical 2,2-diphenyl-1-picrylhydrazyl (DPPH). The solution of this radical, which has a blue color, is measured spectrophotometrically at 517nm. When this solution is added to a substance with antioxidant activity (A-H), then the DPPH radical is reduced with the recruitment of a hydrogen atom or an electron and is converted to 1,1-diphenyl-2-picrylhydrazyl which is colorless. This reaction takes place in the dark during 30 min and gives a yellow color, depending on the extension of the reaction of DPPH reduction in the presence of an antioxidant (AH):



The molecular absorption was measured in a double-beam ultraviolet–visible spectrophotometer Hitachi U-3210, using DPPH solution: 9 mg of DPPH dissolved in 100 mL methanol and then diluted 30/50 (DPPH, Sigma-Aldrich); (+) L-Ascorbic acid (Panreac) and methanol (Riedel-deHaën, analytical reagent).

Methanolic GP extract (m2 in 50 mL) was appropriately diluted (Table 15.4) and 0.5 mL of this solution was transferred in a cuvette and mixed thoroughly with 1.5 mL of DPPH–methanol reagent and allowed to stand at room temperature for 30 min prior to measure the solution absorbance at 517 nm. Ascorbic acid was used as standard for preparing the calibration curve with concentrations 1.00; 2.50; 5.00; 7.50; 10.00; 20.00; 30.00; 35.00 and 40.00 mg/L followed the same procedure as the samples.

Table 15.4. Dilution factor for the DPPH determination

Sample	BLE	BLM	BLP	BLG	TVE	TVM	TVP	TVG
d.f	5	100	10	100	20	20	2	10

From the equation of the concentration (mg/L):

$$C \text{ (mg/L)} = \left[\frac{\text{Abs}_{\text{sample}} - b}{m} \right] \times d.f$$

was introduced in the following formula to obtain the results in mg Ascorbic Acid equivalent/gDM:

$$\text{mg AAE/g DM} = \frac{C \text{ (mg/L)} \times V(\text{L}) \times \left(\frac{m_1(\text{g})}{m_2(\text{g})} \right)}{m_{\text{sample}}(\text{g})}$$

Abs is the absorbance obtained from the spectrophotometer,
m is the slope of the line

C is the concentration in mg/L,

B is the y-intercept of the line,

d.f is the dilution factor

V is the volume in L, for the m₂ dissolution (0.05 L)

m₁ is the mass of the extraction, in g

m₂ is the mass of the sampling, in g

m_{sample} is the mass of the GP lyophilized sample in g, used in the extraction

2.7. High heating value determination

Heat released in a chemical reaction can be determined experimentally by using an adiabatic bomb calorimeter, as the case of heat of combustion. The reaction must proceed without any side reactions and sufficiently fast, so the heat exchange with the surroundings is negligible. In such calorimeter, the combustion reaction occurs in a closed container under constant volume (“bomb”). The bomb is immersed in a weighted quantity of water and surrounded by an adiabatic shield that serves as a heat insulator. Continuous bath stirring ensures that heat is distributed evenly in the calorimeter. The bomb and the water bath, which are in direct thermal contact, constitute an adiabatic bomb calorimeter and the increase in the water temperature is used to calculate the heat of the reaction. The equipment was a Parr Calorimeter 6772, a press for pellet production, Parr with a furnace line function Heraeus, and wire (Parr), benzoic acid (one gram pellets standardized for bomb calorimeter, Parr).

For the procedure for the HHV determination in grape pomace sample, about 0.5 to 1.0 g, was placed in the pellet press to prepare the pellet. The final pellet was weighted accurately. Carefully, it was placed in the sample cup with tweezers. It was measured approximately 10 cm of ignition wire and attached to the electrodes (Figure 15.4A) and each cap was slide downward to complete the connection. The sample cup (with the sample sitting in the center) was placed in the cup holder and the wire bended in a V-shape so that it almost touches the surface of the pellet (about 1 mm separation) and do not touch the cup surface. Figure 15.4B illustrates the proper installation and sample placement. Deionized water (1.0 mL) was pipetted into the bomb to absorb the oxides of nitrogen and sulfur formed from nitrogen and sulfur present in air and sample.

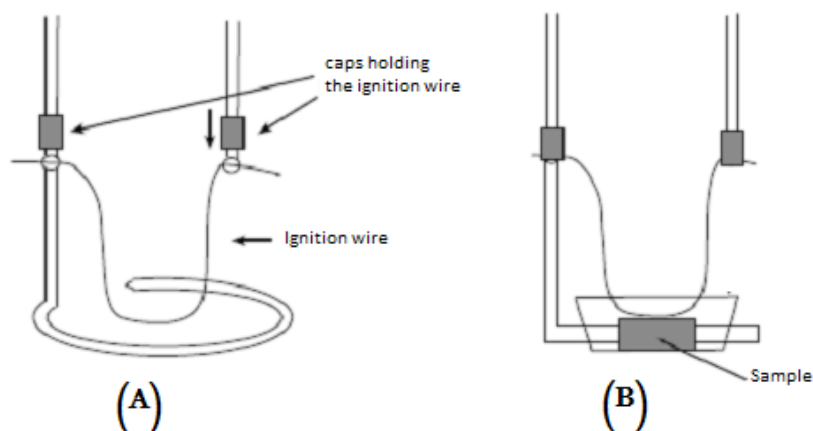


Figure 15.4. (A) Attachment of the ignition wire. (B) Schematic of the sample support stand

Care must be taken not to disturb the sample when sealing and charging the bomb. The head assembly slides into the bomb cylinder, followed by screw opening the vent cap on the head assembly to allow air to be expelled, and the head pushed down and after the vent cap was tightly closed. Later on, the oxygen connection was installed by secure the bomb in the bench clamp and slipped on the oxygen tank connection hose to the pin on the head assembly. The oxygen tank valve was opened to fill the bomb slowly by watching the gauge in the oxygen bottle as the bomb pressure was rising to the desired filling pressure (30 atm). Once this pressure was reached, the control valve and then the tank valve were closed. The filling of the bomb should not be very fast because it can blow the sample out of the sample cup.

After the bucket was filled with $2,000 \pm 0.5$ g of water it was checked to see that it is resting properly in the jacket, confirming the four pegs on the bottom of the jacket, which hold the bucket in place. Carefully the charged bomb was placed in the bucket, noting that it rests on the raised circular area on the bottom of the bucket and making sure that there are no oxygen leaks, by watching if there are bubbles. The ignition wires were connected to the terminal socket on the bomb head, avoiding touching with the fingers the water. The cover on the jacket was placed and the screw attached to the lid fitted into the screw hole in the ledge of the jacket. Finally the stirrer was turned on by hand to be sure that it runs freely, and then the drive belt slipped onto the pulley. In some samples it is also needed

the spike weight. If a sample does not ignite easily or press well, then the spiking method of ignition can be used to promote complete combustion of the sample. The heat produced by the combustion aid must be subtracted from the total energy release. In this work a known amount of benzoic acid was added with the sample as a medium to compress easily the sample and make pellet. The benzoic acid is removed from the calculation of the heating value. When the calorimeter was finished any unburned fuse wire length still attached to the electrodes was measured and subtracted from 10 cm, in the calculation for the heating value. Also after the end of each analysis the cup was heated in a muffle furnace, maintained at 550 °C till a constant weight to weight the unburned sample. Ten independent measurements of the benzoic acid standard were carried out and six independent measurements of each GP samples.

For calculation, the heat produced by the reaction $q_{rxn} = -(q_{water} + q_{bomb})$ can be accurately determined by measuring the temperature increase in the known amount of surrounding water. This result obtained automatic from the equipment.

2.8. Statistical analyses

In this study three types of statistical analysis were carried out. For the comparison between the same fraction from the two varieties (e.g. BLE versus TVE) a t-test was used after the evaluation of homogeneity variances of the two samples. A paired t-test was used for the comparison for a lot of pairs, between the same fraction from the two varieties when the results were very different between one pair to another. Finally, the comparison of averages of three or more samples (e.g. BLE versus BLG versus BLP) in the same variety, was made using ANOVA followed by the Tukey's post hoc test. Significant differences were defined for a $p < 0.05$ and very significant differences were defined for a $p < 0.01$. The calculations were made with XLSTAT 2014.4.10 add-in (Addinsoft, Paris, France) for Microsoft Excel 2010 (Microsoft, Redmond, United States of America).

3. Results and Discussion

Considering the different studies on grape pomace in the literature, this study is innovative about these varieties, Loureiro and Vinhão. Two varieties of GP, composed of stalks, skins and seeds collected from Adega as fresh samples were studied, however the mixture (seed and skin) was also studied because the main results presented in the literature are about the mixture. The analyses of TPC and

DPPH were done in duplicate, while the analysis of HHV was done in six replicates. Results were expressed as mean $\pm$ standard deviation ($\bar{x} \pm sd$). For the total phenolic content, antioxidant activity and HHV, the statistical comparison was applied between the same fractions from both varieties.

3.1. Polyphenols quantification in GP

3.1.1. Results of the extraction process

The phenolic derivatives distributed in plant tissues are classified by their structures. Thus, the soluble polyphenols with a low molecular weight are located in the vacuoles of the cells, while the insoluble phenolic derivatives (e.g. polymeric lignins) constitute the structural components of the cell walls contributing to the stability and morphology of the plants (Santos-Buelga Celestino, 2012). The process of extraction releases phenolic derivatives from cells and tissues, leading to qualitative and quantitative determination. With high water content it is recommended the refrigeration before the process of extraction, to inactivate the enzyme functions and protect the unstable polyphenols. Furthermore, the extraction of polyphenols is facilitated when preceded by refrigeration at low temperatures because the crystals of the water are formed and destroyed the cellular walls favoring the release of intracellular material. Finally, another practice followed is the lyophilization of the samples, which takes place at low temperatures and leaves intact the polyphenols, allowing the conservation of the samples for a sufficiently long time followed by the use of a homogenizer to rupture the cell tissue and reduce the size particle. Subsequently, the immersion in an appropriate solvent is carried out, to extract the phenolics derivatives by diffusion. The extraction of polyphenols from plant material can be affected by a number of factors, such as the chemical composition, the process used for the extraction, the extraction conditions, the storage time, the tissue size and the presence of undesirable substances and the sample treatment for extraction. The extracts are mixtures of various polyphenols which are soluble in the solvent however they contain also molecules that are not phenols, such as fats, terpenes, and chlorophylls. To remove the latter, often it requires fractionation based on the polarity of the substances (Santos-Buelga Celestino, 2012). The solubility of the polyphenols is dependent on the polarity of solvent used, the polymerization degree and the interaction with other molecules (e.g., proteins) to form insoluble products. For these reasons there is not a single procedure to extract all the phenolic derivatives from a plant sample. The most common technique applied

is the extraction, depends on the author, as it could be the solid-liquid extraction, the Soxhlet extraction, the supercritical fluid extraction etc. Some authors for the fractionation of the undesirable substances, use hexane to remove the fat, dichloromethane to remove the chlorophylls and other pigments and only after that, polar protic media such as hydro alcoholic solutions, to extract the polyphenols. Methanol exhibits the highest capacity to extract phenolics even though the ethanol is cheaper and safer and should be preferable in the case of later food applications. The published results are not conclusive about an ideal solvent, and different mixtures have been proposed (Fontana Ariel R., 2013).

Table 15.5. Extraction yields obtained from Loureiro and Vinhão lyophilised GP samples

Type of Sample	Hexane (%)	Dichloromethane (%)	Methanol (%)
BLE	1.09 ± 0.08	0.40 ± 0.01	34 ± 3.1
BLM	10.9 ± 0.14	1.49 ± 0.14	18.1 ± 0.62
BLP	4.7 ± 0.34	3.36 ± 0.11	40 ± 4.1
BLG	16.5 ± 0.12	0.43 ± 0.01	18.6 ± 0.20
TVE	1.8 ± 0.22	0.44 ± 0.03	16.5 ± 0.11
TVM	13.15 ± 0.03	1.09 ± 0.02	11 ± 1.1
TVP	4.6 ± 0.21	1.67 ± 0.12	28 ± 1.2
TVG	16.7 ± 0.18	0.60 ± 0.06	7.4 ± 0.39

In the present study the GPE was obtained by using firstly hexane, followed by dichloromethane and finally methanol was selected in order to obtain a high yield of polyphenols. The total extraction yields obtained from Loureiro and Vinhão GP are presented in Table 15.5. The yields from hexane showed a higher percentage in the seeds of the two varieties with 16.5% and 16.7% from Loureiro and Vinhão respectively. The dichloromethane extraction showed higher yield in the skin with a percentage of 3.36% in Loureiro and 1.67% in Vinhão. The high extraction yield with methanol, which contains the polyphenols, could be explained because of the presence of other substances, than polyphenols, which were not determined. The highest yield obtained, was from the skin (40 %) and the stalk (34 %) from white Loureiro GP. The extraction yields with methanol from another study were Chardonnay 23.3%, Macabeu 32.4%, Parellada 17.2% and Premsal Blanc 33.3% (González-Centeno M.R, 2013). Authors have published the results of TPC and antioxidant activity and do not present the yield, so the comparison cannot be so extensive.

3.1.2. Results of total phenolic content (TPC) and antioxidant activity (DPPH)

The method of Folin & Ciocalteu (FC), for measuring the total phenolics is a photometric method which was originally developed in 1927 for determining proteins, taking into advantage the fact that the reagent used, reacted with the phenol ring of tyrosine, forming a colored product. Thereafter Singleton and Rossi (Singleton V. L., 1965) improved the method and used it for determination of total phenols in the wine. The process became very popular and widely used since then to determine the phenolic content of various natural products. Although the FC process is used to determine the phenolic substances, actually it is used to determine the reducing ability of the sample, since the reaction carried out in this process is a redox reaction. Therefore, the above method can be considered as a method of measuring antioxidant capacity. The mechanism of this reaction belongs to the category of transport electron, so it should not be surprising that the “polyphenol profile” determined by this method shows good linear correlation with antioxidant capacity determined by other antioxidant methods which also transfer electrons, for example like the ferric reducing ability of plasma (FRAP) or 1,1-diphenyl-2-picryl-hydrazyl (DPPH). The results of TPC and DPPH obtained in this study are presented in Table 15.6. In Table 15.7 are the results of the statistical analysis. Comparing the same fraction between the two GP varieties, the TPC had very significant differences ($p < 0.01$) with higher content in the stalk and the seed of Loureiro GP than Vinhão (26, 86 and 24, 35.1 mg GAE/g, respectively), while in the skin, the content of TPC was higher in Vinhão than Loureiro (120 and 24 mg GAE/g, respectively) with very significant differences ($p < 0.01$).

Table 15.6. Results of TPC and DPPH in red and white lyophilized GP sample

Type of Sample	Antioxidant activity (mg AAE/g DM)	Total phenolic content (mg GAE/g DM)
BLE	16.1 ± 0.46	26 ± 1.3
BLM	40 ± 1.9	39 ± 1.2
BLP	12.2 ± 0.48	24 ± 1.8
BLG	83 ± 17	86 ± 9.5
TVE	18.0 ± 0.73	23.9 ± 0.15
TVM	28.6 ± 0.84	57 ± 1.1
TVP	76 ± 7.2	120 ± 1.4
TVG	29 ± 1.4	35.1 ± 0.97

Table 15.7. Statistical analysis for the TPC and DPPH results (*p* value)

Fractions	Antioxidant activity (mg AAE/g DM)	Total phenolic content (mg GAE/g DM)
BLE vs TVE	0.076	0.008
BLP vs TVP	0.051	0.0003
BLG vs TVG	0.001	0.0004

Figure 15.5 and Figure 15.6 show the correlation between the results of TPC and DPPH with an $r = 0.988$ for red Vinhão and an $r = 0.975$ for the white Loureiro.

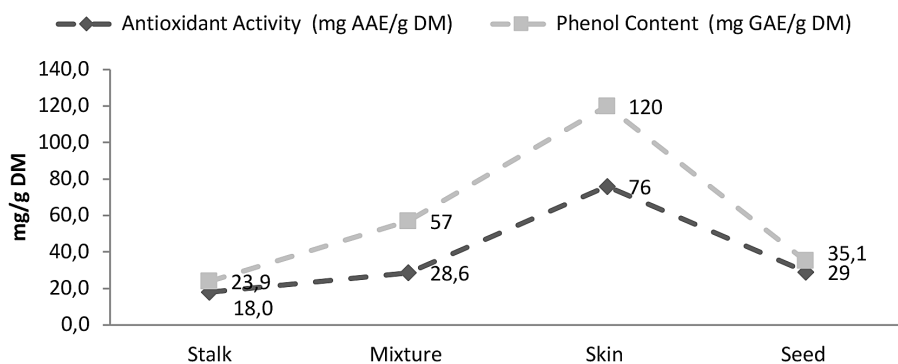


Figure 15.5. Correlation between the TPC and the antioxidant activity in red grape pomace

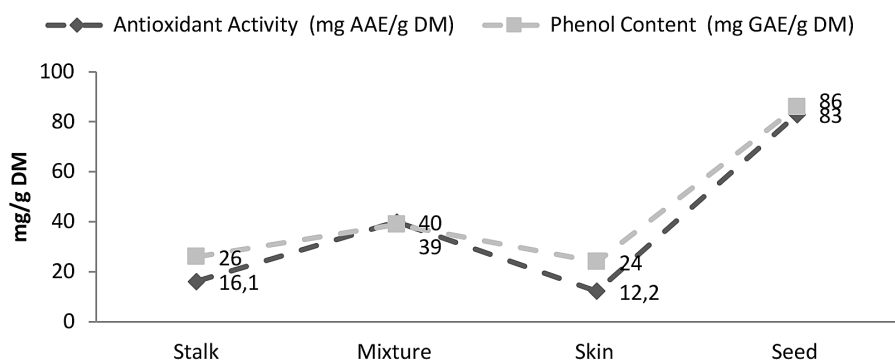


Figure 15.6. Correlation between the TPC and the antioxidant activity in white grape pomace

Comparing these results with other authors (Table 15.8), the values for the seed from Loureiro are similar to Friuli Venezia Giulia but the results of the skin from

Vinhão are higher than all the other varieties. The TPC of the mixture of these two varieties has a range of 39-57 mg GAE/g DM which is between the range of 26.3–131.7 mg GAE/g DM from the bibliography.

Table 15.8. Results for total phenolic content (TPC) in white and red GP varieties from other studies

TPC mg/g DM					Reference
Red varieties	Stalk	Mixture	skin	seed	
Pinot noir	—	67.74	—	—	(Tseng Angela, 2013)
Manto negro	116	26.3	—	—	(Llobera A., 2007)
Friuli Venezia Giulia	—	—	—	51	(Spanghero M., 2009)
California	—	—	—	64	(Spanghero M., 2009)
Pinot Noir	—	56	—	—	(Winkler Anne, 2015)
Touriga Nacional	—	131.7	—	—	(Tournour Hernán H., 2015)
Touriga Franca	—	100.1	—	—	(Tournour Hernán H., 2015)
Tinta Roriz	—	69.3	—	—	(Tournour Hernán H., 2015)
Cabernet S.	—	—	26.7	—	(Deng Qian, 2011)
Merlot	—	—	25	—	(Deng Qian, 2011)
Pinot Noir	—	—	21.4	—	(Deng Qian, 2011)
Agiorgitiko	—	54.02	—	—	(Canellas, 2008)
Kadarka	16–19.4	—	3.2–3.8	35–43	(Llobera A., 2007)
Negro Amaro	—	41.9	33.3	85.8	(Llobera A., 2007)
Dornfelder	—	57	—	—	(Winkler Anne, 2015)
Portugais bleu	—	65	—	—	(Winkler Anne, 2015)
White varieties	Stalk	Mixture	Skin	seed	
Friuli Venezia Giulia	—	—	—	90	(Spanghero M., 2009)
Riesling	—	44	—	—	(Winkler Anne, 2015)
Pinot blanc	—	54	—	—	(Winkler Anne, 2015)
Muller Thurgau	—	—	15.8	—	(Deng Qian, 2011)
Morio Muscat	—	—	11.6	—	(Deng Qian, 2011)
Chardonnay	—	38.91	—	—	(González-Centeno M.R, 2013)
Macabeu	—	30.93	—	—	(González-Centeno M.R, 2013)
Parellada	—	46.54	—	—	(González-Centeno M.R, 2013)
Prensal Blanc	—	36.39	—	—	(González-Centeno M.R, 2013)
Prensal Blanc	87.3	34.9	—	—	(Canellas, 2008)
Roditis	57.98	48.26	—	—	(Canellas, 2008)

3.1.3. Results of high heating value (HHV) with a constant volume bomb calorimeter

In order to investigate the possibility of energy recovery for grape pomace, it was determined the heating value of stalks and from the mixture GP from the Loureiro and Vinhão varieties, in the original GP samples. This property was also studied in the extracted samples, to compare the results before and after the extraction of the bioactive compounds. The results are presented in Table 15.9.

Table 15.9. High heating values for studied GP varieties in DM and other biomass values

Sample	HHV cal/g	HHV MJ/kg	Fuel*	HHV MJ/kg
BLE	4,289 ± 26	18.0 ± 0.11	Corn stalks/stover	17.6–18.5
EBLE	4,103 ± 34	17.2 ± 0.14	Sugarcane bagasse	17.3–19.4
BLM	5,043 ± 32	21.1 ± 0.13	Fruit pits	15.8–20.5
EBLM	4,321 ± 49	18.1 ± 0.20	Miscanthus	18.1–19.6
BLP	–	–	Eucalyptus	19.0–19.6
BLG	–	–	Hardwood wood	18.6–20.7
TVE	4,204 ± 20	17.6 ± 0.08	Softwood wood	18.6–21.1
ETVE	4,040 ± 86	16.9 ± 0.36	Coal (wet basis)	23.97
TVM	4,957 ± 26	20.8 ± 0.11	Petroleum coke	31.31
ETVM	2,432 ± 40	17.7 ± 0.17	Crude oil	45.54
TVP	–	–	Natural gas	52.22
TVG	–	–	Hydrogen	142.18

*From website (Boundy B., 2011).

Table 15.10. Statistical analyses for HHV before and after extraction of polyphenols (*p* value)

Fractions	HHV
t-test	
BLE vs EBLE	< 0.0001
BLM vs EBLM	< 0.0001
TVE vs ETVE	0.006
TVM vs ETVM	< 0.0001

In Table 15.9 are presented the results for high heating values from Loureiro and Vinhão GP and some other biomass samples. The results showed that there

were very significant differences between the two varieties, for all the fractions ($p < 0.01$) (Table 15.10). Comparing high heating value for stalks and mixture the later has the highest values (21.1%) and very similar to the study of Toscano that found a heating value for grape mixture of 20.1 MJ/kg and for the stalks of 16.8 MJ/kg (Toscano G., 2013). Comparing the results for the heating value of the wood pellet from Table 15.9 it can be observed that the GP samples even after the fat and the polyphenol extraction have heating values near to the wood pellets, which indicates that this biomass has high potential for energy recovery. Both mixture and stalks from the two varieties have similar values after the extractions (Figure 15.7).

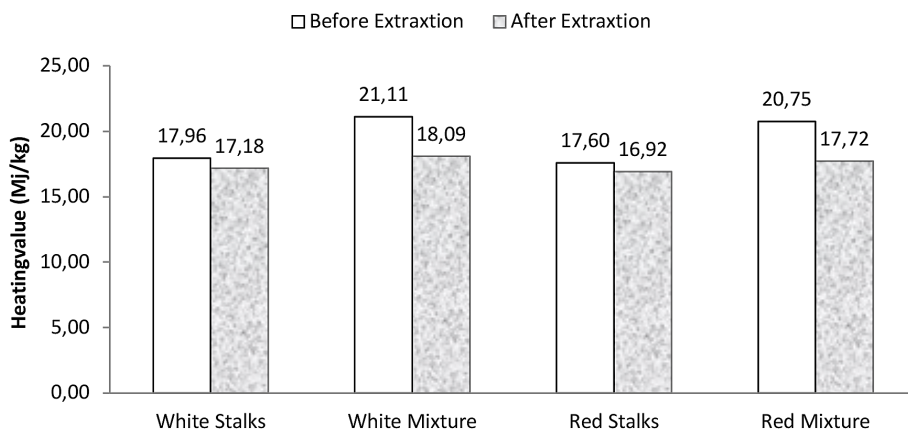


Figure 15.7. Correlation between the heating value (MJ/kg) of the original and extracted sample

4. Brief considerations for the grape pomace applications and conclusion

In conclusion, it can be said that grape pomace cannot be considered anymore as a winery waste but as a by-product, which could extend the grape's commercial life cycle. The separation of GP into different components can be useful to give a distinct value to each part according to its typical characteristics.

The results indicate a high content of oil, 16.4% and 15.7% w/w DM in Vinhão and Loureiro GP, respectively. The high content of total phenolic compounds (TPC) makes them excellent candidates as food additives, which provide food commodities with high antioxidant activity, until 83 mg AAE/g DM in Vinhão

seeds and 76 mg AAE/g DM in Loureiro variety skin, which makes both components of GP great candidates for use as food additives due to their high content.

When comparing the high heating values for stalks and the GP combination, the latter has the greatest values (21.1 MJ/k), which are quite similar to the results of other studies here mentioned and the heating value of the wood pellet. It can be shown that the GP samples still exhibit heating values close to the unextracted GP of 18.1 MJ/k, indicating that this biomass has a strong potential for energy recovery, even after the fat and polyphenol extraction. After the extractions, the mixes and stalks from the two grape varieties have comparable heating values.

Finally, the obtained results on the energy value and chemical composition of GP provided guidance for developing innovative industrial applications. Considering the amounts of GP that are produced annually in Portugal and the chemical properties of GP, it is evident that this sub-product from the winery industry provides new perspectives on potential profitability with alternative industrial applications. Thus, recycling winery by-products constitutes an opportunity for providing valuable materials, contributing to reducing costs and the environmental impact linked to the disposal of these by-products in the production areas.

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Produced Energy Storage System at the Braking of a Train

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Abstract

High-speed railway transport is the most efficient and environmentally friendly form of transportation. At a time when energy saving is a central issue in society, it is crucial to find solutions to improve the efficiency of this transport, given the economic and environmental savings that can be achieved. For several years, the use of additional systems to increase the efficiency of railway transport has been discussed, but so far, implementing these systems is still minimal. Regenerative braking is one of the systems that allows part of the energy that would usually be dissipated as heat to be recovered. Although this system is implemented on the railway, its operation implies that the regenerated energy is injected into the catenary to be used, for instance, by another train running on the same section or injected into the grid with no economic return. This work proposes an onboard energy storage system capable of storing the energy generated from its available electrical braking functionality. This stored energy will be used during train's accelerations, thus achieving peak shaving. This innovative idea contributes to energy sustainability. A study on energy storage systems, DC/DC converters, as well as simulation and experimental work, is presented in the chapter.

Keywords: Energy Efficiency in Railway, Onboard Storage Systems

1. Introduction

Since its invention, the train has been fundamental in transporting people and goods. An efficient railway system is unquestionable in developing a country's or region's economic activities by allowing improved accessibility between localities and increasing the productivity of different industries. In addition to the economic and social advantages of railways, this transportation mode is one of the most efficient compared to others, demonstrating its relevance in the current context. In the current plan, where there are significant efforts towards decarbonization, railway systems are included in the efforts to reduce greenhouse gas emissions and ecological footprint. Thus, efforts are needed from researchers and engineers to apply environmental concepts in the railway industry (International Energy Agency, 2019).

During regular operation on railway systems, a journey comprises four driving regimes (acceleration, cruising, coasting, and braking), as shown in Figure 16.1.

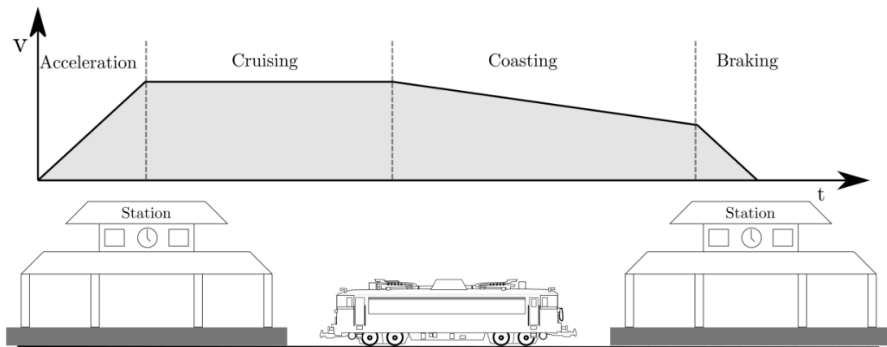


Figure 16.1. Driving Profile of the Train

Source: Rocha et al., 2018.

Analyzing the driving profile, acceleration and braking regimes have the highest impact on the catenary. During acceleration, a high amount of energy is consumed from the grid since the train's maximum torque is required to achieve a comfortable acceleration (Rocha et al., 2018). On the other hand, energy is recovered by the electric traction motors and injected into the grid at braking. If the energy is sent back to the catenary, it can be delivered to the grid or be used by another train when accelerating at the same line section.

The typical catenary load diagram is presented in Figure 16.2. As can be seen, it has several power peaks coinciding with the periods of acceleration and regenerative braking. From the grid, these load profiles are not the most desirable from a technical, economic, and environmental point of view. The most appropriate profile should be constant power consumption, minimizing reliance on fossil fuel-based power plants and enhancing the electrical grid's overall efficiency and reliability. To achieve this ideal profile, techniques such as peak shaving should be applied to the system.

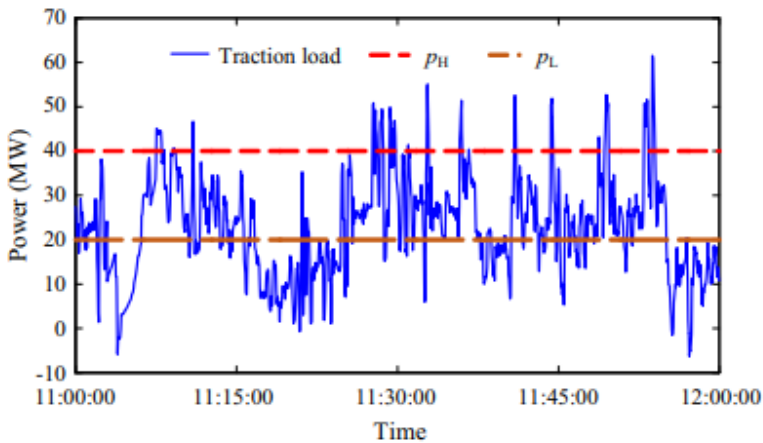


Figure 16.2. Load Diagram

Source: (Huang et al., 2020).

This work proposes a solution that allows the storage of the energy recovered during braking. Once stored, the energy can be used on train acceleration or auxiliary systems. The aim is to research, develop and implement a functional storage system that can be installed on a train so that it can peak shave the load diagram of the network and reuse the energy from the regenerative braking into an acceleration regime. In this way, the train will be less dependent on the grid, reduce consumption, and improve the system's overall efficiency. This way, implementing the energy storage system will contribute to system sustainability.

This chapter will present a literature review on rail storage systems and converter topologies. Then, an energy storage system technology suited for the application will be selected. A solution for the energy storage system will be proposed and the results of computer simulations will be discussed. In the end, a laboratory prototype of the system will be presented showing the main results.

2. Literature review

2.1. Electrified Railway System in Portugal

The train under study is the alfa pendular or series 4000 of the Portuguese railway company Comboios de Portugal. The train of the 4000 series is composed of six wagons, of which 2 are traction units. Each train set has an independent microgrid for redundancy and system robustness. This way, if one of the traction systems fails, moving the train with the second traction unit is possible, and the railway network operation is not affected. The microgrid of a 4000 series train is divided into two parts: traction system and auxiliary systems, as seen in Figure 16.3.

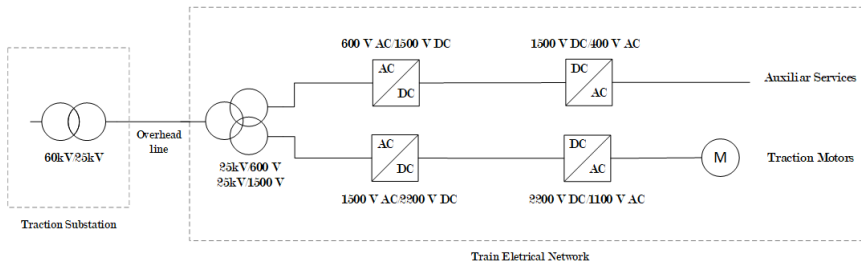


Figure 16.3. Simplified Unifilar Schematic of the Train's Electrical Network

Source: (Fonseca, 2021).

The traction system powers the four three-phase induction motors of 500 kW each. The auxiliary systems are composed of the remaining train loads, such as lighting, air conditioning, power outlets, and sound systems.

The train's electrical system is fed from the various traction substations along the track to which the overhead contact line is connected to a voltage value of 25 kV. The electrical system of the train has a transformer with two secondary windings. For traction, the system converts 25 kV into 1500 V. Then, rectification is done through a three-phase bridge controlled by thyristors connected to a DC bus with 2200 V. The three-phase motors are fed by a three-phase inverter, generating an 1100 V AC voltage. For auxiliary systems, the line 25 kV is converted into 600V. After that, a rectification generates a DC voltage of 1500 V, and all the loads are connected to a 400V AC grid generated through a DC-to-AC converter.

When a railway vehicle brakes, induction motors function as generators that convert the kinetic energy into electrical energy. Regenerative braking is one

of the technologies with the most significant energy-saving potential. Combined with an energy storage system, it can achieve a 30 % energy-saving in railway transport (Kumar et al., 2019).

Implementing a converter that transfers the energy produced to an energy storage system to store energy during braking, reducing speed, or maintaining downhill speed is necessary.

2.2. Energy Storage System

Energy storage technology is one of the most important elements to define because of its technical, economic, and environmental impact. Thus, it is necessary to identify and evaluate the technologies available in the market through critical parameters. Several technologies can be used in energy recovery on the railroad, such as flywheels, batteries, supercapacitors, and superconducting magnets (Liu and Li, 2020).

The flywheel-based storage system consists of a power electronic converter, electric machine, rotor, and magnetic bearings. The electrical energy recovered through this system is stored as kinetic energy in a high-speed rotor placed in a vacuum to minimize frictional losses (Liu and Li, 2020).

Batteries are the most common element used to store electrical energy. A battery consists of two electrodes, one positive and one negative, the electrolyte, a conductive medium, and a separator that physically divides the sections of different polarities (Rocha, 2013). There are several types of batteries with various construction, constitutions, and characteristics, namely Lead (Pb), Nickel-Cadmium (Ni-Cd), Nickel-Metal Hydride (Ni-MH), Lithium-Ion (Li-ion), and also Sodium-Ion, for example, ZEBRA batteries.

Superconducting magnet-based storage systems allow energy to be stored in a magnetic field created by the direct current flowing through the coil of the magnet. To maintain its superconducting state, the magnet needs to be immersed in liquid helium and cooled to a cryogenic temperature ($< -150^{\circ}\text{C}$) (Liu and Li, 2020).

Supercapacitors are a technology used to store electrical energy. They have similar characteristics to capacitors, but the electrodes are embedded in an electrolytic solution in this one. The capacity is formed by the electrostatic accumulation of charges at the interface between the electrode and the electrolyte (Liu and Li, 2020).

In Railway systems, the storage system's location can be divided into two categories: onboard and stationary. Stationary storage systems, also called way-side systems, are installed in traction substations or placed on the line where significant voltage fluctuations occur (Fedele et al., 2021). Once installed on the line, the storage system can receive and supply power from several trains running on the line (Liu & Li, 2020). Figure 16.4 presents a schematic diagram of stationary ESS in railway systems. The figure represents the interactions between the train and the storage systems.

On the other hand, onboard systems are installed directly on the train, storing regenerated energy. If it is battery-based, it allows the train to operate on non-electrified sections of the line. The choice of one or both solutions depends on the project's objective, for example, the use of regenerative energy from train braking, power management on the line, or operation of the train off the grid (Fedele et al., 2021).

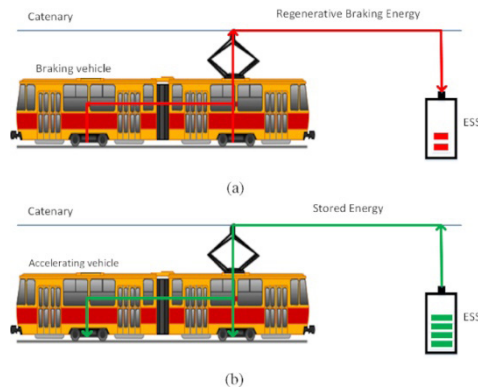


Figure 16.4. Operation schematic of a stationary ESS in a railway system: (a) Energy recovery in the braking phase; (b) Energy delivery in the traction phase

Source: Liu and Li, 2020.

Figure 16.5 presents a schematic diagram of an onboard ESS operation. The energy flow on the ESS is represented, and as it can be concluded by comparing both figures, using an onboard ESS reduces the power losses on storage since the energy path is shorter. On the other hand, the onboard storage allows local energy management independent of catenary/grid availability.

Chapter 16

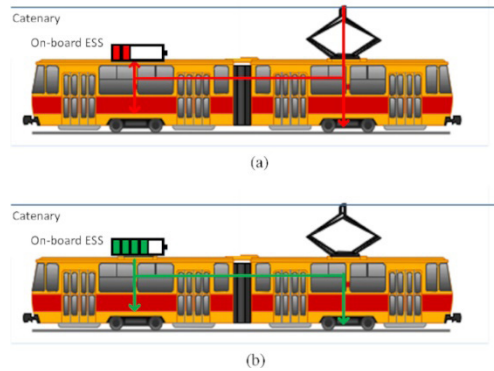


Figure 16.5. Schematic diagram of onboard ESS operation: (a) Under catenary operation; (b) Catenary-free operation

Source: Liu and Li, 2020.

Having two possible locations to install an ESS, a deep analysis of each option's advantages and disadvantages should be done before any decision. Table 16.1 lists the advantages and disadvantages of each ESS location on railway systems.

Table 16.1. Advantages and Disadvantages of the Energy Storage System Location

ESS	Advantages	Disadvantages
Onboard	• More efficient; • Smoothing of power peaks during acceleration; • Stability of tension on catenary; • Possibility of operation in non-electrified areas of the line (e.g., batteries); • There is no need to make changes to the electrical infrastructure of the line.	• Volume and weight restrictions; • Increasing train costs; • The train needs to be taken out of service for the installation of the system; • Restrictions of ESS technology due to safety reasons.
Stationary	• Voltage stability on catenary; • No weight and volume restrictions; • Implementation and maintenance do not imply interruption in railway operation; • Fewer security constraints in the choice of ESS technology; • No modification in the trains;	• No load reduction at the pantograph, • Unable to operate in non-electrified line areas; • Higher costs than the onboard solution; • Need for study and analysis of the power flow in the line for sizing and selection of the installation site.

Source: Fedele et al., 2021.

2.3. Supercapacitors

From the analysis performed in the ESS Technology section, supercapacitors appear to be the best solution for the ESS to be installed. Supercapacitors can be divided into three categories. The first category includes electric double-layer capacitors or electric double-layer (EDLC) capacitors, which typically have a short charging period (Funabashi, 2016). The second is pseudo-supercapacitors, which have a working principle more like batteries than capacitors. Finally, the last category is hybrid supercapacitors, a combination of the abovementioned types EDLC and pseudo-supercapacitors. Their main advantage is that they have a high energy density value while simultaneously delivering high current values (Libich et al., 2018). Table 16.2 lists the main parameters to consider when choosing the supercapacitor's technology.

Table 16.2. Supercapacitor Category Comparison

Characteristics	EDLC	Pseudo-supercapacitors	Hybrid Supercapacitor
Charging time (s)	1–10	1–10	100
Number of cycles	1 000 000	1 000 000	1 000 000
Voltage per cell (V)	2,7	2,3–2,8	*
Energy Density (Wh/kg)	3–5	10	180
Operating temperature (°C)	-40 a 65	-40 a 65	-40 a 65

* Information not available

Source: Libich et al., 2018

2.4. Electrical Model

The classical equivalent circuit of the supercapacitor (Figure 16.6) consists of the representation of capacitance, equivalent series resistance (ESR,) and equivalent parallel resistance (EPR). The ESR and EPR represent the internal voltage drop and the self-discharge phenomenon, respectively (Naseri et al., 2022; Sharma and Bhatti, 2010). The equivalent parallel resistance is only considered in the self-discharge effect, which takes hours or days, so it is not considered for design purposes. Figure 16.7 illustrates the states of charge and discharge in a supercapacitor.

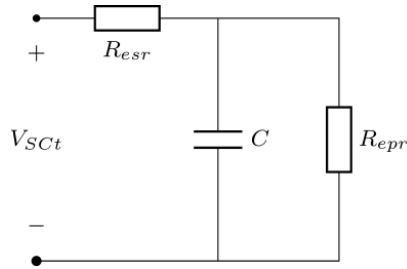


Figure 16.6. Equivalent Circuit of a Supercapacitor

Source: (Ehsani et al., 2017).

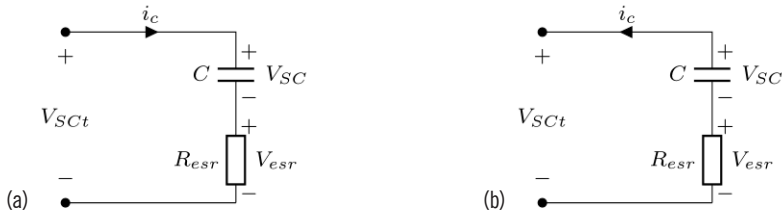


Figure 16.7. Charge (a) and Discharge (b) Phase of a Supercapacitor

Source: (Ehsani et al., 2017).

The voltage at the terminals, V_{SCt} during the charging period, can be determined by Equation 1.

Equation 1

$$V_{SCt} = V_{SC} + i_c * R_{esr}$$

The voltage at the terminals during the discharge period is determined by Equation 2.

Equation 2

$$V_{SCt} = V_{SC} - i_c * R_{esr}$$

2.5. Energy Density vs Power Density

Supercapacitors have a value of up to 15 kW/kg power density; however, only 5 to 8 Wh/kg energy density (Béguin et al., 2014). The energy density (Wh/kg), or specific energy, refers to the amount of energy it can store per unit mass

or volume. It is a measure of how much total energy can be stored in a supercapacitor and is obtained by Equation 3:

Equation 3

$$E_{esp} = \frac{C \cdot V_{max}^2}{2 \cdot m \cdot 3600}$$

where m corresponds to the mass (kg) of the supercapacitor. The power density (W/kg), specific power, or Impedance Match Specific Power refers to its ability to deliver or absorb electrical power per unit mass or volume and is defined in Equation 4 (Maxwell, n.d.):

Equation 4

$$P_{esp} = \frac{V_{max}^2}{4 \cdot R_{serie} \cdot m}$$

2.6. DC/DC Converters Topologies

Several DC/DC converter topologies can be used in this application. The best choice should be considering each topology's advantages and disadvantages. The DC/DC converters can be divided into isolated or non-isolated types (Figure 16.8).

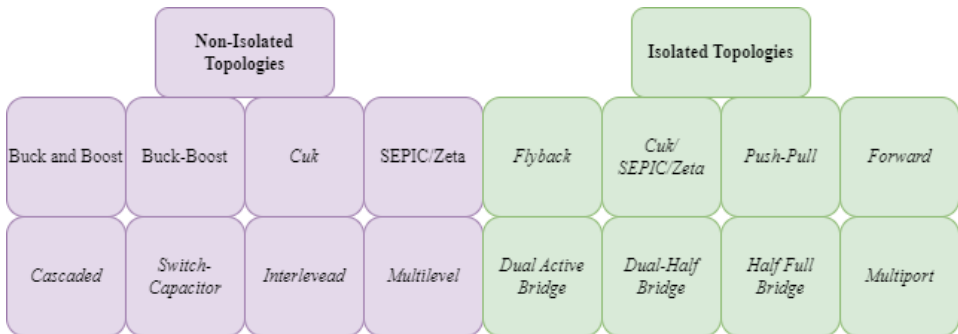


Figure 16.8. DC/DC Converter Topologies

Source: Gorji et al., 2019.

The operating principle of these converters is based on the transfer of energy using a properly dimensioned inductor. Interleaved and cascaded converters are buck/boost converter variations, so only the second will be discussed.

In the configuration of Figure 16.9, the ESS presents a higher voltage than the DC bus. The converter is bidirectional DC/DC and behaves as a boost converter in charging mode and as a buck in discharging mode. During the charging mode, the lower transistor and the upper diode are on, and the upper transistor and the lower diode turn on during the discharge process.

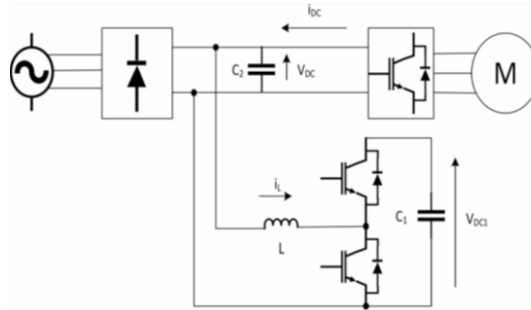


Figure 16.9. Bidirectional Boost/ Buck Converter

Source: Kumar et al., 2019.

2.6.1. Buck/Boost

In the configuration of Figure 16.10, the circuit operates the opposite way to the previous one. In charging mode, the converter operates as a buck; in discharge mode, it operates as a boost. In the charging, the upper transistor and the lower diode conduct, and the lower transistor and the upper diode conduct in the discharging process.

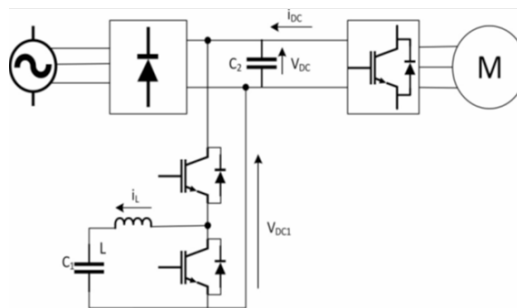


Figure 16.10. Bidirectional Buck/Boost Converter

Source: Kumar et al., 2019.

3. Supercapacitor Bank

This section describes the equations that define the train motion, the energy consumed, and the energy produced in the regenerative braking period. Based on this data, the capacity of the supercapacitor bank will be calculated.

The first step is identifying the forces applied to the train, enabling it to accelerate and brake. Figure 16.11 shows the forces acting on the train.

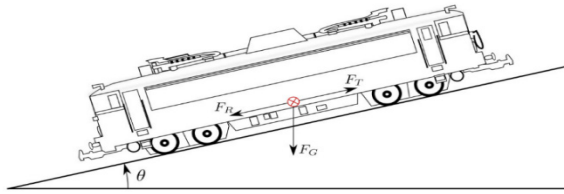


Figure 16.11. Train acting forces

Source: (Rocha et al., 2018).

Equation 5 allows to calculate the force applied to the train where F_T represents the traction force applied in the acceleration period with positive value and F_B the braking force with negative value applied in the braking phase.

Equation 5

$$F = F_T - (F_B + F_R + F_G)$$

The gravitational force, F_G , due to the slopes of the route is defined by the Equation 6.

Equation 6

$$F_G = Mg \sin(\theta)$$

Where M corresponds to the train mass, which for the Alfa Pendular is equal to 298 300 kg (Trainlogistic, n.d.), g , to the gravitational acceleration and θ to the slope angle.

The traction resistance force, F_R , consists of a second-degree polynomial equation where parameters A and B are related to the mechanical resistance and dependent on the train mass. Parameter C is associated with the aerody-

dynamic resistance (Rocha et al., 2018). This equation is known in the literature as Davis equation (Douglas et al., 2017). The parameters A, B, and C considered to be approximate values for the case of the Alfa Pendular are equal to 2000 N, 40 Nm/s² and 6.9 Nm/s² respectively.

Equation 7

$$F_R = A + Bv + Cv^2 \Leftrightarrow F_R = 2000 + 40v + 6,9v^2$$

The traction force, described by the Equation 8, varies according to the speed of the train (Rocha et al., 2018). For values below the synchronism speed, the traction force is constant and for higher values it is equal to the quotient between power P_{tr} and speed v . The synchronism speed (V_{sync}) corresponds to the value from which the induction motors stops operating in the constant torque region (T_1) and start operating in the constant power region P_{tr} . From (Trainlogistic, n.d.) we know that the traction force T_1 equals 210 kN and the power P_{tr} equals 4 MW.

Equation 8

$$F_T = \begin{cases} T_1, & v \leq V_{sync} \\ \frac{T_1 V_{tr}}{v} = \frac{P_{tr}}{v}, & v > V_{sync} \end{cases}$$

The braking force of the train has a similar response to the traction force. In the braking procedure the electric traction motors, for train in study, operate in regenerative braking mode only for speeds above 15 km/h (V_{min}). For lower values than V_{min} only the service brakes act (Liu & Li, 2020; Trainlogistic, n.d.). Therefore, only in this speed range [v_{min} , v_{max}] is possible to recover energy. B_1 corresponds to the torque for the constant torque region, which is lower than the equivalent torque in the traction equation, and v_{br} to the synchronous speed for this period. The braking force is described by Equation 9 adapted from (Rocha et al., 2018).

Equation 9

$$F_B = \begin{cases} \frac{B_1}{v_{min}} \cdot v, & 0 \leq v \leq V_{min} \\ B_1, & V_{min} \leq v \leq V_{br} \\ \frac{B_1 V_{tr}}{v} = \frac{P_{tr}}{v}, & v > V_{br} \end{cases}$$

The calculation of the mechanical energy consumed by the train in the acceleration period can be calculated by the following formula $E_{mec} = \int_{t_{inicial}}^{t_{final}} P_{mec}$ where P_{mec} corresponds to the mechanical power calculated by the equation $P_{mec} = v(t) \times F_T(t)$. The mechanical energy value obtained was 198,61 kWh.

To calculate the mechanical power P_{mec} is necessary to know the speed of the train to time $v(t)$. To calculate this value the acceleration is integrated using the Euler method, obtained from the second law of Newton ($F = M \times a$). The velocity is obtained by the following equation: $v(t_i) = v(t_{i-1}) + a_{acel}(v(t_{i-1})) \times \Delta t$. From the mechanical energy it was possible to calculate the electric energy consumed by the train, considering a motor efficiency η_m of 80% and 95% from the converters (Equation 10).

Equation 10

$$E_{ele} = \frac{E_{mec}}{\eta_m * \eta_{retificador} * \eta_{inversor}} = 261,32 kWh$$

3.1. Energy Production in Regenerative Braking

Using the same procedure as in the acceleration period, at the braking period the mechanical power is equal to $P_{mec} = v(t) \times F_B(t)$. By integrating P_{mec} for the braking interval the mechanical energy value equals 138,430 kWh.

By applying the efficiency of the electrical elements to the mechanical energy value it is possible to calculate the value of electrical energy generated. AF, Equation 11, is the availability factor and represents the percentage of the locomotive braking mechanical power (P_{mec}) that can be used by the regenerative braking system ($P_{eleregen}$), which may be between 20% and 30% according to (Fayad et al., 2021; Rodriguez-Cabal et al., 2022).

Equation 11

$$AF = \frac{P_{eleregen}}{P_{mec}}$$

For the calculation, we considered a motor efficiency of 80%, an inverter efficiency of 95 %, a DC/DC converter efficiency of 95 % and a supercapacitor

efficiency of 95 %, all values in accordance with (Rodriguez-Cabal et al., 2022) and an availability factor of 30 %.

It can be concluded that in the regenerative braking process of the Alfa Pendular train there is a potential to recover 28.486 kWh of energy which represents 20.58 % of the total mechanical braking energy. The availability factor considered was 30 % since there is no information on this parameter. This factor presents a great impact on the calculation of the storable energy value so a study should be done on it in a more reliable approach of the real system in the future.

3.2. Sizing of Supercapacitor Bank

From the calculations, the capacity of the supercapacitor bank to store the recovered energy should be at least 28.486 kWh. Knowing that the train of the series has 2 electric traction systems it will be necessary to divide the storage system in two with the same capacity. In this way, a bank with a capacity of 15 kWh will be dimensioned. For dimensioning purposes, we considered the model 2.7V 3000F ULTRACAPACITOR CELL from MAXWELL. Using this model to build a 15kWh bank would require 5000 units. Using a modular approach, each module will have 48V, to facilitate assembly, handling, and possible replacements. The maximum voltage of the supercapacitor bank will be 750V for safety and system requirements.

In the Table 16.3 the characteristics of the supercapacitor bank are presented.

Table 16.3. Supercapacitor Bank (MAXWELL, n.d.)

Characteristics	Value	Units
Number of modules in series	16	
Number of strings in parallel	18	
Total number of modules	288	
Capacity	187	F
Maximum voltage	768	V
Maximum charge and discharge current	2574	A
Series equivalent resistance	3.68	
Maximum power	38	MW
Energy	15319	Wh
Weight	2670	kg
Volume	3.2	

Source: (MAXWELL, n.d.)

4. DC/DC Converter

Throughout this section, the modes of operation of the converter, the simulation and the proposed prototype are described. Thus, the system architecture, operating principle and control will be discussed.

The DC/DC converter chosen was the buck/boost. This converter presents the following characteristics, which contributed to the choice of this configuration: bi-directional power flow; it does not have galvanic isolation, so it does not need a transformer and has a more compact size; allows a system to store energy at a lower voltage than the DC bus; it does not require galvanic isolation, so it does not need a transformer and is therefore more compact in size; it presents the smallest number of elements among the various topologies available, reducing the costs and complexity of the system. Therefore, the chosen converter will be the object of study regarding its operation and control inserted in the traction system of the 4000 series train. Figure 16.12 shows the schematic of the bidirectional DC/DC converter consisting of IGBT'S with a diode in antiparallel, in half H-bridge configuration, an inductor and the supercapacitor module.

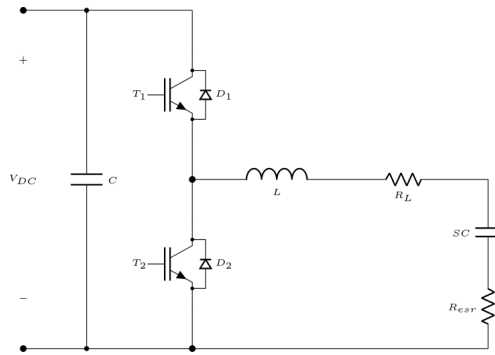


Figure 16.12. Schematic of the bidirectional DC/DC converter

Source: Adapted from: (Daniel Hart, 2011).

The buck mode or charging mode will be defined in the regenerative braking period of the train. Therefore, during the period when regenerated energy is injected into the grid, it will be stored in the supercapacitors until it reaches its maximum capacity. In Figure 16.13(a), the operation of the converter in charging mode for the period t_{on} is represented. Figure 16.13(b), for period t_{off} . t_{on} and t_{off} represent (S), respectively, the period during which the upper IGBT drives and opens, for a total period T.

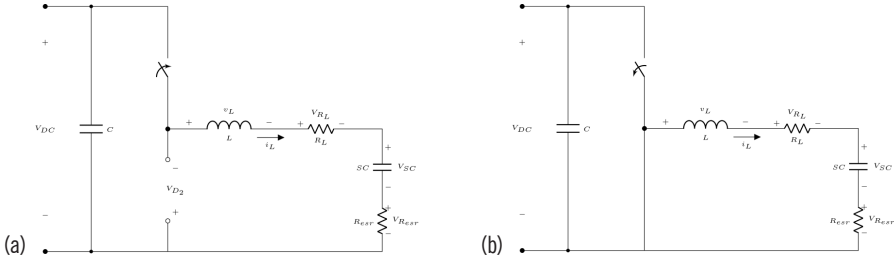


Figure 16.13. Schematics of the bidirectional DC/DC converter in buck mode

Source: Adapted from: (Daniel Hart, 2011).

The boost mode is activated during train acceleration and if the state of charge of the supercapacitors allows it. Thus, this mode is again described by two intervals t_{on} and t_{off} and relative to the times when the bottom IGBT drives and opens.

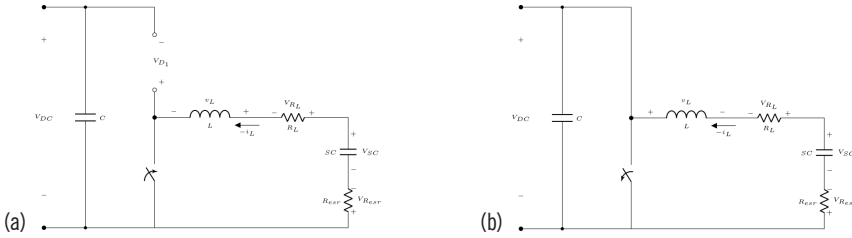


Figure 16.14. Schematic of the bidirectional DC/DC converter in boost mode

Source: Adapted from: (Daniel Hart, 2011).

The inductor is a relevant element for the stable operation of the converter. To fulfill this goal, it is necessary to calculate the inductance value considering the conduction mode of the converter. The inductance value can be calculated from the equation:

Equation 12

$$L = \left(\frac{V_{DC} - V_{total}}{\Delta I_L f_{sw}} \right) D$$

where V_{DC} corresponds to the voltage value on the DC bus, V_{total} is equal to the voltage on the supercapacitors, ΔI_L the ripple value of the current in the inductor, the f_{sw} switching frequency in Hertz and D the duty-cycle.

The power electronics circuit, the modulation, and the control scheme in use were simulated in PLECS software. The power electronics circuit, shown in Figure 16.15, consists of a DC power supply, the DC bus capacitor with 36 mF (Fonseca, 2021), two IGBT's with a diode in antiparallel, and the previously dimensioned elements: a 0.5 mH inductor and the supercapacitor module, represented by a capacitor with 187 F. To simulate the operation of the bidirectional DC/DC converter, two controllers were built: one for the charge mode and another for the discharge mode. To simulate the logic states of the train's acceleration and braking periods, the "steps" blocks were used so that at the defined intervals the modes of operation of the converter are activated. The operating modes of the converter are represented by the block "Acceleration Period" and "Braking Period".

To manage the state of charge (SoC) of the supercapacitors, the "SC Voltage" block was built, which allows the actual voltage of the supercapacitor to be obtained by subtracting the voltage drop in the series equivalent resistor.

The "Charge State" block allows the definition of logical states. Using an AND block the signal from the "Acceleration Period" and "Braking Period" blocks combined with the signal from the previous block allows for activation of the respective operating mode of the converter.

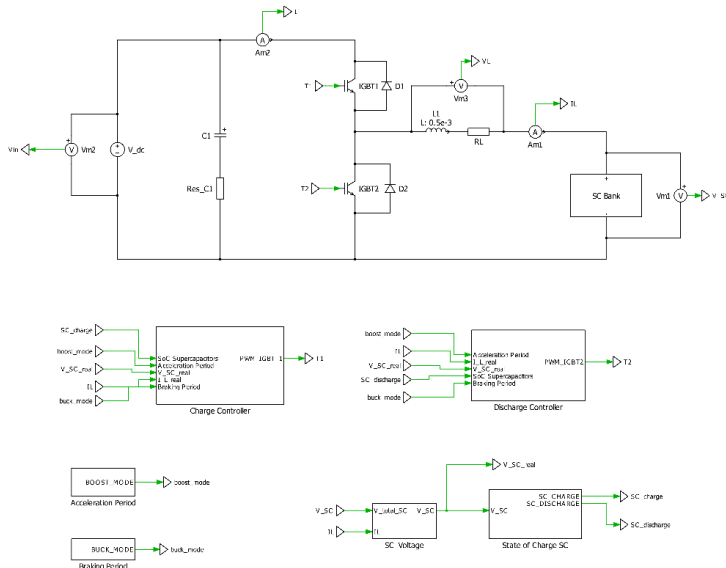


Figure 16.15. Simulation: Power and Control Circuits

Source: Authors.

The charge mode and discharge mode controller can be divided into two groups: voltage control and current control. Voltage control of supercapacitors consists of comparing the maximum (in charge mode) and minimum (in discharge mode) voltage to the actual voltage of the SC. Using a PI controller, with proportional gain (K_p) of 10 and integral (K_i) of 0.1 the current reference I_L is calculated and applied to the current control. The current control allows calculating the duty-cycle value and depending on the active operating mode it will control the corresponding IGBT.

A 1200V 120A FF100R12KS4 module from Infineon was used to build the converter. A 0.3mH inductor and Maxwell supercapacitors are the other elements of the power circuit. The microcontroller used was the XMC 4500 from Infineon. The controller was implemented in Dave IDE using Tustin's method to discretize the PI controllers.

A signal acquisition and control circuit were built to receive the signals from the voltage and current sensors and monitor the status of the IGBT's. In addition, this board also allows to transmit command signals generated in the microcontroller to the gates. Figure 16.16 shows the assembled prototype and Printed Circuit Board.

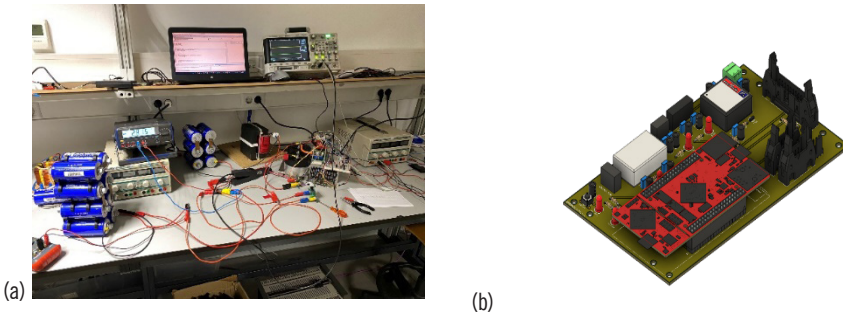


Figure 16.16. Assembly (a) and Printed Circuit Board (b)

Source: Authors.

5. Results and Discussion

In this section the results of the simulation and the experimental work are presented and discussed. To obtain the results, the simulation and the laboratory prototype were tested at constant power mode, referring to the DC bus. Figure 16.17 shows 1 charge cycle and 1 discharge cycle of the supercapacitors using the described control method.

Produced Energy Storage Systemat the Braking of a Train

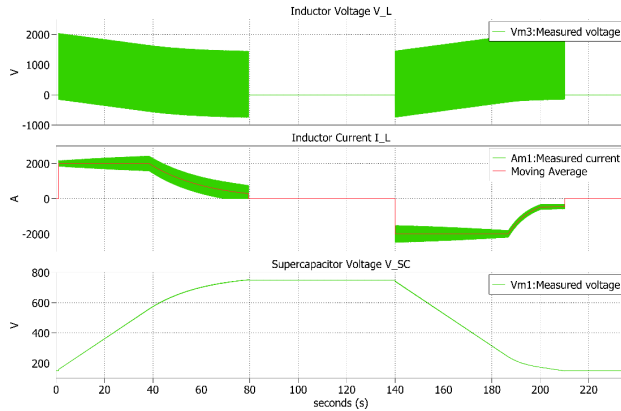


Figure 16.17. Simulation Results

Source: Authors.

In the charge mode, a small overshoot of the current relative to the reference value (2000A) occurs in the transient period, as shown in Figure 16.18. The maximum value reached in this phase does not exceed the maximum current limit for the converter. The system takes about 5 ms to reach the reference current and the charging time of the supercapacitors is 60 seconds.

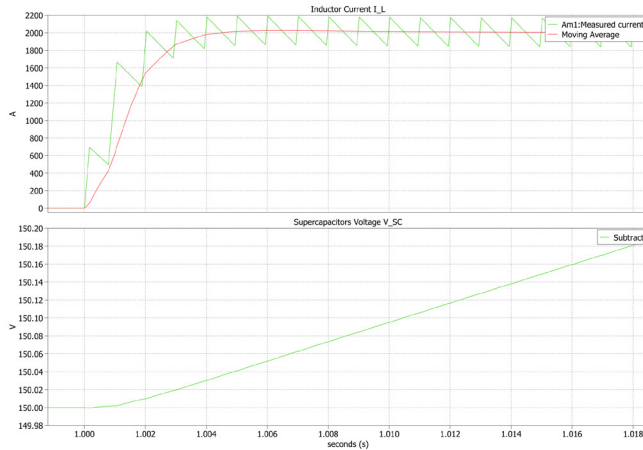


Figure 16.18. Simulation Results: Charge Mode

Source: Authors.

From the results in discharge mode (Figure 16.19), the current takes 10 ms to reach the reference value. In the first 2 switching cycles, the converter operates in discontinuous mode. This situation is acceptable since the performance of the converter is not significantly affected since the conduction losses in these two periods are low due to the low current value, around 200A. The full discharge time of supercapacitors for this method takes about 60 seconds.

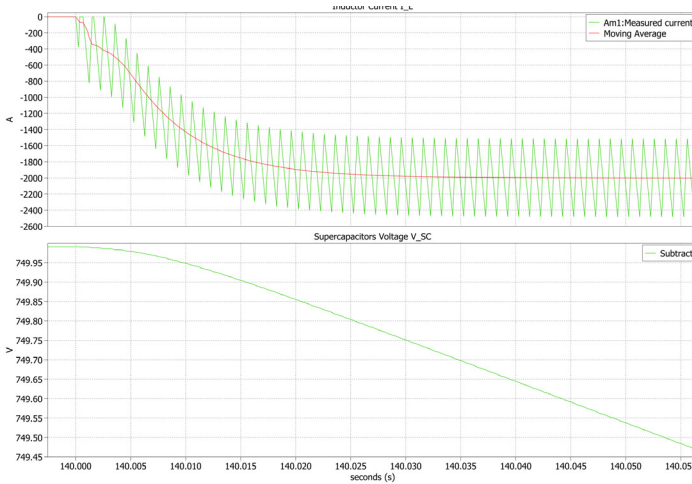


Figure 16.19. Simulation Results Boost Mode

Source: Authors.

Due to not having a prototype of the microgrid of the train, the test to the converter was carried out separately. For this, two supercapacitor modules were built. The first module with a maximum voltage of 20V replaces the DC bus and the second module with a voltage of 15V corresponds to the supercapacitor bank. The first step of the test was to fully charge the 20V module using the DC power supply. Finally, the system was assembled, and energy was transferred between the two modules.

In Figure 16.20, the test results for the transient period are shown. By analyzing the current output I_L , the system takes 0.3 s to reach the reference current of 5A. Figure 16.21 represents the permanent regime of the converter, presenting operation according to theory and computer simulation.

Produced Energy Storage Systemat the Braking of a Train

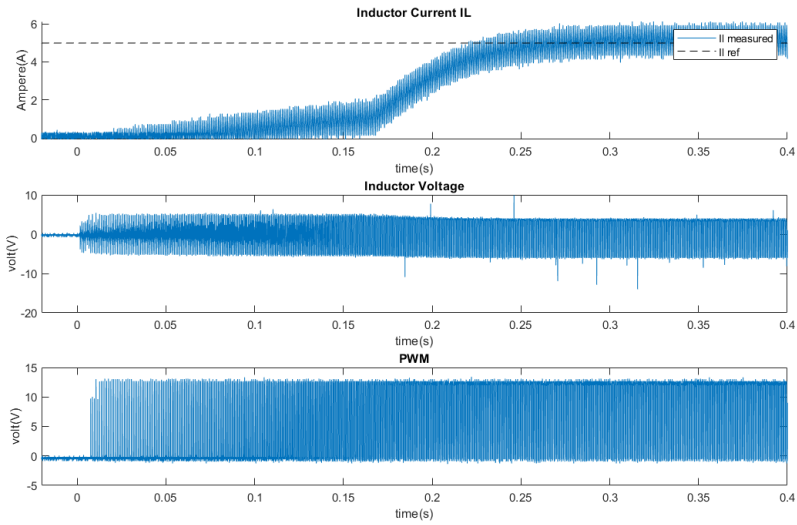


Figure 16.20. Buck Transient Regime

Source: Authors.

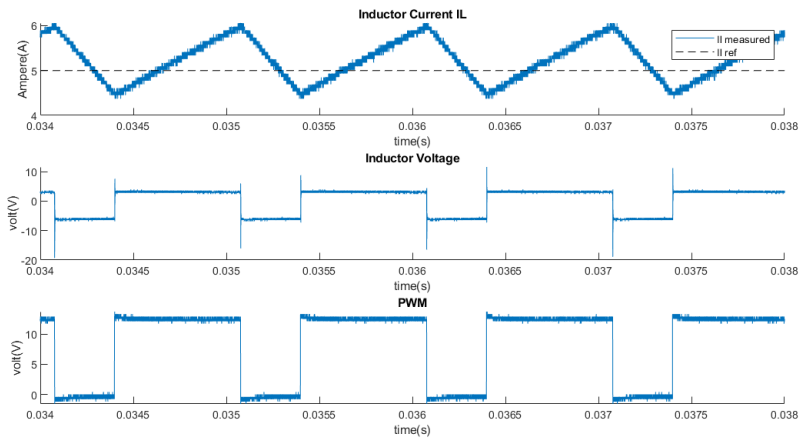


Figure 16.21. Buck Steady state

Source: Authors.

In the discharge mode test, it is verified from the graph of the current in Figure 16.22 that the system takes 0.12 s to reach stability. The graph in

Figure 16.23 shows that the converter stably transfers power from the 15V module to the 20V module during the permanent regime.

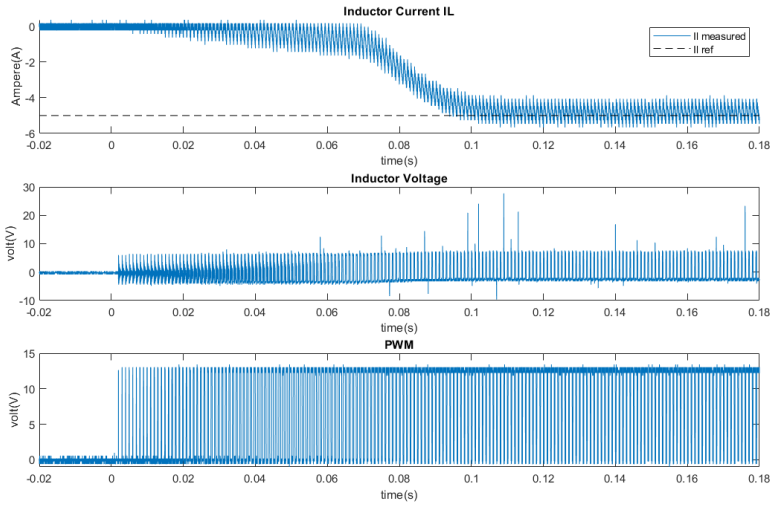


Figure 16.22. Boost Transient Regime

Source: Authors.

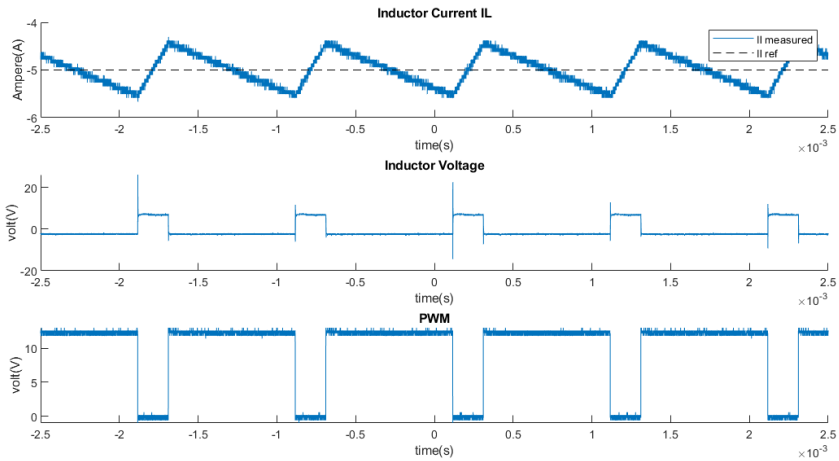


Figure 16.23. Boost Steady state

Source: Authors.

6. Conclusion and recommendations

This work presents a proposal for an energy storage system, based on supercapacitors on board the Alfa Pendular train.

Considering the actual state of the art on ESS an onboard storage system based on supercapacitors of EDLC type and a with a step up/down DC/DC converter would be the most appropriate solution to meet the established objectives. The storage system was designed and dimensioned based system's requirements. A dynamic analysis of the train was performed for the two most demanding periods in terms of energy consumption and regeneration. From the dynamic analyses, it was concluded that a 15kWh capacity for the bank of supercapacitors would be the most appropriate. This is a fundamental aspect due to its technical impact, since it limits, for example, the maximum current value of the converter as well as the amount of energy that can be stored.

The topology of the converter was also studied to understand its operation in this type of application. In this study, the impact of the voltage variation in the supercapacitors and the ripple value of the current in the coil were contents considered. The simulation of the converter was performed to analyze the system behavior. In this part of the project, it was possible to validate the theoretical operation of the converter for the charge and discharge modes of the supercapacitors. It was also relevant for the adjustment of the PI controllers, responsible for the correct operation of the system. The development of a laboratory prototype of the converter was done to validate the control method in use. The charging and discharging modes were validated on the laboratory prototype, and the results were as expected. In the end, it was possible to validate the converter operation, and the authors consider that introducing this system on trains will actively contribute to increasing the sustainability of the rail system.

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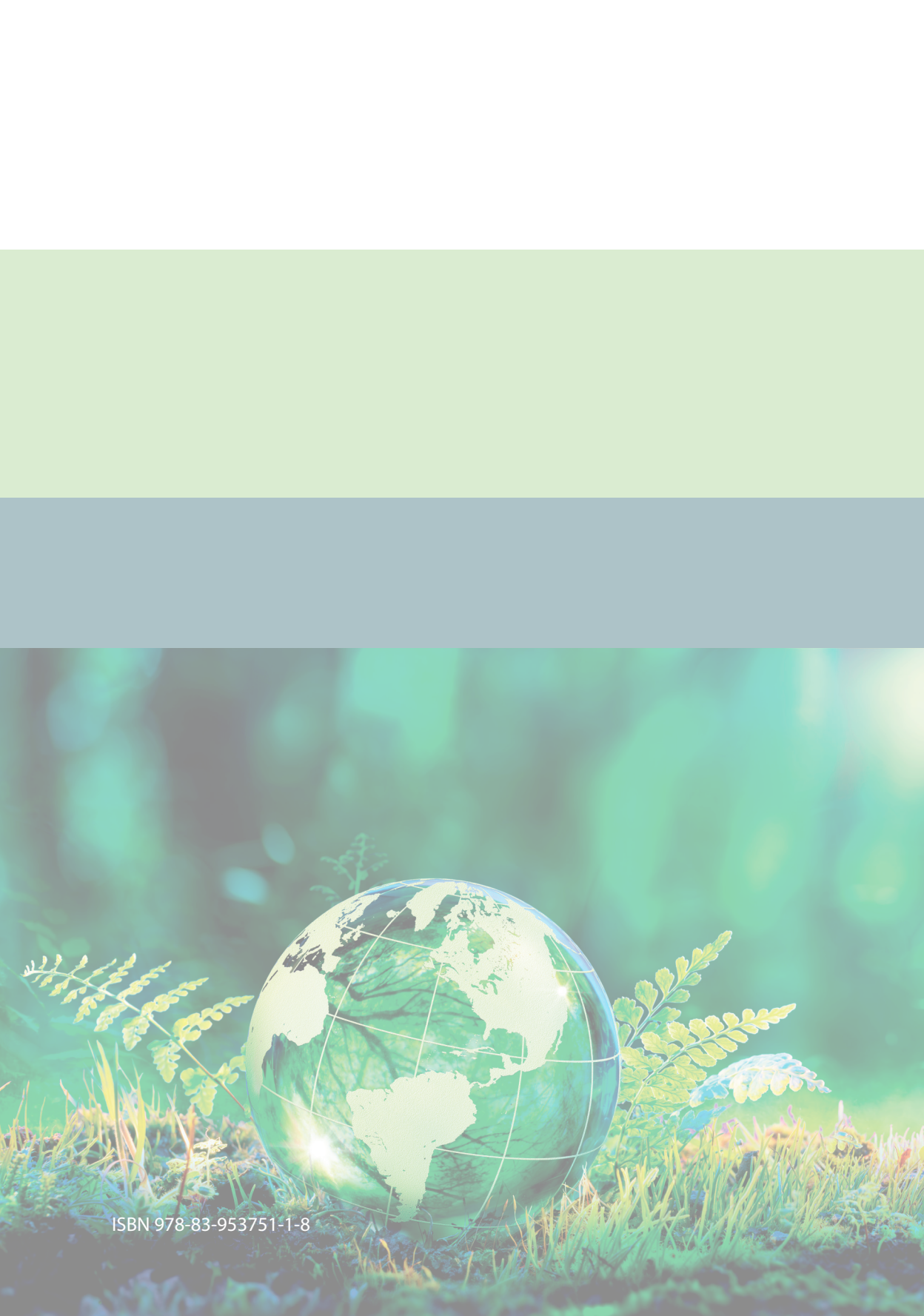
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