Varazdin Development and Entrepreneurship Agency and
Lusofona University, Lisbon University Centre, Portugal

In cooperation with:
ECEO - Lusofona University, Portugal
Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat, Morocco
Ecole Nationale de Commerce et de Gestion de Tanger - Abdelmalek Essaadi University, Morocco
GOVCOPP - University of Aveiro, Portugal
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APPROACHES TO SUSTAINABLE DEVELOPMENT GOALS

Editors:
Ana Lorga, Paula Vicente, Dijana Vukovic, Sandra Raquel Alves

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CONTENTS

SHARING ECONOMY AND SUSTAINABLE DEVELOPMENT: CHALLENGES AND EU27 PERSPECTIVE

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ABSTRACT

The sharing economy has a growing trend, together with its value. It is generally defined as an interaction between the providers and the users of shared items mediated by IT platforms, with the main operating purpose and objective to exercise the right of use items instead of ownership. However, there are certain obstacles to global participation in the sharing economy: the disparity between individuals with an access to modern communication technologies and those without this access known as the digital divide and the unequal representation and support of different languages in digital environments known as the digital language divide concept. These structural inequalities are particularly evident among older populations due to limited digital access, insufficient digital skills or lack of trust in digital platforms. The aim of this paper is to analyse the sharing economy and its connection to the sustainable development by providing the literature review and tracking the comparative analysis ratio of car-sharing as a selected indicator of sharing economy in the period 2020-2024 for the EU-27 countries, as peer-to-peer transportation generates the highest revenue within the collaborative/sharing. Continuous growth and increasing consumption of sharing economy trends and platforms require legal regulation as well as reflection on the impact on the environment, on both the national and global scales. Therefore, it is of a great importance to provide a critical analysis and insights into the contemporary theories and analytical background, categorisation of the sharing economy activities and connecting sharing economy activities with the impact to the chosen Sustainable Development Goals (SDGs), according to the sustainable development pillar(s).

Keywords: *ageing, digital (language) divide, EU27, sharing economy, Sustainable Development Goals (SDGs)*

1. INTRODUCTION

Sustainable development is a critical necessity in a contemporary society. Therefore, sharing and collaboration for the final consumer and society powered by technological innovations and conducted by online platforms and technology is a prerequisite for this innovative business model. There are numerous researchers defining sharing economy (Botsman & Rogers, 2010; Görög, 2018; Fragoso Martins, 2019; Karobliene & Pilinkiene, 2021; Grybaitė et al., 2022, Podrug, 2023, etc). The sharing economy is based on sharing, dividing, redistributing and distributing products and services, resources and capacities but it should not be taken literally, because sharing implies solidarity and gifting, which is not the case here. In this paper, sharing economy relies on the idea of sharing items and facilitating access to these items without gaining ownership but utilizing them in exchange for some profit by a platform.

Obstacles of participation for individuals may be a limited access to modern communication technologies or lack of knowledge needed. Another challenge to be considered is the concept of digital language divide, which refers to unequal representation and support of different languages in digital environments. These challenges are especially present among the elderly. Therefore adequate active ageing initiatives could be of a help in reducing existing obstacles – at least for those reflected in the limited digital knowledge, since the structural limitations are the ones that could be reduced by (local) community measures. Therefore, the paper aims at conducting an analysis into the sharing economy, its challenges related to ageing and its connection to the sustainable development, providing the literature review and tracking the comparative analysis ratio of sharing economy from the sharing transportation, i.e. car-sharing sector percentage in the period 2020-2024 and projection for 2030 in the EU-27 countries. The paper comprises four chapters. After introduction, definitions and different authors' perspectives of sharing economy and sustainable development are analysed. The sharing economy trend is analysed and argued in the context of the sustainable development impact, concerning its environmental, social and economic potential. Car-sharing usage data in percentage for 2020 compared to the projection to 2030 was elaborated, since car-sharing is a representative of transportation sector and the sharing economy sector with the highest revenue. Critical evaluation of selected Sustainable Development Goals (SDGs) most related to the sharing economy is analysed and finally, the summary of the findings and recommendations is given.

2. SHARING ECONOMY AND SUSTAINABLE DEVELOPMENT: THEORY, ANALYSIS AND CHALLENGES

2.1. Sharing economy perspective and literature review

Lawrence Lessig, a professor at Harvard University, was among the first one to mention the term sharing economy, defining it as sharing, exchanging ant renting of resources, but without owning the goods, as part of collaborative consumption (Lessig, 2008). Rachel Botsman and Roo Rogers are credited with being among the first ones to study and interpret economic activities in the sharing economy (Botsman & Rogers, 2010). Many other authors have contributed to research and left their mark in the field of sharing economy, e.g. Heinrichs (2013), Mi & Coffman (2019), Laukkanen & Tura (2020), Karobliene & Pilinkiene (2021), etc. taking into consideration the rise of the sharing economy. Karobliene & Pilinkiene mention remarkable attention that sharing economy has received and over the past decade lead to multiple definitions and various terms and some of the most used in the literature, e.g. "collaborative consumption", "access-based consumption", "in web platforms facilitated peer-to-peer exchanges" and many others (Karobliene & Pilinkiene, 2021). Very similar is noted by Korabova, describing sharing or receiving products and services through a digital platform instead of traditionally purchasing them from companies, entities or other institutions (Korabova, 2019). The idea of sharing is not a new occurrence or something of sensation in our society, but just the new form of sharing goods in contemporary society and therefore seems to be a modern model (Fitzmaurice & Schor, 2015). The sharing economy benefit comprises saving the value and the access right to a certain product or service (Görög, 2018). Today's intense and excessive technological IT development based on digital platforms in sharing underutilised goods or services replaced traditional enterprise business model (Podrug, 2023). Burinskiene, Grybaitė & Lingaitienė even analyse technology driven variables and their highest impact on expanding sharing economy (Burinskiene, Grybaitė & Lingaitienė, 2024). As stated by Dervojeda *et al.*, it also impacts entrepreneurial activity were start-ups can benefit from the sharing economy uptake (Dervojeda *et al.*, 2013). The sharing economy has become more popular and therefore the consumption pattern (Botsman & Rogers, 2010). According to OECD, online platforms are contemporary present across sectors of tourism and hospitality, retail, e-commerce, culture and creative industries, the medical industry and many others (OECD, 2023).

The idea of sharing economy but with a different form existed already in ancient times as sharing between loved ones, families, villages or social groups and other entities. The beginnings of contemporary sharing economy perspective dates back to 1995, when eBay and Craigslist were established as digital markets for sale and provision of goods and services, that have become an integral part of consumer's experience and therefore influenced consumers' behaviour (Podrug, 2023). To meet the needs of today's market and world's growing population, together with preserving scarce resources, new methods and forms of providing goods and services were established and now the Internet has been used as a medium of connectivity between users and resources, thus increasing efficiency of resources that have been scarce and limited. The sharing economy began originally as small and non-profit oriented, such as Couchsurfing and Freecycle, but by gaining larger portion of market share and greater sharing fee, large business models, such as Uber and Airbnb, gradually emerged (Podrug, 2023). Online platforms (e.g. Airbnb, Uber etc.) have many users evident in number of app(s) downloads. At first, they appear just as an alternative to already existing accommodation or a taxi service just more reachable and easily manageable, but there are other positive causes as well that influenced changes in consumption behaviour and practice, such as flexible employment, depending on predominant use of communication and information technology. One of the most well-known representatives of the aforementioned changes was Uber as an online platform for providing urban transport services (Bjelinski Radić, 2017). Apart from Uber as a sharing economy example, there are numerous other business practices and models, e.g. Couchsurfing, Freecycle and Airbnb, etc. According to Böcker and Meelen, the popularity of sharing economy started after 2007-2008 and people adjusted their consumption habits, behaviour patterns, and private property and ownership value (Böcker and Meelen, 2016). After the financial crises, unemployed workers needed new job opportunities when employers such as Uber offered an alternative and became a source of income in a time and in an era marked by a high unemployment rate (Kathan, Matzler & Veider, 2016). European institutions recognised an excessive emergence of collaborative economy variety business models in Europe (Fragoso Martins, 2019). In the *European Agenda for the Collaborative Economy*, the European Parliament also defines sharing economy. There online platforms are used for the business model activities for temporary use of goods and services (European Parliament, 2016). The European Economic and Social Committee has highlighted and given opinion that collaborative or participatory consumption practices can apply virtually and literally to any aspect of human life on a daily basis – mobility; energy efficiency, housing and areas for growing food, business, communication, work, education, culture, finance, and prompting the use of renewable energies (European Economic and Social Committee, 2014). In short, as stated by Kathan, Matzler and Veider, the features of the phenomenon of sharing economy are temporary access, non-ownership, and redistribution of material goods or less tangible assets such as space, time or money with the basis of these systems being heavily relied on communication, information and IT technologies (Kathan, Matzler & Veider, 2016). There is a triad structure of participants in the sharing economy: the service providers by sharing resources, assets, time or skills and can be offered by private individuals or by professional service providers; the service users, and sharing or collaborative economy IT platforms that connect the providers with the users, monetizing their connection (Fragoso Martins, 2019). In general, there are service providers, service users and the intermediary, but only two of them enter a contractual relationship, while the third one makes sure that the platform operates properly and that the monetary transactions are controlled and supervised, taking a fee for maintaining and enabling the platform and charges for each connection, meaning that it takes commission for each service that was provided, but by not changing the ownership. The intermediary will define its own business customs and construct terms and conditions of use that would have legal force, be obligatory and binding for all participants of its affairs.

According to Ritter and Schanz, there are different models as the basis upon which the third party can be set up and defined to operate, such as singular transaction models e.g., taxi companies; subscription-based models e.g. Netflix and Glovo Prime; commission-based models of platforms e.g., Airbnb and unlimited platforms e.g. Craigslist, but all of them have a common idea in the process of making and distributing services (Ritter & Schanz, 2019). Moreover, some authors like Görög (2018) and Mukhopadhyay & Mukhopadhyay (2021) would argue that the triangular structure might potentially be critical and questionable for the intermediary, thus the sharing platform itself. The intermediary may face the risk that the user of the service, therefor a current and potential frequent customer, will establish a direct relationship with the provider of the service in future access to the service and become a client of the provider of the service, and not the client of the intermediary and their platform. Several possibilities that would put the intermediary in a better position and induce the user of the service to use the platform are reviews, regular checks and revisions of providers of the service, options to report negligence that would consequently lead to the removal of negligent, insufficient and unprofessional service providers from the platform, and to sanctions, penalties and other punishments for any breach of contractual relationship, etc. According to Görög, the online reputation based upon given evaluation is of a huge importance (Görög, 2018). Therefore, the value and quality of products and services should be conducted upon online feedback possibility, community and the previous experience of the users who share their opinion and give ratings. Moreover, the platform has a decisive role in the definition and development of legal terms and conditions upon which goods and services can and will be provided and delivered, as well as in enforcing them as legally binding to all the participants of sharing activities.

2.1.1. Analysis of sharing economy in EU-27 countries

According to the Eurobarometer of the European Union, there is a prevalence (73%) of the proportion of Europeans believing that their life is becoming easier if digitalisation of public and private activities exists (Eurobarometer, 2025). Grybaitė et al. research reveals that the environment of the sharing economy differs across EU countries (Grybaitė et al., 2022). Anyway, as stated by Gerlich, participants in collaborative consumption contribute to the EU economic growth, noting that the individuals aged 25-34 and 35-44 with higher education and a local market orientation are the most inclined to engage with online trading platforms in the collaborative economy. In the new consumption pattern, digital and green transitions in the economy are implemented, and the rise of collaborative consumption has a positive impact on purchasing behaviour and sustainable consumption. Regarding adequate targeted policies, innovations and start-ups should be promoted, together with educational consumer awareness programmes, international cooperation and interconnectedness between government, businesses and civil society sectors. For the future research efforts, the focus should be on the European employment market and the flexibility and entry barriers (Gerlich, 2023). There are five key sectors, according to Vaughan and Daverio, facilitating transactions in collaborative economy: Peer-to-peer accommodation; Peer-to-peer transportation; On-demand household services; On demand professional services; Collaborative finance (e.g. crowd-funding and peer-to-peer lending) generating revenues of nearly €4bn and facilitating €28bn of transactions within Europe in 2015 (Vaughan & Daverio, 2016). Measuring the value level of the collaborative development of EU28 in 2016, according to Nunu *et al.,* it was estimated to EUR 26.5bn as 0.17% of EU28 GDP and about 394 000 persons employed which is 0.15% of EU28 employment. When speaking of the largest collaborative economy markets in context of value in 2016, ranking was as follows: France (EUR 6.5603 billion), UK (EUR 4.6377 billion), Poland (EUR 2.7366 billion) and Spain (EUR 2.5243 billion) (Nunu *et al.*, 2018).

The peer-to-peer transportation sector is by revenue regarded to be the largest collaborative economy sector including ride sharing, car-sharing networks and driveway sharing models whereas the largest sector by total transactions value includes peer-to-peer accommodation sector, peer-to-peer rental platforms and vacation rental platforms, and home swapping platforms (Vaughan & Daverio, 2016). Since the largest collaborative economy sector by revenue originates from the transportation sector and car-sharing data for the EU-27 countries are presented according to the available Statista data for the period 2020-2024 together with the 2030 projection.

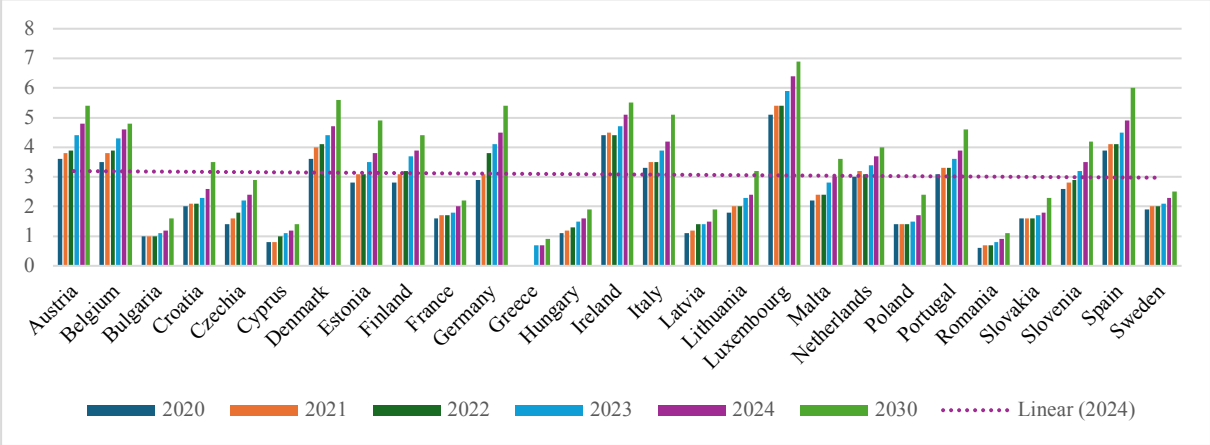

Figure 1. Car-sharing in the countries of EU-27 for the 2020-2024 period (in percentage %) (Source: Author's work, according to the Statista, 2025)

A rising trend of car-sharing usage can be noted as expected according to the Statista projection by 2030. However, there is a huge difference among the countries of EU-27 in the observed period according to the percentage of the car-sharing users. The EU-27 average in 2020 was 2.33% and above average in car-sharing percentage usage for 2020 among the EU-27 countries was as follows: Luxembourg (5.1%), Ireland (4.4%), Spain (3.9%), Austria and Denmark (3.6%), Belgium (3.5%), Italy (3.3%), Portugal (3.1%), Germany (2.9%), Estonia (2.8%), Finland (2.8%) and Slovenia (2.6%). Although car-sharing average percentage rose for all EU-27 countries in 2030 (3.08%) compared to 2020 (2.33%) (difference is 1.30), above average in 2030 were again the same countries with the Netherlands being the only country that joined the countries above the average. The ranking of car-sharing users in percentage for 2030 is as follows: Luxembourg (6.9%), Spain (6.0%), Denmark (5.6%), Ireland (5.5%), Austria (5.4%), Germany (5.4%), Italy (5%), Estonia (4.9%), Belgium (4.8%), Portugal (4.6%), Finland (4.4%), Slovenia (4.2%) and the Netherlands (4.0%). Besides the conclusion that many countries are under the EU-27 average, there are additional challenges presented in the paper, namely, the ones dealt with in Digital (Language) Divide Challenges subchapter.

2.1.2. Sharing Economy Challenges – Digital (Language) Divide Challenges

The emergence of the concept of the sharing economy has resulted in specific challenges for economies due to business models and digital platforms operating in different geographical markets in different countries. In addition, the growing share of the elderly population in most EU Member States entails specific challenges, particularly as regards their role as consumers of goods and services offered online and via digital platforms. Furthermore, Zarifis, Ingham and Kroenung mention that national economies and their consumers differ in terms of the languages used for communication and interaction on platforms (Zarifis, Ingham, & Kroenung, 2019).

Although the primary function of a language is communication, in the context of the platform-based sharing economy, language is not only the means of communication but also an information access, trust and social inclusion indicator of platform services mediated by digital interface. However, digital technology is not necessarily inclusive and it does not guarantee equally successful communication to all users. Moreover, it can generate common bases for digital discrimination such as linguistic affiliation, age and other. While the literature on platform economy (Srnicek, 2016) emphasizes economic structures and data monopolies, it often overlooks how linguistic hierarchies and language policies shape participation in digital economies. This section draws on a sociolinguistic framework to analyse how language operates both as a form of symbolic capital and as a barrier in the sharing economy, particularly for speakers of non-dominant languages. Digital divide as a concept emerged in the 1990s and was used to denote a gap between certain groups of users in their access to digital technology. In focus of every attempt to introduce a new digital technology (e.g. sharing economy platforms), it is important to reconsider users' access to secure their social inclusion (Warschauer, 2003). The causes of digital divide lie within the socioeconomic status (income, education), age (elderly people often excluded), geographic location (rural vs. urban), language (minority and non-digitalized languages), and disability (technical inaccessibility) (Ragnedda, 2019). Globally, developed countries have better access to technology and the Internet whereas underdeveloped countries, the speakers of "digitally disadvantaged" languages, and people with disabilities are often excluded from the digital society. Moreover, the concept of digital language divide denotes the gap emerging between the users and digital technology caused by insufficient usage of the digital platform because of the lack of platform language competence. In this context, some languages are considered digitally vital and others not.

This divide refers not only to inequality to access digital technology, but also to marginal status of linguistic minority and it is rooted in global language ideologies that privilege dominant languages. In this regard, Wodak and Scott state that the digital language divide addresses unequal access to digital technologies causing online marginalisation of the speakers of non-dominant languages. Its causes lie in the global dominance of certain languages, particularly English, which renders other languages invisible, less represented, or even symbolically diminished in status (Wodak & Scott, 2007). In the context of platforms, digital language divide results in inequalities in the digital support of a particular language, whereby dominant languages enjoy full technical and market support, while others, the so-called digitally disadvantaged languages, are marginalized. In terms of sharing economy platforms, this means that users whose languages do not have developed digital tools (keyboards, localized applications, and quality translation algorithms) enjoy significantly less visibility, trust and competitiveness on the market. According to Danet and Herring, English acts as the Internet *lingua franca* although the majority of network users are not native English speakers and a significant part of Internet communication takes place in other languages, in non-native English variants or in a combination of both. In spite of this, most scholarly research on the Internet communication (computer-mediated communication – CMC) written in English does not take this linguistic diversity into account (Danet & Herring, 2007). According to Bella et al. (2023:11), the digital language divide concept denotes "the difference between languages that have, and those that do not have significant representation on the Internet and within the global digital infrastructure." The authors refer to the increasing imbalances in digital language support of languages around the world focusing on the structural linguistic bias in developing language technologies. The dominant models of natural language processing, developed based on AI and machine learning are designed to systematically favour a few globally dominant languages, predominantly English, neglecting most of the world's languages.

Thus, communities of speakers of smaller languages are excluded from the digital sphere of knowledge and communication, and their linguistic and cultural identities are suppressed, which leads to epistemological injustice and unequal access to information within the digital society (Bella, Helm, Koch & Giunchigliaar, 2023). The ideal concept of Digital Language Equality (DLE) as pointed out by Gaspari as "the state of affairs in which all languages have the technological support and situational context necessary for them to continue to exist and to prosper as living languages in the digital age" (Gaspari, 2023:44). In today's digital environment, vast amounts of information are created, exchanged and consumed, enabling billions of people to access educational, health, business and communication resources instantly. These can be accessed in their mother tongues, but there is no global digital equality between languages. In 2023, 54% of the world's population had limited or no access to digital language technologies (Eberhard, Simons & Fennig, 2025). There are observations that the discussion must be extended beyond mere access to digital technologies if we wish to realise the true objective of bridging the digital divide, namely achieving digital democracy (Besser, 2004). Besides achieving digital democracy enabling participation in the sharing economy, it is crucial to implement sustainability, represented also by the SDGs.

2.2. Sustainable development and sustainable development goals

Numerous sources, scientists and different authors described, defined and explained the term and concept of sustainable development, but a common and generally accepted standpoint is that the development should incorporate the needs of today's generations without jeopardising the future and needs of the generations to follow (Herceg, 2013). As a development model, sustainable development is a holistic and future caring approach that acknowledges three pillars - the environmental, social and economic impacts of decisions and actions taken today, with the future in mind. As a result, three pillars which therefore consequently form the main threefold goal of sustainable development were created - economic development, social and cultural progress, and environmental responsibility known as ESG (Environmental, Social, Governance) standards used for estimating the impact and sustainability of companies and enterprises' activities around the world. Certain authors, e.g. Mi and Coffman believe that government should also be included as a fourth pillar and as the main catalysts of pro-social and pro-environmental actions in shaping policies and constructing consumer's behaviour while monitoring and supporting development in desired direction (Mi & Coffman, 2019). As in any market, the same applies to sharing economy market, and that is the decisive governmental role since by means of state economic control tools, it shapes policies, determines taxes, expenditure, and regulations, sets rules and decides on direction of development, and the type of market applicable to the states' territory (Samuelson & Nordhaus, 2007). A contemporary perspective of sustainable development was developed in the 1992 at the UN Conference on Environment and Development constituting the most significant universally endorsed statement of general rights and obligations of states with the environment in focus (Birnie, Boyle & Redgwell, 2009). There, the Commission on Sustainable Development, as a UN body responsible for observing the impact of the initiated activities was established. Contemporary sustainable development goals were set in 2015 by the United Nations as UN Agenda 2030 for Sustainable Development known as the Agenda 2030 where 17 Sustainable Development Goals (SDGs) were elaborated (European Commission, 2025). Measuring countries overall performance regarding the 17 SDGs is conducted by SDG Index where 100 is the best result and 0 is the worst possible outcome, after which ranking and overall achievement classification of all countries from first to last with regard to the SDGs is done each year (Sustainable Development Report, 2025). This is an international community's response to global challenges that aims to reach the principle of *leave no one behind* (UNDP, 2018).

In order to achieve certain goal or a high rank of a country according to the index of SDGs cooperation and inclusive policies at the community local levels, as well as national and global levels are needed. Although the 2030 Agenda is not a legally binding act but a voluntary course of steps, guidance and instructions in achieving an ideal global situation, it still gives an overview and feedback regarding goals that need improvement in a certain country and therefore it serves as a reference point for a respective national economy.

3. SDGS AND SHARING ECONOMY CONNECTION

Sharing economy contributes to achieving the United Nations SDGs, but it can also pose challenges in many fields and by different factors. The fact that sharing economy is a relatively new business concept that emerged primarily for economic reasons, motivated by the desire of sharing underutilised goods, making profit, and appearing as a serious competitive market actor that will establish and earn its right in taking the market share, economic dimension will be discussed first. Clearly, sharing economy trend as a collaborative consumption has proven to be a worthy and valuable indicator recognising the conditions and demands on the market in the best possible way. Korabova claims that changes in the existing markets have been done, motivating the nature of competition in certain industries and entry of new actors (Korabova, 2019). Critical evaluation of the economic dimension of sustainable development in this paper will consider SDG 8 as "decent work and economic growth", SDG 9 as "industry, innovation, technology and infrastructure" and SDG 12 as "responsible consumption and production". It is unquestionable that the sharing economy provides additional jobs and income opportunities, e.g. by improving individuals' standard of living or being their only source of livelihood, either by earning additional income or just being of a help in difficult times of (financial) crisis. Additionally, sharing economy creates a liberal market and decreases obstacles in approaching entrepreneurship, since individuals can become entrepreneurs with fewer barriers to entry by using digital platforms to offer services or rent out assets that further improve efficiency, minimize costs, as well as provide competitive atmosphere among participants in this kind of economic trade. Disadvantage of many sharing economy jobs is the lack of job security, social benefits and workers' rights. Moreover, as stated by Mi & Coffman, tax evasion is quite common in sharing economy and governments should use the tax collected from sharing activities to promote sustainability and provide incentives (Mi & Coffman, 2019). Proper measures and policies should be given in order to limit the overall economic benefits and fairness and to reduce the existing grey economy.

If proper regulation is not in place, it could be detrimental and affect not just the inequality of market, but also the inequality of all participants in sharing economy resulting in the unequal division with wealthier individuals and communities benefitting disproportionately, leaving marginalised groups at disadvantage. As for the SDG 9, Karobliene and Pilinkiene emphasize technology and innovation factors as an important tool and IT-based platforms as an essential element of the sustainable business model (Karobliene & Pilinkiene, 2021). Sharing economy affects innovation positively as it stimulates the competition (Görög, 2018). Besides only positive, there is, as stated by Böcker and Meelen, danger for existing businesses in certain sectors caused by sharing economy platforms (Böcker & Meelen, 2016), since the sharing economy activities are done by digital solutions (Karobliene & Pilinkiene, 2021) but the innovation factor is limited. In the SDG 12, as stated by the Böcker and Meelen, a more effective use of goods contributes to saving scarce resources, which is crucial for responsible production and consumption (Böcker & Meelen, 2016). In this paper the social and legal dimensions of the sustainable development aimed at improving global society as well as everyday life and living standard is going to be closely observed in SDG 11 "sustainable cities and communities" and SDG 16 "peace, justice and strong institutions".

Mukhopadhyay & Mukhopadhyay would even state that sharing economy has positive and motivating social factors, for both the customers and the providers, but also for the platform itself - described in a way that the users and consumers gain social utility while from the service providers' standpoint, sharing has social motives that influence participation. Companies such as Airbnb stress the community aspect and the locality of the accommodation, and there, no matter the type of company or the type of business operation, the platform positions itself as a community (Mukhopadhyay & Mukhopadhyay, 2021). As Korabova emphasizes, the impact of the sharing economy is definitely affected by the regulation applied to those businesses (Korabova, 2019). However the current legal frameworks do not suffice nor apply to the new sharing actors due to contrasting systems of online and offline markets and the high speed and scale of change, with the main obstacle in defining particular services and platforms although one of the recommendations is to ensure equal opportunities for both online and traditional offline industries. An important information is that any additional cost – regulatory, fiscal, operational or tax-related – is likely to influence the final price, which is an unwanted result and an outcome that policymakers often seek to avoid.

In reference to the environmental dimension of sustainable development aiming at protection of the global environment, SDG 13 "climate action" is presented. According to Laukkanen and Tura, the sharing economy business models have increased exponentially in recent years, and there is an interest in increasing social wellbeing, reducing the environmental load, and providing economic benefits (Laukkanen & Tura, 2020). The economic factors impact can be transferred and partly applied to the environmental impact, as well – i.e. the rational and efficient use of resources together with the sharing, swapping and renting of existing ones. The production and consumption itself pose a problem and cause damage to the nature, where a large amount of waste and pollution comes hand in hand with it. Karobliene and Pilinkiene emphasize the sharing economy in creating sustainable value speaking for the relevance of the sharing economy, as its perspective is reducing consumption, resource and energy usage, and affecting SDGs improvement (Karobliene & Pilinkiene, 2021). Similarly, Böcker and Meelen confirm that the sharing economy is an important mechanism for attribution to environmental sustainability (Böcker & Meelen, 2016). The Union itself took upon role to be the global leader in the transition to climate neutrality, participating in strengthening the positive climate change effects (European Climate Law, 2021). Regarding the SDG 13, with an idea towards the climate neutrality, some authors see a great potential and possible solution as regards today's global issues, especially in decreasing overall CO2 emissions, eliminating ownership and preserving land, while others see it more as a side benefit and added bonus than a primary or even chosen catalyst and motivator for people.

Korabova indicates that economic benefits have the highest percentage towards sharing behaviour (Korabova, 2019). With that in mind, there are positive standpoints regarding sharing economy environmental impacts, for instance in reduction of the total resources required as well as reduction of emissions, pollutants and carbon footprints. Positive effect in the transportation sector could be seen by vehicle sharing, decreasing the number of kilometres travelled (Mi & Coffman, 2019). The positive externalities of sharing practices may lead to lasting transformation in consumer behaviour, particularly by redirecting personal transportation choices from ownership to on-demand. Moreover, in vehicle sharing platforms, the customers use empty seats of vehicles and there is a potential for overall decrease in automobiles used that would result in better environmental conditions (Mukhopadhyay & Mukhopadhyay, 2021). Apart from all potential benefits and despite seeing the sharing economy as a potential new pathway to sustainability, its social, economic and environmental effects are still mostly uncertain.

Contrary to prevailing assumptions, not all sharing practices are inherently sustainable, and some authors even suggest that the sharing economy may reinforce existing unsustainable economic behaviours (Laukkanen &Tura, 2020). Therefore, it is essential to harmonise 'conflicts' between social well-being and business profits, i.e. finding a solution between maximising business profits on the one hand and sustainable value creation and human well-being on the other hand.

4. CONCLUSION

Sharing economy relies on the ideals of cooperation and solidarity, and it is constructed by the demand for assets and resources needed for a particular person or customer. The sharing economy as a collaborative consumption is an economic model based on activities of renting, bartering or sharing products and services without contracting ownership, done electronically connected by a platform. Sharing economy has a potential in achieving higher rates of sustainable development, but there are additionally many effects of the social, environmental and economic dimensions that should be taken into consideration. In addition, there are certain challenges for which adequate measures should be taken, such as ageing divide present in number of technology users where most of the users still belong to the younger population - who follow the novelties, use the available digital solutions and share services that are stimulated by globalisation, technological innovations, decreased resources and IT resolutions. Knowing that most of the EU27 countries face ageing challenges, the question has acquired a significant importance especially if digital democracy is to be achieved. Besides, digital language divide is additional important issue when challenges of sharing economy are considered – for instance, platforms enable global connectivity and economic opportunity, but they can simultaneously not only generate and deepen linguistic inequalities but also make grounds for social exclusion and marginalisation. The problem can be resolved in synergetic approach involving technical standards, researchers, policy makers and the platforms safeguarding that participation in the sharing economy facilitated by digital technology does not depend on the privilege of speaking the "dominant" language. In order to reduce existing gap in the age of users and the digital (language) divide, there are few suggestions that could be implemented at the local community's level:

- ✓ Organising workshops for public at large interested in raising their level of knowledge of financial literacy and available sharing economy platforms;
- ✓ Ensuring the use of the residents' national language;
- ✓ Introducing the intergenerational digital mentorship programmes conducted in local/native languages;
- ✓ Motivating the creation of age-tailored inclusive digital content (videos, podcasts etc.).

Although this paper and analysis entail certain limitations, e.g. due to lack of available data on sharing economy value for EU-27 for each country and overall, an indicator of car-sharing as a representative of sharing transportation and sharing economy has been chosen. Therefore, the ranking might have slightly changed if another sector, e.g. sharing accommodation had been selected, as in case of the countries where tourism is one of the main economic sectors. It is therefore recommended that future research include this indicator as well as sharing finance and any other sector(s) relevant for the sharing economy ratio. It is evident from the theoretical analysis that the sharing economy as a collaborative consumption, has proven to be a worthy and valuable actor. It recognises demands of the market, therefore provides services that meet the consumers' needs and offers opportunities to individuals, implements the idea that this model can additionally bring benefits to the environment, in both local and global perspectives.

Regarding the environment, it is certainly supported by reducing waste and pollution, promoting the re-use of products, and decreasing the overall production of goods, which encourages a more sustainable consumption pattern that can contribute to resource conservation and bear in mind future generations. Sharing economy could be the basis for a side job or an easier form in becoming entrepreneur by utilizing digital platforms in order to improve efficiency, impact minimization of costs and boost a competitive atmosphere among sharing economy participants.

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SOCIOECONOMIC AND POLICY DRIVERS OF ELECTRICITY ACCESS IN ASIA

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ABSTRACT
The exploration of electricity spans several centuries, yet the widespread integration of the electric grid for industrial use emerged in the late 19th and early 20th centuries. This rapid expansion significantly transformed both industry and society. Electricity's introduction profoundly influenced societal well-being. Regions connected to an electric grid tended to experience an enhanced quality of life. Consequently, access to electricity became integral to the modern societal standard of living. Investigating the concept of electrical poverty, this study delves into it is manifestations.
Keywords: *Electricity Access, Energy Poverty, Socioeconomic Determinants, Renewable and Fossil Fuel Consumption*

1. INTRODUCTION

Energy poverty can be defined as the inability to afford adequate energy services [1]–[3], it is conceptualization underscore the critical importance of energy consumption juxtaposed with its limited or insufficient availability [4], [5]. This rationale substantiates the utilization of proxies aimed at gauging energy poverty. Given the dearth consistent theoretical frameworks, ad hoc selection of indicators to quantify access to electricity prevails in scholarly discourse [6]. The reduction of energy poverty is closely related to energy consumption, for example, the increase in the consumption of renewable energies is related to the reduction of energy poverty [7], [8]. As well as the consumption of energy from non-renewable sources, the consumption of this type of energy matrix tends to contribute to the reduction of energy poverty, mainly due to its lower cost, however, reliance on fossil fuels in the long term tends to cause damage to health and also to the environment [8]. Economic factors can contribute to the reduction of energy poverty, such as GDP per capita, with an increase in income, individuals can allocate expenses to factors other than just subsistence. In addition, the increase in income can be a factor that contributes to a higher collection by the state, in this way, being able to direct resources to infrastructure, providing subsidies, and supporting energy efficiency programs, which can contribute to the reduction of energy poverty [9], [10]. Along with the expansion of economic activity, employment tends to increase, thus, can be inferred that energy poverty may be reduce.

It is complex not to link energy poverty to the broader problem of poverty, of course, access to energy infrastructure would avoid its most serious consequences and help encourage development [11]. In the regions of Asia and the Pacific, an excess of 600 million individuals currently lack access to electricity. In comparison, approximately 1.8 billion individuals rely on wood or charcoal as their primary sources for cooking and heating [12]. This study examines energy poverty through economic, social, and energy matrix lenses, particularly in 26 Asian countries. However, it is essential to acknowledge that energy poverty presents a distinct issue for vulnerable consumers, necessitating unique metrics for its definition, measurement, and resolution [13]. Therefore, the primary aim of this study is to assess and scrutinize the varied impact of factors contributing to energy poverty across the Asian continent from 2000 to 2022. This investigation endeavors to address the following inquiries: (i) What key socio-economic factors serve as drivers or determinants enabling the analysis and assessment of energy poverty, gauged by the percentage of electricity access in Asia? (ii) What are the principal recurring differential impacts of unemployment or per capita income on households' access to electricity?

2. METHODS

The data used in this study have been sourced from online secondary repositories, compiled by the World Development Indicators (WDI). Energy poverty is measured using the metric "Access to electricity (% of population)." The model incorporates the explanatory variables, including Fossil fuel energy consumption (% of total), Renewable energy consumption (% of total final energy consumption), GDP per capita (constant 2015 US$) as a proxy for household income, General government final consumption expenditure (constant 2015 US$), Unemployment, total (% of the total labor force), and Labor force (total). The sample encompasses data from 2000 to 2022, encompassing 26 Asian economies. These economies are Armenia, Bangladesh, Bhutan, Cambodia, Cyprus, India, Indonesia, Iran, Islamic Rep., Israel, Japan, Kazakhstan, Kyrgyz Republic, Lao PDR, Lebanon, Malaysia, Nepal, Oman, Pakistan, Philippines, Russian Federation, Saudi Arabia, Singapore, Sri Lanka, Tajikistan, and Vietnam. To investigate the association between the energy poverty metric and its determinants, Fractional Regression Models (FRM) were selected. This approach was preferred to mitigate the econometric issues often encountered with linear models. Moreover, FRM is deemed suitable due to its conservative nature and robustness in identifying determinants, especially concerning access to electricity.

3. MAIN RESULTS

The Logit model emerged as the most robust choice. Notably, this analysis considered the entire sample as a whole. Moving on to the two-part analysis, the first component focused on the lower half of the sample, representing the 50% most energy-poor individuals. In the second part of the fractional model, the statistical results reinforce the suitability of the Logit specification as the most appropriate binding function. The GOFF-I, GOFF-II and GGOFF tests showed high and highly significant values ($p < 0.01$) for this specification, indicating a good fit of the model to the data. Based on the marginal effects derived from the one-piece Logit model, several key findings emerge. The most substantial positive marginal effect are observed for the Energies Consumption variables, where a one-unit increase is associated with a percentage point increase 0.3 and 0.6 respectively, in the likelihood of electricity access. Conversely, GDP per capita and Unemployment show positive marginal effects, with 0.00447 and 0.86995 percentage points respectively, indicating that increased may be linked to reduce energy access among certain groups, potentially due to affordability or infrastructural constraints. Labor exerts a modest positive marginal effect.

In the One-Piece model, which considers the entire sample, renewable and non-renewable energy consumption contributing to the reduction of energy poverty, such a relationship is coherent, considering that if there is an increase in consumption it is likely that more people may be having access to energy. A positive correlation with GDP per capita was expected, as it serves as an indicator of a nation's growing prosperity. With an increase in per capita income, economic expansion is likely, leading to higher government revenue that can be allocated towards expanding electrical infrastructure, consequently reducing energy poverty. However, The results point to the opposite. Despite the counterintuitive result, the findings may be due to the economic characteristics of the sample, since it is mostly about economies considered to be developing, the increase in per capita income contributing to an increase in energy poverty may be related to a concentration of income in these economies.

The increase in unemployment contributing to the increase in energy poverty is coherent, considering that a higher unemployment rate is usually accompanied by an increase in poverty, therefore, with a drop in income, individuals may be forced to redirect scarce resources to subsistence, leaving energy, despite being of paramount importance for quality of life, in the background. , the same logic applies to the labor force, the results indicate that an increase in the labor force is related to a decrease in energy poverty, a coherent result, considering that an increase in the workforce can be related to several economic factors, such as a growth in economic activity. The growth of the labor force is often associated with the increase in the level of economic activity and the expansion of the country's productive base. With more economically active people, there is a trend towards an increase in the aggregate income of households, despite the unexpected result observed in this sample, which tends to improves the ability to pay for essential services, including access to electricity.

For the two-part model, in the first component, only GDP per capita affect energy poverty, with positive, with a margin effect of 0.00176% for each unit added. The GDP per capita, the General government final consumption expenditure observes, the expected result was a reduction in energy poverty, considering that part of these expenses may be allocated to electrical infrastructure. , in the second component, Fossil fuel energy consumption, Renewable energy consumption, and labor force harm energy poverty contributing to its reduction. the variables GDP per capita (0.00544%) and unemployment (1.22404%) affect it positively, contributing to an increase in energy poverty.

4. CONCLUSION AND POLICY IMPLICATIONS

In conclusion, this study has delved into the multifaceted issue of energy poverty, particularly focusing on its manifestations and determinants across 26 Asian countries from 2000 to 2022. Through the utilization of Fractional Regression Models (FRM), we sought to understand the nuanced relationships between various socio-economic factors and electricity access, a key metric in gauging energy poverty. Our analysis revealed several notable findings. Firstly, we observed a consistent pattern across both one-part and two-part models, indicating inverse relationships between energy poverty and factors such as Fossil fuel energy consumption, Renewable energy consumption, and Labor force, in the sense that an increase in these variables is related to a reduction in energy poverty. Conversely, positive associations was found with variable unemployment, in other words, an increase in unemployment is related to an increase in energy poverty. However, our study also unearthed unexpected results, particularly regarding the relationship between GDP per capita, General government final consumption expenditure and energy poverty. Contrary to conventional wisdom, rising on these variables appeared to increase energy poverty, a phenomenon requiring further investigation to unravel its underlying mechanisms.

Policymakers can propose programs that tend to implement renewable energies, therefore, policies that can contribute to mitigating climate change. The implementation of this type of policy contributes to reducing energy poverty by expanding access to electricity, but also reduces the cost of energy and creates jobs. In addition, the proposition of social programs government interventions and subsidies, as social safety net programs during periods of high unemployment, so that these individuals do not have to give up electricity, therefore, quality of life. In this way, it is possible to deal with energy poverty through two pillars: social and sustainability. In light of these findings, it is evident that addressing energy poverty necessitates a multifaceted approach that considers not only economic development but also social and environmental factors. Policies aimed at promoting sustainable energy access and employment opportunities while mitigating environmental degradation can play a pivotal role in reducing energy poverty across the Asian continent.

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MULTIDIMENSIONAL IMPACTS ON THE REFORM OF SOCIAL SERVICES FINANCING IN THE SLOVAK REPUBLIC

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ABSTRACT

Social services are an integral part of the social protection system, and their availability and quality are directly influenced by the manner and volume of their financing. In the Slovak Republic, there has been a long-standing imbalance between the demand for social services and their capacity and financial resources, which significantly limits their functionality and effectiveness. The dominance of short-term sources of funding does not cover the systemic needs of the sector and does not contribute to its long-term stability. The aim of this paper is to identify factors influencing the functioning and development of social services with the potential to create jobs in the social care sector. The paper reflects the content of the Concept for the Reform of Social Services Financing, developed in 2024 as part of the Recovery and Resilience Plan of the Slovak Republic. The document presents a strategic framework for the creation of a new financing model based on the principles of efficiency, targeting, and financial predictability. At the same time, the article analyses the economic, social, and technological influences that have a significant impact on the social services sector. The conclusion of the article draws attention to the necessity of multi-source financing as well as the growing need for personnel, which will become more urgent due to the ageing population. Modern technologies that relieve the burden on residential social services facilities and enable the supervision of vulnerable groups in their home environment may be a partial solution.

Keywords: Seniors, Social services, Demographic aging, Slovak Republic

1. INTRODUCTION

The document "National Priorities for the Development of Social Services for 2021-2030" (MPSVR SR, 2021a) explicitly emphasizes that one of the basic prerequisites for ensuring a sustainable development trajectory for social services and the effective implementation of the priorities set is the existence of a strategic framework for social services with a view to 2030. Following this strategic commitment, preparatory expert discussions were initiated in the Slovak Republic aimed at drafting a document entitled "Vision and Strategy for the Development of Social Services in Slovakia until 2040". The ageing of the population in the Slovak Republic is a serious demographic trend with profound socio-economic implications. This phenomenon calls for systematic and long-term sustainable measures in the areas of social policy, health care, and, in particular, the provision of social services. The growing number of elderly population places growing pressure on public resources, institutional capacity and the quality of services provided, while at the same time emphasizing their accessibility, efficiency and human rights principles. One of the key causes of population ageing is the long-term low fertility rate, which is below the replacement level. According to available statistics, natural population decrease has been recorded in recent years. In one particular year, the difference between the number of live births and deaths was –7,635, representing one of the largest natural declines in the history of the Slovak Republic. The decline was even more pronounced in 2021, when it reached -16,896. Since 2020, the Slovak Republic has been facing a sustained natural population decline – in the early years of this trend, increased mortality dominated, mainly in connection with the COVID-19 pandemic, but since 2022, the main determinant of this decline has been falling fertility.

Another important factor influencing the ageing process is the decline in mortality. In 2024, 53,876 people died in Slovakia, representing a decrease of 257 people compared to the previous year. This trend is in line with developments in the previous two years, and points to a degree of stabilization of mortality, which, after a significant increase due to the pandemic (especially in 2021, when 73,461 people died), is returning to pre-pandemic levels. The gradual ageing of the large population cohorts born in the second half of the 20th century, which are gradually entering post-productive age, also has a significant impact on the change in the age structure of the population. For the first time in Slovakia's history, the number of people in this age group (65 and over) exceeded one million, specifically 1,018,725 people. This represents a significant milestone in the country's demographic development, with enormous pressure on the social services system. The proportion of seniors in Slovakia's population is clearly increasing. At the beginning of the 20th century, it was approximately 5%, and by the end of the 1980s, it had increased to 10%. A further increase occurred in the following decades, and by the end of 2024, the proportion of people aged 65 and over reached almost 19%. Population projections (Šprocha, Ďurček, 2019) indicate that during the 2060s, this proportion may exceed 30%, placing the Slovak Republic among the fastest ageing countries in the European Union.

Age group	2000	2010	2020	2024
Pre-productive age: 0 – 14 years	19,18	15,28	15,90	15,80
Productive age: 15 – 64 years	69,35	72,34	67,03	65,40
Post-productive age: 65+ years	11,47	12,38	17,07	18,80

Figure 1: Population structure by main age groups
(Source: own processing on the basis of data of the Statistical Office of the Slovak Republic)

The proportions of individual age groups are changing slightly over a short period of time, but in the long term it is clear that the ageing of the Slovak population is accelerating. In 2024, the ageing index exceeded 118%, the economic burden index reached 52.94%, and the economic dependency index for the elderly reached 28.7%. These facts point to an urgent need to adopt comprehensive, intersectoral policies that reflect demographic realities and ensure an adequate response to the changing needs of the ageing population. In addition to developing social service capacities, these policies should also include support for intergenerational solidarity, accessible forms of community and home care, and support for active and healthy ageing. From a public policy perspective, it is essential not to limit oneself to demographic indicators of the increase in the proportion of older people in the population, but to monitor equally closely their health status, which has a fundamental impact on the level of self-sufficiency, autonomy, and quality of life of older individuals, as well as their life expectancy. Data from the Statistical Office of the Slovak Republic (STATdat, 2025) show that in 2024, the "average life expectancy" at age 65 was only 5.9 years for men and 19.6 years for women. These figures indicate that a significant part of the life in old age is accompanied by health problems, limited functional capacity, and the need for daily support from formal or informal caregivers. In its strategic document "National Priorities for the Development of Social Services" (MPSVaR SR, 2021a), the Ministry of Labor, Social Affairs and Family of the Slovak Republic (MoLSAF SR) predicts that the majority of the remaining life expectancy in old age will be characterized by some degree of functional limitation and dependence on the assistance of others. This assumption reinforces the need to develop long-term care, including the provision of accessible, high-quality and integrated social and health services. At the same time, the rapidly growing number of older people is creating new social, economic and technological challenges. Despite the frequent interpretation of population ageing as a threat to the sustainability of public finances or the labour market, it is also important to highlight its development potential.

Seniors represent an significant segment of society that can stimulate demand for new products and services, create job opportunities, and initiate new forms of entrepreneurship within the so-called silver economy. In this context, it is essential to support and implement social and technological innovations that enable older people to remain in their homes and familiar surroundings for as long as possible, while maintaining their independence, safety, and dignity. Innovative solutions – whether digital technologies for remote health monitoring, smart homes or community care models – can substantially contribute to improving the quality of life of older people and reducing the institutional burden on the system. Social innovation, as defined by Skokan (2005), refers to the creation and implementation of new solutions in response to social challenges that lead to improved living conditions for individuals and communities. Its importance is growing, particularly in the context of increasing public demands for social stability, equal opportunities, and sustainable development. From a macroeconomic perspective, social and technological innovations have the potential to increase the efficiency and effectiveness of long-term care and healthcare systems, which is particularly important in times of demographic change and growing pressure on public spending. In order to adequately address the consequences of population ageing, it is therefore essential to create a connected innovation ecosystem that links the public, private and civil sectors, supports research and development, and reflects the changing needs of older people at different stages of ageing. The aim of this paper is to identify factors influencing the functioning and development of social services with job creation potential in the social care sector.

2. THEORETHICAL BACKGROUND

All European Union countries are addressing the issues of developing and modernizing social service systems, as the ageing population affects the entire European continent. Social services contribute significantly to ensuring the fundamental rights of European Union citizens, such as dignity and personal integrity. The need to create a comprehensive strategic framework as a key prerequisite for the further development of the social services system is also repeatedly emphasized in various strategic and position papers. Respect for fundamental human rights and freedoms is the fundamental value framework of the social services system, which is based on the consensus of the international community of states in the field of human dignity protection. At the global level, these are commitments arising from key international legal instruments such as the United Nations Convention on the Rights of Persons with Disabilities (Ministry of Foreign Affairs of the Slovak Republic (MZV SR, 2010), the Convention on the Rights of the Child (Federal Ministry of Foreign Affairs - FMZV Czechoslovakia, 1991), and notably the 2030 Agenda for Sustainable Development (OSN, 2015). In the European context, relevant principles and recommendations for social services are articulated, for example, in the European Charter of the Rights and Responsibilities of Older People in Long-Term Care (Daphne, 2010), and in the Voluntary European Framework for Quality of Social Services (Social Protection Committee, 2010). At the national level, a human rights-based approach to social services is enshrined not only in legislation through Act No. 448/2008 Coll. on social services, but is also systematically reflected in key strategic and programmatic documents. These include, in particular, the Strategy for the Deinstitutionalization of the Social Services and Alternative Care System in the Slovak Republic (MPSVaR SR, 2021b), the National Program for Active Ageing for 2021–2030 (MPSVaR SR, 2021c), the National Program for the Development of Living Conditions for Persons with Disabilities for 2021–2030 (MPSVaR SR, 2021d), and the Strategic Framework for Health Care for 2014–2030 (MZ SR, 2022). The mission of the social services sector is to ensure the qualified and systematic provision of comprehensive, multidisciplinary professional social services for all social strata of the population.

Social services are one of the key components of the social assistance system, through which the state actively promotes the integration of people into society and responds to their individual social needs. An unfavourable social situation is understood as a state in which there is a weakening or loss of the ability of an individual or group to effectively deal with life circumstances in such a way as to maintain the conditions for their social inclusion and minimize the risk of social exclusion. Such a situation can be determined by various factors, including advanced age, poor health, the occurrence of life crises and lifestyles that conflict with social norms, living in a socially disadvantaged environment, the threat to fundamental rights and legitimate interests as a result of criminal activity by another natural person, as well as other significant social determinants. The recorded increase in the proportion of the population at risk of or already affected by social exclusion generates an increased demand for qualified professionals in the field of crisis intervention and social counselling services. At the same time, given the demographic trends characterized by an ageing population, there is an increasingly urgent need to introduce systematic mechanisms for predicting labour force needs in the social services sector. An important part of the future direction of the social services system is the process of deinstitutionalization, which emphasizes the development of community-oriented services and the preference for field and outpatient forms of social support over residential (inpatient) services. This approach reflects the need to strengthen social cohesion and supports the retention of individuals in their natural social environment. In its Communication on the EU Strategy on Care, the European Commission draws attention to the benefits of the digital transformation of society for the long-term care sector, which can be seen in the possibility of replacing strenuous and risky tasks performed by care and nursing staff with technologies, monitoring dependent persons, or streamlining the recruitment and training of those who provide care on a formal and informal basis (Európska komisia, 2022). The Digital Transformation Strategy of Slovakia 2030, approved by the Slovak Government (2019) in Resolution No. 206/2019, defines digital transformation as the process of transition from an industrial society to a society based on innovative technologies in the form of: artificial intelligence; Internet of Things; 5G technology; big data and data analytics; blockchain; high-performance computing.

3. METHODOLOGY

The methodological approach to examining the impacts on the social services system in the Slovak Republic is based on a qualitative analysis of secondary sources, documents, and strategic materials in combination with descriptive and comparative methods. The aim of the research is to identify and interpret the main factors influencing the current social services financing system and to propose recommendations for its long-term sustainability and efficiency with the potential to create jobs. For the purpose of quantifying future needs, a methodology is used that employs a demographic projection model based on official population forecasts by age cohort, life expectancy, and care needs in different age groups. The analysis was based on national and European documents, including Act No. 448/2008 Coll. on social services, the Slovak Republic's Recovery and Resilience Plan (2021), the Concept for the Reform of Social Services Financing (2024), as well as other analytical materials from the Office of the Government of the Slovak Republic and the Ministry of Labor, Social Affairs and Family of the Slovak Republic. These documents were analysed in terms of their content, objectives, and implications for the social services system. The research identified three main areas of impact: (1) demographic changes, in particular the ageing of the population and the prolongation of the period of dependence of older people on the assistance of others, (2) economic factors, in particular the issue of the efficiency and sustainability of public expenditure and the need for systemic solutions, (3) technological progress, particularly innovative solutions in the field of monitoring and care for seniors in their home environment.

Based on the identified determinants, an analytical synthesis was also applied, which made it possible to create a conceptual framework for further discussion on social services reform. The proposed methodological approach enabled a comprehensive understanding of the issue in an interdisciplinary context, taking into account economic, social, and technological interconnections and their impact on the quality of life of social service recipients.

4. RESULTS

Since 2009, social services in the Slovak Republic have been provided on the basis of Act No. 448/2008 Coll. on social services and on amendments to Act No. 455/1991 Coll. on Trade Licensing, as amended. This Act comprehensively regulates the legal relations, conditions and framework for the provision of social services, the main purpose of which is to promote the social inclusion of persons and to satisfy their individual social needs in cases of adverse social situations. Social services thus fulfil an important integrative function, helping not only to solve social problems on an individual basis, but also to strengthen social cohesion and stability in society as a whole. The growing importance of social services in the context of demographic and socio-economic transformation of society is determined by several structural factors:

- the increase in life expectancy, which leads to an increase in the number of people in the senior age categories, while at the same time extending the period of life during which individuals are dependent on the help of others to meet their basic needs
- increased expectations of quality of life in old age, which are linked to the transfer of the standard of living acquired during working life to the period of economic inactivity, placing greater demands on the scope and quality of services provided
- increasing costs of compensating for the loss of self-sufficiency, which place increased demands on the efficiency and sustainability of social service systems, as well as on their ability to respond flexibly to the changing needs of recipients.

These factors significantly influence not only the scope and structure of demand for social services, but also the nature and capacity of the social services sector itself, including its staffing, financial mechanisms, and quality standards. In view of the above, it is therefore necessary to identify the factors that have a significant impact on the social services sector. The key economic factors influencing the functioning and development of social services include, in particular, the balanced coordination of the state's economic and social policies, which is reflected in the scope and stability of public expenditure allocated to meet the growing needs in this sector. A sufficient volume of public funding is a prerequisite for ensuring the accessibility, quality, and sustainability of the services provided. The economically justified costs per place per month averaged € 1,198, with the highest costs in residential facilities – specialized facilities € 1,669, in social services homes, facilities for the elderly and care facilities, they ranged from € 1,371 to € 1,450 per month on average. The lowest economically justified costs were in day care centres, where they reached € 494. (MPSVaR SR, 2025) Despite the relatively high costs of this type of social services, the Slovak Republic reports a shortage of available places in social service facilities, which is expected to increase due to demographic developments. Slovakia spends 0.9% of its GDP on long-term care. Due to the ageing population alone, spending will increase to 1.2% of GDP by 2030. In practice, the needs related to the provision of social services are often co-financed by the European Union, which temporarily alleviates the pressure on public budgets but does not represent a systemic solution. Their time-limited nature and project-oriented structure make long-term planning impossible and do not address the need for stable and predictable financing of the sector. In response to this situation, a Concept for the Reform of Social Services Financing was developed in 2024 as part of the implementation of the Recovery and Resilience Plan of the Slovak Republic.

This strategic document identifies the fundamental systemic shortcomings of the current financing model and formulates the starting points for its transformation. The aim of the reform is to ensure equal physical and financial access to social services for all persons dependent on their support, with an emphasis on the efficiency and effectiveness of public spending. The concept focuses primarily on reforming the financing of social services based on the degree of dependency, but its ambition is to create a comprehensive framework for a new system of financing all types of social services. A basic prerequisite for the success of the reform is the creation of a sustainable model that reflects demographic and social changes, is fair to both service providers and recipients, and supports balanced regional development. Insufficient, fragmented, or targeted funding is currently reflected in the low availability of social services, which negatively affects the opportunities of people who need help in their daily lives and reduces the effectiveness of the entire social support system. In this context, reform of financing is one of the most important prerequisites for ensuring an accessible, functional, and fair social services system in the Slovak Republic. According to the Report on the Social Situation for 2024 (MPSVaR SR, 2025), the average time taken to process all applications was around 135 days, with 220 days in facilities for the elderly and 229 days in social service homes. Of the total number of applications, 44% were processed, i.e. 19,359. Fifty-six percent of applications, or 24,742, remained unprocessed in 2024, with the highest proportion of unprocessed applications in facilities for the elderly (13,616), specialized facilities (5,644), and social service homes (2,972).

	Number of applications	Number of applicants	Number of applications processed	Number of unresolved applications
Supported housing facility	312	213	143	169
Facilities for seniors	23 322	16 524	9 706	13 616
Care service facilities	4 451	3 712	2 359	2 092
Rehabilitation centre	84	57	64	20
Social services home	4 409	2 279	1 437	2 972
Specialized facility	10 831	6 177	5 187	5 644
Day care centre	692	605	463	229

Figure 2: Register of applicants for social services for 2024
(Source: MPSVaR SR, 2025)

Another key economic factor influencing the functioning and development of social services is the maintenance and growth of human capital in social services. According to the Report on the Social Situation for 2024 (MPSVaR SR, 2025), as of December 31, 2024, there were 31,276 employees working in social services facilities for people dependent on the assistance of others **(**76% of the total number of employees in social services). The average age of employees working in social services facilities for people dependent on the assistance of others was 48.25 years. The largest number of employees work in facilities for the elderly (35%), social service homes (31%) and specialized facilities (25%). Most employees in social services facilities for people dependent on the assistance of others work in client care (20,212 – 64%), with the most common position in this area being adult caregiver in a facility (10,917), nurses (2,085), social rehabilitation instructors (1,730), social workers (1,702) and healthcare assistants (1,439). The next largest category is support activities, which employs 8,042 people (25%), mainly as cooks, cleaners, and other support staff. There are 3,389 employees in administration, representing 11% of the total. Women dominate almost all job positions (87% of the total number of employees).

This is physically demanding and financially undervalued work. Between June 4 and 13, 2025, the Slovak Chamber of Social Workers and Social Work Assistants collected data to obtain feedback from social service workers on their experiences, obstacles, and suggestions for improvement. The questionnaire was completed by 187 respondents working in various types of social service facilities and services. The respondents' answers show that the most common obstacles are related to working conditions, personal exhaustion, inadequate remuneration, and staff shortages. These factors significantly affect the quality of services provided and the overall satisfaction of employees. Respondents often felt powerless, emotionally exhausted, or insufficiently supported by the system. The most frequently identified obstacles were: low financial remuneration (25.7%), demanding work with clients and powerlessness (22.5%), lack of skills and support (19.8%), other or specific obstacles (15.5%), poor cooperation and team relations (8.6%), lack of staff and overload (6.4%), low status and prestige of social workers (0.5%), systemic and legislative barriers (0.5%), and substandard working conditions (0.5%). The questionnaire also asked respondents what specific measures they would propose to improve working conditions. The responses showed that they would most like to see improved financial conditions, more staff, access to training and professional support, better legislative protection, and clearer rules for the profession. Among the suggestions for increasing interest in working in social services, respondents mainly proposed: higher salaries and better financial conditions (54.5%), other or specific suggestions (20.3%), improving staffing conditions and security (18.7%), improving legislation and the system (2.7%), increasing social recognition and prestige (2.1%), and increasing information and awareness (1.6%). The results of the questionnaire show that social service workers are often exposed to demanding conditions, emotional and physical exhaustion, underappreciation, and a lack of institutional support. (Slovenská komora SP a ASP, 2025) These findings are reflected in the national priorities for the development of social services for 2021-2030, which aim to ensure the financial and human resource sustainability of social services. This is not only about securing funding for social services personnel, but also about taking measures to improve the motivation of professional and other workers to engage in social services and to support their professional growth through systematic training and development (MPSVR SR, 2021a). The key social factors influencing the functioning and development of social services include, in particular, the migration of the working-age population from smaller settlements to larger cities, with a shortage of human resources in rural areas being particularly likely. Other factors include the outflow of skilled workers to more lucrative work environments, public attitudes toward social service professions, and the attractiveness of job positions. Equally important are the attitudes of the public and workers toward change, reform, and innovation. Current workers are accustomed to providing institutional care and are not always prepared for changes that also require a different job structure. The process of deinstitutionalization is still perceived by the public as a pilot project and, according to them, only concerns large-capacity social service facilities for dependent persons. Transformation and deinstitutionalization are approached mainly from the perspective of "leaving social service homes and moving to small houses," without properly addressing the need for structural changes the need for structural changes in the entire social service system, or even in the entire system of public services provided mainly at the community level (health, transport, education, other social, communication, construction, and other public services) (MPSVR SR, 2021a). The key technological influences affecting the functioning and development of social services include, in particular, the availability and possibilities of new technologies and innovations – facilitation of work processes, reduction of physically demanding work, modernization and innovation in service and activities, innovation in security, new forms of social service provision (e.g., the use of social services through telecommunications technologies).

The Social Services Act divides social services into several groups, depending on the nature of the adverse social situation or the target group for which they are intended, namely crisis intervention social services, social services to support families with children, to address adverse social situations due to severe disability, poor health or reaching retirement age, social services using telecommunications technologies and support services (MPSVaR SR, 2025). According to data from the Public Health Authority of the Slovak Republic, approximately one in five falls among seniors results in injury, and one in forty requires hospitalization. Falls are the most common cause of injury in the elderly population and the fifth leading cause of death among older adults, with the majority occurring in the home. Early and adequate intervention after a fall is often a decisive factor in survival and minimising health consequences. In the context of the growing need to ensure safe and dignified conditions for ageing in the home environment, modern technologies represent an innovative and effective support tool. Their application is based on passive monitoring systems that use wireless sensors placed in individual rooms of the home to continuously monitor the level of activity or inactivity of the person being monitored. The collected data is transmitted to a central control unit, from where it is sent to a data centre, where it is evaluated using specific artificial intelligence algorithms. If significant deviations from the senior's usual behaviour are identified (e.g., absence of movement, change in daily routine), the system automatically generates an alert, which is then sent to the designated person in the form of a text message, email, or audible alarm. An important feature of these systems is that they preserve the privacy and dignity of the people being monitored, as they do not use camera or audio recording devices. Monitoring is carried out exclusively through a network of motion sensors and detection units that communicate wirelessly. The system also includes SOS buttons for calling for help, which are located in various places – for example, on a personal pendant, a central unit, or a separate module, often installed in the bathroom, where the risk of falling is statistically highest. (Sika, Hajtmánková, Pongrácz, 2023) Technological solutions aimed at monitoring seniors in their home environment represent a significant contribution to both individual and systemic care for older people. From the perspective of family members, they enhance perceived safety and control, while from the perspective of the social services system, they complement traditional forms of support. Their application also improves the quality of life of seniors living alone and makes it possible to delay or eliminate the need for institutional care, thereby contributing to the optimization of public spending on long-term care.

5. CONCLUSION

In less than a decade, the Slovak population aged 65+ has grown by more than 241,000, which means that this is not a marginal group of society, but a population with specific potential and needs that both the private and public sectors must prepare for. Slovakia is still facing one of the most rapid population ageing processes among European Union countries. The proportion of the population aged over 79 will rise from the current 3.4% to almost 15% of the total population in 2070, which will represent the fastest percentage increase in the population aged over 79 and the second-fastest increase in the population aged over 64 among European Union countries. These projections will also bring new challenges in the area of social care. Based on available statistical data on the capacities and staffing of the OPIO sector (institutional and residential social services) in Slovakia as of 2023 and using Eurostat demographic projections until 2040, a forecast of labour demand until 2040 has been prepared. The starting point is the finding that in 2023, there were 46,199 recipients in institutional and residential social services facilities, of whom 34,204 were of retirement age (65+). To provide this care, 30,456 workers were employed, representing 50,293 full-time jobs. Demographic projections estimate that the number of people aged 65 and over will increase from approximately 960,000 in 2022 to 1.266 million in 2040.

This trend will have a significant impact on the demand for residential social services. The model works with three scenarios for service utilization: low (3.0% of the population aged 65+), medium (maintaining the 2023 level – approximately 3.56%), and high (4.5%). The proportions were interpolated linearly between 2023 and the target value in 2040. The results indicate that in the low scenario, there will be a slight increase in the number of recipients, but this will be relatively modest compared to the growth of the senior population. The need for jobs will increase only slightly, with growth determined primarily by demographic developments. In the medium scenario, the use of services is expected to stabilize at the current level, which, combined with population growth, will lead to a more significant increase in the number of recipients and the number of jobs required – by approximately a quarter compared to 2023. This scenario reflects the continuation of current trends without any major changes in social services policy. The highest increase is expected in the high scenario, in which the proportion of seniors using OPIO would increase to 4.5% by 2040. In this case, the number of recipients would increase by approximately 60% compared to the current situation, which would require a similar percentage increase in jobs. This would require a significant increase in the workforce, including measures to recruit and retain staff, as well as possible reforms in education and qualification requirements. In fact, technological innovations, changes in work organization, or a shift towards field and outpatient forms of care may affect these parameters. The national priorities for the development of social services for 2021-2030 continue to focus on supporting the development of new and existing social services and community-based professional activities, taking into account their local, type and financial accessibility, including through the use of modern technologies. Nevertheless, the projection clearly shows that even with a conservative estimate, Slovakia will face an increase in labour demand within the OPIO sector by 2040, ranging from moderate (low scenario) to significant (high scenario). Strategic planning in the area of human resources and investment in staff training will therefore be crucial for the sustainability and quality of care provided.

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POLICIES FOR THE SOCIO-PROFESSIONAL INCLUSION AND WELL-BEING OF VICTIMS OF DOMESTIC VIOLENCE: SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Domestic violence poses serious personal, economic, and social challenges, requiring innovative public policies that promote autonomy, socio-professional inclusion, and sustainable reintegration of victims. Despite legislative advances, barriers to accessing financial support, employment, housing, and psychological assistance persist, highlighting the need for integrated and effective strategies. This study conducts a systematic review of the literature (1990–2024) to analyse models of socio-professional inclusion and well-being policies for victims of domestic violence, with a focus on territorialisation and multilevel governance. In line with Sustainable Development Goals (SDGs) 5 (Gender Equality), 8 (Decent Work and Economic Growth) and 10 (Reduced Inequalities), it compares the approaches of Portugal and Sweden. Following the PRISMA protocol and using the Web of Science and Scopus databases, 35 relevant studies were analysed. The results show that Sweden stands out for its institutionalisation of preventive measures and comprehensive support systems, while Portugal is making progress in decentralised responses and protective legislation. Integrated models that combine financial support, professional training, and psychological counselling—especially when adapted to local contexts through place-based policies—show better results. Decentralisation improves access and the contextual relevance of services, although challenges such as institutional fragmentation, resource constraints, and lack of long-term monitoring remain. An intersectoral approach, involving the public, private and civil society sectors, is essential for comprehensive and sustainable policies. This review identifies good practices and critical gaps, advocating for the strengthening of vocational training, housing support and incentives for employers, contributing to the global debate on gender equality, decent work and social inclusion, and offering evidence-based guidance for policymakers.

Keywords: *Well-being; Multilevel governance; Socio-professional inclusion; Policy paradigms; Public policies; Territorialisation; Domestic violence*

1. INTRODUCTION

The socio-professional inclusion of victims of domestic violence is essential for their autonomy and social reintegration. However, this process faces structural challenges, including social stigma, difficulties in accessing the labour market, and a lack of adequate financial and housing support. The territorialisation of institutional responses and multilevel governance emerge as key factors for the effective implementation of public policies that promote labour inclusion and the well-being of these victims. The literature indicates that the decentralisation of public policies facilitates victims' proximity to support services, allowing for more efficient adaptation to regional needs.

Models that integrate financial assistance, professional training, and psychological support demonstrate greater effectiveness, especially in countries with well-defined governance structures. However, the lack of long-term monitoring compromises the assessment of the impact of these policies, highlighting the need for more structured follow-up. In addition, the fragmentation of public policies can undermine the effectiveness of measures for the socio-professional reintegration of victims. The lack of coordination between sectors such as social assistance, the labour market and health services represents an additional obstacle. International experiences show that place-based policies, combined with tax incentives for employers and professional support programmes, favour the integration of victims into the labour market. Based on these assumptions, this article is organised into four main sections. The first describes the methodology adopted, based on the PRISMA protocol, including the eligibility criteria and databases used. The second presents the main results of the systematic literature review, structured around policy developments, the territorialisation of responses and multilevel governance. The third section provides a critical discussion of the findings, with a particular focus on the approaches developed in Portugal and Sweden. Finally, the fourth section presents the conclusions and implications for the development of more integrated and sustainable public policies, as well as suggestions for future research.

2. METHODOLOGY

This study adopts an interpretative paradigm, aiming to understand the dynamics of public policies and their implications for the socio-professional inclusion of victims of domestic violence. The main objective is to identify effective approaches, good practices and intervention models that can contribute to the improvement of national reintegration policies, based on an international comparative analysis. We opted to conduct a Systematic Literature Review (SLR), following the PRISMA guidelines (Neto, de Almeida Biagiotti, Baldessar & de Siqueira, 2017; Donato & Donato, 2019; Page et al., 2021), due to its ability to ensure methodological rigour, replicability and transparency in the study selection and analysis process. The SLR was complemented by an integrative review, allowing us to articulate empirical evidence and theoretical concepts, clarify definitions, identify gaps and propose new directions for research. The research focused on public policies for the socio-professional inclusion and well-being of victims of domestic violence, with an emphasis on territorialisation and multilevel governance (Gonçalves, 2022; Ferreira, 2022). The following research questions were formulated:

1. What lessons can literature offer for the development of policies promoting the social and professional inclusion of victims of domestic violence?
2. Are integrated models with complementary support more effective for the well-being of victims?
3. Do territorialisation and multilevel governance increase the effectiveness of public policies?

The research was conducted using the Web of Science (Thomson Reuters) and Scopus (Elsevier) databases, covering the period 1990–2024. Portuguese and English terms were used — “violência doméstica”, “domestic violence”, “inclusão socioprofissional”, “social inclusion”, “bem-estar”, “well-being” — combined with Boolean operators (AND, OR).
O The process followed the PRISMA protocol, including inclusion criteria such as: publications between 1990 and 2024, focus on public policies and socio-professional reintegration programmes for victims of domestic violence. After removing duplicates, 35 studies were selected for full analysis, 12 of which were considered fundamental due to their empirical and thematic relevance.

Regarding the research strategy:

Stages - Systematic review	Description
Search in Scopus	Domestic violence and policy paradigms Domestic violence and areas of social and labour action Domestic violence and universal rights Domestic violence and territorial policies
Search by scientific field	Applied Social Sciences; Sociology; Gender Studies; Public Policy; Public Administration; Social Work; Social and Community Psychology; Public Health; Law; Social Economics; Labour and Employment.
Time period	1990-2024
Type of documents	Articles
Eligibility criteria	Scientific articles published between 1990 and 2024, indexed in the Scopus and Web of Science databases, peer-reviewed, and written in Portuguese, English, or Spanish were included. The studies had to address domestic violence and focus on public policies, socio-professional inclusion, victim well-being, multilevel governance, territorialisation, or place-based models. Publications without scientific review, studies focusing exclusively on clinical interventions or the perpetrator's perspective, documents not accessible in full, and grey literature (such as reports, dissertations, or communications at events) were excluded.

Table 1: Research strategy

Stages of the investigation process:

Stages of the Process	Number of Articles
Initial identification	415 articles identified through the Scopus and Web of Science databases between 1990 and 2024
Articles analysed in their entirety	35 articles selected for full analysis after applying eligibility criteria
Results considering research questions - Search for data on each of them	- What lessons can we learn from literature to develop policy models for the socio-professional inclusion of victims of domestic violence? The literature shows that integrated models, which combine financial support, vocational training and psychological support, yield better results in reintegration. - Are integrated models with complementary support more conducive to the well-being of victims? Yes. Studies show that the integration of multiple dimensions (employment, housing, mental health) is associated with higher levels of autonomy and recovery. Are models that territorialise integration dynamics and incorporate multilevel governance more effective? The data analysed suggests that the territorialisation of public policies contributes to a better adaptation of responses to local specificities. In addition, the adoption of multilevel governance models favours coordination between different sectors and levels of decision-making, promoting more coordinated and effective intervention.
Main conclusion	The territorialisation of public policies is crucial for socio-professional reintegration, allowing adaptation to local realities.

Table 2: Results of the article search

The initial search identified 415 articles, of which 35 were analysed in full, as shown in the flowchart:

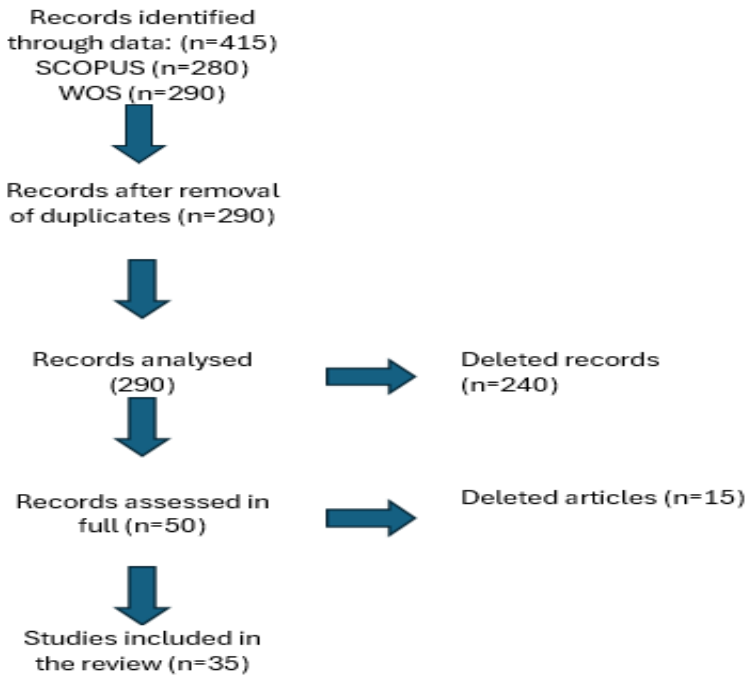

Figure 1: Search protocol 1 in the Web of Science and Scopus databases. Own compilation.

The results indicate that the territorialisation of public policies plays a crucial role in the socio-professional reintegration of victims by allowing responses to be adapted to local realities. However, the fragmentation of initiatives compromises their effectiveness, especially in countries with less inter-institutional coordination. Multilevel governance models, which promote cooperation between different levels of government, non-governmental organisations and the private sector, show better results in integrating victims into the labour market and providing access to psychological, housing and financial support.

Literature points to persistent challenges, such as social stigma, financial dependence, and barriers to accessing the formal labour market. Strategies that combine professional training, tax incentives for employers, and support networks show the greatest potential for mitigating these obstacles. Place-based policy models, adapted to specific territorial characteristics, emerge as promising solutions for a more effective approach. Despite advances, the socio-professional inclusion of victims of domestic violence continues to face structural challenges. Strengthening territorialisation, expanding professional training programmes and creating incentives for hiring are essential to promoting victims' autonomy.

Multilevel governance must also be improved, ensuring greater coordination and effectiveness of public policies. Future research should focus on the longitudinal evaluation of the impact of these strategies, allowing for the replication of good practices in different contexts. The comparative study between Portugal and Sweden could contribute to a more detailed analysis of effective models, considering populations with distinct sociocultural characteristics, as we can see in Figure 2.

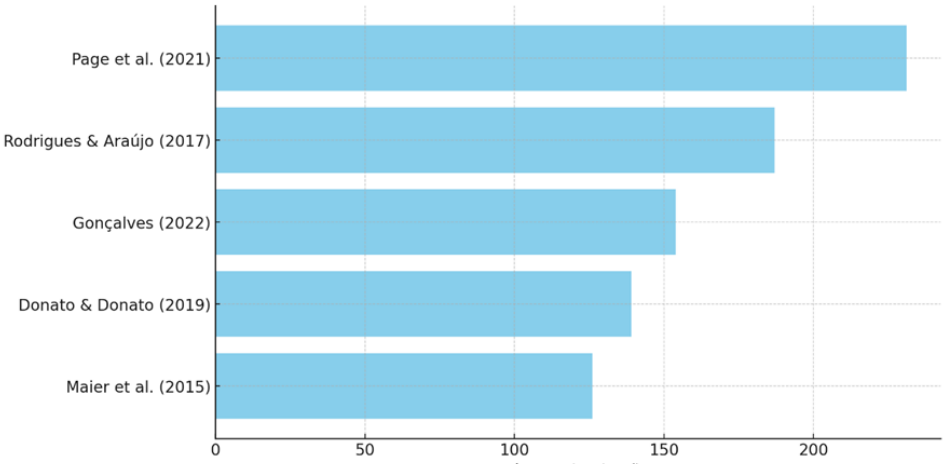

Figure 2: Most cited articles

The temporal evolution of publications reveals a growing trend in academic interest in public policies for the socio-professional inclusion of victims of domestic violence between 1990 and 2019. In the period from 1990 to 1999, the number of studies was still low (45 publications), reflecting initial and sporadic attention to the topic. Between 2000 and 2009, there was a significant increase (110 publications), a trend that intensified in the following decade, peaking between 2010 and 2019 with 175 publications. This growth reflects the consolidation of the topic on the international scientific and political agenda. However, between 2020 and 2024, there was a relative decrease (85 publications), possibly associated with the impact of the COVID-19 pandemic on the dynamics of scientific production or the dispersion of the topic into other intersectional areas (such as mental health, gender, and work). This trajectory demonstrates the maturation and emerging challenges of research in this area, as shown in Figure 3.

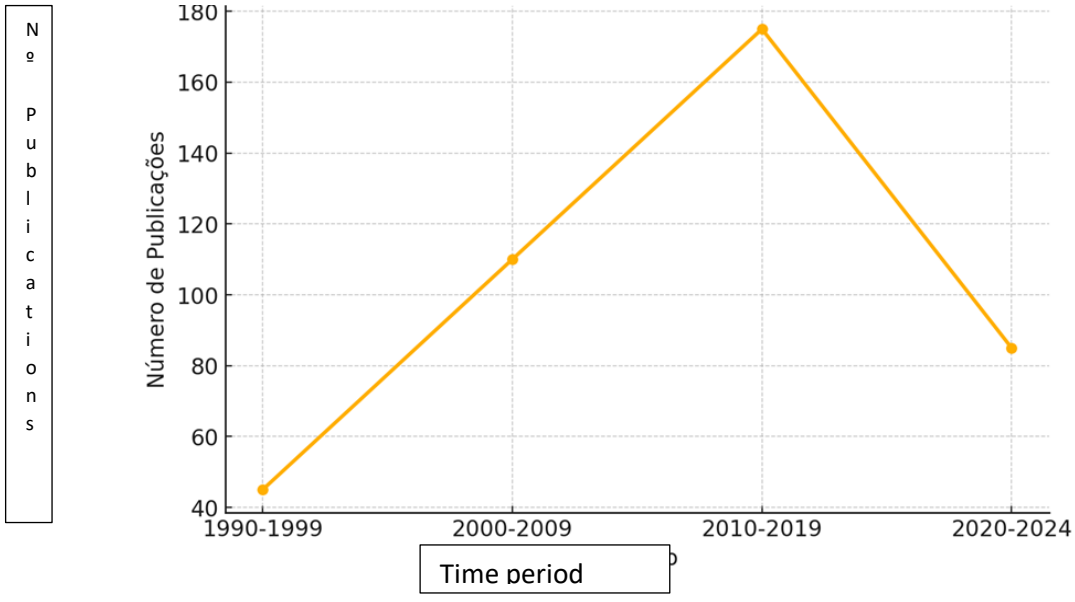

Figure 3: Evolution of publications by period (1990–2024)

3. RESULTS

3.1 Evolution of Socio-Professional Inclusion Policies

Since the 1990s, the recognition of domestic violence as a violation of human rights has driven socio-professional inclusion policies, aligned with SDGs 5 (Gender Equality), 8 (Decent Work) and 10 (Reduced Inequalities). The Istanbul Convention (Council of Europe, 2011) has catalysed measures such as vocational training, financial and housing assistance, and psychological support in several countries (Donato & Donato, 2019). In Sweden, the criminalisation of domestic violence (1982) and territorial labour reintegration programmes strengthened the autonomy of victims, while Portugal implemented unemployment benefits (18 months) and the UNIDAS Network for local support (CIG, 2025). In 2023, Portugal recorded 26,041 cases of domestic violence, with 22 fatalities (19 women, 3 men; Table 6), while Sweden reported 42,161 cases but fewer homicides, reflecting a greater propensity to report and less social tolerance (INE & Frenzel, 2024). Despite progress, the lack of territorial coordination and longitudinal data limits the sustainability of these policies (Page et al., 2021).

Year	Total number of victims	Total female victims	Total male victims
2017	11	10	1
2018	26	22	4
2019	18	16	2
2020	17	13	4
2021	19	15	4
2022	10	10	0
2023	10	10	0

Table 3: Fatalities from domestic violence in Sweden (2017 to 2023) (Frenzel, 2024)

Year	Total number of victims	Total female victims	Total male victims
2017	27	-	-
2018	39	-	-
2019	45	-	-
2020	51	-	-
2021	31	-	-
2022	28	-	-
2023	22	19	3
2024*(data up to September 2024)	18	15	3

Table 4: Fatalities from domestic violence in Portugal from 2017 to 2024 (APAV, 2024; CIG, 2025.)

Analysis of this data reveals a growing trend in reports of domestic violence in both countries. Among the factors explaining this increase are greater public awareness of the issue, less fear or shame in reporting it, more intensive prevention campaigns, and stronger local support networks. Portugal, like Sweden, has strengthened its legal framework and promoted the decentralisation of victim support services, enabling responses that are more closely tailored to the needs of the population.

3.2 Territorialisation of public policies – measures and combating domestic violence

The territorialisation of public policies is essential to combat domestic violence and promote socio-professional inclusion, in line with SDGs 5 (Gender Equality), 8 (Decent Work) and 10 (Reduced Inequalities).

In Sweden, the criminalisation of domestic violence (1982), the Protection Against Domestic Violence Act and the requirement for express consent (2018) are part of the Zero Tolerance Strategy 2020-2030, which prioritises prevention, victim support and strict enforcement of the law (Frenzel, 2014; Strategi för nolltolerans, 2020). Territorial coordination between municipalities, police and social services ensures rapid and tailored responses, with structured monitoring. Portugal has adopted similar measures, such as the UNIDAS Network, with local support offices, shelters, legal and psychological assistance, and 18 months of unemployment benefits for victims who leave their jobs for safety reasons (CIG, 2025). However, fragmentation between levels of government and a lack of private sector involvement limit effectiveness, especially in rural areas (Ferreira, 2022; Gonçalves, 2022). The COVID-19 pandemic has intensified cases, highlighting the need for more robust territorial responses (Silva & Santos, 2022). Despite advances, the absence of longitudinal evaluations compromises policy sustainability. Studies focus on describing initiatives without systematic monitoring, making it difficult to identify good practices (Page et al., 2021). Greater intersectoral integration and use of regional data are recommended to strengthen multilevel governance and the reintegration of victims.

4. DISCUSSION

This section answers the research questions posed and links the empirical data presented with the main contributions from literature. The comparative analysis between Portugal and Sweden provides an understanding of the effectiveness of socio-professional inclusion policies for victims of domestic violence, as well as the factors that enhance or constrain them.

4.1 Do territorialization and multilevel governance increase the effectiveness of public policies?

Multilevel governance is essential for the effectiveness of socio-professional inclusion policies for victims of domestic violence, promoting coordination between national, regional and local governments and reducing institutional fragmentation (Maier et al., 2015). Territorialisation, based on proximity and density, strengthens social interactions and adapts policies to local realities, aligning with SDG 10 (Reduced Inequalities) (Reis, 2015, p.110). Gonçalves (2022) highlights that network cooperation between the public and private sectors and community organisations enhances local responses, as observed in Sweden, where coordination between municipalities, the police and social services, with common objectives and shared monitoring, improves results (Samverkan, 2020). In Portugal, decentralisation, exemplified by the UNIDAS Network, facilitates access to vocational training, housing support and psychological support, but faces challenges such as lack of funding and continuous evaluation (Ferreira, 2022; Rodrigues & Araújo, 2017). The White Paper on European Governance (2001) reinforces the importance of involving citizens in local governance, promoting democratic participation. However, the absence of long-term monitoring and obstacles such as bureaucracy and misalignment between administrative spheres hinder the replication of good practices (Donato & Donato, 2019; Page et al., 2021).

4.2 Are integrated models with complementary support more effective for the well-being of victims?

Empirical and theoretical evidence confirms that this is the case. Models that offer a multidimensional response enable victims to rebuild their lives, break cycles of dependency, and reintegrate socially and economically (Maier et al., 2015; Othman et al., 2021). In Portugal, although relevant policies exist, such as shelters, legal and psychological support, and employment incentives, their effectiveness is hampered by limitations in the continuity of support and coordination between services. Sweden, with a more coordinated approach, has better effectiveness indicators.

4.3 What structural challenges remain in the socio-professional inclusion of victims?

In Sweden, the decline in domestic violence cases between 1970 and 1990 is largely due to the integration of women into the labour market, the strengthening of social protection and the implementation of stricter legislation. However, challenges remain, especially among economically vulnerable populations. The Swedish model for combating domestic violence is based on a collaborative approach between the police, municipalities, and social services, divided into five stages: defining objectives and establishing partnerships; collecting data and assessing the local situation; joint planning and signing of inter-institutional agreements; implementation of measures and monitoring of results; review and adjustments based on impact assessments (Samverkan, 2020). Despite progress, significant obstacles remain. The lack of systematic evaluation, fragmentation of policies, bureaucracy and territorial inequality limit the effectiveness of measures. A comparison between the two countries reveals that, although Sweden has more reports, Portugal has more fatalities — 22 in 2023 and 18 by September 2024 — signaling weaknesses in prevention and response mechanisms. This model has several similarities with Portuguese initiatives, such as the creation of victim support offices in municipalities and the implementation of the National Support Network for Victims of Domestic Violence (RNAVVD), currently known as UNIDAS. This network promotes an integrated and inter-municipal approach, involving 33 victim support technicians and teams specializing in legal and psychological assistance. The territorialisation of public policies allows for a faster response that is better adapted to victims' needs, reducing barriers to accessing services and promoting coordination between different entities. However, challenges such as unequal access to services and lack of funding for local programmes continue to hinder their full implementation (Frenzel, 2014; Page et al., 2021).

Criterion	Portugal	Sweden
Legal Framework	Strengthening legislation since 2000	Strict laws since 1982
Governance Models	Partial decentralisation with municipal involvement	Highly centralised model
Victim Support	Shelters, unemployment benefits, psychological counselling	Shelters, subsidies, psychological and legal support
Integration into the Labour Market	Training programmes and incentives for companies	Greater private sector participation
Impact Monitoring	Lack of continuous assessment	Structured monitoring systems

Table 5: Comparative analysis between Portugal and Sweden

5. CONCLUSION

This systematic review (1990–2024) highlights advances in policies for the socio-professional inclusion of victims of domestic violence, in line with SDGs 5 (Gender Equality), 8 (Decent Work) and 10 (Reduced Inequalities). Territorialisation and multilevel governance, as demonstrated by the UNIDAS Network in Portugal and municipal coordination in Sweden, increase the effectiveness of measures such as vocational training and housing support (Table 6; Samverkan, 2020). However, institutional fragmentation and a lack of longitudinal monitoring limit sustainability (Ferreira, 2022). Limitations include the focus on Web of Science and Scopus databases, with a European bias, and the scarcity of longitudinal studies, making generalisations difficult (Page et al., 2021). Future research should adopt mixed methodologies, incorporate the perspective of victims, and explore the use of digital technologies for more inclusive policies.

This study contributes to SDG 10 by proposing territorial strategies that reduce inequalities, promoting the socio-professional reintegration and well-being of victims.

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DESIGN AND DEVELOPMENT OF A DIGITAL APPLICATION TO SUPPORT THE LEARNING OF STATISTICS IN HIGHER EDUCATION

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ABSTRACT

The purpose of this paper is to present the design and implementation of the https://aesi-estatistica.pt platform; a digital tool set up to facilitate Applied Statistics teaching and learning at tertiary level, especially in engineering and technology programmes. Rooted in student-centred learning and active learning methodologies such as autonomous learning, formative assessment, and multimodal instructional strategies, the platform offers structured content, worked examples, self-assessment, and interactive materials. The backdrop of this development arose from a common phenomena that is often observed in statistics classes: in most cases, students are able to do computations; yet, ironically, they rarely manage to select appropriate statistical measure or interpret the data distribution in a given context. Henceforth, it should guide students in the analysis while also helping them to identify the most appropriate techniques for their data sets. Interfacing in Python, the platform also offers some interactive edutools to aid the understanding of data analysis, data distributions and other topics in statistics.

Keywords: *AI, Gamification, Mobile Learning, Phyton Language, Statistical Analysis*

1. INTRODUCTION

The learning of statistics in higher education has received increasing attention in academic literature, particularly in response to the increasing necessity for data literacy in both academic and professional fields (Garfield & Ben-Zvi, 2008; Chance et al., 2007). The existence of statistics courses across several academic programs, such as engineering, psychology, education, health sciences, and business, it has become evident that challenges related to pedagogy and learning outcomes need to be addressed. However, despite the growing importance of statistics in various disciplines, students often perceive it as an abstract, complex, and intimidating subject. This perception has the potential to hinder engagement, intensify emotional barriers such as statistics anxiety, and restrict the development of statistical literacy (Onwuegbuzie & Wilson, 2003).

Research indicates that students often encounter difficulties in selecting appropriate descriptive and inferential measures for specific data contexts (Lovett, 2001; Zieffler et al., 2008). Moreover, the interpretation of results and the conclusions presented tends to be superficial, students frequently depend on memorized procedures rather than developing a deep conceptual understanding and application to real-world problems (Ben-Zvi & Garfield, 2004; delMas et al., 2007). According to Lane & Peres (2006), students exhibit a tendency to misapply or excessively rely on summary statistics such as the mean, disregard other descriptive measures. These challenges highlight the limitations inherent in traditional lecture-based pedagogical approaches and emphasize the necessity for educational strategies that prioritize reasoning and interpretation. Considering these issus, there is an increasing necessity for educational resources that facilitate conceptual learning and encourage independent, student-centered exploration. Digital interactive tools have demonstrated potential in this context, as they enable learners to simulate various scenarios, visualize abstract concepts, and receive immediate feedback, thereby promoting deeper engagement and comprehension. The main objective of this article is to introduce a digital application created to enhance the learning of statistics within higher education contexts, such as engineering and technology programmes. This application, interfacing in Python, offers interactive edutools to aid in the comprehension and interpretation of essential statistical concepts through interactive, visual, and self-explanatory resources. Simultaneously, it is essential to empower students to select the appropriate measures and methods in various real-world situations. The article is structured in a systematic manner, beginning with an introduction, follows a section where pedagogical motivation and didactic framework, that informed the main reasons for development of the tool, are presented. It then provides a thorough description of the application's functional structure, highlighting its main modules, features, and the diverse types of user interactions. After a technical explanation of the developed application, a results section display some present several questions related to the application. Finally, the conclusion and some keys for future work.

2. PEDAGOGICAL MOTIVATION AND CONCEPTUAL FRAMEWORK

The incorporation of digital learning resources has emerged as a widely endorsed strategy to enhance student engagement and facilitate conceptual understanding. Educational researchers emphasize the importance of autonomous learning, as highlighted by Ziemmerman (2002), which involves personal responsibility. Through exploration, reflection and taking initiative students can take control and participate in their learning processes. Another important issue is the delivery of immediate feedback, which offers students real-time insights into their performance. Feedback is essential for rectifying misconceptions, reinforcing accurate reasoning, and sustaining learner motivation (Shute, 2008). Formative assessment techniques that incorporate feedback within scaffolded tasks have demonstrated efficacy in enhancing statistical reasoning skills (delMas et al., 2007). According to Chance et al. (2007) and Tishkovskaya & Lancaster (2012), interactive tools such as simulations, visualizations, and online applets, empower students to handle data, visualize distributions, and obtain immediate feedback on their understanding, all while presenting information in a format that is accessible and student friendly. A review of the literature identifies a variety of technological approaches that have been leveraged to enhance the learning process. These approaches includ E-Learning, Learning Management Systems (LMS), Artificial Intelligence (AI), Gamification, Virtual Reality (VR), Augmented Reality (AR), and Mobile Learning (mLearning). Research indicates that LMS platforms, such as Moodle and Blackboard, enhance access, organization, and feedback mechanisms (Aljawarneh, 2020), thereby supporting blended and asynchronous learning models. AI technology enables the development of adaptive learning systems that personalize educational experiences based on student behavior (Holmes et al., 2023).

Additionally, the utilization of chatbots, automated grading systems, and AI tutors is becoming increasingly prevalent in digital education. The integration of game elements into educational contexts has been shown to boost motivation and engagement. Research conducted by Deterding et al. (2011) suggests that gamification can enhance learning outcomes. Moreover, VR and AR technologies provide immersive experiences that support experiential learning. A study by Radianti et al. (2020) found that VR significantly enhances comprehension in complex subjects, such as medicine, engineering, and science. Lastly, the widespread use of smartphones and tablets facilitates access to educational resources anytime and anywhere. Studies by Traxler (2007) underscore the potential of mLearning in both formal and informal educational settings. Within the scope of this research, a digital application was designed and implemented using Python, informed by evidence-based pedagogical principles and best practices. Specifically, the application was intended to: enhance conceptual understanding; promote independent exploration; deliver immediate, formative feedback; and encourage active participation. These design principles are linking the gap between procedural knowledge and conceptual understanding, thereby providing students with a flexible, accessible, and engaging learning experience in statistics. The development of this application stems from the need to promote student engagement in the statistics course provided within an engineering program, while simultaneously ensuring equitable access to digital learning tools for all students, as outlined by Selwyn (2021).

3. FUNCTIONAL DESIGN OF THE APPLICATION

Currently, the AESI web app is in the development phase and has a clearly defined modular design. As per the main menu, it is split into five sections, each catering to a different teaching method – Exploratory Data Analysis Statistics, Quizzes, Discover the Distribution, the Statistical Calculator, and the Educational Podcasts. Each of these app sections is equipped with appropriate materials, such as the relevant tools for calculation and distribution, quiz-like content, and even podcasts. The navigation seems to revolve around a simple menu from which a user could directly access any of the different sections, which is crucial in maintaining the segmented approach to learning.

3.1 Navigation and Modules

The following list represents the specific functions and the main pages where they are located on the website:

- Home page: subjects that have tools available.
- Subject page: available tools.
- Tool page: the tool's functionality.

From laptops and desktop computers to tablets and mobile phones, the website supports all such devices. It also automatically adjusts the navigation menu based on the device and screen size. The website works intuitively on both types of devices.

Figure 1: Frontend for website – Computer

Figure 2: Frontend for website – smartphone

On the website, you can find different types of quizzes, a probability calculator, and podcasts created with the help of Google's NotebookLM tool. The quizzes serve as an example of the different questions and answers that can be stored on the website, and they are offered to users in a random fashion. In Figure 3, the Global State Management architecture of an application is shown. This architecture is responsible for maintaining consistent interactions with the app's videos and effective navigation when moving between different parts of the app. The architecture has two complementary parts: Navigation State Management and the Persistent Audio Player. In the Navigation State Management, which is on the left, the main concern is to keep and update the user's contextual information of navigation. It starts by recording the current page, which is the view the user is actively visiting. This is used to update the navigation state and consistency of the application when a user shifts between multiple sections is maintained. This updated state is then used to update the breadcrumbs, which is a usability enhancement that provides a hierarchical path and helps users reorient themselves rapidly within the system. On the right side, the Persistent Audio Player ensures that the audio continues to play without any interruptions, even as the user switches from one page to another. This is made possible by two processes: retaining the player state, which includes the current track, playback position, and volume, and cross-page playback, which allows the audio to continue playing without any breaks, even when the interface changes or reloads.

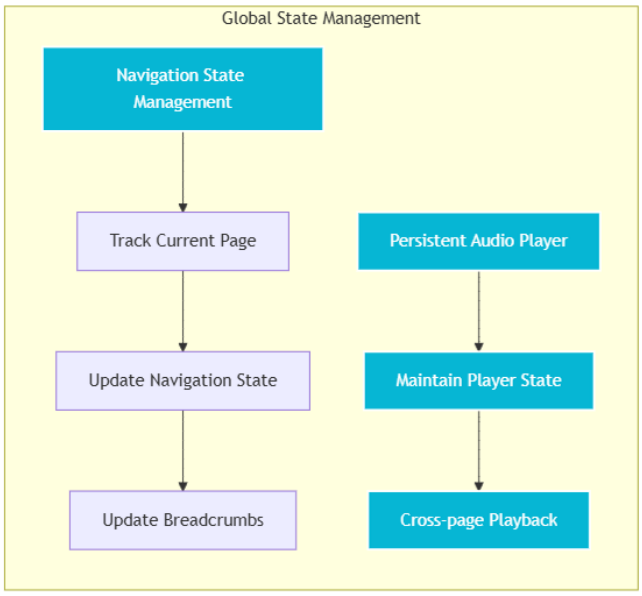

Figure 3: Global state management

These processes combine to create a single global state management framework in which navigation context and audio playback are continuously and persistently synced. This approach enhances the overall experience of the user by providing minimal interruptions, better contextual insight, and seamless multimedia interactions throughout the platform.

4. TECHNICAL IMPLEMENTATION

A system needs to be robust, scalable, and consistent across layers, and this is the focus of the solution's technological architecture. For an interactive multi-platform environment, the appropriate tools and languages need to be selected. These also need to be supported by a strong community and have technological maturity. In addition, the multi-platform environment needs to have flexibility during development and a smooth and consistent experience to the user. Python 3.11 was selected for the backend as it is a well-known programming language with a wide range of features, including clarity of its syntax and a large collection of libraries. Based on this, Flask was used. Flask is a lightweight web framework that focuses on modularity and allows for efficient API service construction. Its relevant features include dynamic routing with multilingual support, context processors for injecting global variables, integration with the Jinja2 templating system, and the definition of custom error management mechanisms, such as the display of pages dedicated to HTTP status codes (e.g., 404). As for the interface, it is structured across separate layers. The HTML5 files make up the content layer, while style definition, the arrangement of elements, and adaptability to various screen sizes are all handled by CSS3. A variety of advanced techniques were put to the test, including customizing the theme with custom properties (CSS variables), composing responsive layouts with Flexbox and CSS grid, and employing adaptations for different devices with animations, transitions, and media queries. JavaScript ES6+ is responsible for interactivity and interface logic, and it offers the necessary modularity and abstraction, such as the use of classes for the handling of the quiz, dynamic DOM changes through event listeners, and also the use of LocalStorage for saving user preferences. Of course, the external libraries and CDNs that have been integrated are Motley Chart.js, which is in charge of visualizing statistical graphs and distributions; Howler.js (v2.2.3), for advanced management of audio content related to podcasts; Font Awesome (v6.4.0), which allows the scalable icon system to be integrated; as well as the Inter (via Google Fonts) and Fira Code fonts, which make easier and distinguish the reading of code elements. At the end of the day, system components need to communicate with each other, and this is achieved using JSON. The principal format for data exchange is JSON, due to its lightweight nature, user-friendliness, and remarkable compatibility. Its use is noted in handling the translation mechanism, configuring questionnaires and learning materials, and depicting statistical data, making it a vital element in the collaboration of backend and frontend.

4.1 Backend

The backend is built on Python 3.11 with the Flask framework, which makes the delivery of web services streamlined and still modular. The application supports multiple languages (i18n) and uses JSON files for translations and dynamic routing generation. Determining the route involves three steps: detecting the locale, reversing the slug to the semantic key, and dispatching it to the appropriate view. Context processors inject global variables like the active language, theme, and breadcrumbs and ensure consistency across pages. This reduces duplication and allows for easier testing. The view layer uses Jinja2 along with template inheritance, custom filters, and language-aware rendering to ensure components are rendered correctly and can be reused. Error handling (404) is customized, showing appropriate translations, breadcrumbs, and telemetry logging.

The translation system uses cache and inverted indexes, which improve slug resolution performance. Moreover, the backend offers API endpoints (/api/quiz, /api/quizzes) to serve the frontend in JSON format.

Algorithm 1: Locale detection and routing

```
FUNCTION handle_request(request):
   locale ← detect_locale(request)
   (subject, feature) ← extract_slugs(request.path, locale)
   IF subject NOT FOUND:
      RETURN render_404("Subject Not Found")
   IF feature IS NULL:
      RETURN render_subject_home(subject)
   IF feature NOT FOUND:
      RETURN render_404("Feature Not Found")
   RETURN dispatch_feature(subject, feature)
END FUNCTION

FUNCTION global_context_processor():
   RETURN {
      "locale": current_locale(),
      "theme": user_theme(),
      "breadcrumbs": build_breadcrumbs(),
      "t": FUNCTION(key){ RETURN translations.get(locale, key) }
   }
END FUNCTION

FUNCTION render_subject_home(subject):
   strings ← translations.get_page(locale, subject + ".index")
   RETURN render_template("subject_home.html", { "strings": strings })
END FUNCTION
FUNCTION render_404(reason):
   log_event("404_error", { "path": request.path, "reason": reason })
   strings ← translations.get_page(locale, "error.404")
   RETURN render_template("404.html", { "strings": strings, "reason": reason })
END FUNCTION
```

Algorithm 2: API endpoints

```
ROUTE "/api/quiz?id=<id>" → load_quiz(id)
ROUTE "/api/quizzes"      → list_quizzes()
FUNCTION load_quiz(id):
   data ← read_json("quizzes/" + id + ".json")
   IF data IS NULL: RETURN http_error(404)
   RETURN http_json(data)
```

4.2 Frontend

The frontend is built in HTML5, using Jinja2 templates from the backend to guarantee consistent semantics and structure. The visual presentation is in CSS3. It uses Custom Properties to handle theming, Flexbox/Grid to create responsive layouts, media queries to adapt to various devices, and transitions to enhance the user interface.

JavaScript ES6+ is used to enable interactivity, and the code is structured into classes and modules based on features. Dynamic DOM changes are operable through event listeners. User settings, such as language or chosen theme, are saved using LocalStorage, ensuring their persistence.

Algorithm 3: Template rendering (HTML5 and Jinja2)

```
    FUNCTION render_page(template, context):
       merged ← global_context + context
       RETURN jinja_render(template, merged)
    END FUNCTION
    FUNCTION apply_theme(mode):
       set_css_var("--bg-color", theme[mode].bg)
       set_css_var("--fg-color", theme[mode].fg)

    FUNCTION responsive_layout(width):
       IF width < 600: set_layout("1-column")
       ELSE IF width < 1024: set_layout("2-columns")
       ELSE: set_layout("3-columns")
    END FUNCTION
     CLASS QuizEngine:
        init(questions):
        this.questions ← shuffle(questions)
        this.index ← 0
        this.score ← 0

        submit(answer):
         IF answer == current.correct: this.score++

        next():
        this.index++
      END CLASS

FUNCTION bind_quiz_ui(engine):
   on_click(".answer", → engine.submit(selected_id))
   on_click("#next", → engine.next())
END FUNCTION

FUNCTION save_theme(mode):
   localStorage["theme"] = mode

FUNCTION load_theme():
   RETURN localStorage["theme"] OR "light"
END FUNCTION
```

4.3. Bibliotecas e CDNs Externos

The application depends on several external libraries offered through a CDN. These complement the frontend's native features, simplify development, and maintain cross-device compatibility:

- Chart.js offers dynamic and responsive graphics to visualize descriptive data.
- With Howler.js (v2.2.3), the app supports advanced audio features, including podcasts with volume control, seeking, and episode lists.

- Font Awesome (v6.4.0) supplies a scalable icon system and maintains the interface's visual style.
- Google Fonts (Inter) and Fira Code serve as advanced typographic solutions, aiding the reading of textual and code elements.

Together, these third-party tools improve the overall user experience without impacting the application's core.

Algorithm 4: Chart.js (data visualization), Howler.js (podcast player) and Font Awesome (icons)

```
FUNCTION render_chart(canvas_id, dataset):
   chart ← new Chart(canvas_id, {
      type: "bar",
      data: dataset,
      options: { responsive: TRUE }
   })
   RETURN chart
END FUNCTION

FUNCTION init_podcast_player(file_url):
   player ← new Howl({
      src: [file_url],
      html5: TRUE,
      volume: 0.8
   })
   RETURN player
END FUNCTION

FUNCTION load_icon(icon_name):
   RETURN "<i class='fa-solid " + icon_name + "'></i>"
END FUNCTION

FUNCTION apply_fonts():
   load_stylesheet("https://fonts.googleapis.com/css2?family=Inter")
   load_stylesheet("https://fonts.googleapis.com/css2?family=Fira+Code")
END FUNCTION
```

4.4. Formato de Dados

JSON is delegated as the standard format for statistical distributions for an application. This is because it is light, readable, and highly interoperable, facilitating seamless integration between the backend (Python/Flask) and the frontend (JavaScript/Chart.js). Each JSON document contains the following three items:

1. Distribution parameters (e.g., n, p in binomial, λ in Poisson, or μ, σ in normal).
2. The domain of values of the distribution.
3. The results (pmf, pdf, cdf) or values to be calculated by the statistical engine dynamically.

We gain the following benefits:

- Uniform representation of various distributions.
- Ease of export and reuse in interactive charts.
- Ability to add new distributions without changes in the architecture.
- Support for data validation and versioning.

Algorithm 5: Statistical distributions

```
FUNCTION load_distribution_json(name):
        ds ← read_json("stats/" + name + ".json")
        validate_distribution(ds)
        RETURN ds
    END FUNCTION
FUNCTION binomial_pmf(n, p, k):
  RETURN combination(n, k) * (p^k) * ((1-p)^(n-k))

FUNCTION binomial_cdf(n, p, k):
  sum ← 0
  FOR i FROM 0 TO k:
    sum ← sum + binomial_pmf(n, p, i)
  RETURN sum
FUNCTION poisson_pmf(lambda, k):
  RETURN ( (lambda^k) * exp(-lambda) ) / factorial(k)

FUNCTION poisson_cdf(lambda, k):
  sum ← 0
  FOR i FROM 0 TO k:
    sum ← sum + poisson_pmf(lambda, i)
  RETURN sum

FUNCTION normal_pdf(mu, sigma, x):
  coeff ← 1 / (sigma * sqrt(2 * PI))
  expo  ← exp( -((x - mu)^2) / (2 * sigma^2) )
  RETURN coeff * expo

FUNCTION normal_cdf(mu, sigma, x):
  z ← (x - mu) / (sigma * sqrt(2))
  RETURN 0.5 * (1 + erf(z))      // erf = error function

FUNCTION generate_distribution_json(type, params, domain):
  results ← {}
  IF type == "binomial":
    results.pmf ← [binomial_pmf(params.n, params.p, k) FOR k IN domain]
    results.cdf ← [binomial_cdf(params.n, params.p, k) FOR k IN domain]

  IF type == "poisson":
    results.pmf ← [poisson_pmf(params.lambda, k) FOR k IN domain]
    results.cdf ← [poisson_cdf(params.lambda, k) FOR k IN domain]

  IF type == "normal":
    results.pdf ← [normal_pdf(params.mu, params.sigma, x) FOR x IN domain]
    results.cdf ← [normal_cdf(params.mu, params.sigma, x) FOR x IN domain]

  RETURN {
    "distribution": type,
    "parameters": params,
    "domain": domain,
    "results": results,
    "version": "1.0"
  }
END FUNCTION
```

5. RESULTS

The primary objective of this application's development is to facilitate an accessible approach to learning fundamental concepts of statistics. This section presents some of the questions included within the application. For instance, pertaining to the topic of exploratory data analysis, the following questions are provided:

- It is possible to compute the mean for the variable "sex"?
- If the mean, the median and the mode are equal the data distribution is said to be symmetrical or not?
- Which measure is more robust to the presence of outliers in our data? Mean or median?

For the topic, please identify the appropriate distribution that should be utilized to compute the probability , an example of the included questions are:

- A telephone exchange receives an average of 60 calls per hour. What is the probability that only 1 call is received during a period of 1 minute?
- A company sells dishwashing detergent in its own packaging. It is assumed that 25% of these packages contain a smaller amount of product than indicated on the label. Having purchased 6 packages, what is the probability that 2 of them contain a quantity less than that indicated on the label?

6. CONCLUSION

The existing literature suggests that conventional approaches to teaching statistics frequently fall short in fostering students' conceptual understanding and statistical reasoning. Students consistently encounter challenges in choosing suitable measures and interpreting them effectively. Furthermore, identifying the correct distribution, understanding the interpretation of estimated values, and performing appropriate hypothesis tests are topics that pose significant difficulties, highlighting the need for a pedagogical transformation. The incorporation of interactive, conceptual, and autonomy-supporting tools is strongly advocated to bridge these gaps. As digital learning technologies advance, their strategic implementation in statistics education presents substantial potential for enhancing both learning outcomes and student engagement. In this work, we present the development of a digital application designed to improve the understanding of statistics in higher education context. This application, developed in Phyton, seeks to facilitate the analysis and comprehension of fundamental statistical concepts by utilizing interactive, visual, and self-explanatory resources. However, this application is an ongoing task, more statistic topics should be introduced.

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THE IMPORTANCE OF DIGITAL LITERACY IN CONTEMPORARY SOCIETY

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ABSTRACT

Digital literacy has become an essential competency in contemporary society, influencing the ways in which individuals engage with information, technology, and the community. As digital tools are increasingly woven into the fabric of everyday life, including education, professional environments, and civic participation, the importance of comprehending and cultivating digital literacy is at an all-time high. This work explores the definition, dimensions, and importance of digital literacy, examines the challenges to its advancement, and highlights strategies for improving digital competency in diverse contexts. Furthermore, this issue is analyzed within the context of Portugal and compared with other European countries. The analysis addresses varying levels of digital literacy across different demographics, including sex, age, and educational attainment.

Keywords: *Digital literacy, Education, Professional environments, Comparison between Portugal and other European Countries*

1. INTRODUCTION

The rise of the digital era has transformed the way people access, share, and produce information. From smartphones and social media to online learning platforms and remote work tools, digital technologies permeate every aspect of modern life. In this context, digital literacy - the ability to use digital tools critically, effectively, and responsibly - has become a core skill. It extends beyond basic computer use to include information evaluation, digital communication, and awareness of digital rights and ethics (Ng, 2012). The pré-digital era is the period before the adoption and large utilization of digital technologies. People over 50 years old went through almost this evolution so this has an impact on their digital literacy.

2. WHAT IS DIGITAL LITERACY

Digital literacy encompasses a wide range of skills and competencies. According to Belshaw (2014), it includes eight elements: cultural, cognitive, constructive, communicative, confident, creative, critical, and civic. Similarly, the European Commission (2018) frames digital competence as the confident and critical use of Information Society Technology (IST) for work, leisure, learning, and communication. Acording to UNESCO Institute for Statistics (2025) digital literacy involves the confident and critical use of a full range of digital technologies for information, communication and basic problem-solving in all aspects of life. It is underpinned by basic skills in Information and Communication Technology (ICT): the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.

"The objective of the Digital Literacy Global Framework (DLGF) project is to develop a methodology that conserve as the foundation for Sustainable Development Goal (SDG) thematic Indicator 4.4.2: "Percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills"." (Law, N. Woo, D., Torre, J. & Wong, G. 2018). Law, N., Woo, D., Torre, J., and Wong, G. (2018) provide definitions of digital literacy that illustrate how various countries present distinct frameworks based on their unique contexts and reasons. According to Eurostat, digital literacy encompasses five distinct areas of digital competence and a total of twenty one specific digital competencies. These areas include information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. Digital literacy is assessed through the digital skills indicator, which serves as a composite measure based on selected activities that individuals perform online within these specific domains. Until 2019, the indicator included information, communication, problem-solving, and software competencies; however, from 2021 onwards, an additional area, safety, was incorporated. As of 2021, the overall levels of digital skills evaluated are categorized as follows: no skills, limited skills, narrow skills, low skills, basic skills, and above basic skills. It can be presented here several others definitions that will converge somehow in it's essence. These definitions reflect the multidimensional nature of digital literacy, combining technical, cognitive, and ethical components.

3. THE IMPORTANCE OF DIGITAL LITERACY

Digital literacy in education enhances critical thinking, collaboration, and independent learning. It is crucial for effectively navigating online resources, engaging with e-learning platforms, and participating in digital classrooms (Livingstone, 2008). In the workforce, the demand for digital skills continues to rise across various sectors, ranging from fundamental digital communication to advanced data analysis. Employees possessing higher levels of digital literacy are better prepared to adapt to technological changes and innovations (van Laar et al., 2017). Furthermore, digital literacy is instrumental in promoting civic participation and social inclusion. It empowers individuals to access public services, engage in political discussions, and become active members of digital communities. According to UNESCO digital technology has emerged as a critical component in ensuring that education is recognized as a fundamental human right, particularly in a world increasingly affected by crises and conflicts. The COVID-19 pandemic highlighted the challenges faced by countries lacking adequate technologic infrastructure and well-equipped digital learning systems, resulting in significant educational disruptions and learning losses. Consequently, approximately one-third of students globally were left without access to educational resources during prolonged school closures.

This disruption underscored the pressing need to integrate technology with human resources to innovate schooling models and establish inclusive, open, and resilient learning systems. UNESCO promotes the integration of digital innovations to expand access to educational opportunities and to create pathways for lifelong learning that leverage information and communication technologies. These initiatives aim to ensure and foster inclusion while enhancing the relevance and quality of the learning experience. On the other hand, the Sustainable Development Goals (SDGs), commonly referred to as the Global Goals, were established by the United Nations in 2015 as a universal call to action aimed at eradicating poverty, safeguarding the planet, and ensuring that by 2030, all individuals can experience peace and prosperity. These 17 SDGs are interconnected, acknowledging that actions in one area can influence outcomes in others, and emphasizing the importance of balancing social, economic, and environmental sustainability in development efforts. To successfully achieve the SDGs across various contexts, it is essential to mobilize the creativity, expertise, technology, and financial resources of all sectors of society

4. CHALLENGES TO DIGITAL LITERACY DEVELOPMENT AND PROMOTION

Many barriers hinder the development of digital literacy, including disparities in access to devices and internet connectivity—often referred to as the digital divide—insufficient formal training, generational differences, and the prevalence of misinformation. These challenges are particularly pronounced in underserved communities, where they contribute to restricted digital engagement and diminished educational or economic outcomes (Selwyn, 2004). To effectively address these issues, it is essential to implement systemic approaches that integrate infrastructure development, educational policy reform, and community support initiatives. The promotion of digital literacy necessitates a multifaceted strategy that encompasses formal education, public awareness campaigns, and inclusive access initiatives.

Educational institutions should incorporate digital competencies into their curricula, while opportunities for lifelong learning should be accessible to individuals across all age groups. Furthermore, libraries, community centers, and non-governmental organizations (NGOs) can play a critical role in providing training and resources. In addition, enhancing critical media literacy is vital for countering misinformation and fostering informed digital citizenship (Hobbs, 2017). In Portugal there is a program from the Portuguese government "Iniciativa Nacional Competências Digitais e.2030 (INCoDe.2030)" it means National Digital Skills Initiative e.2030. It aims to improve the level of digital skills of the Portuguese, thus placing Portugal at the same level as the most advanced European countries in this area, in a timeframe that extends until 2030 and that promotes ten challenges (incode2030.gov.pt):

- The digital transition of education
- The digital transition of vocational training
- Stimulating employability
- Strengthening the digital skills of public sector workers
- Mainstreaming digital literacy
- Digital-based entrepreneurship
- Attracting investment
- The digital transition as a factor in the inclusion of people with disabilities.

5. DIGITAL LITERACY IN EU COUNTRIES

The key indicator for digital literacy as defined by Eurostat is the Digital Skill Indicator (DSI), which quantifies the proportion of individuals aged 16 to 74 possessing at least basic digital skills. This composite indicator is derived from the EU Survey on ICT use and evaluates competencies across five domains: information and data literacy (for instance, verifying facts online), communication and collaboration (such as sending emails), digital content creation (including the use of spreadsheet software), safety (for example, managing access to personal data), and problem-solving (like adjusting software settings).

The following figures present an analysis of the current situation across 27 EU member states. Additionally, the data includes countries from the EU economic area, members of the European Free Trade Association (EFTA), and those that are official candidates for EU membership. Figure 1 presents the percentage of citizens, classified by country, who have attained at least the minimum level of digital skills as of 2023.

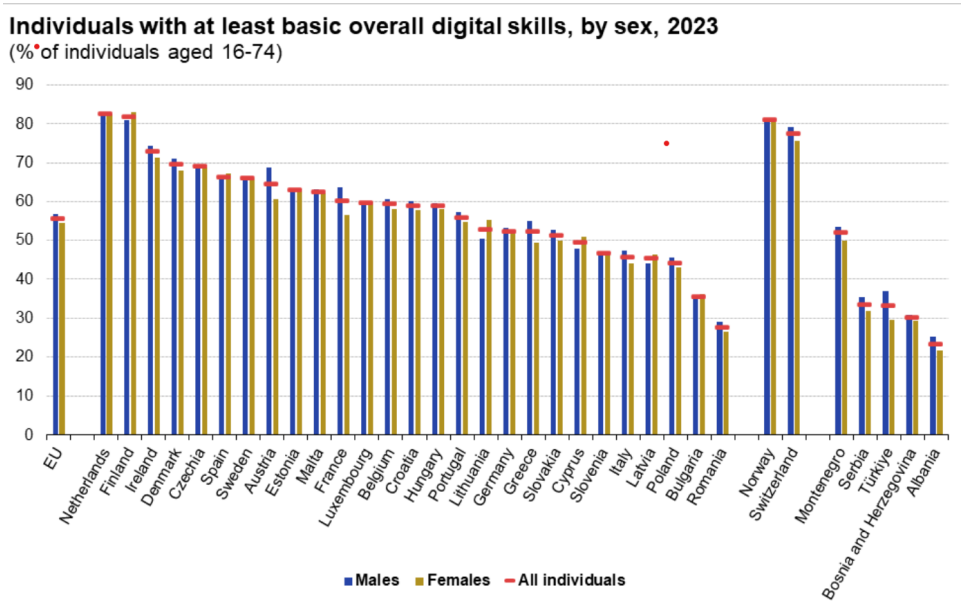

Figure 1: Individuals with at least basic overall digital skills, by sex, 2023 (Source: Eurostat (isoc_sk_dskl_i21)

At the overall level of the European Union, 56% of individuals aged 16 to 74 years possess at least basic digital skills. The variation among member states in this statistic ranges from a high of 83% in the Netherlands and 82% in Finland to a low of 28% in Romania. The Digital Decade target for 2030 aims for 80% of EU citizens to possess basic digital skills; however, in 2023, the EU fell short of this goal by 24 percentage points. Despite being within the average range, Portugal is still distant from the target, as the percentage of individuals possessing basic digital skills falls between 50% and 60%.

Therefore, it is essential to undertake efforts to enhance this indicator. Figure 2 shows the percentage of individuals possessing at least basic digital skills in the EU, categorized by age and sex, for the year 2023. The data indicates that younger individuals exhibit a higher percentage of digital competencies, with those aged 16 to 24 representing the highest percentage, while individuals aged 65 to 74 demonstrate the lowest. Among the younger individuals, a significant proportion possesses advanced digital skills. However, as age increases, this proportion diminishes, resulting in a larger percentage of individuals with only basic digital competencies. In the age group of young adults (25-44 years), women are more likely to have advanced digital skills compared to men.

Conversely, in older age groups (55+ years), this trend is opposite, with women aged 65 to 74 years exhibiting particularly low percentages of advanced digital competencies. The age group of 55 to 74 shows a marked decline in digital skills, indicating that these individuals are at a heightened risk of digital exclusion. Additionally, it is possible to observe that a greater proportion of young women in the EUpossessed at least basic digital skills compared to their male counterparts. Conversely, among individuals aged 45 and older, the trend is opposite, with a higher percentage of men demonstrating these skills, resulting in an increasing gender gap in the older age demographics.

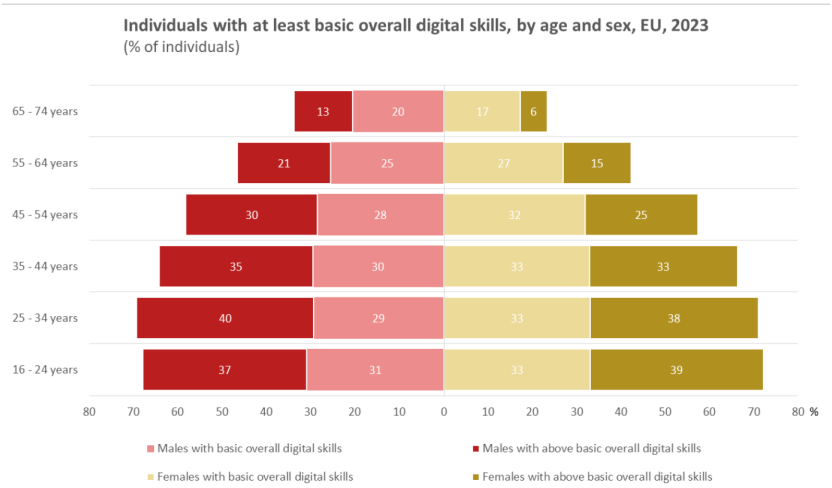

Figure 2: Individuals with at least basic overall digital skills, by age and sex, EU, 2023 (Source: Eurostat (isoc_sk_dskl_i21)

The analysis of Figure 3 indicates that less than half of the individuals possess a level of digital skills that exceeds basic proficiency, with the majority demonstrating only basic skills. The percentage of people with at least basic digital skills in the EU varied between 80% for those with high formal education and 34% for those with no or low formal education. Individuals with higher levels of education exhibit the highest percentages of digital skills, encompassing both basic and above-basic categories. Those with medium level of education achieve reasonable performance. However, their results are notably lower than those of the higher education group. In contrast, the group with low or no education displays a significantly reduced percentage of individuals possessing basic or above-basic digital skills, thereby underscoring the pronounced digital exclusion within this demographic. Among students, the highest levels of digital skills are observed, thereby affirming the relation between youth, educational attainment, and increased digital engagement. Employees, including salaried workers, self-employed individuals, and family workers, demonstrate commendable levels of digital skills, albeit lower than those of students, with a predominance of basic proficiency. Conversely, the unemployed exhibit lower percentages of digital skills than employees, suggesting that a lack of digital proficiency may serve as a barrier to employability. Finally, retired individuals or those who are out of the labor force are characterized by the lowest levels of digital skills across all categories.

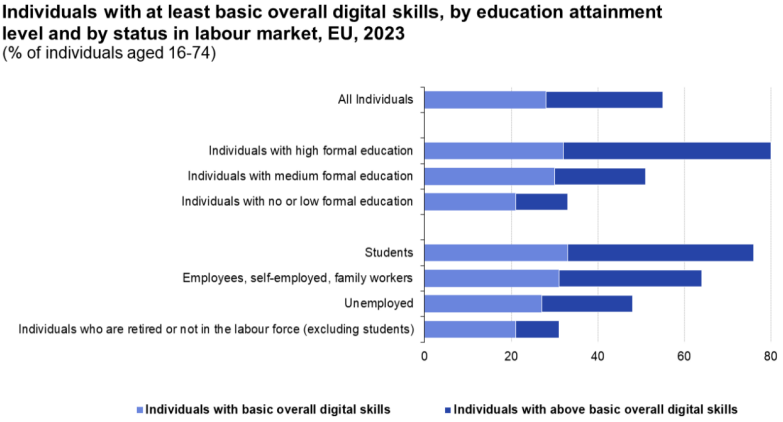

Figure 3: Individuals with at least basic overall digital skills, by education attainment level and by status in labour market, EU, 2023 /(Source: Eurostat (isoc_sk_dskl_i21)

6. CONCLUSION

As the digital landscape continues to evolve, digital literacy remains essential for personal, professional, and civic life. It empowers individuals to navigate digital environments effectively and ethically, while contributing to more inclusive and informed societies. Policymakers, educators, and communities must work together to ensure that everyone can develop these critical skills. Data from the EU indicates that public policy should prioritize digital training for individuals aged 55 to 74 years, with particular emphasis on women aged 65 to 74 years. Higher education and professional training play a significant role in addressing critical issues related to digital literacy. Academic attainment and active participation in educational or professional endeavors are strong determinants of digital skill levels, while lower educational attainment and exclusion from the labor market are associated with considerable digital gaps. In EU member states, although there has been a general rise in digital literacy in recent years, some countries continue to fall considerably short of both the average and the objectives set for 2030. Therefore, it is imperative to implement targeted initiatives to rectify these disparities.

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ASPECT OF OPEN DATA OF SOCIAL COOPERATIVES AND ILLUSTRATIVE TEST QUALITY: A LITERATURE REVIEW

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ABSTRACT

Our study does not aim to be statistically representative. Its primary objective is to identify and analyze the actions implemented regarding cooperatives. This is why pursuing statistical representativeness makes little sense in qualitative methods, which instead prioritize and encourage diversity. Nonetheless, we conducted econometric modeling of 84 representative Moroccan cooperatives from various regions and diverse sectors. The survey was conducted among cooperatives from various sectors, such as handicrafts, agriculture, argan oil, foodstuffs, the collection of medicinal and aromatic plants, literacy, waste management, labor, e-commerce, tourism, fishing, arts and culture, quarrying, telecommunications, transport, retail, forestry, consulting, and management. In sectors like handicrafts, agriculture, argan oil, and foodstuffs, women are the primary workers. Sectors such as agriculture, literacy, handicrafts, and forestry are primarily operated by cooperatives of young graduates. The methodology applied is a qualitative/interpretative approach, used to address the phenomenon from the subjects' perspective, based on their insights into this social innovation within cooperatives supported by the ADF. Fieldwork was inspired by ethnography and conducted through case studies with small cooperatives (constituting a community of practice) using on- site observations, work experience narratives, semi-structured interviews, and group reflection activities. Our empirical research was carried out within two Moroccan cooperative organizations briefly introduced in the following lines, along with the study of the 84 modeled cooperatives.

Keywords: *Agriculture, Cooperatives, Econometrics, Morocco*

1. INTRODUCTION

The structural adjustment program (SAP) implemented in Morocco in the 1980s, advocated by international institutions such as the International Monetary Fund (IMF), is considered the "bane" of many populations due to the social effects of these austerity policies. It also led to the state withdrawing from certain economic and social sectors. Moreover, globalization and market liberalization produced disastrous effects on public policies, employment, and purchasing power. These structural adjustment programs were created to support debt refinancing and adjust the economies of countries subjected to these measures. While these policies often stabilized current account deficits, they contributed little to development. People were frequently sidelined, with these measures inevitably leading to a decline in purchasing power due to stagnant wages recommended by the World Bank and the IMF. The resulting decline in incomes and purchasing power had direct impacts on education, health, and housing. In the specific conditions of Third World countries and without appropriate support, structural adjustment policies exacerbated the misery of populations and fueled migration. To address these numerous problems, it became necessary—even vital—to establish a system placing human welfare at its core.

This is the social economy. Morocco owes the establishment of its social economy network to the National Initiative for Human Development (INDH), launched by King Mohammed VI on May 18, 2005. The INDH aims to implement democracy and good governance while contributing to the country's economic, social, cultural, and environmental development. This initiative placed social economy organizations, primarily cooperatives, at the heart of the human development strategy. Cooperatives have mitigated these adverse effects, particularly in rural areas, as their goal is to serve their members and communities rather than solely seek profit. For example, in Morocco, women's cooperatives dominate the argan oil sector, accounting for 93% of the cooperative network. Their numbers grew significantly by 11.5%, from 157 cooperatives on June 30, 2009, to 175 on June 30, 2010, and 274 cooperatives on December 31, 2015, according to ODCO. Globally, the cooperative sector comprises nearly one billion members and more than 100 million jobs.

Cooperatives are a key component of Morocco's social and solidarity economy. They play a crucial role in the country's socioeconomic development by fighting poverty and exclusion, improving living conditions in rural areas, and creating jobs. However, these cooperatives face challenges, including internal management issues, competition, difficulties in accessing raw materials, and market entry barriers. Management challenges within cooperatives are highly complex. Even when managers are trained in business management, the cooperative model requires additional consideration of its associative aspect and its impact on organizational dynamics. Additionally, a study showed that cooperatives are capable of producing high-quality goods but lack the knowledge to satisfy market demand or attract potential buyers. They limit themselves to production and storage, waiting for customers to approach them or for an administration to invite them to an exhibition. In a market economy, cooperatives must adopt a marketing approach and establish a marketing mix plan to sell their products and services in line with consumer preferences, competitor pricing strategies, and effective distribution channels. Cooperatives and their groupings are seen as efficient models within the social and solidarity economy and are crucial players in Morocco's new orientations for local socioeconomic development.

Furthermore, the cooperative sector promotes income-generating projects and job creation while combating unemployment, particularly in rural areas. Through their values of democracy, solidarity, sharing, and mutual aid, cooperatives play an increasingly important role in Morocco's economic and social development. Their appeal has grown, especially since 2005, the year the INDH was launched, encouraging the creation and sustainability of social and solidarity economy structures.

2. OBJECTIVE OF THE SURVEY

The objective of our study is to present an overview of Moroccan cooperatives at detailed activity levels and fine geographical scales. This domain remains, however, difficult to grasp through the usual sources of cooperative statistics to conduct an in-depth analysis and draw significant conclusions because these data are scattered, insufficient, and sometimes absent for certain periods. The year 2012 was declared the International Year of Cooperatives by the United Nations and highlights the contribution of cooperatives to economic development and their impact on fighting poverty, creating jobs, and social integration. Moreover, this particular year had the slogan: "Cooperative Enterprises Build a Better World," and we will apply the spirit of this motto throughout this research work. Theoreticians in the field have extensively drawn from their experience to provide us with a methodology for setting up, organizing, and operating a cooperative. The idea is to establish a qualitative study that accurately describes the practices of Moroccan cooperatives. Qualitative methods are well-suited for studying individuals' opinions, behaviors, and practices.

Unlike quantitative studies, the goal of qualitative studies is not only to measure but to understand the sequences and logics of individuals' experiences, the interpretations they make, taking into account the contexts specific to each. To establish a diagnosis of the internal environment of cooperatives, we conducted a qualitative study based on case studies in the desire to discover and understand organizational structures**.** This study focused on semi-structured interviews conducted with officials from the Office for Cooperative Development (ODCO) and a field study with some women's cooperatives and the largest Moroccan cooperative, COPAG, which is seen as a model of success. This survey was conducted based on an interview guide.

The theme revolves around the diagnosis of Moroccan cooperatives. However, as we mentioned earlier, it is difficult to find reliable statistics on cooperatives. To conduct an in-depth analysis and draw significant conclusions because these data are scattered, insufficient, and sometimes absent for certain periods. Nevertheless, we were still able to design an econometric model using the data coding method, allowing us to better understand the functioning of a Moroccan cooperative and closely monitor its activity and financial situation to apprehend the many obstacles and limitations surrounding it, and subsequently become more efficient and competitive in the market alongside traditional companies, such as the COPAG cooperative, which managed to do so and is currently seen as a model of hope and success for all cooperatives. This survey aims to answer the following questions**:**

- Which sector has the highest capital?
- Which sectors are conducive to the creation of women's cooperatives?
- Does the training received have a significant impact on the cooperative's financial situation?
- Are cooperatives that have benefited from support/subsidies female or male?
- Do participation in events and training received have a positive impact on the cooperative's activity situation?
- Does a given region favor the creation of cooperatives more than another?
- Is there a significance between capital and the number of members?
- Does the gender factor have a significant impact on regions?
- Does the gender factor have a significant impact on the cooperative's activity situation?
- To delimit our study, we chose three main regions, namely: the Rabat region, the Oriental, and the Souss-Massa-Draa region. What are the main activity branches in the different listed regions?

3. QUESTIONNAIRE DEVELOPMENT

To collect data concerning the functioning of a Moroccan cooperative to be surveyed, two solutions are available: on the one hand, using a questionnaire with closed questions. These are used to obtain certain factual information, to judge the approval or disapproval of a given opinion, the position on a range of judgments, etc. Moreover, the responses are predetermined, and the respondent must absolutely choose from the options offered. This solution has the advantage of allowing better processing and facilitating the analysis of responses: since the responses are anticipated, there can be no ambiguity.

However, it has the disadvantage of "dictating" the respondent's answer: the respondent will tend to choose the response that seems most in line with the surveyors' expectations rather than the one closest to what they think. Thus, closed questions cannot and should not be used to collect nuanced information corresponding to deep-seated attitudes but to collect objective characteristics. On the other hand, designing a questionnaire with open-ended questions. As the name suggests, this type of question will allow the interlocutor to respond without constraint.

In this context, the response is not predetermined, and the respondent is free to express themselves. If the questions are well- formulated, they allow for collecting interesting and more relevant information. The only and main disadvantage of this method is the difficult processing. We opted for a mix of both methods to better target our research and achieve better results. Our objective is to analyze as best as possible the functioning of the Association du Docteur Fatiha (ADF), which cooperates exclusively with rural women and allows them to improve their economic situations. The questionnaire includes 17 open and closed questions at the same time, which led us to have better visibility of this association that helps women in the Oriental region to create their own cooperatives.

Moreover, thanks to this questionnaire and the field survey conducted over two months with the ADF, we were able to better understand the functioning of this association/cooperative. To discover the various ecological products these cooperative members resold, which were handcrafted, ultimately helping to preserve this cultural heritage. As a result, we were able to witness the fulfillment and emancipation of rural Moroccan women and their socio-economic development, but also to discover the limits and obstacles they face daily.

4. CHOICE OF SAMPLE

The main characteristic of a sample is that it should reflect the population's characteristics as much as possible. Great importance should be attached to it since it determines the precision of the results obtained. Our study does not claim to represent the situation of the Moroccan cooperative as a whole; it simply aims to shed light on its diversity. To carry out this project successfully, we opted for a selection of companies. We believe that this selection, concerning our objective, is better than statistical representativeness: this research is simply exploratory. This choice should allow covering a wide range of practices and representations. The selection involved initial exploration and contact work. We primarily contacted the Office for Cooperative Development (ODCO). The 84 cooperatives were selected with great difficulty from this organization, which took 24 months of intense work.

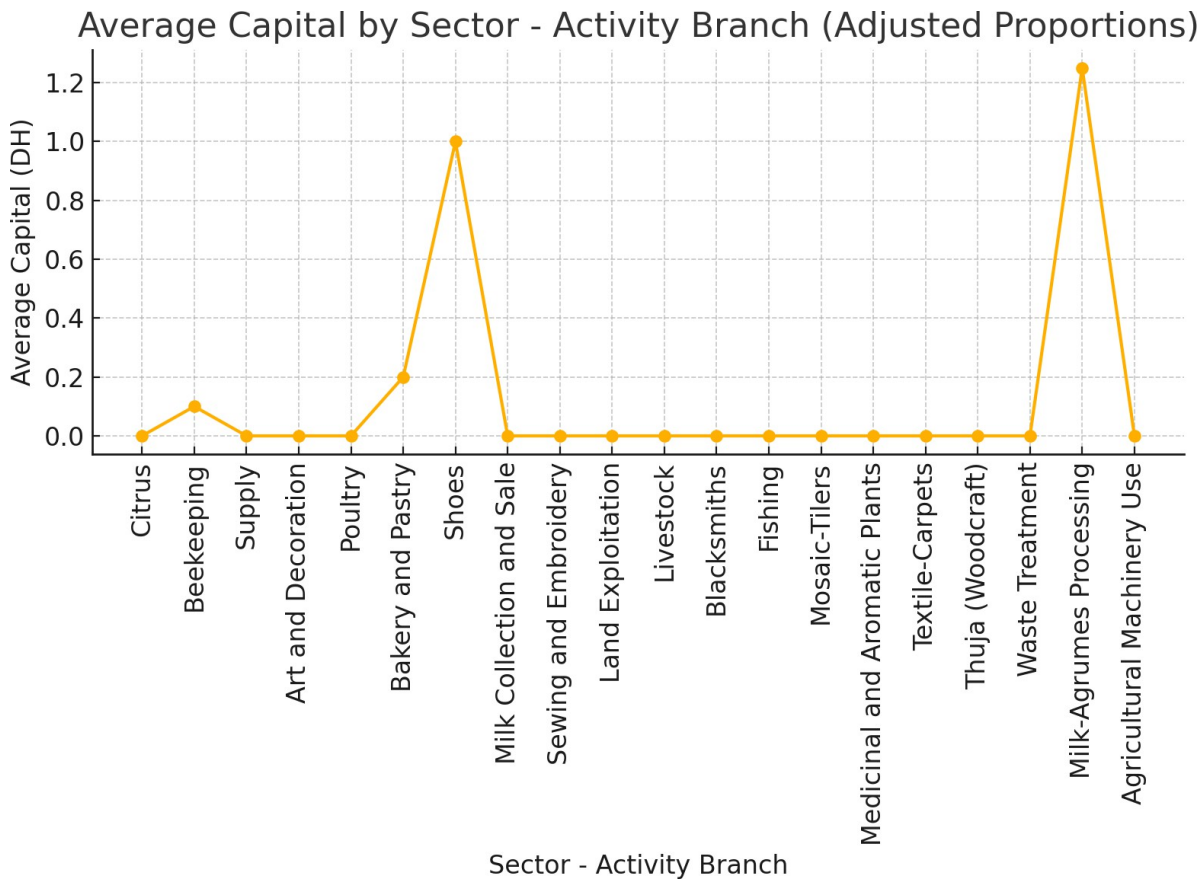
5. SURVEY RESULTS

The first question asked: Which sector has the highest capital?

ANOVA with One Factor

Capital (DH)

	Sum of Square	df	Mean square	F	Significance
Between Groups	2,106,043,386,936.7684	40	52,651,084,673.4192	162.325	.000
Within Groups	1,427,163,348,039.5880	44	32,435,530,637.26336		
Total	2,120,315,020,417.1644				



We observe through these graphs that the sector with the highest capital is CMA (cereals), followed by citrus fruits, as well as mainly milk collection and commercialization.

The second question asked: Which sectors/branches are conducive to the creation of women's cooperatives?

Observations
Table ends on the next page

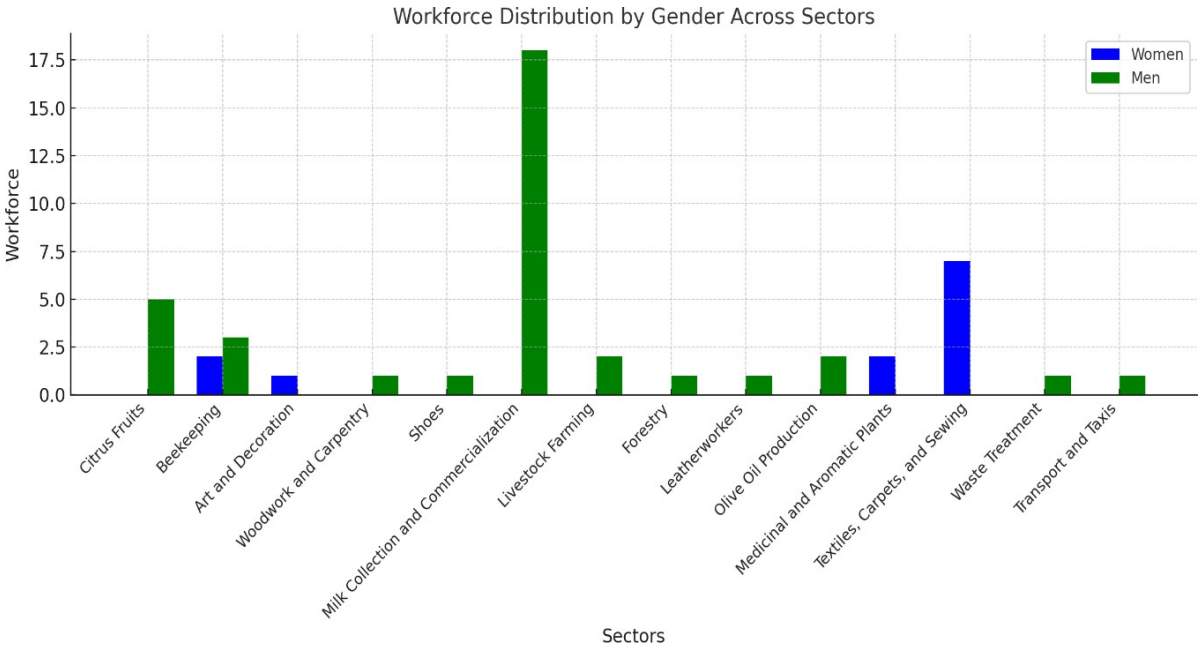
Sector Branch of activity	Female	Male	Total
Citrus Fruits		5	5
Literacy		2	2
Apiary		2	2
Apiculture		3	3
Supply		4	4
Argan	5		5
Art and decoration		1	1
Culinary arts	1		1
Poultry		1	1
Wood Work Carpentry		1	1
Bakery and Pastry		1	1
Cereals		1	1
Shoes		1	1
CMA (cereals)		1	1

Milk collection and commercialization		1	1
Collection and commercialization of milk		18	18
SEWING - EMBROIDERY	1		1
RABBIT FARMING	1		1
Livestok		2	2
QUARRY EXPLOITATIO N		1	1
LAND EXPLOITATION		1	1
Forest		1	1
BLACKSMITHS AND IRONWORKERS		1	1
MARKET GARDENING		3	3
MAROQUINERIE		1	1
METAL-JEWELRY		1	1
MOSAIC-ZELLIGE		1	1
OLEICULTURE (OLIVE TREES)		2	2
FISHING		1	1
Artisanal fishing		1	1
MEDICINAL AND AROMATIC PLANTS		2	2
SUGAR PLANTS		1	1
TEXTILE-CARPETS	7		7
TEXTILE-CARPETS-SEWING	1		1
THUYA (ARAR TREE)		2	2
Weavers		1	1
Waste treatment		1	1
Milk Processing		1	1
Milk processing-Citrus		1	1
Transport Taxis		1	1
Shared use of agriculture equipment			1
Total	16	69	85

Chi-Square Tests

	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	**85.000[a]**	**40**	**.000**
Likelihood Ratio	**82.221**	**40**	**.000**
Linear-by-Linear Association	**1.247**	**1**	**.264**
Number of Valid Cases	**85**		

80 cells (97.6%) have an expected count less than 5. The minimum expected count is .19.



According to these various graphs, the sectors/branches conducive to the creation of women's cooperatives are mainly argan cooperatives, culinary arts, sewing-embroidery, rabbit farming, textile-carpets, and textile-carpets-sewing.

Third question is: Does the training received have a positive impact on the cooperative's financial situation (namely, surpluses and turnover)? To answer this, we tested their significance.

Formation Received (1)

	N	**Mean**	**Std. Deviation**	**Std. Error Mean**
Turnover (DH)				
NO	**17**	**324,759.65**	**360,589.414**	**87,455.779**
YES	**59**	**49,906,410.47**	**289,556,330.049**	**37,697,023.277**

Levene's Test for Equality of Variances t-test for Equality of Means
Variable: TURNOVER (DH)

	F	**Sig**	**T**
Equal Variance assumed	1.410	.239	-0.703
Turnover DH			
Equal variance not assumed			**-1.315**

Explanation:

- **Levene's Test for Equality of Variances:** This test checks if the variances of the two groups (those who received training and those who did not) are equal.
  - **F:** The F-statistic value from Levene's test (1.410).
  - **Sig.:** The significance value (p-value) of the Levene's test (.239). Since this value is greater than 0.05, we do not reject the null hypothesis of equal variances.
- **t-test for Equality of Means:** This test compares the means of two groups.
  - Equal variances assumed:
    - **t:** The t-statistic value when equal variances are assumed (-0.703).
  - Equal variances not assumed:
    - **t:** The t-statistic value when equal variances are not assumed (-1.315).

Note:

- **TURNOVER (DH):** Indicates that the variable being tested is the turnover in Moroccan Dirhams.
- The **t** values are provided under both assumptions (equal variances assumed and not assumed) due to the result of Levene's test.

Test for Equality of Means Variable:
TURNOVER (DH)

	Df	Sig. (2-tailed)	Mean Difference
Equal variances assumed	74	.484	-49,581,650.828
Equal variances not assumed	58.001	.194	-49,581,650.828

Explanation:

- **df (Degrees of Freedom):**
  - **Equal variances assumed:** 74
  - **Equal variances not assumed:** 58.001
- **Sig. (2-tailed):** The two-tailed p-value of the t-test.
  - Equal variances assumed: .484
  - **Equal variances not assumed:** .194
- **Mean Difference:** The difference between the mean turnover of cooperatives that did not receive training and those that did.
  - **Mean Difference:** -49,581,650.828 DH

Interpretation:

- The **negative mean difference** indicates that cooperatives **which received training** have a higher average turnover compared to those **which did not receive training** by **49,581,650.828 DH**.
- Statistical Significance:
  - Since the **p-values** (.484 and .194) are **greater than 0.05**, the difference in turnover between the two groups is **not statistically significant**.
  - We **fail to reject** the null hypothesis that there is no difference in mean turnover between cooperatives that received training and those that did not.

Note:

- The t-test was performed under two assumptions:
  - **Equal variances assumed:** Assumes that the variances of the two groups are equal.
  - **Equal variances not assumed:** Does not assume equal variances; adjusts degrees of freedom accordingly.

Independent Samples Test
t-Test for Equality of Means

95% Confidence Interval of the Difference

Upper	
Turnover (DH)	
Equal variances assumed	**91,021,623.133**
Equal variances not assumed	**25,877,325.540**

Dimension	**1**	**2**	**Mean**
Activity situation	0.425	0.497	0.569
Training received (1)	0.047	0.358	0.668
Participation in events (2)	0.153	0.397	0.642
Total Active	0.625	1.252	1.879

TRAINING RECEIVED (1)
Variable: SURPLUS (DH)

Training received	N	Mean	Standard Deviation	Standard Error of the Mean
NO	**17**	**15,532.53**	**40,463.150**	**9,813.755**
YES	**57**	**411,537.18**	**1,146,670.402**	**151,880.205**

Explanation:

- **TRAINING RECEIVED (1):** Indicates whether the cooperative received training.
  - **NO:** Cooperatives that did not receive training.
  - **YES:** Cooperatives that received training.
- **N:** The number of cooperatives in each group.
- **Mean:** The average surplus (in Moroccan Dirhams) for each group.
- **Standard Deviation:** Measures the dispersion of surplus values in each group.
- **Standard Error of the Mean:** Estimates the variability between sample means if multiple samples were taken from the same population.

The data suggests that cooperatives which received training have a higher average surplus compared to those that did not receive training.

Levene's Test for Equality of Variances
t-Test for Equality of Means
Variable: SURPLUS (DH)

	F	**Sig.**	**t**	**df**
Equal variances assumed	6.337	.014	-1.417	72
SURPLUS (DH)				
Equal variances not assumed			-2.602	56.465

t- Test for Equality of Means
Variable: SURPLUS (DH)

	Sig. (2-tailed)	Mean Difference	Standard Error Difference
Equal variances assumed	.161	-396,004.646	279,510.149
Equal variances not assumed	.012	-396,004.646	152,196.933

Explanation:

- **Sig. (2-tailed):** The two-tailed significance (p-value) of the t-test.
  - **Equal variances assumed: .**161
  - **Equal variances not assumed:** .012
- **Mean Difference:** The difference between the mean surplus of cooperatives that did not receive training and those that did.
  - **Mean Difference:** -396,004.646 DH
- **Standard Error Difference:** The standard error of the mean difference.
  - **Equal variances assumed:** 279,510.149
  - **Equal variances not assumed:** 152,196.933

Interpretation:

- The **negative mean difference** indicates that cooperatives **which received training** have a higher average surplus compared to those **which did not receive training** by **396,004.646 DH**.

Statistical Significance:

  - Under the assumption of **equal variances**, the p-value is **.161**, which is greater than **0.05**, indicating that the difference is **not statistically significant** at the 5% level.
  - Under the assumption of **unequal variances**, the p-value is **.012**, which is less than **0.05**, indicating that the difference is **statistically significant** at the 5% level.
- This suggests that when variances are not assumed to be equal, the training received has a significant positive impact on the surplus of the cooperatives.

t-Test for Equality of Means
95% Confidence Interval of the Difference

	Lower bound	Upper bound
Equal variances assumed	-953,197.944	161,188.652
SURPLUS (DH)		
Equal variances not assumed	-700,836.326	-91,172.966

After performing the significance test, we observe that there does not seem to be a relationship between turnover and the training received. Concerning the significance test for turnover, it is 0.239, which is greater than 0.05, so there is no relationship between turnover and the training received. However, we note from the significant test for surpluses that there is a relationship between the training received and the cooperative's surpluses; we found 0.014, which is less than 0.05, so the training received has an impact on the cooperative's surpluses.

6. CONCLUSION

The purpose of this study is to clarify the functioning of Moroccan cooperatives, namely the 84 cooperatives, the COPAG cooperative, as well as the study conducted with the Association of Dr. Fatiha. The interviews conducted with the ODCO, the Association of Dr. Fatiha, and the COPAG cooperative have led to the drafting of reports. Compiling these reports allows us to synthesize our results and propose recommendations.

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FROM MILITARY RUINS TO SUSTAINABLE DESTINATIONS: ADAPTIVE REUSE OF ABANDONED SOVIET BASES FOR TOURISM AND LOCAL DEVELOPMENT

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ABSTRACT
This study explores the adaptive reuse of abandoned Soviet military sites across Central and Eastern Europe as a pathway to environmental, cultural, and economic sustainability. By converting these brownfield areas into tourist attractions, communities can avoid land-consuming greenfield developments, preserve historical heritage, and stimulate local economies. Drawing on five comparative case studies from Latvia, Czechia, Germany, Poland, and Hungary, the research combines secondary data and online review analysis to assess current functions, visitor perceptions, and redevelopment strategies. Findings reveal that successful transformations integrate heritage interpretation with innovative tourism products, ranging from museums and festivals to recreational facilities, while addressing environmental challenges such as contamination and structural decay. The results underline that, despite legal, financial, and technical barriers, the repurposing of such sites can support Sustainable Development Goals by fostering resource efficiency, cultural preservation, and community engagement. The paper offers practical insights for policymakers, urban planners, and tourism developers seeking to transform post-military landscapes into assets for sustainable development.
Keywords: *adaptive reuse; heritage tourism; sustainability; brownfield redevelopment; communism tourism*

1. INTRODUCTION

The adaptive reuse of abandoned buildings has emerged as a crucial approach to addressing the environmental, social, and economic challenges of our time. By reimagining and revitalizing existing structures rather than constructing new ones, communities can conserve natural resources, reduce waste, and preserve cultural heritage. This approach is particularly relevant in the context of former Soviet military bases and barracks scattered across Central and Eastern Europe. These sites, remnants of the Cold War era, not only occupy valuable land but also carry significant historical and cultural meaning. Following the withdrawal of Soviet troops in the early 1990s, thousands of military installations were left abandoned. While many fell into disrepair, others have been successfully transformed into spaces for tourism, education, culture, and recreation. Such transformations are not merely acts of preservation; they represent opportunities to foster intergenerational understanding, as these sites reflect the lived experiences of those who grew up during the communist period. Sustainability provides the broader framework for this discussion. The reuse of former military sites prevents further encroachment on green spaces, reduces the environmental footprint of development, and supports local economic revitalization. At the same time, it safeguards a unique segment of twentieth-century history, offering younger generations tangible connections to the past.

This study examines the touristic reuse of selected former Soviet military sites, exploring their potential to contribute simultaneously to heritage preservation and sustainable development. It addresses the historical context of these structures, the principles of adaptive reuse, and the role of niche tourism segments such as dark tourism and communism tourism. By situating the research within this multidisciplinary framework, the paper seeks to highlight the opportunities and challenges inherent in transforming abandoned military landscapes into meaningful cultural and economic assets.

2. LITERATURE REVIEW

The adaptive reuse of abandoned and underutilized buildings has been widely discussed in the context of sustainable urban development. Scholars emphasize that reusing existing structures contributes to the reduction of environmental impacts by limiting resource consumption, avoiding waste from demolition, and preventing the unnecessary occupation of undeveloped land (Bullen & Love, 2011; Langston et al., 2008). This aligns closely with the principles of sustainable development as defined in the Brundtland Report (WCED, 1987), which stresses the need to meet present needs without compromising the ability of future generations to meet theirs. Adaptive reuse also supports social sustainability by preserving cultural identity and fostering community engagement (Yung & Chan, 2012). The concept of brownfield regeneration, where abandoned or contaminated sites are repurposed for new uses, has particular relevance for former military installations. Brownfields often pose complex challenges, including environmental contamination, infrastructure decay, and ownership disputes (Alker et al., 2000). However, successful redevelopment can deliver substantial benefits, from increased property values to enhanced local economies (Thornton et al., 2007). Post-military landscapes are a specific subset of brownfields, carrying not only physical but also symbolic meanings. As Woodward (2004) notes, such sites embody historical narratives of power, conflict, and geopolitics. Their reuse therefore engages with both tangible and intangible heritage dimensions. Within tourism studies, the transformation of military sites is often examined under the framework of heritage tourism (Timothy & Boyd, 2003) and dark tourism (Lennon & Foley, 2000). Heritage tourism focuses on the presentation and interpretation of historical assets, while dark tourism involves visiting sites associated with death, tragedy, or conflict. The term “communism tourism” has also emerged to describe visits to locations linked to the socialist and communist eras in Eastern Europe (Light, 2000; Rátz, 2006). Such tourism can offer educational and reflective experiences, but it also raises debates about commercialization, nostalgia, and the ethical representation of the past (Beech, 2000). Several studies have examined the reuse of former Soviet military sites across Central and Eastern Europe. Răcăşan (2014) highlights the potential of these sites to diversify local tourism offerings, while Leary and Sholes (2000) underline the importance of integrating them into wider regional development strategies. The transformation of these facilities is not without obstacles: financial constraints, environmental remediation requirements, and conflicting stakeholder interests often slow down or prevent redevelopment (Grimski & Ferber, 2001). In this respect, public-private partnerships and EU funding mechanisms have played a crucial role in successful projects (Ferber & Grimski, 2002). From a cultural perspective, the interpretation of post-military heritage requires careful balance. Ashworth (2004) warns against excessive sanitization, which can strip a site of its historical authenticity, while Uzzell (1989) argues that confronting visitors with uncomfortable aspects of the past can foster deeper understanding and empathy. This is particularly relevant in the case of Soviet military sites, which evoke memories of political repression and foreign occupation in many communities. The integration of adaptive reuse into sustainable tourism development has been recognized by the United Nations World Tourism Organization (UNWTO, 2013), which promotes tourism’s role in preserving heritage while contributing to the Sustainable Development Goals.

In the case of post-military sites, this involves aligning redevelopment with environmental objectives such as remediation and biodiversity protection alongside social and economic goals. Projects that achieve this balance not only preserve historical narratives but also create new livelihoods, strengthen community identity, and reduce the environmental footprint of tourism infrastructure. In summary, the literature positions the adaptive reuse of former Soviet military sites at the intersection of heritage preservation, brownfield regeneration, and sustainable tourism. While challenges remain in terms of environmental remediation, funding, and interpretation, a growing body of research points to the potential of these transformations to serve as models for integrating historical memory into sustainable development strategies.

3. METHODOLOGY

This study examines five selected former Soviet military bases and barracks with the primary objective of identifying sustainable, tourism-oriented reuse strategies that can be applied to currently abandoned sites. By analyzing exemplary cases, the research aims to reveal functional transformations that balance heritage preservation with environmental, social, and economic sustainability. The methodology relies on secondary data sources, including internet-based materials, social media content, local tourism websites, and online reviews. This approach was necessitated by the lack of comprehensive official statistics and scholarly studies for all of the sites under investigation. Non-academic sources, such as blogs, YouTube channels, and online forums, were also incorporated to fill information gaps, particularly where professional documentation was unavailable. Although these sources are not peer-reviewed, they often provide rich, first-hand observations that can inform tourism development strategies. Particular emphasis is placed on the analysis of online reviews, which constitute an increasingly important dimension of tourism research. As Banerjee and Chua (2016) note, user-generated reviews offer authentic insights into visitor satisfaction, perceived value, and service quality. These reviews, accessible through platforms such as Google and TripAdvisor, combine qualitative narratives with quantitative rating systems, enabling both descriptive and comparative assessments. Consistent with Ye et al. (2014), the study uses review ratings as a metric for gauging perceived quality, while also examining recurring themes in visitor feedback. However, the analysis acknowledges the inherent limitations of online review data. As Chua and Banerjee (2013) caution, biases whether overly positive or negative may distort overall impressions, and some reviews may originate from individuals who have not actually visited the site. Despite these caveats, such data remains valuable in contexts where official visitor surveys or academic studies are scarce, offering a broad, real-time snapshot of tourist perceptions. The collected data suggest that the majority of the examined Soviet-era sites have undergone partial reuse, with only a smaller proportion achieving full functional transformation since the end of the communist period. By documenting these varying degrees of adaptation, the study not only evaluates current outcomes but also identifies best practices for integrating historical heritage into sustainable tourism and community development initiatives.

4. FINDINGS

4.1. Skundra-1, Latvia

4.1.1. Location context

Skundra is a small rural settlement in the Latgale region of eastern Latvia, close to the Russian border. The surrounding area is sparsely populated, characterised by agricultural land, forests, and scattered villages. Latgale is culturally distinct, with strong influences from Latvian, Russian, and Belarusian traditions. Skundra's remote location and limited accessibility made it strategically suitable for Cold War military purposes, while today its isolation adds to the mysterious atmosphere for visitors interested in Soviet-era heritage.

4.1.2. History of Skundra

Situated in proximity to Skundra, Latvia, the former Soviet base, "Skundra-1" originated as a radar station during the Cold War era, accommodating approximately 5,000 individuals, comprising Soviet soldiers and their families. Founded in 1963 with the primary objective of detecting incoming missiles from Western Europe, this installation encompassed a comprehensive infrastructure, including barracks, educational institutions, shopping centres, hospitals, administrative facilities, and factories, catering to the diverse needs of its inhabitants. Following the withdrawal of Soviet forces in 1994, the site remained operational for an additional four years. Noteworthy for its strategic significance as one of the Soviet Union's pivotal radar stations, the demolition of its radar tower received sponsorship from the United States. The complete cessation of radar operations was officially verified by a monitoring team from the Organization for Security and Cooperation in Europe (OSCE) (Fischer, 2022).

4.1.2. Touristic use of Skundra

Without financial investments, the abandoned site underwent a transformation, retaining only the shells of its former glory, such as furniture, Lenin portraits, and residual artifacts offering glimpses into the daily lives of Soviet soldiers and their families. In accordance with governmental initiatives to preserve the site, it was designated as a tourist attraction in 2015, allowing visitors to explore the ghost town and witness the remnants of its dilapidated structures. Prior to its reconversion into a military training base, tourists were granted access to the site for a fee of 45 euros. Numerous foreign groups visited it to gain insights into the experiences of those living under communism (Voa News, 2016). Presently, however, civilian access has been restricted, with the area falling under the purview of the Ministry of Defense, serving as a military training ground (Latvijas Sabiedriskie Mediji, 2016).

4.1.4. Review analysis of Skundra

While lacking a Google rating, the abandoned base has an overall score of 4.5 out of 18 reviews on TripAdvisor. These reviews, predominantly in English, representing diverse nationalities, including French, Swedish, Canadian, American, and Baltic states, indicate the captivating ambiance of the site. The unique and authentic atmosphere has been lauded by visitors who found the experience both "eerie" and "spooky." Skundra, being a heritage site, strategically emphasizes its historical legacy, a characteristic that resonated positively with tourists. Despite its continuing deterioration over the years, visitors express a persisting appreciation for the site. Negative comments primarily stem from the disappointment arising from the inability to access the ghost town (TripAdvisor, 2024a).

4.2. Milovice, Czechia

4.2.1. Location context

Milovice is a town in the Central Bohemian Region of Czechia, situated about 40 kilometres northeast of Prague. Originally a small rural settlement, it has grown significantly in recent decades, partly due to its proximity to the capital and good transport connections. The surrounding area is characterised by flat agricultural landscapes and patches of woodland, with a few small rivers and ponds. Milovice's location made it strategically important for various armies over time, and today its mix of military heritage, new residential areas, and recreational facilities attracts both locals and visitors from Prague and beyond.

4.2.2. History of Milovice

Predating its status as a Soviet base, Milovice had been established by the Austro-Hungarian Army. Serving diverse military purposes over the years, it functioned as a prisoner camp during the First World War and subsequently became a Czechoslovak Army military base.

Following the German occupation, Milovice was known for its role in producing staged footage of the Eastern Front. In 1968, it fell under Soviet control, hosting the Central Group of Forces, which necessitated expansion, incorporating an airport and a bigger territory to accommodate approximately 100,000 Soviet soldiers and their families. The base was wholly abandoned in 1995, four years subsequent to the departure of the last troops. The subsequent revitalisation efforts, initiated shortly thereafter, have transformed Milovice into a burgeoning city, predominantly inhabited by a young demographic. However, the aftermath of the Soviet departure witnessed the demolition of structures and the contamination of fields with substances such as gasoline (Tomek, 2017).

4.2.3. Touristic use of Milovice

The transformation of the former military base into a civilian city has started the active development of Milovice as a tourist destination. A variety of attractions have been introduced, including the family-oriented Park Mirakulum, the Tankodrom, and the annual Let It Roll music festival. Park Mirakulum, an entertainment park, caters to families with younger children, offering educational trails and high-quality playgrounds (Mirakulum, 2024). The Tankodrom Milovice focuses on military experiences, allowing visitors to operate tanks and explore well-maintained military equipment, with additional options such as army drills and paintball for the more adventurous (Tankodrom Milovice, 2024). On the cultural front, the Let It Roll music festival, hosted on the former airport, draws electronic music enthusiasts to the city annually, having been held since 2015, excluding 2020 (Letitroll, 2024).

4.2.4. Review analysis of Milovice

While there is a lack of reviews on TripAdvisor, Google reviews provide insights into the two attractions: Park Mirakulum (4.8 stars, 17,671 reviews) and Tankodrom Milovice (4.6 stars, 511 reviews). Park Mirakulum, catering to a younger audience, received compliments for its extensive area, diverse toys and equipment, and visual design. Criticisms primarily revolved around the absence of roller coasters, perceived high pricing, and concerns about single-use plastic. Visitors appreciated the variety of games and activities, acknowledging the quality of the playgrounds, while expressing objections about the costliness and insufficient real-time information on social media platforms (Google, 2024a). Tankodrom Milovice, offering military experiences, received praises for fulfilling visitors' dreams by allowing them to drive tanks and engage with military equipment. Regarded as an essential attraction for Prague visitors, it was acclaimed as a unique and lifelong experience. Nevertheless, some complaints were voiced about perceived rudeness and incompetence among the staff (Google, 2024b).

4.3. Lärz, Germany

4.3.1. Location context

Lärz is a small municipality in the state of Mecklenburg-Vorpommern in northern Germany, situated near the southern shore of Lake Müritz, the largest inland lake entirely within Germany. The area is part of the Mecklenburg Lake District, known for its extensive network of waterways, forests, and nature reserves, making it attractive for both tourism and recreation. Lärz lies approximately 150 kilometres north of Berlin and benefits from its proximity to popular holiday destinations around Müritz National Park. This strategic yet scenic location contributed to its historical role as a military base and its present appeal as a venue for large-scale cultural events.

4.3.2. History of Lärz

Rechlin-Lärz traces its origins back to the First World War when it functioned as a military base and airfield, and as such, it was the target of heavy bombardments during the Second World War. Initially utilised as a testing ground for the Luftwaffe, the site underwent expansion with additional airfields, achieved through forced labour from prisoners of the nearby Ravensbrück concentration camp. Following the Red Army's occupation in 1945, it continued serving as a military settlement for the Soviet Air Force, accommodating around 2000 soldiers until the withdrawal of the Soviet corps. Presently known as Müritz Airpark, the former Rechlin-Lärz Airfield serves as a civilian airfield for leisure activities and hosts the annual Fusion Festival (Forgotten Airfields, 2011).

4.3.3. Touristic use of Lärz

Evidence remaining of its Soviet occupation, the military base in Lärz retains Cyrillic inscriptions, intact shelters, a nuclear storage shelter, and military equipment displayed in the aviation museum. The site has become notable as the venue for the annual nonprofit Fusion Festival, characterised by its focus on communist music and arts, covering techno, electronic, and various other genres. Attracting a predominantly young and left-wing demographic, the festival aims to provide an immersive experience of "Holiday Communism", fostering a parallel society rooted in nondiscrimination and self-organisation, both among organisers and attendees (Riceburg, 2013; Fusion Festival, 2024).

4.3.4. Review analysis of Lärz

Currently serving as a civilian airport, a private museum, and a living space, Müritz Airpark has gained 94 Google reviews, achieving a rating of 4.6 stars. Described as "small and lovely", the airport is praised for its accessibility by various aircraft, courteous staff, and a bistro providing excellent offers. The private museum is known for its extensive and impressive collection. Positive mentions also extend to the Fusion Festival, the picturesque surroundings, and the overall charm of the location (Google, 2024c). Conversely, the Fusion Festival has received eight reviews on TripAdvisor, garnering a score of 4.0. Criticisms primarily revolve around perceived overpricing and a perceived shortfall in delivering on the festival's core message and promised values (TripAdvisor, 2024b). In contrast, detailed accounts from commenters on the r/Techno subreddit paint a more nuanced picture, emphasising the festival's diverse music genres, art performances, and overall experience. Participants are encouraged to embrace the unique atmosphere of the "DIY festival", enjoying activities beyond alcohol consumption, such as chilling, partaking in offered activities, and relishing vegan food (Reddit, 2024).

4.4. Borne Sulinowo, Poland

4.4.1. Location context

Borne Sulinowo is located in northwestern Poland in the West Pomeranian Voivodeship, about 140 kilometres east of the German border. The town lies amid forests and lakes in the Drawsko Landscape Park area, a region valued for its natural beauty and biodiversity. Its relatively remote location contributed to its secrecy during the Soviet occupation, as it was well shielded by dense woodland and limited access roads. Today, its setting offers opportunities for outdoor recreation such as hiking, cycling, and water-based activities on nearby lakes, complementing its military heritage tourism.

4.4.2. History of Borne Sulinowo

Borne Sulinowo, a Polish town, served as a German Army training ground during World War II and was integrated into the Pomeranian Wall, functioning as military barracks and a prisoner of war camp. Located behind the war lines, the town escaped significant damage and was subsequently seized by the Red Army, evolving into one of Poland's largest military camps with nearly 12,000 stationed Soviet troops. Eradicated from official records for five decades, the last Soviet military unit departed in 1992, returning control to Poland. Following a brief period under the Polish Army, civil authorities assumed control, officially opening the town to the public (Czarnecka & Demski, 2018).

4.4.3. Tourism of Borne Sulinowo

Borne Sulinowo has emerged as a destination for adventure and nature tourists, drawing visitors to explore its natural surroundings and the remnants of Soviet ruins. Celebrations during significant anniversaries highlight the town's formation, attracting additional visitors. Notably, the International Gathering of Military Vehicles stands out as a major draw, contributing significantly to tourist numbers and local profits. Museums within the former Soviet military base showcase the area's heritage, providing a space for reflection and understanding of Poland's unwanted past (Czarnecka & Demski, 2018).

4.4.4. Review analysis of Borne Sulinowo

The Military History Museum, Muzeum Militarnej Historii W Bornem Sulinowie, is a prominent attraction in the area, receiving a 4.6-star rating from 820 Google reviews (Google, 2024d). Visitors express satisfaction with the displayed tanks and trucks, particularly highlighting the military vehicle shows held on Saturdays as a unique and engaging experience. Many view the museum as an invaluable opportunity to learn and "feel the past", commending the passionate and knowledgeable guides. Criticisms include the site's relatively small size, occasional overcrowding, and perceived high prices in comparison to the number of vehicles on display. Despite these negatives, the museum is considered a "must-see" by those interested in military history, emphasizing its significance. Unfortunately, the International Gathering of Military Vehicles lacks a dedicated review site, but visitors to the museum frequently recommend it as an essential component of exploring Borne Sulinowo's military history (Sulinowie Museum, 2024).

4.5. Tököl, Hungary

4.5.1. Location context

Tököl is situated in central Hungary, approximately 30 kilometres south of Budapest, on Csepel Island along the Danube River. Its proximity to the capital, combined with relative seclusion due to the surrounding agricultural areas and waterways, made it strategically valuable for military purposes during the 20th century. Today, the location benefits from good transport connections, enabling easy access for leisure visitors while still preserving a sense of isolation suitable for adventure tourism activities.

4.5.2. History of Tököl

Constructed in the 1940s, the Tököl airport initially served a dual purpose, functioning both as an airport and an airplane factory. During the Second World War, it housed the 5/3 fighter squadron, responsible for the defense of Budapest. Occupied by the Soviets in 1944, Tököl became a pivotal site for various Soviet troops until 1991. Notably, the location played a central role in the 1956 Hungarian Revolution, hosting negotiations between Hungarian and Soviet parties that resulted in the forced deportation of Hungarian delegates to the Soviet Union (Szentesi, 2003; Lupkovics, 2009).

4.5.3. Tourism of Tököl

Transforming the landscape, the former Soviet barracks in Tököl have undergone renovation, evolving into a residential park. Simultaneously, the disused airport and base have been repurposed to offer diverse forms of active entertainment, including laser tag, airsoft, and paintball. Numerous companies operate these engaging activities within the confines of the old structures and expansive green spaces, catering to both local and international enthusiasts.

4.5.4. Review analysis of Tököl

Patriots Paintball Tököl, one of the paintball businesses, has a 4.6-star rating from 162 reviews, featuring feedback from both domestic and international commentators. Visitors praise the quality and variety of the courses, using terms like "brilliant place" to express their satisfaction. However, criticism is directed at the staff, with dissatisfaction noted in several reviews. The positive responses highlight the excellent location, often described as a "real environment", particularly praised for its historical connection to the Soviet barracks. Despite some service-related concerns, no negative reviews pertain to the location or the overall experience, indicating the successful integration of recreational activities within the historical context of Tököl (Google, 2024e).

4.6. Comparative summary of analyzed locations

The five examined sites – Skundra-1, Milovice, Lärz, Borne Sulinowo, and Tököl – illustrate different trajectories in the post-military transformation of Soviet-era bases. As summarised in Table 1, these locations once served various strategic functions such as radar stations, airfields, barracks, training grounds, and even prisons. Their current uses range from military training grounds still under army control, through recreational and cultural venues, to fully integrated residential areas.

Table 1. Summary of Analyzed Locations (source: own edit)

Name of the location	Previous function	Current role	Review analysis
Skundra-1, Latvia	Radar station, military settlement	Military training ground	Limited online reviews indicate a positive visitor experience during the period it was used as tourist attraction, with appreciation for its historical significance and atmosphere.
Milovice, Czech Republic	Military base, prison	Thematic parks, venue for music festival	Positive reviews highlight the unique and unforgettable adventurous and cultural experiences offered at Milovice.
Lärz, Germany	Military base, airfield	Civilian airport, private museum, venue for music festival	The reviews comment on the attractiveness of the military museum and the Fusion Festival, while noting some issues with overcrowding and contradictory service.
Borne Sulinowo, Poland	Training ground, military barrack, prison	Military museum, venue for military history events	Reviews commend the Military History Museum for its exhibits and knowledgeable guides, though some mention overcrowding and high prices.
Tököl, Hungary	Military base, airport, factory	Residential area, venue for recreational activities	Positive reviews highlight the quality and variety of activities available at the ex-soviet base, though some note issues with staff professionalism.

Table 1: Comparative overview of the analyzed former Soviet military sites (Source: own edit based on collected online data of the analyzed locations)

From a tourism perspective, the sites present a diverse spectrum of attractions. Milovice and Lärz have leveraged large-scale events such as music festivals to attract wide audiences, while Borne Sulinowo has positioned itself as a centre for military heritage through its museum and historical vehicle gatherings. Tököl has opted for active recreation such as paintball and airsoft, repurposing historical structures to suit adventure tourism. Skundra-1, despite offering authentic Cold War heritage, remains under limited tourist utilisation due to accessibility and operational constraints. Visitor feedback, drawn from online review platforms, reveals generally positive perceptions across all sites. Common strengths include the uniqueness of the settings, the authenticity of preserved military features, and the variety of activities offered. Recurring challenges include overcrowding during peak events, perceived overpricing, occasional service quality issues, and in some cases, restricted access. Overall, the comparative analysis demonstrates that adaptive reuse of former Soviet military installations can generate cultural, economic, and social value for local communities. Successful transformations appear to depend on a combination of preserved heritage, diversified attractions, and effective visitor management strategies, ensuring that these sites serve both as reminders of the past and as sustainable drivers of present-day tourism.

5. CONCLUSION

This research examined selected former Soviet barracks and military facilities, both in Hungary and abroad, in order to highlight approaches for repurposing such structures in ways that preserve their heritage value while creating new, viable uses. Although the study did not aim to cover all examples, it provides insights into the spectrum of outcomes, ranging from partial reuse to complete transformation. While retaining a military function is often the simplest path, alternative uses such as tourism, cultural, residential, educational, recreational, commercial, or hybrid models can generate broader and more sustainable benefits. Military heritage sites occupy a unique niche within heritage, dark, and communist tourism, attracting diverse audiences. Even in regions where the communist past remains a sensitive subject, such sites can appeal to domestic visitors and international tourists alike, particularly younger generations seeking authentic and unconventional experiences. Successful redevelopment requires active cooperation between local governments, property owners, cultural institutions, residents, and other stakeholders, ensuring that economic, social, and environmental objectives are met. The analyzed examples illustrate that repurposed sites can become community hubs, adventure venues, and cultural landmarks. From ghost-town exploration and paintball fields to museums, festivals, and residential complexes, these transformations show that adaptive reuse can revitalize neglected spaces. The eerie ambiance of abandoned military architecture, combined with creative reinterpretation, can create distinctive tourism products. Moreover, innovative ideas such as interlinking nearby barracks via thematic trails, establishing guided tours to interpret historical narratives, creating immersive socialist-era museums, hosting artist colonies similar to Rivoli 59 in Paris or Metelkova in Ljubljana, developing themed leisure zones, or offering specialized photography studios for horror and post-apocalyptic scenes can further diversify visitor offerings. Each concept, however, must be grounded in feasibility studies, safety requirements, legal clearance, and long-term operational plans. From a sustainability perspective, adaptive reuse reduces the need for new land development, preserves architectural heritage, and fosters local identity. When projects actively involve local communities in planning and management, they not only protect the environment but also strengthen social cohesion. The most effective initiatives balance heritage preservation with creative reinterpretation, allowing sites to serve both as reminders of the past and as platforms for contemporary cultural expression. Such projects also align with the principles of sustainable tourism development by integrating environmental protection, economic viability, and cultural authenticity.

Ultimately, the functional transformation of former military sites should be guided by the unique characteristics of each location. Whether targeting domestic communities, niche adventure tourists, or broader international audiences, success depends on matching the site's historical narrative with sustainable development goals. Some projects may require minimal safety measures to be operational, while others such as museums, recreation centers, or large-scale events demand substantial investment in infrastructure and services. If approached collaboratively and strategically, these once-restricted places can evolve into dynamic assets that contribute to local prosperity, cultural vitality, and environmental stewardship, turning a difficult legacy into a sustainable opportunity for both tourism and community development.

LITERATURE

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IMPROVING HEALTH LITERACY IN PHARMACIES THROUGH SUSTAINABLE PRACTICES

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ABSTRACT

Health literacy is a cornerstone of modern healthcare systems, encompassing not only access to information but also the ability to understand and apply it effectively. According to the World Health Organization, health literacy is based on individuals' capacity to make informed decisions aimed at preserving and improving their health. Pharmacies hold a particularly important position in advancing health literacy, as pharmacists maintain direct contact with the public and are therefore well placed to support its functional, interactive, and critical dimensions. Educational materials, patient counselling, screening initiatives, and personalised pharmacy consultations all contribute to enhancing health awareness. International best practices such as Ireland's Crystal Clear programme demonstrate that structured quality criteria can serve as a solid foundation for effective health literacy systems. In Hungary, the Gyógyszereim 5XM and SZEBB programmes illustrate how improved pharmacy–patient collaboration can be implemented in practice. Incorporating sustainability considerations, including reducing pharmaceutical waste and using environmentally friendly educational resources, further increases the social and ecological benefits of health literacy initiatives. Based on a review of the literature and best practices, this study provides an overview of pharmacy-based health literacy programmes and examines how their implementation can be aligned with sustainability principles.

Keywords: *health literacy, pharmacies, greener healthcare, sustainability, digital education*

1. INTRODUCTION

Health literacy, defined as the ability to obtain, understand, evaluate, and apply health-related information, is a fundamental prerequisite for individuals to make informed decisions about their own health (Pelikan & Ganahl, 2017; Csizmadia, 2016). Modern healthcare is becoming increasingly complex: medical terminology, the functioning of healthcare systems, the diversity of treatment options, and the often unverified abundance of online information can all pose serious challenges for laypersons. In this environment, adequate health literacy is not merely advantageous but is essential for prevention, effective treatment, and maintaining quality of life (HLS24, 2024). Numerous international studies have confirmed that people with low health literacy are more likely to misuse medicines, have poorer control of chronic diseases, make less use of preventive services, and experience higher rates of hospital readmissions (Eichler et al., 2009; Haun et al., 2015; Palumbo, 2017). Conversely, high levels of health literacy not only improve individual well-being but also reduce the long-term burden on healthcare systems. For this reason, improving health literacy is a matter of public interest that extends beyond the boundaries of education and healthcare, requiring broad social cooperation (NFFS2, 2025). Pharmacies can play an outstanding role in this process. Pharmacists are easily accessible, trusted healthcare professionals who interact daily with patients seeking advice about medicine use and their health status (GyogyGond, 2023).

This offers an opportunity for pharmacies to operate not merely as points of service but as active centres of health education and counselling. This is especially important in countries such as Hungary, where a significant proportion of the population visits pharmacies regularly, often turning to pharmacists for guidance before consulting a doctor (Somogyi, 2023). The aim of this study is to explore how pharmacies and pharmacists can contribute to the development of health literacy (Cork & White, 2022). We first review the concept and significance of health literacy (Nutbeam, 1998), then examine the methods and tools through which pharmacies can help the public make more informed health decisions. We present both international and Hungarian examples, including Ireland's Crystal Clear Pharmacy programme ("Crystal Clear" 2024) and the Hungarian Gyógyszereim 5xM and SZEBB initiatives (MGYK, 2023). Our analysis pays particular attention to sustainability, digital innovation, education, and interdisciplinary cooperation, all of which are crucial for long-term health promotion (Hasan et al., 2023). The role of pharmacies in enhancing health literacy is not only an opportunity but also a responsibility. To fulfil this role effectively, structured programmes, professional support, and collaboration between healthcare and educational systems are required (FIP, 2025). Such efforts can ensure that health knowledge is not the privilege of professionals alone but is accessible, understandable, and applicable for everyone in everyday life.

2. IMPROVING HEALTH LITERACY: CONCEPTS AND KEY CHALLENGES

The concept of health literacy was first introduced by the World Health Organization (WHO) in 1998 and has since become a central focus of research. In its 2016 report, the WHO defined health literacy as "the ability of individuals to gain access to, understand, and use health-related information in ways that promote and maintain good health" (WHO, 2016). Health literacy therefore encompasses not only the knowledge required to maintain, improve, and preserve health but also the ability to apply that knowledge in practice. Nutbeam (2000) identifies three main components of health literacy:

- Functional health literacy – Basic skills in reading, writing, and numeracy needed to understand health-related information.
- Interactive health literacy – More advanced cognitive and social skills that enable active participation in health-related decision-making.
- Critical health literacy – The ability to evaluate and use information to maintain control and autonomy.

The level of health literacy is influenced by multiple factors, including education, income, age, gender, and the transparency and accessibility of the healthcare system. The digital divide, referring to differences in access to technology and the ability to use digital tools, also contributes to these inequalities (Ercsey, 2025). Low health literacy is not only an individual concern but also a societal issue. Misunderstanding information, failing to follow treatment instructions, gaps in doctor–patient communication, and the rejection of preventive programmes can have serious consequences. Health influencers can also play a role in improving health literacy (Buglyó-Nyakas & Gál, 2025). The application of digital technologies and artificial intelligence offers new opportunities for advancing health literacy. García-Hernández et al. (2022) emphasise that educational models promoting sustainability are crucial in fostering a future generation that is conscious of both health and environmental issues. However, Beherimaid & Khajedad (2025) caution that the use of AI in education and healthcare can exacerbate social inequalities if equal access is not guaranteed. This challenge is particularly relevant for older populations with limited digital skills. As we will see in this article, both international and Hungarian programmes have been designed to improve health literacy, providing practical insights into potential interventions.

These initiatives, which are discussed in greater detail later in the article, illustrate diverse approaches to pharmacy-based health education. In Ireland, the National Adult Literacy Agency's (NALA) Crystal Clear programme promotes health literacy–friendly practices through pictograms, easy-to-understand patient leaflets, and clear communication (Crystal Clear, 2024). In Hungary, the Gyógyszereim 5XM programme supports adherence by offering five key recommendations for better understanding medical therapy (marketingpirula.hu, 2019). Similarly, the SZEBB publication emphasises the importance of patient cooperation through plain language explanations and practical examples (Galenus, 2023). Overall, health literacy is a complex and dynamic concept whose improvement poses challenges at both individual and societal levels. Interdisciplinary cooperation, integrating healthcare, education, and technological development, is essential for building a sustainable and health literacy oriented future.

3. THE ROLE OF PHARMACIES IN IMPROVING HEALTH LITERACY

In addition to their primary function of ensuring the supply of medicines, pharmacies are playing an increasingly important role in health education and the development of health literacy. Pharmacists have direct contact with the public and can therefore be key actors in conveying health-related knowledge, particularly in the area of medicine use (Tamás, 2022).

3.1. International Recommendations

The International Pharmaceutical Federation (FIP) is a global professional organisation founded in 1912. Today, it brings together more than 150 national pharmaceutical associations, as well as scientific and educational members, representing over 4 million pharmacists, pharmaceutical scientists, and educators worldwide. In 2023, the FIP convened an international advisory roundtable and formulated recommendations for improving health literacy in pharmacy practice. The recommendations were as follows (FIP_HL, 2025):

- Increasing pharmacists' awareness of their role in improving health literacy.
- More effective coordination and integration of pharmacists' roles within healthcare systems.
- Raising patients' awareness of the role of pharmacies in health promotion.
- Identifying opportunities to improve time management in pharmacy practice.
- Enhancing the training of pharmacists and other healthcare professionals, with particular attention to health literacy.
- Overcoming language and communication barriers between patients and healthcare professionals.

3.2. Pharmacists as Health Advisors

Pharmacists answer patients' questions on a daily basis and help them navigate the wide range of over-the-counter products. They also provide advice on medicine administration, potential side effects, and drug interactions. This activity is not limited to the provision of information but also supports the development of both functional and interactive health literacy. Furthermore, pharmacists may play an important role in prevention, for example by organising screening programmes (for blood glucose, blood pressure, and cholesterol levels), offering lifestyle counselling (such as smoking cessation and healthy eating), and administering or organising vaccinations (Pilling, 2019). The policy guidelines of both the World Health Organization and the European Union place increasing emphasis on the role of pharmacists in health promotion.

3.3. Pharmacies as Information Channels

Pharmacies also serve as communication channels, delivering health information through leaflets, posters, digital displays, and face-to-face consultations. This is particularly important for patients who have limited digital skills or no access to the internet. Educational materials placed in pharmacies, such as those on the correct use of medicines, the prevention of antibiotic resistance, or the management of pharmaceutical waste, contribute to the development of critical health literacy (Szabó et al., 2021).

3.4. Medicine Use Education and Environmental Awareness

Pharmacists have the opportunity to draw attention to the links between responsible medicine use and environmental protection. This includes raising awareness about the proper disposal of expired medicines, the environmental risks of pharmaceutical waste, and the prevention of unnecessary accumulation of medicines. These activities not only enhance individual health awareness but also contribute to achieving the Sustainable Development Goals (SDGs), in particular Goal 3: ensuring healthy lives and promoting well-being for all at all ages.

4. PHARMACY PROGRAMMES

4.1. Good Practice in Ireland – The Crystal Clear Pharmacy Programme

According to a 2012 OECD survey, one in six Irish adults experienced difficulties in interpreting the patient information leaflets accompanying medicines, while one in four struggled with performing basic mathematical calculations. The Crystal Clear programme to improve health literacy in pharmacies was jointly developed by the Irish Pharmacy Union, the pharmaceutical company MSD, and the National Adult Literacy Agency (NALA). The programme established 10 quality criteria, grouped into four categories. The first category focuses on communication, requiring pharmacies to:

- Use plain language when communicating with patients.
- Write medicine labels in simple, jargon-free language.
- Check that people have understood what they have been told.
- Ensure that the pharmacy layout is easy to navigate.

The second category concerns staff awareness and sensitivity, encouraging pharmacy staff to:

- Increase awareness of work practices that support health literacy.
- Respond sensitively to individuals with limited literacy or numeracy skills.

The third category addresses procedures and corporate policy, recommending that pharmacies:

- Develop health literacy–friendly policies.
- Help people find and use key information and instructions.
- Support pharmacy staff in improving their own literacy, numeracy, and digital skills if needed.

Finally, the fourth category covers evaluation and improvement, urging pharmacies to:

- Assess and continuously improve their health literacy–friendly services.

Participation in the programme is free of charge for pharmacies, and once accredited, a pharmacy earns the Crystal Clear designation for three years, signifying that it provides health literacy–friendly services to patients (Crystal Clear, 2024). To date, nearly 100 pharmacies and 5 general practices have been accredited (MSD, 2025).

4.2. Programmes in Hungary – Gyógyszereim 5XM and SZEBB

In 2023, Hungary had 2,343 community pharmacies employing 17,559 staff. The total turnover of pharmacies in that year, including prescription and non-prescription products, approached HUF 1.5 trillion (EUR 3.75 billion) (HVG, 2024). The estimated number of annual pharmacist–patient interactions was around 60 million, which is exceptionally high for a population of less than 10 million. This represents one of the largest opportunities for communication between patients and healthcare professionals in the healthcare system. It is therefore logical that mapping and improving health literacy should be a goal for pharmacy staff. One of the key topics for development is adherence, meaning patients' compliance with their prescribed medication regimens. As defined, adherence refers to the degree to which a patient follows the recommendations prescribed and suggested by their physician (lexiq.hu, 2024). This study presents two Hungarian pharmacy-based adherence programmes: Gyógyszereim 5XM, launched in 2018, and SZEBB, launched in 2023.

4.2.1. Gyógyszereim 5XM — What, Why, How Much, When, How

The programme was developed with the involvement of Hungaropharma, one of the leading pharmaceutical wholesalers in the Hungarian market, the Hungarian Chamber of Pharmacists, the Hungarian Society for Pharmaceutical Sciences, and Semmelweis University. On the one hand, professional support materials were prepared for pharmacists; on the other, a public information booklet was created for patients with the involvement of communication specialists. Using five key questions, patients could assess whether their medicine-taking practices were appropriate. Surveys were conducted among both pharmacists and patients regarding the programme. Among the patients surveyed, 47% reported that the booklet helped them change improper medicine-taking habits, confirming that nearly half had not been adherent prior to the programme. Among the 205 pharmacies participating in the study, pharmacists identified the most significant outcome as the increased therapeutic support for regular patients already known to the pharmacy (84 responses). Other frequently cited benefits included the opportunity to create a patient-friendly atmosphere (53 responses) and the enhancement of reliable counselling during dispensing (44 responses) (Galenus, 2023; MTI – 5XM, 2019).

4.2.2. SZEBB Programme

Launched in 2023, the SZEBB programme takes its name from the Hungarian words Szükséges (Necessary), Eredményes (Effective), Biztonságos (Safe), and Beteg-együttműködés (Patient Cooperation). It also aims to improve adherence and safe medicine use. The word SZEBB itself also has a meaning in Hungarian, namely "more beautiful", symbolising the programme's mission of creating a healthier and brighter future. As stated, "The number of medication-related problems can be reduced by promoting correct medicine use and increasing patients' therapeutic cooperation. This is why the Hungarian Chamber of Pharmacists launched the SZEBB programme, in collaboration with the Hungarian Society for Pharmaceutical Sciences and the Faculty of Pharmacy of Semmelweis University. A key element of the programme is to strengthen pharmacists' and healthcare professionals' support for patients, resulting in the publication of the SZEBB protocol for pharmacists. This professional guide helps pharmacists identify the most common medication-related problems in pharmacies more effectively" (SZEBB – MGYK, 2024). The professional material also defines the concept of consultative dispensing as "a healthcare service that includes the dispensing of prescription and non-prescription medicines, as well as other therapeutic products available in pharmacies; professional verification based on patient safety, medicine safety, and cost-effectiveness considerations; patient counselling tailored to individual needs; and a strong focus on adherence-enhancing advice and problem-solving pharmacy or pharmacist interventions"

(SZEBB – MGYK, 2024). In practice, this means defining the areas of health literacy development for both pharmacists and patients within the pharmacy setting. Printed materials are made available to patients in all participating pharmacies, with the goal of ensuring that they receive reliable information both through these materials and in conversations with pharmacists. The SZEBB programme also uses social media tools to reach a wider audience. The Hungarian Chamber of Pharmacists promotes related content through a video series available on YouTube (Hungarian Chamber of Pharmacists, 2023).

5. INTEGRATING GREEN CONSIDERATIONS INTO HEALTH LITERACY PROGRAMMES

Health literacy development in pharmacies is still largely based on traditional, predominantly paper-based educational tools, as seen in both Irish and Hungarian practice. This raises the question of how the process can be made more sustainable. In the following, we will outline practical strategies and examples for making pharmacy-based health literacy initiatives more sustainable.

- Digital but conscious tool use: Digitalisation can reduce environmental impact by decreasing the need for printed materials. However, the carbon footprint of digital devices such as tablets, screens, and servers can also be significant. It is therefore recommended to use low-impact technology, such as energy-efficient devices and green data centres, and to design websites with a reduced carbon footprint. Digital learning materials should be created in a modular format, allowing for partial updates. This way, even readers who prefer printed formats only need to print the updated sections, which reduces waste and CO_2 emissions (Rausch, 2024).
- Environmentally conscious redesign of paper-based education: If paper-based information is unavoidable, recycled paper and minimalist design should be prioritised, requiring less ink and processing. As an alternative, QR codes printed on educational leaflets can direct patients to digital content, allowing the size of printed publications to be reduced.
- Encouraging sustainable behaviours among patients, with health literacy as a tool for sustainability: Improved health literacy promotes prevention, which can reduce medicine use. This in turn decreases manufacturing energy consumption, packaging waste, and the number of expired or unused medicines (Zanobini et al., 2024).
- Adherence improvement as an environmental tool: Programmes such as SZEBB and 5XM have benefits beyond health outcomes: by reducing wasted medicines, they also lower the amount of hazardous waste generated.

6. EXAMINING SUSTAINABLE TOOLS IN EDUCATION

A growing number of studies address the sustainability aspects of education. García-Hernández et al. (2022) conducted a systematic literature review on the presence of sustainability in digital education. The study analysed the characteristics of relevant publications, pedagogical dimensions, related Sustainable Development Goals (SDGs), educational levels, and applied methodologies, based on seven research questions. The results revealed that most studies were linked to SDG 4, which focuses on quality education. In terms of educational level, research was predominantly conducted in higher education, while primary and vocational education appeared only marginally in the sample. Innovative practices included gamification, virtual simulations, and the use of e-portfolios. The authors also highlighted that digital tools not only enhance learning experiences but also contribute to environmental sustainability. The study by Bagherimajd and Khajedad (2025) explored an AI-based sustainable education model covering seven key areas: organisational structure, curriculum, global citizenship, lifelong learning, the teaching–learning process, creativity and innovation, and communication.

The results indicated that AI can support the development of critical thinking, automate administrative processes, and enable personalised learning. Challenges include unequal access, lack of expert knowledge, and ethical or security concerns. AI can make curricula more learner-centred, improve assessment processes, and foster global competencies. It also supports lifelong learning, adaptive learning, and the strengthening of digital skills. Additionally, it stimulates creativity and promotes student engagement. The study emphasised that the use of AI in education can contribute to achieving the SDGs. However, it is important to consider the rapid pace of technological change as well as potential linguistic and cultural biases. Given that the development of health literacy in pharmacy practice clearly relies on educational tools, the conclusions and innovative solutions presented in these studies should be taken into account. The use of gamification and digital tools, together with the rapid expansion of artificial intelligence, is having a significant impact on education and must be considered in the design of future health literacy programmes.

7. CONCLUSION

The level of health literacy has a significant impact on individuals' health status, quality of life, and the overall efficiency of the healthcare system. A population with adequate health literacy makes more conscious decisions, communicates more effectively with healthcare providers, and places less unnecessary or misguided demand on the system. Pharmacies are particularly important actors in health promotion, as they are widely accessible, provide rapid service, and offer personal interaction. An increasing number of international and Hungarian examples demonstrate that the educational role of pharmacists is not only effective but can also serve as a long-term and sustainable way to improve health literacy. However, implementing a few short-term projects is not enough. Sustainable, systemic, interdisciplinary, and environmentally conscious solutions are required. In light of this, the following conclusions and recommendations can be formulated:

- The development of health literacy must be integrated into pharmacy education, healthcare policies, and the standards of pharmacy services. Only in this way can its long-term presence and impact be ensured.
- Financing mechanisms should be developed to support preventive activities, such as pharmacist counselling. While pharmacies are profit-oriented businesses and might appear to have conflicting interests in developing health literacy, the sale of health-preserving products can generate comparable revenue and create healthier regular customers. This can result in a system that is both economically and socially more sustainable.
- Digital platforms, such as mobile applications and e-learning modules, should be used to disseminate health literacy materials. These are more environmentally friendly, require fewer printed materials, and can be updated more easily. Pharmacies can also operate as digital educational points.
- Pharmacies should themselves set an example in sustainability, which includes energy efficiency, waste reduction, and the responsible disposal of unused medicines. This also strengthens their credibility in their educational role.
- Sustainability cannot be achieved without social equity. Programmes must take into account the lower health literacy levels of socially disadvantaged groups and assist them through targeted, smaller-group, or even personalised approaches. Sustainable health literacy can only be achieved if education, healthcare, local governments, and the civil sector work together. Joint campaigns, local health programmes, and interprofessional training can create systems that operate effectively in the long term.

- The effectiveness of programmes must be measured regularly, and tools and messages must be adapted where necessary based on the results. This ensures that interventions are targeted and effective rather than wasting resources. Health literacy is not a one-time "package of knowledge" but requires continuous development. Therefore, programmes should be created that are relevant at different stages of life, such as school health education, workplace programmes, and counselling for older adults.
- An essential element of sustainability is spreading environmental awareness. Health literacy programmes should address lifestyle-related environmental factors, such as nutrition, air quality, and sustainable consumption. Sustainable solutions cannot exist without innovation, whether in the form of new communication tools, game-based education (gamification), or AI-based knowledge assessment platforms.

In conclusion, the sustainable development of health literacy is not only a healthcare goal but also a social and ecological interest. Pharmacies can play a key role in this process, not only in serving patients but also in promoting health awareness, supporting independent decision-making, and encouraging sustainable lifestyles.

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THE IMPACT OF MOTIVATION AND JOB SATISFACTION - CASE STUDY: BIAL COMPANY IN PORTUGAL

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ABSTRACT
This study aims to investigate the relationship between motivation and job satisfaction, exploring how these elements influence the performance and well-being of employees at BIAL, one of the main pharmaceutical industries in Portugal. The research was carried out through questionnaires and interviews with employees and managers of the company, with the aim of understanding the factors that promote a positive working environment and the challenges faced by employees. The methodology adopted provided valuable insights into BIAL's organizational culture and how motivation and satisfaction impact workers' productivity and mental health.
Keywords: *BIAL; motivation; satisfaction; work; Portugal*

1. INTRODUCTION

Motivation at work is a crucial factor that determines the level of employee performance, directly reflecting on organizational effectiveness. Motivation is understood as the set of impulses that lead an individual to act in order to satisfy their needs and achieve the objectives set. Job satisfaction is related to the contentment and fulfillment that a worker feels in relation to their tasks and the environment in which they work. BIAL recognizes the importance of these concepts and seeks to promote an organizational climate that fosters the motivation and satisfaction of all its employees.

2. FUNDAMENTAL CONCEPTS (MOTIVATION)

Motivation

Motivation is a central element in any organization. It is stimulated through practices that align employees' personal goals with those of the company, including recognition programs, professional development opportunities and a collaborative working environment. When employees' needs are met, their willingness to work increases, resulting in superior performance and a more harmonious and pleasant environment. As stated by (Locke 1976), "motivation is one of the most influential factors in productivity and performance in the workplace".

Theories of Motivation

Maslow's Theory
Maslow's Hierarchy of Needs proposes that individuals are motivated by a series of needs organized in a pyramid scheme, where basic needs, such as security and interpersonal relationships, must be met before seeking higher needs, such as self-actualization. (Maslow 1943) states that "individuals must satisfy their lower needs before they can concern themselves with their higher needs". This theory suggests that organizations should focus on meeting employees' basic needs in order to promote motivation.

McGregor's Theory X and Y
McGregor's Theory X and Y describe two opposing views of human nature in the work context. Theory X assumes that employees are lazy and need to be controlled and coerced to get the job done, while Theory Y believes that employees are intrinsically motivated and seek new responsibilities and challenges. (McGregor 1960) states that "the way managers perceive human nature has a direct impact on their approach to managing people". The Y approach, which promotes employee autonomy and participation in decision-making, tends to boost motivation and engagement.

Herzberg's Motivation-Hygiene Theory
Herzberg's Motivation-Hygiene theory distinguishes between motivational factors, which generate satisfaction, and hygiene factors, which, if absent, can cause dissatisfaction. (Herzberg 1966) pointed out that "motivational factors are essential for job satisfaction, while hygiene factors are more related to dissatisfaction". This implies that organizations must not only provide adequate working conditions, but also implement motivational factors, such as recognition and growth opportunities, to ensure employee satisfaction.

Self-Determination Theory
The Self-Determination Theory, proposed by (Deci and Ryan 2000), emphasizes the importance of intrinsic motivation, which is driven by the satisfaction of the basic psychological needs of competence, autonomy and relatedness. They state that "self-determination and the satisfaction of basic psychological needs are fundamental to motivation and well-being". This theory suggests that environments that promote autonomy and the ability to choose can increase employees' intrinsic motivation and lead to better performance.

McClelland's theory
David McClelland proposed that human motivation at work is influenced by three main needs, acquired throughout life. The need for achievement, where people are motivated by goals, challenges and personal success; the need for affiliation, where people value good interpersonal relationships and seek social acceptance; and finally, the need for power, where people seek to influence and lead.

Relationship between Motivation and Job Satisfaction
The scientific literature points to a significant correlation between intrinsic motivation and high levels of job satisfaction (Judge 2001), which identified in a meta-analysis that intrinsically motivated employees tend to have higher satisfaction and better job performance. In addition, Bakker and Demerouti (2017) found that the level of motivation directly influences the degree of involvement of professionals, positively impacting satisfaction levels and, consequently, reducing absenteeism and turnover.

Leadership and Organizational Motivation

Effective leadership is fundamental to promoting motivation and satisfaction in the workplace. Molina (2022) carried out a literature review highlighting that leaders who promote harmony and encourage the personal development of employees contribute significantly to team motivation. Motivational leadership, when well implemented, benefits both employees and the organization as a whole.

Teleworking: Challenges and Opportunities for Motivation

With the increase of the teleworking, especially during and after the COVID-19 pandemic, new challenges related to motivation and job satisfaction have arisen. Monteiro (2022) investigated the relationship between motivation, psychological well-being, stress and job satisfaction in a teleworking context, concluding that the satisfaction of basic psychological needs (autonomy, competence and relationships) is positively associated with job satisfaction. The study also highlighted that psychological well-being and stress explain a significant part of the variance in job satisfaction. In addition, Soares (2023) emphasized the importance of support from leaders in the context of teleworking. The research showed that support from leaders is positively associated with the satisfaction of basic psychological needs and, consequently, with job satisfaction. The model proposed by the authors explained 46.1% of the variance in teleworkers' job satisfaction.

3. FUNDAMENTAL CONCEPTS (SATISFACTION)

Satisfaction

Satisfaction can be defined as an individual's positive perception of their experiences and working conditions, resulting in a state of well-being and motivation. Job satisfaction is a reflection of employees' emotional well-being and is directly linked to their performance and productivity. According to (Spector 1997), "job satisfaction can be seen as an emotional state that results from the evaluation of work and experiences in the workplace".

Impact of Satisfaction on Productivity

Satisfied employees tend to be more productive, creative and loyal to the organization. Companies recognize that job satisfaction not only improves individual performance, but also contributes to a positive organizational climate. (Judge and Bono 2001) point out that "job satisfaction is strongly related to performance, and satisfied employees are more likely to be committed to their jobs". Furthermore, a study by (Harter 2002) suggests that "increased employee satisfaction can result in a significant increase in organizational productivity".

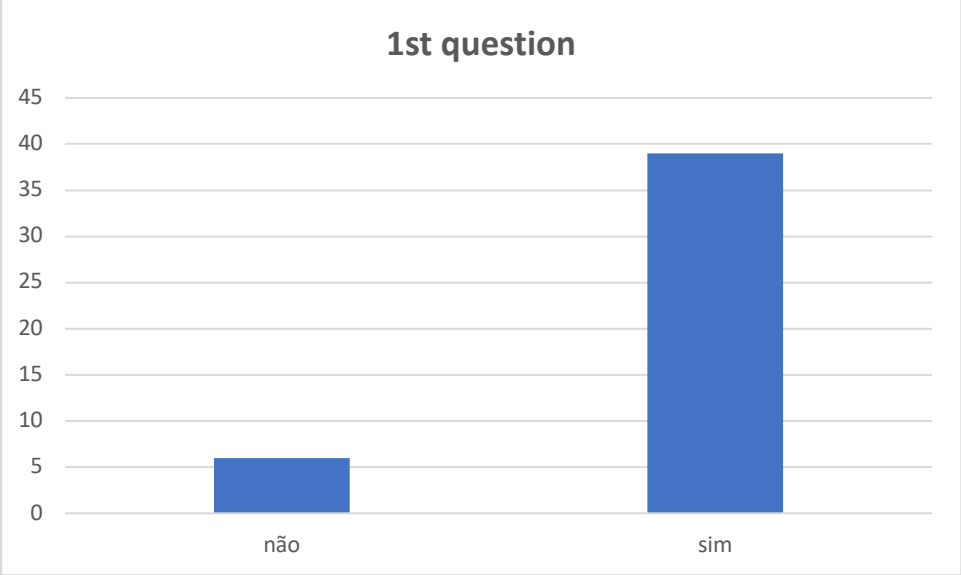
Factors that can influence Job Satisfaction

According to recent literature, job satisfaction results from a combination of objective and subjective factors, which can vary depending on the organizational culture, the sector of activity and the profile of the employees. Some of the main factors identified in empirical studies are systematized in Table 1. Remuneration, which is the financial value perceived as adequate and fair for the work done; working conditions and the quality of the physical and organizational environment. Finally, Bakker and Demerouti (2017) reinforce the importance of recognition for performance, considering that professionals who feel valued tend to have higher levels of satisfaction and more results. In addition, studies such as that by López-Cabarcos (2022) identify professional development and autonomy as decisive factors, especially in dynamic sectors such as information technology. Salanova (2014) also adds the importance of quality interpersonal relationships and the cohesion of work teams in promoting a positive organizational environment and well-being at work.

Research Methodology
The research was carried out with a mixed approach, using quantitative questionnaires and qualitative interviews with BIAL employees and directors. Data was collected over a two-week period in March 2025. A questionnaire of yes/no questions was used, and a total of 45 people responded, 5 directors and 40 workers. Of these 45 people, 20 are men and 25 are women. There are 8 questions in total, divided into 4 questions for workers and directors, 2 only for workers, and 2 only for directors.

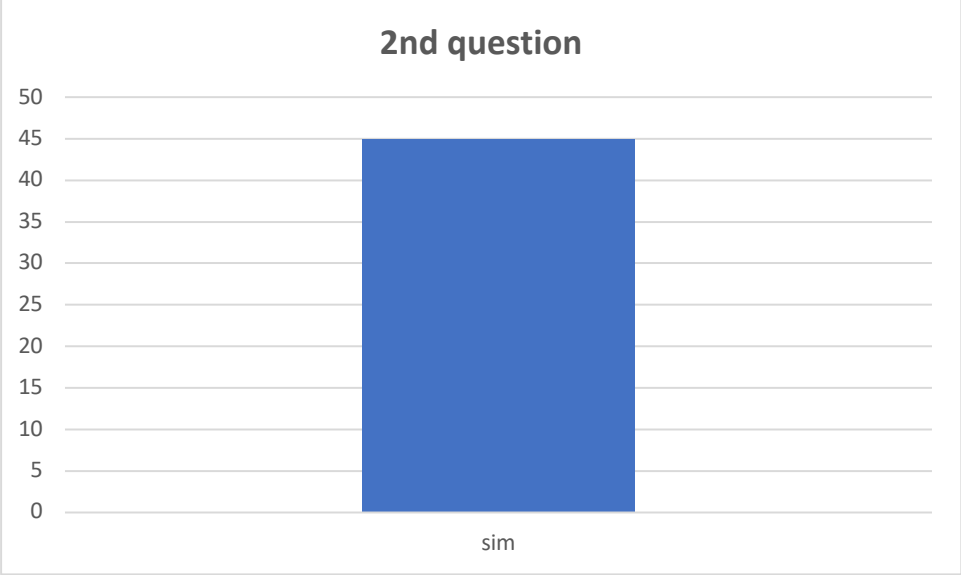
4. QUESTIONNAIRE

1st question - Do you feel recognized in your company?



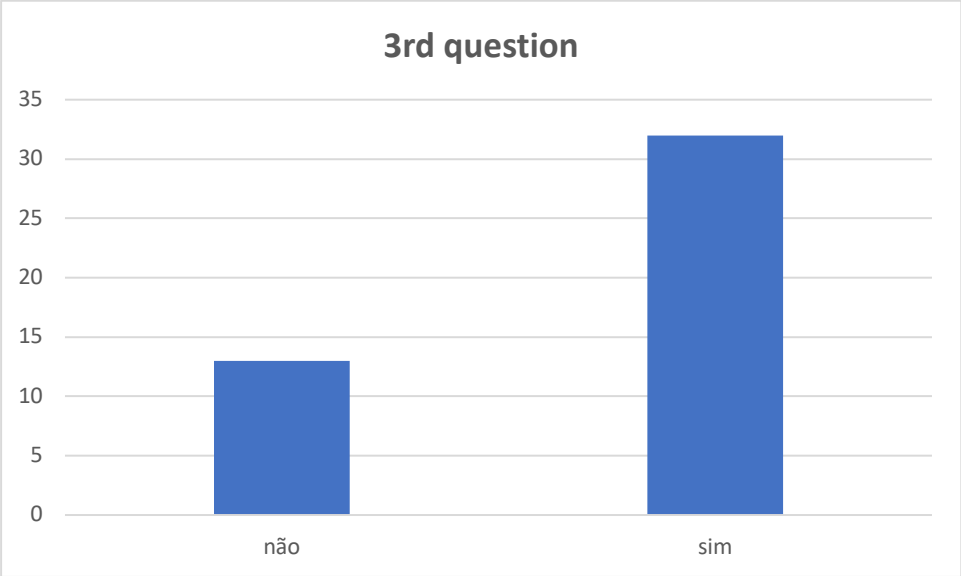
Results:
- 86.6% (39 people) answered that they feel recognized in the BIAL company.
- 13.3% (6 people) answered that they don't feel recognized.

2nd question - Does job satisfaction have a direct impact on your productivity?



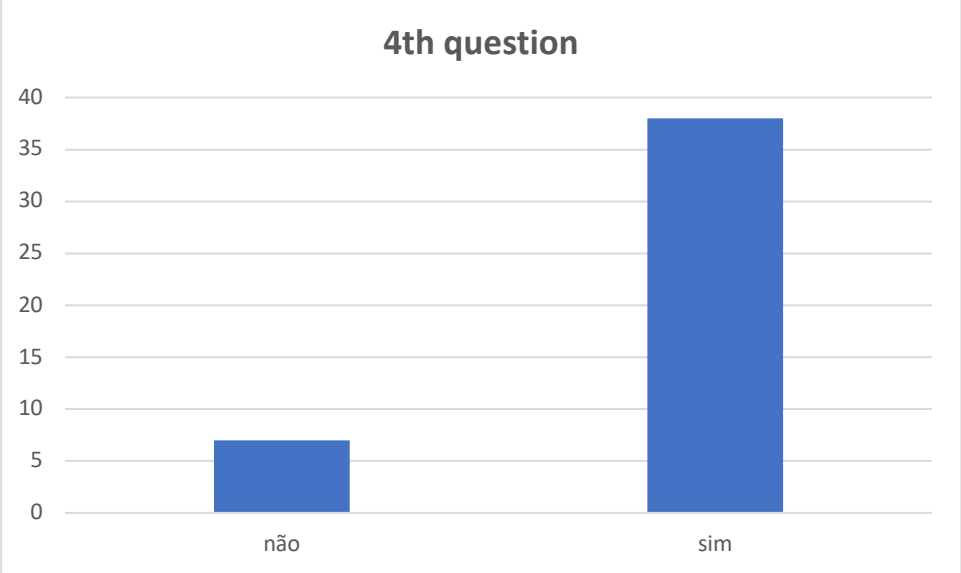
Results:
- 100% (45 people) answered that job satisfaction directly impacts productivity.

3rd question - Do you feel you have enough autonomy to make decisions related to your work?



Results:
- 71.1% (32 people) answered that they have enough autonomy to make decisions related to their work.
- 29.9% (13 people) answered that they don't have enough autonomy to make decisions related to their work.

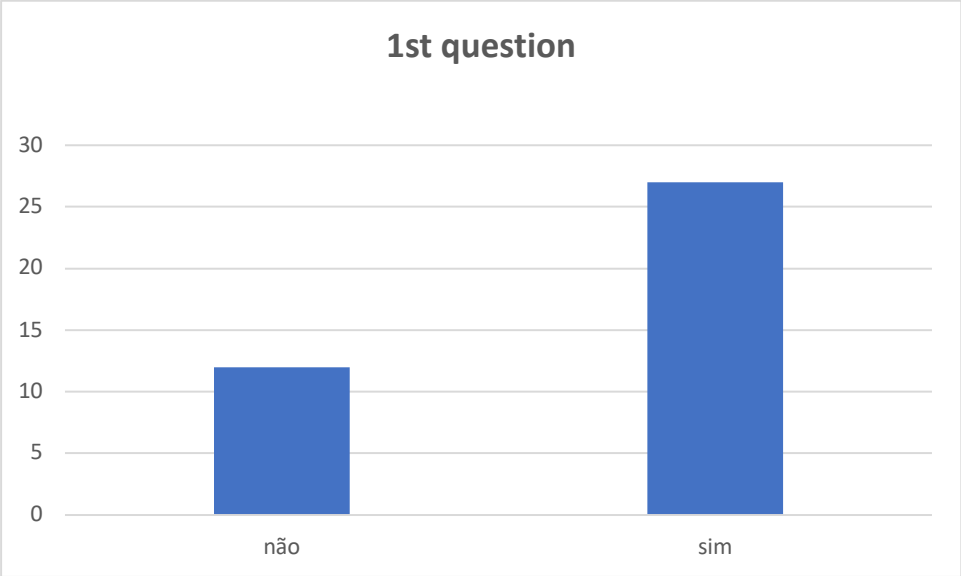
4th question - Do you feel that your opinions and feedback are valued by BIAL's management?



Results:
- 84.4% (38 people) feel valued by management.
- 16.6% (7 people) do not feel valued by management.

Questions for workers:

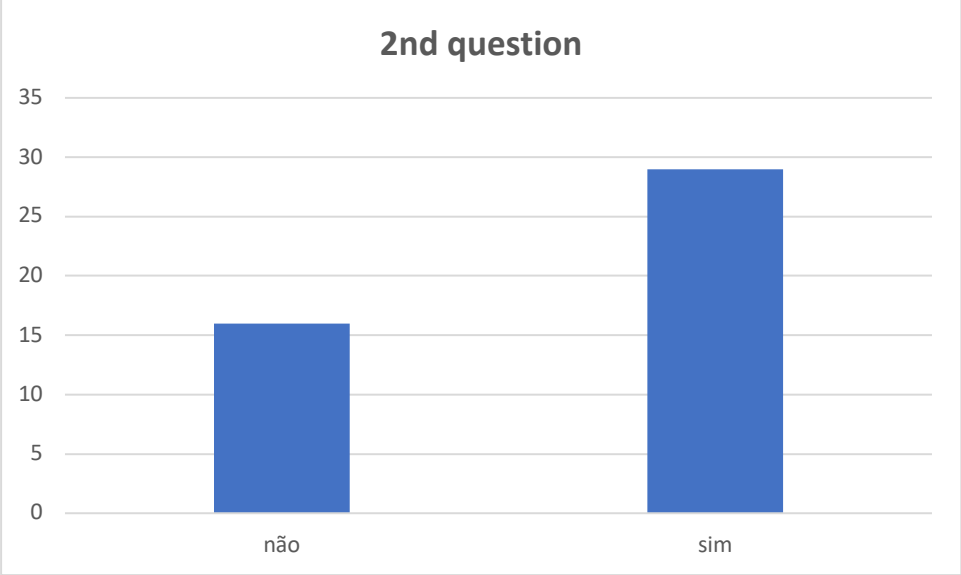
1st question - Do you feel that your manager cares about your progress?



Results:

- 70% (28 people) feel that their manager cares about their progress.
- 30% (12 people) feel that their manager doesn't care about their progress.

2nd question - Do you miss any corporate welfare benefits?

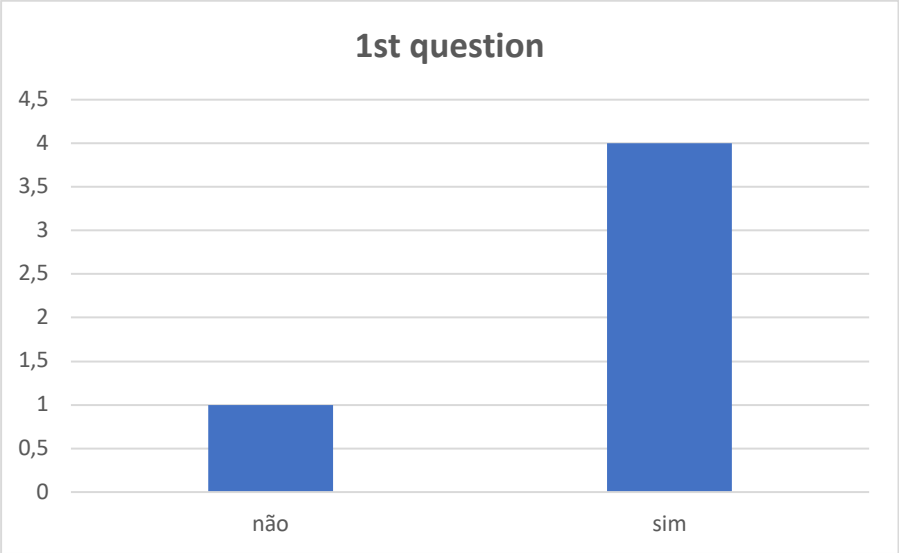


Results:

- 62.5% (25 people) miss some corporate benefit.
- 37.5% (15 people) don't miss any corporate benefit.

Questions for Directors:

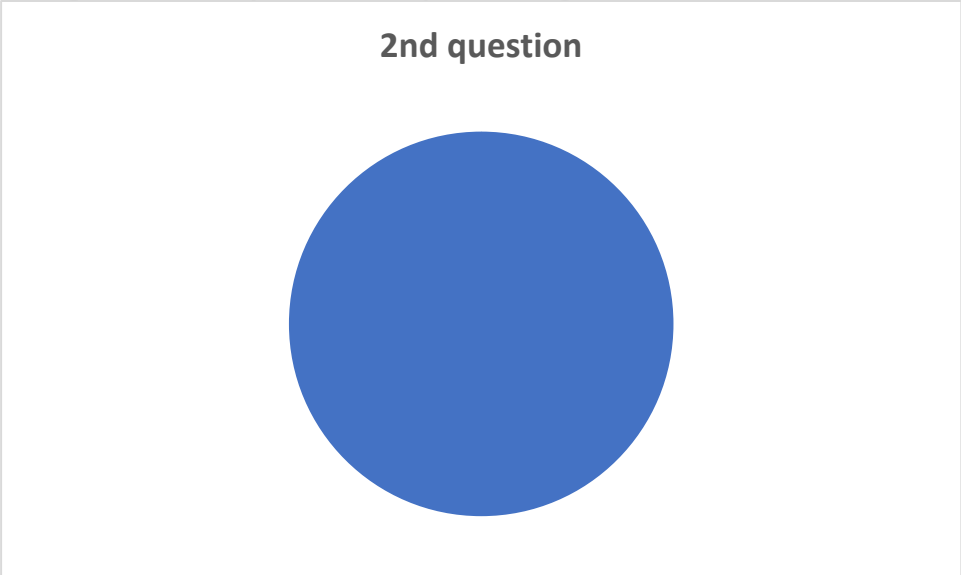
1st question - Do you think your workers are motivated?



Results:

- 80% (4 people) think their workers are motivated.
- 20% (1 person) don't think their workers are motivated.

2nd question - Do you consider yourself a good leader?



Results:

- 100% (5 people) all the directors consider themselves to be good leaders.

5. DISCUSSION OF RESULTS

The survey carried out at the BIAL company, with a mixed approach and the participation of 45 employees, 5 of whom were directors and 40 workers, made it possible to identify important perceptions related to recognition, satisfaction, autonomy, appreciation, leadership and corporate benefits. The results indicate that 86.6% of the participants feel recognized in the company, which demonstrates a positive organizational culture in this respect. However, 13.3% said they did not feel recognized, which suggests the importance of ongoing actions to reinforce professional recognition, since this factor is a determining factor for motivation and engagement in the workplace.

Regarding the relationship between satisfaction and productivity, there was unanimity: 100% of respondents agreed that job satisfaction has a direct impact on productivity. This shows the importance of maintaining a healthy and motivating environment, since organizational productivity is closely linked to individual employee satisfaction. With regard to decision-making autonomy, 71.1% said they had sufficient autonomy, while 29.9% said they did not. These figures indicate that, although the majority have freedom to act, there is a significant proportion of employees who still feel limitations in relation to their autonomy, which can have an impact on motivation and agility in work processes. With regard to the valuing of opinions and feedback by leadership, 84.4% of respondents feel valued, while 16.6% do not share this perception. These results show that, although most employees perceive the importance of their opinions in the workplace, there is still room for improvement in communication and the effective valuation of feedback, which is fundamental to promoting a healthy and participatory organizational climate. Looking at the employees' specific responses, 70% believe that their managers care about their progress, while 30% believe the opposite. This result suggests that the majority perceive support and accompaniment, but reinforces the need for greater proximity and individualized interest on the part of management in order to strengthen employees' professional development. With regard to corporate wellbeing benefits, 62.5% of workers said they felt they lacked some benefit, compared to 37.5% who did not. This reveals an opportunity to invest in wellness, health and quality of life programs, which can help increase satisfaction and motivation in the workplace. From the directors' perspective, 80% believe that their workers are motivated, while 20% do not share this view. Although the majority have a positive perception, the data suggests that there are areas that may have lower levels of motivation, requiring specific strategies to strengthen this aspect. Finally, all the directors (100%) considered themselves to be good leaders. This unanimity in self-assessment demonstrates security and confidence in their own performance, but it is important that this perception is constantly validated by feedback from their teams, ensuring alignment between the self-perception of leadership and the reality of employees. Overall, the results indicate a positive perception of important aspects of people management at BIAL, but also point to opportunities for improvement, especially with regard to autonomy, valuing feedback and well-being benefits. In order to improve, BIAL can increase the autonomy of employees and thereby allow more operational and task management decisions to be made by the teams. Create pilot projects where employees can lead internal initiatives and set team goals that can be managed directly by the employees themselves, thus improving wellbeing benefits.

6. CONCLUSION

This case study made it possible to analyze the importance of motivation and satisfaction in the workplace, highlighting the direct impact of these factors on the productivity and well-being of employees at BIAL. Using a mixed methodology, combining questionnaires and interviews, it was possible to understand the perceptions of both employees and managers on key aspects of the organizational culture. The results showed that the majority of employees feel recognized, valued and satisfied, which contributes positively to the organizational climate and to levels of motivation and production. However, the survey also revealed points for improvement, such as the need to increase autonomy in the workplace, reinforce the value of feedback and invest in corporate welfare benefits, all of which could further strengthen employee satisfaction and engagement. Another relevant finding is the discrepancy between the perception of leadership and the reality of some teams, which reinforces the importance of constant and transparent dialog between managers and workers. Management, while confident in its role, must remain attentive to the needs and expectations of its teams, promoting a participatory and welcoming environment.

It can therefore be concluded that motivation and job satisfaction are indispensable elements for organizational success. Investing in these factors not only promotes the mental and emotional health of employees, but also boosts the company's performance and competitiveness. Despite the good results, BIAL has the opportunity to improve its personnel management practices, ensuring an increasingly healthy, productive and motivating work environment.

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ANALYSIS OF QUALITY MANAGEMENT FROM THE CONSUMER'S PERSPECTIVE – A CASE STUDY OF TAP AIR PORTUGAL

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ABSTRACT
This study analyses quality management at TAP Air Portugal from the consumer's perspective. Using a quantitative approach, it examines how passenger feedback influences service improvement, integrating theoretical foundations of Total Quality Management (TQM), ISO standards, Corporate Social Responsibility (CSR), and Quality 4.0 technologies. The results from a questionnaire conducted with a sample of 56 individuals highlight the airline's key strengths and weaknesses, suggesting pathways for improving its competitiveness and reputation.
Keywords: *Quality Management, TAP, customer satisfaction, aviation, service*

1. INTRODUCTION

Quality management has become one of the essential pillars of organizational strategy, especially in highly competitive sectors like aviation. This paper aims to analyse how TAP Air Portugal, as the national flag carrier, implements quality management strategies based on customer perception. It also seeks to understand how international standards, regulatory requirements, and technological factors influence this management process.

2. LITERATURE REVIEW

2.1. Concept of Quality and Consumer Perspective

The concept of quality has evolved from a technical definition to a customer-centric dimension (Deming, Juran). Grönroos (1984) distinguishes between technical quality and functional quality, both of which are essential in aviation.

2.2. Quality Models and Standards

Airlines adopt standards such as ISO 9001, 14001, and 45001 to ensure safety, reliability, and continuous improvement. IATA audits are also a fundamental part of certification.

2.3. Service Quality and TAP

TAP strives to balance functional quality (crew, comfort) with technical quality (punctuality, safety). The airline invests in fleet modernization and personalized service.

2.4. CSR and Quality Perception

Communicating environmental and social best practices strengthens corporate image (Sorsa et al., 2024).

2.5. Quality 4.0 in Aviation

With AI, IoT, and Big Data, airlines optimize services. TAP has implemented online check-in, predictive maintenance, and smart loyalty programs.

Based on the table (Source: TAP Air Portugal), the airline transported 15.2% more passengers and increased revenue passenger kilometres (RPK) by 16%, indicating higher demand and operational efficiency. Available seat kilometres (ASK) also rose by 14.9%, showing an expansion in capacity, while the occupied capacity improved by 1%, suggesting better seat occupancy. The number of departures increased by 10.2%, and the number of aircraft grew by 5.4%, reflecting investment in modernization. Regularity reached 99%, a crucial quality indicator that confirms a significant reduction in cancellations. Although the number of destinations dropped slightly (-2.2%), overall, the data demonstrates TAP's commitment to growth, efficiency, and service quality.

Table 1 - TAP operations in 2022 and 2023

	2022	2023	Variation (2022/2023)
Passengers (thousands)	13 759	15 856	15,2%
Revenue passenger kilometres (millions)	36 782	42 673	16,0%
Available seat kilometres (millions)	45 960	52 797	14,9%
Occupied Capacity (%)	80	81	1,0%
Number of departures	107 856	118 878	10,2%
Number of aircraft	93	98	5,4%
Number of destinations	90	88	-2,2%
Regularity	97,6%	99,0%	1,4%

2.6 TAP Air Portugal

2.6.1 Contextualization of TAP Air Portugal

TAP Air Portugal is the national airline of Portugal, founded in 1945. It plays a key role in connecting Portugal to Europe, the Americas, and Africa. Operating mainly from its hub in Lisbon, TAP is part of the Star Alliance network and serves a wide range of international destinations. The airline focuses on providing comfort, safety, and quality service, while facing competition from both low-cost and major international carriers.

3. METHODOLOGY

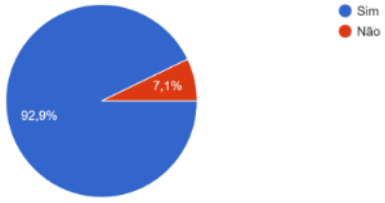
This paper uses a quantitative approach. A structured questionnaire was digitally applied to 56 passengers using a 5-point Likert scale along with open-ended questions. The variables examined include punctuality, comfort, in-flight service, baggage handling, value for money, and comparison with other airlines. The sample was gathered through convenience sampling via social media. Despite limitations, it captured diverse perceptions from frequent and occasional travellers.

4. RESULTS AND DISCUSSION

4.1 Have you ever travelled with TAP Air Portugal?

The first part of our survey collected information about the respondent's profile, such as whether they have travelled with TAP Air Portugal, how often they travel and the reason for their travels. This question assesses consumers' knowledge of the airline, i.e. the quality of the perspective of repeat customers tends to be more accurate because it is based on multiple interactions over time. Most respondents have flown with TAP (92.9%).

Figure 1 - Have you ever travelled with TAP Air Portugal?

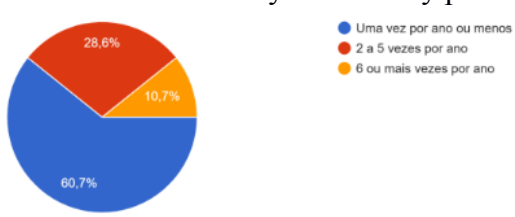


Source: Google Forms Questionnaire

4.2 How often do you travel by plane?

This question is essential because the frequency of travel can influence the passenger's expectations and demands. Frequent passengers evaluate the quality of air services more rigorously and are more sensitive to certain factors. The main travel purpose is leisure (71.4%).

Figure 2 - How often do you travel by plane?

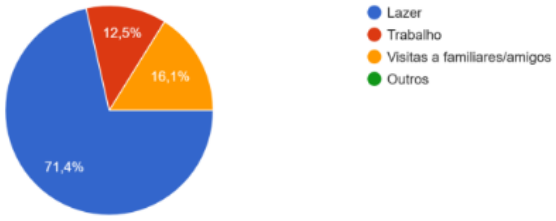


Source: Google Forms Questionnaire

4.3 What is the main reason for your travels?

With this question, it is possible to understand why people travel, 71.4%, which is equivalent to 40 people, travel for leisure, 16.1%, which is equivalent to 9 people, travel to visit family and friends and 12.5%, which is equivalent to 7 people, travel for work. With these results, it is possible to understand that since the majority of the sample travels for leisure, they are "tourists" who value comfort and experience.

Figure 3 - What is the main reason for your travels?

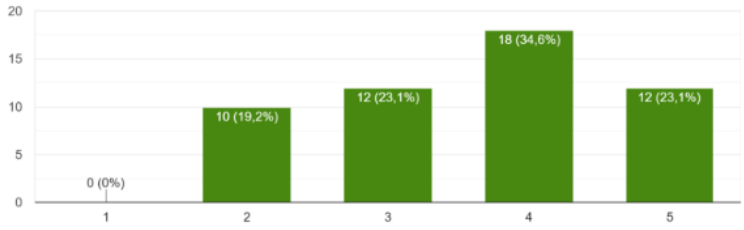


Source: Google Forms Questionnaire

4.4 How do you rate the punctuality of TAP flights?

The second part of the questionnaire collected information on the evaluation of the quality of TAP Air Portugal's service. To answer these questions, we created a scale from 1 to 5, where 1 represents very dissatisfied and 5 represents very satisfied. From the graphic we can see that 4 was chosen by the majority with a percentage of 34.6% (18 people), followed by 3 and 5 with a percentage of 23.1% (12 people), and 2 with a percentage of 19.2% (10 people). We can see that in this sample of 52 people, because out of 56 people only 52 flew with TAP Air Portugal, the majority are satisfied with the punctuality of the flights.

Figure 4 How do you rate the punctuality of TAP flights?

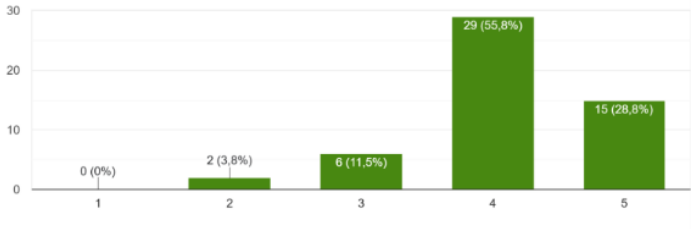


Source: Google Forms Questionnaire

4.5 How do you rate the comfort of the aircraft (space between seats, cleanliness, on-board environment)?

This question allowed us to understand whether people think the aircraft are comfortable and clean. Analysing the graphic, the majority are satisfied or very satisfied with the comfort of the aircraft, representing 55.8% (29 people) and 28.8% (15 people). Despite this, 11.5% (6 people) gave a rating of 3 and 3.8% (2 people) gave a rating of 2, with no one giving the comfort a rating of 1 (which is equivalent to very dissatisfied).

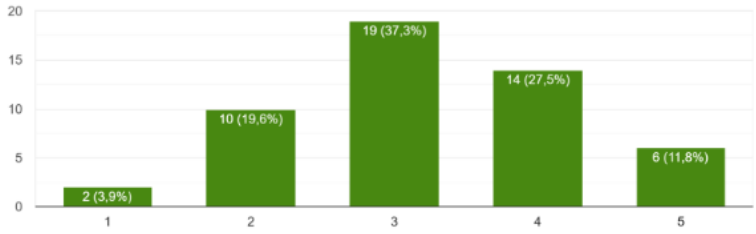
Figure 5 How do you rate the comfort of the aircraft (space between seats, cleanliness, on-board environment)?



Source: Google Forms Questionnaire

4.6 How do you rate the quality of the meals and services offered on board?
From the graphic we can see that the majority gave a rating of 3 (37.3%) and 4 (27.5%), the rating of 2 had 19.6% of the responses, 5 had 11.8% of the responses and 1 had 3.9% of the responses for the quality of the meals and services offered on board.

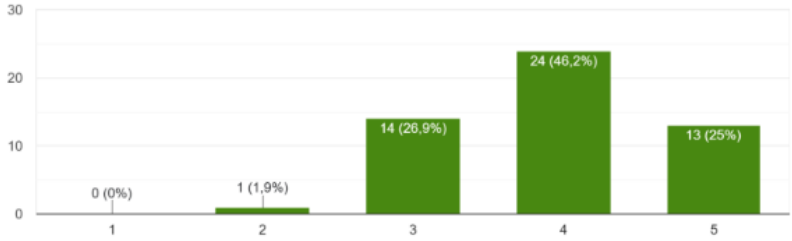
Figure 6 How do you rate the quality of the meals and services offered on board?



Source: Google Forms Questionnaire

4.7 How would you rate the efficiency of baggage management (delivery time, security, loss/damage)?
With this question, the majority are satisfied with the efficiency of baggage management (46.2%), followed by 26.9% who rated it 3, 25% are very satisfied with the efficiency, 1.9% rated it 2, and no one rated the efficiency as 1.

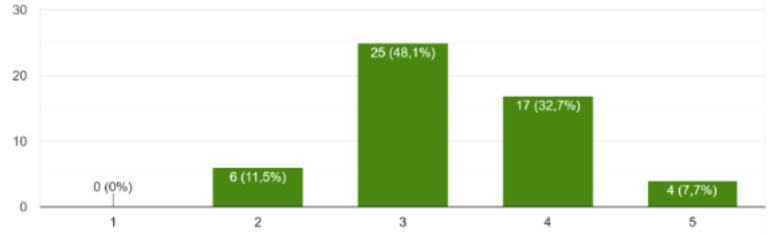
Figure 7 How would you rate the efficiency of baggage management (delivery time, security, loss/damage)?



Source: Google Forms Questionnaire

4.8 How do you rate TAP's quality/price ratio compared to other airlines?
Airlines with higher prices need to justify the difference through superior services. In this question, we wanted to know whether people think that TAP Air Portugal is better or worse than others in terms of quality/price. The majority chose a rating of 3 (48.1%), followed by 4 (32.7%), 2 (11.5%) and 5 (7.7%). With this data, we know that people think that, in relation to other airlines, TAP Air Portugal is in the same position or above, that is, the quality/price is equal to or better than other airlines.

Figure 8 How do you rate TAP's quality/price ratio compared to other airlines?

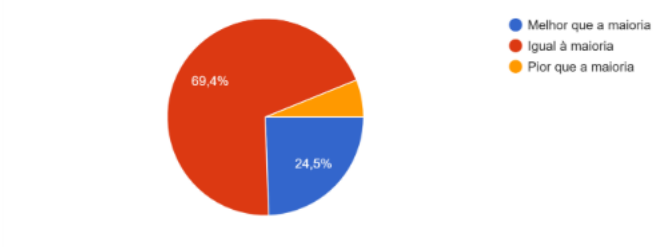


Source: Google Forms Questionnaire

4.9 If you have flown with other airlines, how does TAP compare to them in terms of overall quality?

The third part of the questionnaire collected information on how TAP compares to its competitors, helping to identify strengths and weaknesses. This question compares TAP to its competitors in terms of overall quality. 69.4% think TAP is equal to most airlines, 24.5% think TAP is better than most airlines and 6.1% think TAP is worse than most airlines. We can conclude that TAP is equal or even better than most airlines in terms of overall quality, with challenges in terms of punctuality and customer service, while standing out in terms of comfort and fleet safety.

Figure 9 If you have flown with other airlines, how does TAP compare to them in terms of overall quality?

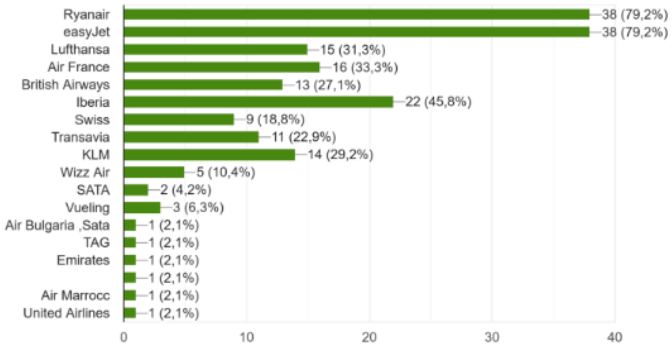


Source: Google Forms Questionnaire

4. 10 Which of these airlines have you flown with?

Of the 16 options, 4 stand out, with 38 people choosing easyJet and Ryanair, 22 choosing Iberia and 16 choosing Air France. The airlines added as other options were Air Bulgaria, TAG, Emirates, Vueling, Air Marrocc, SATA and United Airlines.

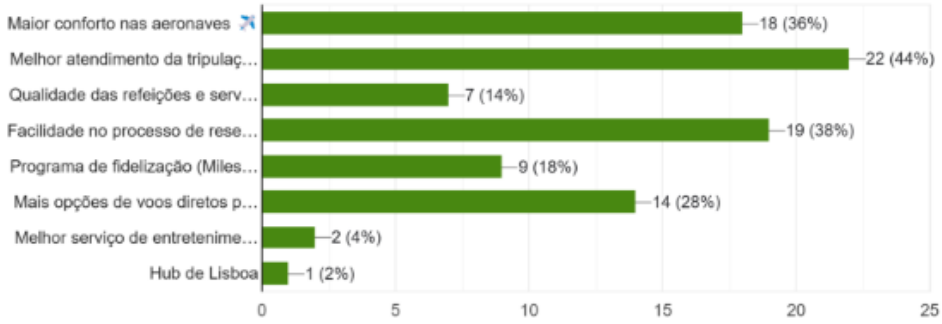
Figure 10 Which of these airlines have you flown with?



Source: Google Forms Questionnaire

4.11 In your opinion, what are TAP's main strengths in relation to its competitors?
Of the 8 options (Greater comfort on the aircraft, better service from the crew, quality of meals and services on board, ease of online booking and check-in, advantageous loyalty program (Miles&Go), more options for direct flights to certain destinations, better on-board entertainment service and Lisbon hub), the main strengths are: better service from the crew for 22 people, ease of online booking and check-in for 19 people, greater comfort on the aircraft for 18 people and more options for direct flights to certain destinations for 14 people.

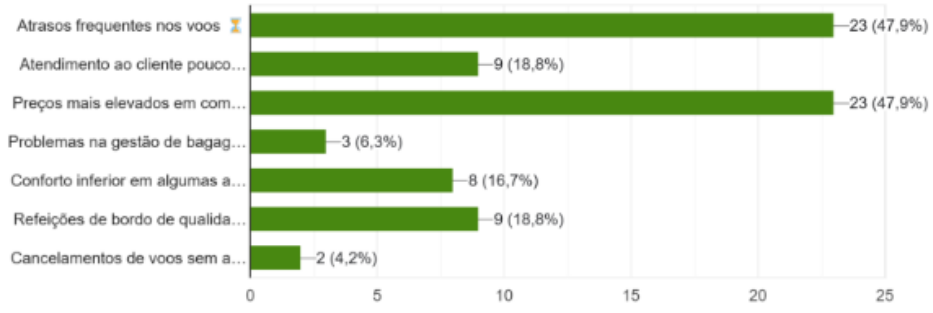
Figure 11 In your opinion, what are TAP's main strengths in relation to its competitors?



Source: Google Forms Questionnaire

4.12 In your opinion, what are TAP's main weaknesses in relation to its competitors?
Of the 7 options (Frequent flight delays, inefficient customer service, higher prices compared to competitors, problems with baggage management (lost luggage, delayed delivery), lower comfort on some aircraft (little space between seats), lower quality in-flight meals, flight cancellations without adequate prior notice), the main weaknesses are: higher prices compared to competitors and frequent flight delays for 23 people, lower quality in-flight meals and inefficient customer service for 9 people.

Figure 12 In your opinion, what are TAP's main weaknesses in relation to its competitors?



Source: Google Forms Questionnaire

4.13 If you could suggest one improvement for TAP, what would it be?
Consumer feedback on improvements is valuable for continuous improvement and feedback is one of the main mechanisms for quality management. With the fourth part of the questionnaire, it is possible to gather information on improvements for TAP:

- 6 answers about reducing delays
- 4 answers about more affordable prices
- 4 answers about improving meals

- 1 answer about more space between seats
- 1 answer about improving the comfort of economy class
- 1 answer about treating employees well
- 1 answer about more flights to Northern Europe and the Baltics

Source: Google Forms Questionnaire

The results obtained from the questionnaire applied to TAP Air Portugal passengers allow for an analysis of the correspondence between consumer perceptions and the theoretical foundations presented in the literature review.

4.13.1 Quality Management and Customer Satisfaction

The results show that perceived quality by consumers aligns with the principles of Total Quality Management (TQM), as described by Yang et al. (2023), emphasizing continuous improvement and employee involvement. Satisfaction with aircraft comfort (55.8% satisfied or very satisfied) and baggage handling efficiency (71.2% satisfied or very satisfied) reinforces that TAP implements appropriate strategies to ensure high standards of operational quality. However, challenges mentioned by passengers, such as high prices and frequent delays (23 responses each), indicate areas for improvement. This supports the view of Wu et al. (2021), who highlight punctuality and cost-benefit as critical factors for satisfaction in the airline industry.

4.13.2 Quality Standards and Certifications

TAP's alignment with international standards, such as ISO 9001 certification (Murmura et al., 2024), is reflected in the high flight regularity (99%) and fleet expansion (+5.4%). The importance of these standards is reinforced by Wu et al. (2021), who show a correlation between ISO certification and perceived service quality. However, the reduction in the number of destinations (-2.2%) may negatively impact the customer experience, requiring adaptive strategies to maintain competitiveness.

4.13.3 Consumer Perspective and Perceived Quality

The distinction between technical and functional quality, as defined by Grönroos (1984), helps interpret the results. TAP presents solid indicators of technical quality, such as flight punctuality and load factor (81%), but faces challenges in functional quality. This is seen in median ratings for crew service and onboard catering (27.5% rated meals 4). This disparity suggests that improving the customer experience could enhance perceived satisfaction.

4.13.4 Impact of Corporate Social Responsibility (CSR)

The study by Sorsa et al. (2024) states that effective communication of CSR actions strengthens the airline's image. Although TAP invests in fleet modernization and sustainable practices, the impact of these initiatives on passengers' perceptions was not directly measured in the questionnaire. Nevertheless, more effective communication strategies could strengthen customer loyalty.

4.13.5 Quality 4.0 and Digitalization

The integration of digital technologies in the airline sector (Carvalho et al., 2024) is a competitive advantage. Passengers rated positively the ease of booking and online check-in (19 responses), showing that TAP is aligned with Quality 4.0 trends. However, improvements in communication and service personalization could further enhance the customer experience.

4.13.6 Conclusion of Data Processing in Comparison with Literature Review

The study's results show a direct relationship between quality management principles and the customers' perception of TAP Air Portugal's services. While the company has strong technical and operational indicators, challenges such as delays, value for money, and onboard meal quality affect passenger satisfaction. To strengthen its competitive position, TAP should continue investing in fleet modernization, internal process optimization, and improvement of the customer experience.

5. CONCLUSION

Quality management at TAP Air Portugal is essential to maintaining customer satisfaction and competitiveness. The study highlighted strong points such as flight regularity, fleet modernization, and crew service. However, issues like frequent delays, high ticket prices, and the quality of onboard meals still impact passenger perception. Based on ISO 9001 standards and the data collected, some improvements are suggested: investing in technology to improve operations, better communication with customers, and ongoing crew training. These actions could help make the service more transparent and efficient. To remain competitive, TAP should continue modernizing its fleet, improving punctuality, and adjusting its pricing strategy. Offering a more consistent and personalized experience can also increase customer loyalty and reduce the impact of competition.

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DIGITAL TECHNOLOGIES AND CORPORATE FINANCE: CAPITAL STRUCTURE DIFFERENCES BETWEEN ICT AND NON-ICT FIRMS IN CROATIA

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ABSTRACT

This paper explores the determinants of capital structure, with a special emphasis on differences between information and communication technology (ICT) firms and those in other industries. Capital structure is defined as the combination of debt and equity that firms use to finance their activities. The decision on whether to use its own or external funds depends on many factors, such as asset structure, firm size, profitability, liquidity, and growth which affect leverage differently across sectors. The analysis is based on the unbalanced panel dataset of about 170,000 firms in Croatia over the period 2008-2024, applying fixed-effects panel regression with interaction terms to identify differences across sectors. According to the results, all considered determinants show statistically significant effects on capital structure, with significant sectoral heterogeneity. The positive effects of firm size, asset structure, and firm growth are consistent with the trade-off theory, while the negative effects of profitability and liquidity are in line with the pecking order theory. In ICT firms, leverage is more strongly driven by asset structure and size, and less by firm growth, while the negative effects of profitability and liquidity are less pronounced compared to other industries. These results show that technological intensity and sector-specific financial strategies influence capital structure decisions, highlighting the role of industry context in corporate financing. Therefore, it is not surprising that capital structure, as documented in the literature, is one of the most controversial areas of financial management. This paper contributes to the literature on corporate finance and capital structure determinants in ICT industries.

Keywords: *capital structure, Croatia, determinants, ICT sector*

1. INTRODUCTION

Digital technology is one of the most significant phenomena in the modern economy. It is changing the way firms access capital, manage business risks, interact with markets, and make financial decisions. Firms in information and communication technology (ICT) sector are the main drivers of the development and diffusion of digital technology. Digital technology represents the core of ICT firms' business models as their competitiveness, innovation and growth directly depend on the continuous development and application of new technological solutions. Consequently, digital technology influences firms' decisions on their capital structure choices. Capital structure is defined as the combination of debt and equity that firms use to finance their activities. If debt in the capital structure make up the majority of financing, it can be said that the firm is heavily leveraged. On the other hand, if a firm relies more on equity to finance its activities, it can be said to be using a more cautious approach to the use of financial leverage. For this reason, the capital structure of a firm is often referred to in terms of its use of financial leverage (Orsag, 2003). Haris and Raviv (1991) point out the common belief that firms in the same industry have similar asset and liability structures and that the industry in which a firm operates directly affects the firms's capital structure.

[1] The author states that the views presented in this paper are those of the author and do not represent the views of the institution the author works at.

They based their conclusion on analyses according to which firms within certain industries have almost the same use of leverage, which seems relatively stable over time. Due to some specific characteristics of ICT firms, such as strong network effects, high R&D intensity and volatile cash flows which can influence ICT firms' financing patterns (Hyytinen and Pajarinen, 2005), this sector may adopt distinct capital structure decisions compared to firms inother industries. Firms' decisions on capital structure are linked to many corporate decisions and strategies, and remain an inexhaustible source of many analyses and research. According to Eurostat data, the ICT sector's varied but generally significant role in European economies, reflecting diverse strategic choices and competitive advantages. In the period from 2012 to 2022 the ICT services share of gross value added in the EU saw steady growth of 24.8 percent, while the share of ICT manufacturing was stabler, at 0.6 percent. In 2022 the value added of the total ICT sector in the EU reached 5.5 percent of the EU's gross value added. In every EU country, labour productivity in the ICT sector is higher than in the rest of the business economy.

Croatia, as a small, open economy and a member of European Union (EU) has been experiencing steady digital transformation. According to the share of value added by the ICT sector in total added value, Croatia is at the level of the EU average, ranked 11th among EU member states in 2022. When it comes to ICT sector's role in driving business innovation, the share of the ICT sector in Croatia accounts for about 28 percent in total business enterprise expenditure on research and development (R&D) in 2022, which places Croatia among the top ten countries in EU. Despite the increasing presence of digital technology in the context of corporate finance and especially firms' capital structure, the number of research studies is still scarce. To the best of the author's knowlwdge, the capital structure of the ICT sector in Croatia has not yet been thoroughly examined. So this paper seeks to fill the gap by exploring the determinants of capital structure, with a special emphasis on differences between ICT firms and those in other industries. This rest of the paper is organized as follows. Section two provides an overview of theoretical framework and literature review; section three presents research methodology employed and the results of analysis; while section four concludes the paper.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

There is no unified theory that fully explains the capital structure. Many authors have contributed to the research on this topic by considering and discussing the factors that determine capital structure, all with the aim of providing an answer to the basic dilemma of capital structure theory, which is the question of the existence of an optimal capital structure.

2.1. Capital structure theories

The earliest theoretical considerations of capital structure theory date back to the 1950s and the presentation of the Modigliani-Miller theory in 1958 which marked the beginning of modern finance (Harris and Raviv, 1991). Their theory is based on the assumption that firms operate in a completely free and competitive market without taxes or transaction costs, where information is completely transparent and available without cost (Myers, 2001). By abandoning the assumptions of a perfect market, new theories were developed, emphasizing the importance of individual factors in explaining the firms' capital structure. Some of them are the trade-off theory, signaling theory and the pecking order theory. The trade-off theory highlights the role of taxes. The tax treatment of debt represents a benefit of using debt because it creates a tax shield that reduces a company's taxable profit. However, one of the possible elements that would reduce or neutralize the tax advantages of using debt is the cost of bankruptcy (Kraus and Litzenberger, 1973; Miller, 1977). Myers (1984) expands the scope of costs that reduce the tax advantages of debt and defines them as the costs of financial distress.

In addition to the legal and administrative costs of bankruptcy, these costs include more subtle agency costs, moral hazard costs, monitoring and contracting costs, i.e. costs that can reduce the value of a company even if the company has not formally gone bankrupt. According to the trade-off theory, a firm will use debt until the marginal value of the interest tax shield created by the additional debt equals the increase in the present value of the potential costs of financial distress such as the direct and indirect costs of bankruptcy (Myers, 2001). Signaling and the pecking order theory are based on the informational asymmetries between corporate insiders and outside investors on the value of their firm's assets and investment opportunities (Schmid Klein, O'Brien, and Peters, 2002). Signaling theory, or the idea of usinf debt as a signal of firm's quality, was first applied in finance by Ross (1977). A firm that borrows money commits itself to paying interest on the debt. If the firm does not fulfill this obligation, it faces financial difficulties or, ultimately, bankruptcy. Therefore, a firm will not want to commit to that unless it is completely certain that it will be able to fulfill its obligations. By their decision to borrow, they send internal information as a signal to the investing public. Lower-valued firms will not want to imitate the signals of high-valued firms because they are aware that this would attract public attention and expose them, and they would also be threatened with the possibility of bankruptcy (Schmid Klein, O'Brien, and Peters, 2002). The pecking order theory was established by Myers (1984) and Myers and Majluf (1984) describing the order in which firms prefer to finance their future activities and growth (Mostarac and Petrovic, 2013). Because of informational asymmetry between corporate insiders and outside investors, firms can minimize the costs of financing by giving primacy to internal compared to external finance. If external finance is required, firms will rather issue debt than issue equity (Hyytinen and Pajarinen, 2005). Prioritizing self-financing, managers tried to prevent the outward transmission of signals about the firms's situation (Teixeira, Miguel, Parreira and Filipe, 2015).

2.2. Theoretical characteristics of ICT industry

According to Varian (2001) and Hyytinen and Pajarinen (2005), although high-technology industries are subject to the same market forces as other industries, there are some forces that are particularly important in high-tech industries and can affect their financial decisions and capital structure choices. Network effects or network externalities (or demand-side economies of scale) are the norm in the information economy. Value of ICT products and services often increases as more users adopt them. This can cause rapid growth but also make future cash flows uncertain and volatile, which can increase the cost of external financing and limit the benefits of using debt. ICT firms are generally characterized by high levels of R&D investment. They usually requires large upfront investment, but with uncertain outcomes. Since intangible assets cannot easily serve as collateral for debt financing, they tend to rely more on equity financing. In addition, when appropriability of investment is high, new profitable opportunities emerge, but high levels of debt may increase under-investment cost and reduce the benefits of debt. The cost structure of some ICT products often includes high fixed entry costs and very low marginal costs because of the nature of products. This implies that the use of debt to finance investment may be infeasible as the probability of financial distress increases.

2.3. The determinants of capital structure

The decision on whether to use its own or external funds depends on many factors, such as asset structure, firm size, profitability, liquidity, growth, control, taxes, managerial conservatism, financial flexibility, market conditions, earnings volatility, etc. Only determinants included in the econometric analysis will be elaborated in more detail (asset structure, firm size, profitability, liquidity and growth). Asset structure refers to the proportion of fixed or intangible assets in total assets. Based on a higher proportion of fixed assets, a firm will be able to borrow more because it will use fixed assets as collateral (Rajan and Zingales, 1995).

They are also likely to have relatively lower bankruptcy costs, and thus, higher debt capacity (Cook and Tang, 2010). As the authors most often use fixed assets as an indicator, there are few works that explicitly examine the relationship between intangible assets and capital structure. In terms of theoretical assumptions, intangible assets should have an effect on financial leverage of the opposite sign to fixed assets. Poor collateralizibility and high valuation risk increase the agency costs, and the firm is not inclined to finance with debt (Niu, 2008). However, Lim, Macias, and Moeller (2020) on a sample of 469 US public companies between 2002 to 2014 come to the conclusions that identifiable intangible assets have the same positive influence on financial leverage as tangible assets, thus supporting debt financing. From a theoretical point of view, the effect of firm size on leverage is ambiguous. Large firms are more diversified and fail less frequently, so firm size can be used as an inverse indicator of the probability of bankruptcy (Rajan and Zingales, 1995; Titman and Wessels, 1988). So, the size should have a positive effect on the use of debt. However, large firms communicate more with the investing public and the problem of asymmetric information should be much smaller than is the case for small firms (Huang and Song, 2002). This should increase their preference for equity financing over debt financing (Rajan and Zingales, 1995) and lead to a negative relationship between firm size and the degree of leverage. The theory does not provide a clear answer on the relationship between profitability and financial leverage. From the perspective of trade-off theory, highly profitable firms will use more debt to take advantage of the interest tax shield. The use of debt has another advantage, debt can be used to more easily control the behavior of managers and thus reduce agent costs. In contrast, the pecking order theory predicts a negative relationship. Highly profitable firms, by making high profits, have the ability to retain earnings more significantly, and retaining earnings is the internal financing of the company, which this theory places at the top of the hierarchy of financing forms (Myers and Majluf, 1984). Most empirical research results are consistent with the assumption of the financial choice hierarchy theory (Rajan i Zingales, 1995; Booth, Aivazian, Demirgus-Kunt and Maksimovic, 2001; Frank and Goyal, 2003). Liquidity is usually understood as a measure of a firm's capability of debt repayment (Kedzior, Grabinska, Grabinski and Kedzior, 2020). According to the pecking order theory, more liquid companies tend to finance their activity mainly by retained earnings. Firm growth, defined as realized growth in sales revenue, is also one of the determinants of a firm's capital structure. According to the trade-off theory, revenue growth means more stable and higher cash flow, which reduces the risk of insolvency and allows for greater use of debt (Huang and Song, 2002). On the other hand, fast-growing firms have a greater demand for additional funds to finance their investments. In doing so, they will primarily rely on internally available funds, which is consistent with the pecking order theory (Rajan and Zingales, 1995).

3. METHODOLOGY AND RESULTS

3.1. Data

The dataset used in this paper included about 170,000 firms in Croatia, observed for a period of 17 years from 2008 until 2024. Information on sample firms was extracted from the Register of Annual Financial Reports (RGFI), conducted by the Financial Agency (FINA). Selected firms are mostly joint-stock enterprises and private limited liability enterprises. The data do not include financial institutions, nonprofit organizations, and government and public administration. To ensure a representative sample of enterprises some adjustments to the data were required. Firms without registered employees and thise with non-positive equity or sales revenue are excluded from the sample. In order to avoid the influence of outliers, all data were winsorized. Because the analysis focuses on the capital structure determinants of ICT firms, the sample was selected according to the Eurostat definition.

The economic activities of ICT sector consists of ICT manufacturing and ICT services based on the statistical classification of economic activities (NACE Rev. 2):

- ICT manufacturing: 26.1 (Manufacture of electronic components and boards), 26.2 (Manufacture of computers and peripheral equipment), 26.3 (Manufacture of communication equipment), 26.4 (Manufacture of consumer electronics) and 26.8 (Manufacture of magnetic and optical media).
- ICT services: 46.5 (Wholesale of information and communication equipment), 58.2 (Software publishing), 61 (Telecommunications), 62 (Computer programming, consultancy and related activities), 63.1 (Data processing, hosting and related activities; web portals) and 95.1 (Repair of computers and communication equipment).

3.2. Variables

The primary focus of this paper is capital structure presented in the form of dependent variable ($LEVERAGE$). According to Rajan and Zingales (1995) financial leverage is defined as the ratio of debt to capital, as this is probably the best representation of past financing decisions. Debt includes short and long-term liabilites, while capital comprises total debt increased by shareholders' equity. Book values are used as the market values are not available. The independent variables in this paper (asset structure, profitability, firm size, liquidity and growth) were selected based on the previously presented capital structure theories and available literature. Asset strucure ($ASSET$) and profitability ($PROF$) are the key determinants of capital structure. Asset structure is measured as the ratio of fixed assets in total assets, while return on assets (ROA) or ratio of earnings before income and taxes (EBIT) to total assets is used to measure profitability of firms. Firm size ($SIZE$) is expressed by natural logarithm of sales, and firm growth ($GROWTH$) as annual change of sales revenue. Finally, liquidity (LIQ) is measured as the ratio of short-term assets in short-term liabilities. In order to avoid intercorrelated variables in the model, a correlation analysis is performed and the results are presented in Table 1. The correlation matrix does not imply the existence of any significant positive or negative relationship between the variables. The highest positive correlation is found between asset structure and leverage, while liquidity and profitability show the highest negative correlations.

	LEVERAGE	ASSET	SIZE	PROF	LIQ	GROWTH
LEVERAGE	**1.000**					
ASSET	0.298	**1.000**				
SIZE	0.076	0.095	**1.000**			
PROF	-0.305	-0.204	0.024	**1.000**		
LIQ	-0.307	-0.184	-0.099	0.130	**1.000**	
GROWTH	0.063	-0.041	-0.197	0.193	-0.083	**1.000**

Table 1: The correlation matrix of the dependent and independent variables
(Source: author's calculations based on Fina data)

3.3. Econometric analysis

In this paper, the panel regression was estimated using fixed-effects with clustered standard errors at the firm level to obtain robust coefficients which allows us to avoid many problems with the specification of the model. Interaction terms with the ICT dummy variable were included to capture differences in the impact of individual determinants of capital structure between ICT and non-ICT firms. Year dummies were also added to control for time-specific effects.

The regression model is, as follows:

$$LEVERAGE_{it} = \alpha_i + \gamma_t + X_{it}\beta + (X_{it} \times ICT_i)\delta + \varepsilon_{it}$$

where, α_i are firm fixed effects, γ_t year fixed effects, X_{it} is the vector of capital structure determinants (asset structure, profitability, firm size, liquidity and growth), β is the coefficient for non-ICT firms, δ are additional effects for ICT firms through interaction terms, and ε_{it} is the error term. Regression results are presented in Table 2. Robust standard errors clustered at the firm level are reported in parentheses, while the levels of significance are noted with stars; *p<0.10, **p<0.05 and ***p<0.01.

Variable	Coefficient	Std. Error
ASSET	0.261***	(0.003)
ICT dummy	-0.062**	(0.024)
ASSETxICT	0.047***	(0.012)
SIZE	0.010***	(0.001)
SIZExICT	0.003*	(0.002)
PROF	-0.270***	(0.002)
PROFxICT	0.063***	(0.006)
LIQ	-0.006***	(0.000)
LIQxICT	0.002***	(0.000)
GROWTH	0.005***	(0.000)
GROWTHxICT	-0.002***	(0.000)

Table 2: Regression results
(Source: author's calculations based on Fina data)

According to the results, all considered determinants show statistically significant effects on capital structure, with significant sectoral heterogeneity. In non-ICT firms, the asset structure measured as the share of fixed assets in total assets has strong and positive impact on firms' financial leverage. This means that firms with a higher proportion of tangible assets are more inclined to use debt. At the same time, firm size and sales growth also show a statistically significant positive association with leverage, although economically more modest compared to asset structure. Positive effects of firm size, asset structure, and firm growth are consistent with the trade-off theory. In contrast, profitability and liquidity exert statistically significant negative effects on leverage, with liquidity having economically more modest compared to that of profitability. Negative effects of profitability and liquidity are in line with the pecking order theory.

The intereacion terms indicate that relationships between leverage on the one hand, and asset structure, profitability, firm size, liquidity and growth on the other hand, differ systematically for ICT firms. ICT firms in Croatia, on average, have lower leverage. In particular, leverage of ICT firms is more strongly positively driven by asset structure compared to non-ICT firms, by about 18 percent. A more important role of the asset structure in ICT firms than in other firms may reflect the relative scarcity of fixed assets in these firms. Even marginal change of asset structure in favour of tangible asset can have large impact on financial decisions of firms in ICT industry. At the 10 percent significance level, firm size has about a 30 percent stronger effect on the leverage of ICT firms compared to firms in other industries, while firm growth also positively affects the leverage of ICT firms, but about a 40 percent weaker than non-ICT firms. The weaker positive impact of growth on leverage can be explained by the fact that sales growth in ICT firms is mostly innovation driven, these firms rely less on debt financing compared to firms whoose growth is based on physical investments.

The negative effects of profitability and liquidity are significantly weaker in ICT firms by 23 and 33 percent, respectively. This finding suggests that ICT firms, even with the availability of internal funds, continue to use external financing to preserve their market position and continue investing in innovation.

4. CONCLUSION

This paper explores the determinants of capital structure, such as asset structure, firm size, profitability, liquidity, and growth , with a special emphasis on differences between information and communication technology (ICT) firms in Croatia and those in other industries. The analysis is based on the panel dataset of about 170,000 firms in Croatia over the period 2008-2024. Results indicate positive effects of firm size, asset structure, and firm growth on leverage, which is consistent with the trade-off theory, while the negative effects of profitability and liquidity are in line with the pecking order theory. The findings provide evidence of sectoral heterogeneity in making capital structure decisions. ICT firms in Croatia respond differently to key determinants of leverage than firms in other industrie. In ICT firms, leverage is more strongly driven by asset structure and size, and less by firm growth. At the same time the negative effects of profitability and liquidity are less pronounced compared to other industries. These results show that technological intensity and sector-specific financial strategies influence capital structure decisions, highlighting the role of industry context in corporate financing. Therefore, it is not surprising that capital structure, as documented in the literature, is one of the most controversial areas of financial management. This paper contributes to the literature on corporate finance and capital structure determinants in ICT industries.

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ATTITUDES TOWARDS FOREIGN WORKERS AND THE LEVEL OF SOCIAL DISTANCE IN THE CITY OF SPLIT

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ABSTRACT

Over the past few decades, Croatia has undergone significant economic, political, and demographic changes. With its accession to the European Union in 2013, the country opened to international markets and labor migration, leading to an increase in the number of foreign workers. These workers bring with them diverse languages, cultures, and work habits, which have a notable impact on the economy, society, and politics. While some view foreign workers as essential for economic growth, others express concerns about their potential negative effects on social cohesion and the labor market. The growing presence of foreign workers in Croatia has become a frequent topic in the media, highlighting the need for a deeper understanding of this phenomenon from the perspective of the local population. In this context, the research focuses on the perceptions of residents of the city of Split toward foreign workers, aiming to determine the level of social distance within the local community. Data were collected through an online survey conducted during May and June 2024, involving 206 adult residents of Split. The results emphasize the importance of continued efforts to reduce prejudice and promote the integration of foreign workers, enabling them to actively contribute to the development and diversity of the community, enriching the social and cultural life of both Split and Croatia.
Keywords: *City of Split, Foreign workers, Labor market, Local population, Social distance*

1. INTRODUCTION

In recent decades, Croatia has undergone significant political, economic, and demographic transformations, particularly following its accession to the European Union in 2013. One of the key outcomes of this process has been the growing influx of foreign workers arriving from various parts of the world. This trend is a result of globalization, the freedom of movement of labor within the EU, as well as specific demands of the Croatian labor market. Foreign workers contribute to cultural and linguistic diversity, introduce different work practices, and exert a notable influence not only on the economy but also on the social structure of the country.

On one hand, their presence is perceived as essential for sustaining economic growth; on the other, it raises concerns regarding potential adverse effects on social cohesion and labor market competition. In this context, Croatia is increasingly emerging as a destination country for immigration, gradually replacing its historical role as a country of emigration. It is therefore crucial to analyse the demographic characteristics of foreign workers, their living conditions, level of integration, and vulnerability to social exclusion. The aim of this research is to gain a deeper understanding of their position and contribution to Croatian society and economy (Božić et al., 2013: 367-369). The concept of social distance explains the variation in interpersonal relations ranging from close and friendly to indifferent or hostile (Supek, 1968, as cited in Mrnjaus, 2013: 311). It measures individuals' attitudes toward members of groups who differ in terms of culture, ethnicity, or religion. These attitudes can be either positive or negative, depending on personal beliefs and social influences. Three key factors shape social distance toward national and religious groups: cultural transmission (through family and education), group categorization (the "us-them" distinction), and individual psychological characteristics, such as frustration (Previšić et al., 2004: 107). Stereotypes, which often carry a negative connotation, stem from cultural differences involving language, customs, religious affiliation, and traditions. Historical events, such as the wars of the 1990s in the former Yugoslavia, further intensified negative attitudes, particularly toward the Serbian national minority in Croatia, leading to the intergenerational transmission of ethnic stereotypes (Mrnjaus, 2013: 311). In today's culturally diverse society, such patterns can also extend to foreign workers from third countries. The concept of social exclusion refers to an individual's deprivation in economic, social, and cultural dimensions. Although it is often assumed that migrants sever ties with their countries of origin, research suggests the opposite, they actively maintain transnational connections and communities (Božić et al., 2013: 368). Meaningful and frequent contact between different groups can significantly reduce social distance and enhance the integration of foreign workers (Mrnjaus, 2013: 311-313).

2. SOCIOLOGICAL DETERMINANTS OF FOREIGN LABOUR IN THE REPUBLIC OF CROATIA

2.1 Legislative Framework, Work Permits, and the Integration of Foreign Nationals in Croatia

Following its accession to the European Union in 2013, Croatia became part of the common European labor market, facilitating the arrival of foreign workers while also contributing to an increase in irregular migration. During the 2015-2016 migrant crisis, large numbers of migrants from Syria, Afghanistan, Pakistan, and Bangladesh passed through the so-called Balkan route, with Croatia serving primarily as a transit country (Vulas, 2022: 171-186). Although migrants are often driven by the pursuit of better living conditions, international law primarily protects refugees (1951 Refugee Convention), while national legislation regulates labor migration (Iom.int, 2024). In Croatia, the employment of foreign nationals is governed by the Occupational Safety Act (Narodne novine no. 71/14, 118/14, 94/18, and 96/18). Foreign workers are required to comply with national occupational health and safety regulations, including the provisions of collective agreements when these offer more favourable conditions than those in their country of origin (Uznr.hr, 2024). Employment through the Croatian Employment Service (HZZ) requires valid identification documents, educational certificates, and a personal identification number (OIB) (Migracije.hr, 2024). Work and residence permits are issued by the police administration, and employers may submit applications provided they operate legally, are free of tax liabilities, and employ at least one Croatian citizen (e-Citizens, 2024). Due to emigration and a shortage of domestic labor, Croatia increasingly relies on workers from third countries, particularly from Nepal and the Philippines.

In 2020, the highest number of work permits was issued in the construction sector, a field often avoided by domestic workers due to low wages and difficult working conditions (Horvat, 2021: 82-83). Research indicates that most foreign workers are men aged 30 to 50, often married and with children, who remit a significant portion of their earnings to their families (Božić et al., 2013: 371-376). The new Aliens Act of 2020 abolished the quota system and simplified the process of obtaining work permits, which are now processed within 30 days (Butković et al., 2022: 40-46). According to estimates by the Croatian Employers' Association, by 2030 foreign nationals could constitute up to a quarter of the workforce (Dubrovacki.slobodnadalmacija.hr, 2024). Individuals under international protection, as well as those residing in Croatia through family reunification, student status, or long-term residence, have the right to work without additional permits. Students and pupils are allowed to engage in self-employment for up to 20 hours per week (Migracije.hr, 2024). This flexibility reflects the adaptability of Croatia's migration policy to the evolving needs of the labor market. The highest concentration of foreign workers is found in Zagreb, where the city government provides free Croatian language courses and €500 vouchers (Index.hr, 2024). Similar initiatives have been implemented in cities such as Split, Varaždin, and others, aimed at facilitating linguistic and cultural integration (Index.hr, 2024). Nevertheless, many foreign workers live in overcrowded and substandard conditions, often housed in groups and with limited interaction with the local population (Večernji.hr, 2024). The integration challenge is further exacerbated by a lack of accurate data on the legal and employment status of foreign workers. The number of issued work permits often does not align with the number of individuals registered for tax and social contributions, indicating the existence of informal employment and undeclared work (Jutarnji.hr, 2024). Such circumstances may have long-term negative implications for the country's macroeconomic stability. The Croatian National Bank (HNB) reports that the inflow of foreign labor positively contributes to GDP growth by increasing overall employment and reducing structural unemployment (HNB.hr, 2024). However, the absence of a systematic integration policy hinders the full societal participation of foreign workers.

2.2 Experiences of Foreign Workers in the Republic of Croatia

Foreign workers in Croatia are predominantly employed in construction, tourism, and hospitality. Most are men between the ages of 30 and 50 with lower levels of formal education. They face numerous challenges, including language barriers, discrimination, and the non-recognition of qualifications (Butković et al., 2022: 28-40). Low wages and difficult working conditions are often cited as the main reasons why Croatian nationals tend to avoid these occupations (Index.hr, 2024). Case studies, such as that of Sivasamy, an Indian worker, illustrate that many foreign workers come to Croatia temporarily, intending to earn income and return to their home countries. They typically live in shared accommodation and send a portion of their earnings to their families (Lidermedia.hr, 2024). Despite their overall adaptability, there has been a rise in incidents of violence against foreign nationals, especially in Zagreb. Attacks are most directed at delivery workers from Asian countries, who often carry cash as part of their work (Index.hr, 2024). The Nepali Association has called on authorities to provide greater protection for foreign workers. The Ombudswoman for Human Rights has warned that foreign workers often work overtime without permits, are denied wages and rest periods, and live in inadequate housing conditions. Many are unaware of their rights or afraid to report abusive employers (Ombudsman.hr, 2024). Public backlash against foreign workers is also evident in the media and on social networks. For instance, during the celebration of the "Nepali New Year" in the streets of Zagreb, workers were met with offensive and racist comments, and incidents of physical assault were reported (zenskirecenziraj.com, 2024; Index.hr, 2024). Political and societal attitudes toward foreign workers remain divided.

Katarina Peović argues that migrants are being used as "scapegoats" to deflect attention from deeper economic problems, while Lucija Mulalić from the Centre for Peace Studies notes that, despite Croatia's large diaspora, there remains a widespread societal reluctance to accept foreigners (Portalnovosti.com, 2024). The integration system is inadequate, and the unregulated operation of employment agencies, combined with a lack of oversight, further exacerbates the precarious situation of foreign workers.

3. CULTURAL DIFFERENCES AND THE CONCEPTUALIZATION OF SOCIAL DISTANCE

3.1 Cultural Differences Between Foreigners and the Local Population Within the Framework of Social Distance

Culture plays a crucial role in shaping an individual's personality and identity, fostering a sense of belonging. Globalization and migration processes lead to cultural mixing and multiculturalism, which can often give rise to tensions due to perceived differences. Multiculturalism is particularly prominent in Western countries (e.g., the USA, Canada, France), where efforts are made to ensure equal treatment of all cultural groups (Mrnjaus, 2013: 309–311). Attitudes toward other cultures are formed during childhood and evolve over the course of a person's life. They are influenced by family upbringing, education, and media. The way cultural groups are represented in the media directly affects public perception-e.g., documentaries can promote tolerance among children (Mrnjaus, 2013: 311). In Croatia, ethnic distance was most pronounced during the wars of the 1990s. The conflict between Croats and Serbs disrupted previously peaceful coexistence. Banovac and Boneta (2006: 22-27) argue that the war halted societal development and led to the establishment of new social regimes marked by ethnic division. Religion and national identity are closely intertwined, with religiosity often associated with negative attitudes toward immigrants. In Croatia, where Catholicism is the dominant faith, Muslims are frequently perceived as the "other", contributing to increased social distance (Kumpes, 2018:276-286). Studies show that more religious citizens tend to express greater social distance toward immigrants, while non-religious individuals exhibit more openness (Kumpes, 2018: 306-309). The Croatian education system is gradually introducing intercultural education and a European dimension through reforms, including the education of national minorities (Blažević Simić, 2011:154). Educational models A, B, and C allow for the preservation of minority languages and cultures while integrating students into the broader educational framework. Social distance measures the degree of acceptance or rejection of other groups. It is closely related to stereotypes, prejudice, and cultural differences. Various factors-such as socialization, education, and media, influence its formation (Previšić, 2004). Supek (1968, according Mrnjaus, 2013: 311) defines social distance as a continuum ranging from friendly relations to overt hostility. Three primary sources of social distance are: cultural transmission, group categorization, and psychological characteristics (Previšić et al., according Mrnjaus, 2013). Stereotypes are often passed down through generations, particularly when fueled by historical conflicts s is the case with the perception of Serbs in Croatia after the 1990s wars (Mrnjaus, 2013: 311-313). Similar patterns have been observed throughout Europe (Rui Gomes, 2000), where intolerance toward minorities is on the rise. Schools play a vital role in reducing social distance. When students witness positive interethnic relationships, they tend to develop more tolerant attitudes (Tomašić Humer and Milić, 2016: 70-71). Norms learned in school settings shape acceptable attitudes and behaviors. Petz (1992) and Supek (1968, accorded Vujević Hećimović et al., 2010: 138-139) argue that individuals often form prejudices without direct experience, under the influence of upbringing, media, and collective memory. In Croatia, war-related events and family-based socialization are among the main sources of social distance (Previšić et al., 2004:107-117).

Croatia is increasingly becoming a country of immigration. Research indicates that immigrants maintain ties with their countries of origin while also establishing new social networks within Croatia (Božić et al., 2013: 367-370). Nonetheless, they face the risk of social exclusion in three key areas: employment, financial stability, and socio-cultural integration. In conclusion, the concept of social distance is a valuable analytical tool for understanding the relationship between the local population and foreign workers in Croatia. In the continuation of this study, this concept will serve to examine the specific cultural barriers and integration challenges faced by foreign nationals.

4. METHODOLOGICAL ASPECTS OF THE RESEARCH

4.1 Research Subject and Objectives

The increasing presence of foreign workers in the Republic of Croatia has become a highly topical issue in the media and therefore necessitates consideration as both a social and economic phenomenon from the perspective of the local population. The subject of this research is the attitudes of the residents of the city of Split toward foreign workers within the city. The primary objective of the research is to examine the level of social distance expressed by the residents of Split toward foreign workers. In accordance with this objective, one main hypothesis and several specific hypotheses have been formulated:

H_0: Residents of the city of Split exhibit a pronounced level of social distance toward foreign workers in the city.

H_1: There is a difference between men and women in the degree of social distance expressed toward foreign workers.

H_2: The age of respondents influences the level of social distance toward foreign workers.

H_3: Marital status affects the level of social distance toward foreign workers.

H_4: Religious differences between foreign workers and the local population contribute to increased social distance toward foreign workers.

H_5: Racial differences between foreign workers and the local population contribute to increased social distance toward foreign workers in the workplace.

H_6: The local population develops prejudices about living in proximity to foreign workers.

H_7: The local population believes that the Republic of Croatia derives no benefit from foreign workers.

H_8: The local population believes that the customs, religious, and moral values of foreign workers are contrary to Croatian values.

4.2 Research Sample

The sample consists of the adult population (aged 18 and over) up to the working-age limit (age 65). The age categories were derived from the 2021 Census of Population and Households of the Republic of Croatia and grouped in the survey questionnaire into the following categories: 18-24, 25-34, 35-49, and 50-64. The sample can be defined as a stratified random sample, as the share of each age category in the predefined total sample of 200 respondents was calculated based on their respective proportions in the 2021 Census (Croatian Bureau of Statistics, 2021). This ensures that the proportion of respondents in each age group corresponds to their actual share in the population.

Table 1: Age Groups of Respondents

Age Group	Total Population According to the 2021 Census	Share of Selected Age Groups in the Population (%)	Total Number in the Sample (N=206)
18–24	12,125	12%	25 (collected: 28)
25–34	18,957	19%	39 (collected: 41)
35–49	33,033	35%	72 (collected: 69)
50–64	33,471	34%	70 (collected: 68)
Total	97,586	100%	206

The research was conducted during May and June 2024 using an online questionnaire distributed via a link among potential respondents who met the criteria of age and place of residence.

Table 2: Key Research Variables

VARIABLES	METHODOLOGICAL LEVEL	INDICATORS
Structural Factors: Sociodemographic	Individual	Age, gender, level of education, number of children, marital status
Structural Factors: Socioeconomic	Individual	Occupation, employment status, political orientation
Cultural Differences	Individual/Societal	Attitudes of foreign workers toward the local population, prejudices and stereotypes, religion
Foreign Workers in Croatia	Individual/Societal	Legal framework regarding foreigners, perceived contribution of foreign workers to the national economy

5. RESULTS AND DISCUSSION

The study, conducted among 206 residents of Split, examined local attitudes toward foreign workers. The sample comprised 56.1% women, predominantly aged 35-64, with the majority holding secondary education (56.3%) and being permanently employed (69.4%). Regarding contact and perceptions, 35.9% reported occasional contact with foreign workers, while 25.2% described their experiences as generally positive. A majority (69.9%) were unaware of legislation protecting foreign workers' rights, and the same percentage had never witnessed conflicts between locals and foreigners. Support for equal working conditions irrespective of origin was expressed by 38.3%, while 40.8% believe that foreign workers accept jobs that locals avoid. Preferences leaned toward locals in employment contexts, with 42.7% favouring local candidates, though 37.9% would assist foreign workers in adjusting. Only 12.6% found the presence of foreign workers troubling; 31.6% were neutral, and 31.1% disagreed. Most respondents rejected the idea of denying foreign workers equal access to healthcare and education. However, 46.1% would refuse a romantic relationship with a foreign worker, while 60.2% had no objection to their children attending kindergarten with those of foreign workers. Nearly two-thirds (64.5%) did not feel foreign workers should abandon their customs. The same proportion supported equal pay for equal work, and 36.4% endorsed assistance in integration. Yet approximately one-third (33.5%) felt that foreign workers might threaten Croatian values and lifestyles.

Hypothesis testing:

H_0: Strong overall social distance toward foreign workers was generally confirmed, though signs of openness and neutrality were also present.

H_1 (Gender): Supported partially, significant gender differences emerged in willingness to collaborate (χ^2=13.916, p=0.008) and befriend foreign workers (χ^2=14.141, p=0.007), with women showing less social distance.

H_2 (Age): Not supported, no significant age differences except in one item.

H_3 (Marital Status): Rejected, no significant differences.

H_4 (Religion): Partially supported, religion showed significance in the statement that foreign workers in one's neighbourhood are bothersome (χ^2=51.230, p=0.001).

H_5 (Race in Workplace Equality): Supported, while 38.3% endorsed equal rights for all, 42.7% would prefer locals for hiring and 38.8% for collaboration, suggesting a gap between declared values and actual preferences.

H_6 (Prejudices & Security): Partially supported, high neutrality (43.2%-35%) signals underdeveloped prejudices.

H_7 (Perceived Utility): Partially supported, 39.3%, 46.6% neutral, indicating uncertainty about cultural diversity and economic contributions.
H_8 (Customs & Values): Rejected, neutral responses (30.6%-46.6%) suggest that traditional differences have limited influence on social distance.

Gender and religiosity significantly affect attitudes; age and marital status do not. Respondents profess tolerance but often prefer local workers in practice. Overall, the findings depict a moderately distant attitude, with notable neutrality concerning personal relationships.

6. CONCLUSION

Over recent decades, Croatia has undergone major economic, political, and social transformations, particularly following its 2013 EU accession. This shift opened the country to international labor markets and increased foreign migration. While foreign workers bring cultural diversity, they also encounter social distance, a phenomenon rooted in stereotypes, prejudice, and limited contact. Reducing this social distance is vital for successful integration. The Split survey (April-May 2024) of 206 residents aged 18-65 offers valuable insights. Gender impacted cooperative and interpersonal attitudes, and religiosity correlated with feelings of discomfort around foreign workers. In contrast, age and marital status did not influence social distance. Though most respondents support equal rights declaratively, hiring biases toward locals persist. Neutral stances dominate many items, indicating partial acceptance. Cultural and traditional differences appear less influential than economic and social factors in shaping attitudes. In summary, Croatia faces challenges in integrating foreign workers but also holds opportunities. Through education, intercultural dialogue, and stereotype reduction, the country can foster an inclusive society that values diversity. Split, as a key urban centre, should harness the enriching potential of diversity to boost its social and economic vitality. Ongoing efforts to reduce social distance and strengthen intergroup contact are essential for social cohesion and realizing the benefits of foreign labor for Croatia's development.

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MAPPING THE SCIENTIFIC LANDSCAPE OF CHATGPT IN BUSINESS ECONOMICS: A BIBLIOMETRIC ANALYSIS OF THEMATIC CLUSTERS, TRENDS, AND SECURITY RISKS

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ABSTRACT

The emergence of ChatGPT has sparked a revolution in interest among users and researchers alike. This study provides a comprehensive bibliometric analysis in business economics area to identify key research themes, trends, gaps, and risks within this rapidly evolving field. A total of 493 scientific studies were analyzed using VOSviewer software, resulting in the identification of nine distinct research clusters. Cluster 1 research groups on the application of artificial intelligence technologies in the business sector. Key nodes in this cluster include models, management, innovation, and performance, with a focus on balancing opportunities and challenges related to automation, supply chains, and sustainability. Cluster 2 explores the intersection of artificial intelligence, education, and ethics. Cluster 3 encompasses studies on the psychological and sociological effects of human interaction with artificial intelligence technology. Cluster 4 includes research on how artificial intelligence influences human behavior, perception, trust, its impact on social media, and anthropomorphism. Cluster 5 is a technical cluster focusing on the algorithms and specific technological applications driving the generative artificial intelligence revolution. Cluster 6 addresses natural language processing technologies and their application in generating measurable, real-world insights. The focus of Cluster 7 is on advanced techniques such as prompt engineering and topic modeling for content analysis. Cluster 8 concerns the core socio-economic narrative of our time: the impact of machine learning on employment and the labor market. Finally, Cluster 9 brings together research on knowledge management within organizations, representing the intersection of organizational learning, strategic management, and emerging artificial intelligence technologies. However, the most significant finding of this study is the notable absence of security-related themes. Key terms such as 'cybersecurity,' 'privacy,' and 'misinformation' are entirely missing from the dataset. This indicates a critical gap in the current research landscape regarding the understanding and mitigation of the risks posed by this technology.

Keywords: *Artificial Intelligence, Bibliometric Analysis, Business Economics, ChatGPT, Security Risks*

1. INTRODUCTION

The emergence of ChatGPT and its availability to the general public has grown into a phenomenon on a global scale. The ease of access to the application and the possibilities it offered have led to a rapid growth of users. From the ability to write essays, poems, translate text and many others, they have led to its widespread use by users of different interests, ages, and fields. In this research, the focus is on its application in the field of business economics.

The approach to analyzing the application of artificial intelligence in the field of business economics is suggested by several research directions that have been identified in bibliometric studies included in this set of 493 documents in the Web of Science database: a) studies that focus on the application of artificial intelligence in the tourism and hospitality sector. Ivasciuc et al. (2025)investigate the tourism experiences of Generation Z by comparing them with analyses generated by artificial intelligence (ChatGPT), Liao et al. (2025) conduct a bibliometric analysis to map the past, present and future developments in AI research in tourism and hospitality. Saleh (2025)analyses practical applications, future capabilities and strategies for using generative AI (such as ChatGPT) in the hospitality and tourism industry. b) studies that focus on the application of AI in education and human resource development. Dissanayake et al. (2025)use bibliometric analysis to assess the development and application of AI in management education. Thottoli et al. (2025) investigate how the integration of AI in university incubation centers can transform entrepreneurial education. Hamouche et al. (2025) conduct a bibliometric analysis of the literature on the application of AI in human resource development. c) the third line of research refers to studies that focus on the role of AI tools in scientific works (methodology, reliability and guidelines for the use of AI tools in the research process). Garg et al. (2024) compare the reliability of AI models (ChatGPT and Bard) with traditional scientific databases (Scopus, Web of Science) for academic writing purposes. Klarin (2024) offers guidelines for conducting bibliometric content analysis and mentions the potential of generative AI as a tool that can contribute to literature review methods. Kraus et al. (2024) discuss the role of review articles in management research and indicate the possibilities of using AI tools in different stages of creating such analyses. Shin and Kang (2023) use ChatGPT as a tool to analyze the evolution, current state and future directions of research in the field of tourism, demonstrating a meta-application of AI. d) The fourth line of research refers to the application of AI and risks in business in construction. Isgüzar et al. (2024) conduct a bibliometric analysis on innovative applications of generative AI in business, identifying advantages, disadvantages and future research directions.

The only study that deals with cyber risks in construction projects is the study by Sonkor and de Soto (2025), with an emphasis on cyber risks arising from its use. The application of generative artificial intelligence in education is represented by the findings of scholars ranging from optimism about improving learning to serious concerns about academic integrity (Lim et al. (2023), Ratten and Jones (2023), Rejeb et al. (2024). Artificial intelligence is changing the way companies create value, manage people, resources Kanbach et al. (2024), Akter et al. (2023), Aguinis et al. (2024), Paul et al. (2023). Research focuses on the benefits and challenges that artificial intelligence brings to individual sectors, tourism, hospitality Dwivedi et al. (2024), Gursoy et al. (2023), Wong et al. (2023), Pham et al. (2024)and in supply chains and logistics Richey et al. (2023), Wamba et al. (2024). User and consumer behavior (behavioral responses) in interaction with artificial intelligence systems are investigated by Camilleri (2024), Hermann and Puntoni (2024). Ethical challenges and risks of artificial intelligence are investigated by Motoki et al. (2024), Dalalah and Dalalah (2023). Considering that a bibliometric analysis of the field of business economics and ChatGPT is being carried out, research clusters and trends in this dynamic area will be identified. Therefore, two research objectives are set:

Research objective 1: to identify clusters in a selected set of scientific publications using bibliometric analysis tools.
Research objective 2: to identify trends and the most influential topics in the research area.

2. RESEARCH METHODOLOGY

The keyword ChatGPT was used to search and select published scientific papers. The analysis included articles published from the first year of publication (2023) to July 25, 2025, 493 documents in English were identified in the Web of Science database, related to the keyword. The analysis used the VOSviewer tool, version 1.6.20. Key terms (keywords) from a set of scientific publications were analyzed. Its frequency, connection with other terms, thematic group (cluster) and scientific impact (citations) were identified.

3. RESULTS

In accordance with the set research objectives, a presentation of the research results is provided.

3.1. Research objective 1

Research objective 1 refers to the identification of clusters in a selected set of scientific publications. The publications were analyzed using the VOSviewer tool. Nine research clusters were identified.

a) Cluster 1: Business, management and strategy. The key terms placed in this cluster are: business, management, challenges, opportunities, innovation, performance, sustainability, framework, model. This cluster suggests the application of AI technologies in the business world. Within this cluster are grouped studies on how organizations and management try to understand, exploit and manage the potential of generative AI. The focus is not on the technology itself, but on its integration into business processes. The central nodes are: model (23 occurrences, 100 connection strength), management, innovation, performance. The keywords benefits (64.67 citations) and opportunities (56.80 citations) suggest the finding that these terms have an extremely high average citation rate. The term challenges (36.92 citations) is also very influential and strongly related. This shows that the research is not only concerned with the positive sides. Papers that address barriers (e.g. implementation costs, employee resistance, security risks, need for new skills) are equally important to the big picture. In a wider context, the terms: Sustainability, Supply Chain, Automation. The inclusion of the term Sustainability shows the maturity of the discussion. Researchers are not only looking at short-term profits, but also at the long-term sustainability of AI-based business models – both economic, social and environmental. Supply chain and automation as terms are classic examples of a complex system where AI can bring huge improvements through automation, inventory optimization, and demand forecasting.

b) Cluster 2: The core of the research is AI, ChatGPT and application. This cluster encompasses the core technologies: artificial intelligence (co-occurrences 213, Total link strength (TLS) 571), chatgpt (289 co-occurrences, 707 Total link strength), their main creators and competitors (openai, bard). From the field of application, the term education (12 co-occurrences, TLS 39) and the most critical social issue at the moment - ethics (co-occurrences 10, TLS 36, but the highest average citation rate (104.2) were identified. Scientific papers dealing with the ethical dilemmas of generative AI are the most influential, attracting the most attention from the scientific community. Topics such as plagiarism in education, bias in AI models, the spread of disinformation and transparency of algorithms are at the very center of the scientific debate within this cluster. The high citation rate shows that resolving these issues is recognized as a key prerequisite for the responsible application of AI. The inclusion of the terms openai (the creator of ChatGPT) and bard (Google's competitor at the time) shows that the research is not only abstract, but also deals with concrete actors in the market at the moment. Furthermore, both terms have an extremely high citation rate (openai 89.5, bard 95.1).

Papers that directly compare these models, analyze their performance or criticize their politics, they are obviously in high demand and influential. This indicates an interest in the so-called an arms race of AI models. The high citation of the term management education (73.88) suggests the finding that business schools and economic faculties are among the first and most active in research and implementation of these technologies in their curricula. The term decision-making is another extremely influential term (76.33 citations). This shows a deep interest in how AI assists or replaces human decision-making, which is one of the fundamental functions in business and life in general. In this cluster, there are specific areas such as tourism, which stands out for its very high citation (67.6), which suggests that tourism, as an information-intensive industry, is recognized as a field with huge potential for the application of AI.

c) Cluster 3: technology acceptance and education (higher education, students, employees, TAM, skills, work). Key terms identified within this cluster are: acceptance, adoption, user acceptance, technology acceptance model (TAM), higher education, students, intention, creativity. The focus of this cluster is on the human factor. It investigates how users, especially students and employees, accept new technologies. Models such as the "Technology Acceptance Model" are an important theoretical framework here. Its presence, along with its high citation rate (24.00), shows that researchers rely on proven scientific methods. The term technology acceptance has the most recent year of publication (2024.8), which means that this topic is still extremely "hot" and relevant. The key context for this research is higher education, and the outcome that is observed is creativity, skills and work.

d) Cluster 4: social and psychological influence (technology, trust, behavior, perceptions, social media, satisfaction, quality). This cluster deals with the "softer" but extremely important aspects of the relationship between humans and artificial intelligence. While Cluster 3 focused on formal models of technology acceptance, this cluster dives deeper into social, behavioral and emotional reactions to AI, especially in the context of the public sphere and the media. Key terms: technology ((39 occurrences, 153 TLS), trust, behavior, perceptions, social media, anthropomorphism, engagement, information, quality. Key topics are anthropomorphism (attributing human traits to AI) and influence on social networks. Cluster 4 investigates how public opinion about AI is formed and user trust. The key arena is social media, where information spreads, shaping perceptions and behavior. The central goal is to achieve user satisfaction and ensure the quality of interaction. Topics such as anthropomorphism — attributing human traits to AI—and the impact on economics and employment demonstrate the breadth of social impact analyzed here. anthropomorphism: This term has an exceptionally high citation rate (28.20), making it a hidden gem of this cluster. Anthropomorphism is the tendency of people to attribute human characteristics, emotions, and intentions to AI systems (especially chatbots). Research on this phenomenon is clearly very influential because it taps into deep human psychology. Employment: The inclusion of this term (which is also in the smaller cluster 8) here shows that the discussion of trust and perception cannot be separated from one of the greatest existential concerns – will AI take jobs from humans (employment)?

e) Cluster 5: technical foundations and models (LLM, Deep learning, assessment, sentiment analysis. This is a technically oriented cluster that deals with specific technologies (deep learning, LLM), methods (sentiment analysis) and new models like Google's gemini. This cluster is the technical heart of the entire analysis. While other clusters deal with business strategy, user acceptance or social impact, cluster 5 descends to the level of algorithms and specific technological applications that drive the generative AI revolution. Main Main actor is the large language model (LLM), based on the deep learning architecture.

This cluster explores how these models are used for specific tasks such as sentiment analysis, how their assessment is performed, and how new, competing models such as Gemini appear. This is undoubtedly the most important term in the cluster and one of the most important in the entire map (right behind of ChatGPT and AI). "Artificial Intelligence" is a general term, and "ChatGPT" is a specific product, "Large Language Model" is a technical term that describes *the type* of technology in question. Deep Learning is present as the technological foundation on which LLMs are built. Its presence in this cluster, although with a smaller number of connections, confirms that research is addressing the fundamental architecture of these systems. The very recent year of publication (2024.5) is noticeable, which suggests that new deep learning architectures are still being actively researched to improve LLMs. Furthermore, sentiment analysis attempts to determine the emotional tone of a text (positive, negative, neutral). Its presence here shows that researchers are using powerful LLMs to solve this specific problem. LLMs, due to their deep understanding of context and language nuances, are exceptionally good at sentiment analysis, which is crucial for analyzing product reviews, postings on social networks, or monitoring public opinion. The keyword assessment: the term assessment refers to the process and methodology of evaluating the performance of these models. This is a key scientific area because without standardized assessment methods, model comparison is impossible. Gemini: This is the newest term in the cluster (year of publication 2024.6). Gemini is Google's answer to OpenAI's GPT-4. Its appearance in the data signals that the research field is moving very quickly and immediately includes the latest players in its analysis and assessment. The low citation rate (0.80) is expected because papers on it have only just started to appear.

f) Cluster 6: Natural Language Processing. Although this cluster contains only three terms, it represents an extremely important and practical direction of application. Cluster 6 groups research with a very specific task: using Natural Language Processing (NLP) technology to analyze and quantify the impact of certain events. This is a highly applied area that shows how fundamental AI technologies are used to generate concrete, measurable insights about real-world phenomena. Impact is the dominant term in the cluster (21 co-occurrences, 80 TLS) and has a high average citation rate (21.10), which is what researchers are interested in. High citation rates show that papers that successfully measure and demonstrate impact are highly valued. Natural Language Processing (NLP) can analyze thousands of tweets to measure the impact of a speech on public opinion. The keyword event is a specific context within which impact is measured. For example, impact can be measured in economics, marketing, politics.

g) Cluster 7: Specific techniques of generative AI. Cluster 7 is defined by the term generative artificial intelligence (101 occurrences, 313 connection strength). He goes a step further than the general term "AI" and specifies that it is about systems that create new content. Two key and very modern techniques/skills are grouped around this central concept: prompt engineering (the skill of communicating with a model) and topic modeling (a technique for analyzing the content generated or analyzed by the model). This is the fourth most important term in the entire analysis, just behind ChatGPT, AI and LLM. Its high frequency and strength of links, together with its high citations (25.18), indicate that researchers have recognized the need to clearly distinguish this new paradigm from older, analytical forms of AI. While traditional AI analyzed data to classify or predict something, generative AI uses it to create something entirely new (text, image, code). This term has become a standard term for the entire field of research. Prompt engineering is the most interesting term in the cluster because it represents a completely new skill that did not exist before the era of LLMs, given that it is the ability to create precise, detailed and effective queries (prompts) in order to obtain the desired output from a generative model.

h) Cluster 8: Machine learning and employment. Since there are only two terms within this cluster, the analysis focuses on the strength and meaning of their direct connection. Machine learning (co-occurrence 9, TLS 21) is a broader and more fundamental term than Large Language Model or Generative AI. It is the branch of artificial intelligence that deals with the development of algorithms that allow computers to learn from data. Its presence here, rather than more specific terms, suggests that the employment debate is not just about the latest wave of generative AI, but about the overall, long-term trend of automation driven by machine learning. Research in this cluster looks at the bigger picture and the underlying causes of change. Employment (co-occurrence 6, TLS 20) is a term that represents the workforce, jobs, careers and livelihoods. The term employment also appears in Cluster 4 (social perception), but there it is part of a broader discussion of trust and attitudes.

i) Cluster 9: Knowledge and strategies. Cluster 9 deals with the transformation of knowledge management within organizations. High citations suggest that papers dealing with how AI can unlock, organize and leverage this existing organizational knowledge are highly influential. AI, especially LLMs, is seen as a tool that can "understand" and search vast amounts of unstructured knowledge (emails, reports, documents) that have been untapped until now. He asks how existing knowledge can be used and how new strategies can be developed with the help of AI. Strategies is a term that refers to long-term plans and decisions that shape the future of the organization. This is the newest term in the cluster (year of publication 2024.5), which makes it an extremely current topic.

3.1 Research objective 2

Research objective 2: to identify trends and the most influential topics in the research area.
The table shows that the most cited terms related to ethics are ethics (104.2 citations), bard (95.1), OpenAI (89.5), decision-making (76.3), research agenda (74.4), tourism (67.6).

Cluster	Cluster description	Identified trends within the cluster	Numerical indicator:
Cluster 2	Core research: AI, ChatGPT, Ethics, Education	Trend 1: Establishing a base. The backbone of the cluster (chatgpt, AI) is mature and central. Trend 2: Shift towards ethics and competitors. Within the cluster, the most influential and cited topics are ethics, bard and OpenAI, which shows that the discussion is moving from technology to its consequences and market context.	Maturity: chatgpt (TLS: 707), ai (TLS: 571). Importance: ethics (Norm. citations: 3.32), bard (Norm. citations: 4.09)
Cluster 1	Business, Management and Strategy	Trend: From general analysis to concrete strategies. The cluster is maturing from general concepts (business) to specific and measurable outcomes (performance) and proactive planning (strategies).	Time: challenges (2024.3), opportunities (2024.2), sustainability (2024.2) are recent topics that require a strategic response.

Cluster 3	Technology adoption and the human factor	Trend: Extending acceptance theory to new domains. The focus is expanding from general user acceptance to specific contexts, especially the impact on work and a deeper understanding of creativity.	Time: work (Year: 2024.8), technology acceptance (Year: 2024.8) are the latest terms in the entire network. Importance: students (Norm. citations: 2.41) indicates a strong focus on the education sector.
Cluster 4	Social and psychological impact	Trend: Deep research into psychological mechanisms. This is the "hottest" cluster for high-impact research. The focus is on complex psychological constructs that explain human-AI interactions.	Importance: anthropomorphism (Norm. citations: 4.17), perceptions (Norm. citations: 2.68), satisfaction (Norm. citations: 2.35), social media (Norm. citations: 2.29) – all terms have exceptionally high normalized citations.
Clusters 5 and 7	Technical basics and specific techniques	Trend: Monitoring the technological frontier in real time. These clusters are the most dynamic. They show how research immediately adopts new technologies (Gemini) and new skills (prompt engineering).	Time: gemini (Year: 2024.6) is the latest model. prompt engineering and topic modeling are specific techniques that become the subject of research. large language model (LLM) is the mature backbone of this cluster.

Figure 1: Trends and influential topics in the field research
(Source: Own calculation)

The research focus shown in Table 1 is clearly shifting from the technology itself to its consequences. The latest and fastest-growing trends are those that address the human side of the equation : how we embrace, adapt to, and strategically integrate AI into work and society. At the same time, ethical issues remain the most important and influential topic, signaling that the responsible use of AI is recognized as a key prerequisite for the future.

3.3. Research gap

The analysis reveals a significant lack of security terms such as security, privacy, risk and cybersecurity in research on AI in the business economy. This represents a critical research gap, given the business losses caused by threats, vulnerabilities and malicious use. The current focus on trust is incomplete, as trust cannot exist without system security. A likely reason for this lack is that security topics are covered in specialized technical journals. It is expected that a major security incident related to generative AI could stimulate the creation of a new, strong research direction focused precisely on these risks.

3.4. Suggestions for future research

The absence of explicit discussion of security risks represents a significant research gap. gap) within this dataset. This is also a great opportunity for all researchers who want to make an original and influential contribution can focus on this area. Works that would systematically analyze could relate to the identified gaps: Specific security threats of generative AI, the connection between user trust and the actual technical security of the model, frameworks for

managing security risks in the business environment. Such research will certainly have a high potential for relevance and citation in the future, because it addresses a critical issue that will become increasingly important with the further adoption of AI technology.

3.5. Research limitations

There are several limitations of this research: only works published in the Web of Science database, in English and in the field of business economics and the application of ChatGPT in that field, were used, while research from the field of technical sciences was excluded from this analysis. The methods of the visualization tool are a quantitative measure, not a qualitative one, and words within and between clusters show correlations (they appear together in the literature), but not causality. Also, citations are not an absolute measure of quality, high citations can mean that the work is of high quality, but it can also be controversial for some researcher for some reason.

4. CONCLUSION

The emergence of ChatGPT has become a global phenomenon that has fueled a wave of academic research, particularly in the field of business economics. With the aim of mapping existing research areas and identifying new trends, a bibliometric analysis of 493 scientific papers published in the Web of Science database was carried out. The analysis resulted in the identification of nine thematic clusters that depict in detail the current state of the scientific field. The first group of clusters shows that the research focus has grown beyond the simple application of tools and has focused on the deep, strategic integration of AI into business models (Cluster 1). The focus is no longer on technology itself, but on its role in management, innovation and performance improvement. The research is balanced, which is confirmed by the high citation of the terms opportunities and challenges, indicating a mature discussion of advantages and obstacles such as implementation costs and the need for new skills. Furthermore, the presence of terms such as sustainability and supply chain signal that research is concerned with the long-term, strategic impacts of AI. This course complements Cluster 9, which deals with knowledge transformation and strategies. Research focuses on how AI can unlock and analyze vast amounts of existing organizational knowledge to develop more effective business strategies based on it. Another key thematic unit deals with the human factor. Cluster 3 explores technology acceptance, particularly in the context of education. Researchers draw on proven theoretical frameworks such as the Technology Acceptance Model (TAM) to analyse the factors influencing the adoption of tools among students and employees. This cluster also looks at the impact on skills development, creativity and the future of work. This is followed by Cluster 4, which delves deeper into the social and psychological impact of AI. It explores trust, perceptions and behaviour, often in the context of social media. An extremely influential concept is anthropomorphism – the tendency of people to attribute human characteristics to AI systems, which profoundly affects interactions. This is also the newest direction of research, as confirmed by the fact that concepts such as work and technology acceptance have the most recent publication years (2024.8). At the heart of the scientific debate is Cluster 2, which encompasses core terms such as "artificial intelligence" and "chatgpt", as well as key market players (OpenAI, Bard). The most important finding within this cluster is the exceptionally high citation rate of the term "ethics", confirming that ethical dilemmas – such as plagiarism, model bias and disinformation – are recognized as the most influential and important topics in the scientific community. There is also significant interest in specific applications in areas such as education and tourism, which are recognized as sectors with huge potential for AI.

The last group of clusters covers technical aspects and their consequences. Cluster 5 represents the technical area of analysis, focused on fundamental technologies such as Large Language Model (LLM) and Deep Learning, and the assessment of their performance. The dynamism of the field is confirmed by the appearance of the latest models such as Google's Gemini as an object of research. Cluster 7 defines specific techniques such as generative artificial intelligence and highlights prompt engineering as a completely new skill that emphasizes the shift towards active human-machine collaboration. At the same time, Cluster 6 shows a practical application through Natural Language Processing (NLP) for measuring concrete impact events. Finally, Cluster 8 significantly singles out the connection between machine learning and employment, suggesting that the fundamental transformation of the labor market is recognized as a unique and key research topic. The latest research trends in this area address the human side of technology – acceptance, trust and psychological impact. In parallel, research follows the rapid evolution of technology and the development of new skills, while application moves towards deep strategic integration into business. Above all, ethical issues dominate as the most influential topic, highlighting that responsible application is recognized as a key prerequisite for the future of artificial intelligence.

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LIABILITY OF THE STATE FOR DAMAGE

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ABSTRACT

The paper analyzes the state's liability for damage caused to an individual using the example of the Republic of Croatia. First, the legal nature of the state with all its powers is explained to understand the relationship that the state has towards the individual. Then, the characteristics of subjective and objective liability for damage are defined and analyzed, taking into account that the highest judicial bodies in the Republic of Croatia today interpret the state's liability for damage towards the individual objectively. To make it clearer, the legislation of the Republic of Croatia in the field of state administration, armed forces (with a special emphasis on war damages and justifying reasons), and the aspect of provisions on terrorism are considered. Finally, it is concluded that despite legal provisions that give priority to subjective liability, when analyzing the relationship between the state and the individual, the state's liability should be based on objective criteria. This topic is important in every case where exist defense (land or marine) in order to achieve education and training of soldiers.

Keywords: *State, liability, damage, terrorism, Croatia*

1. INTRODUCTION

When we talk about human rights and freedoms, the most important thing is that there is responsibility for the unlawful act committed. This issue is also related to achieving legal security in society. At the beginning of the 19th century, the first forms of state responsibility for damage appeared (Mikecin, 2017., p. 160). State responsibility for damage refers to situations when the state appears as a private person. Only recently has state responsibility for damage been linked to the responsibility of state bodies and officials. Although the Constitution of the Republic of Croatia (Official Journal of the Republic of Croatia, No. 56/90, 135/97, 08/98, 113/00, 124/00, 28/01, 41/01, 55/01, 76/10, 85/10, 05/14) does not explicitly prescribe state responsibility for damage, we must emphasize that compensation for damage can be included under the protection of human rights and fundamental freedoms. The Constitution also proclaims the duty to ensure social justice and respect for human rights, implying compensation for damage. Although the Constitution of the Republic of Croatia does not explicitly prescribe state responsibility for damage, Art. 5, par. 2 stipulates that everyone is obliged to abide by the Constitution and the law and respect the legal order of the Republic of Croatia. Compensation for damage is a non-contractual legal relationship that arises based on facts such as actions and circumstances (Mikecin, 2017., p. 161). In civil law, liability for damage is defined as a legal obligation in which one party is obliged to repair the damage caused to the other party, and the other party is authorized to demand such repair (Klarić; Vedriš, 2012., p. 583.)

2. LEGAL NATURE OF THE STATE

A state can be defined as an organization that corresponds to a global society, has political and sovereign power based on the monopoly of legal physical force and economic and ideological power, refers to a precisely defined population and territory, and regulates the most important social relations through legal norms and performs various historical functions, starting from conquest and defense against other societies and exploitation and repression against its population, to the increasingly emphasized role of protecting peace, security, and freedom and achieving the well-being of all members of society (Visković, 2001., p. 39). The state creates the highest general legal norms and gives sanction and coercion to these norms. This is a mutual relationship, the state is created by law, and law creates the state. All of the above, the state had to achieve through an offensive-defensive function, managing large public works, to achieve the function of protecting social peace and security by ensuring the rights and freedoms of man and citizen, not only against private violations but also against violations of these rights and freedoms by the state authorities themselves (Visković, 2001., p. 37). Despite the modernization and development of various social spheres, the international community continues to play a key role in the development of societies. Statehood provides many benefits, such as the privilege of being an equal member of the international community. The emergence of states can be original (when a state is established in an area that at the time of its establishment was not subject to any other state authority), or derivative (when there are one or more predecessor states where the question of state succession arises) (Degan; Pavišić, 2005., p. 210). Every state must have an area in which its authority bodies exercise their jurisdiction. The boundaries of its authority are determined by the territory of the state. A state is at the same time a community of people on its territory. There cannot be a state without permanently settled inhabitants, and therefore an area without inhabitants cannot become a state. The beginning of state liability for damage first appeared in all relations where the state appeared as a private person, that is, in the area of non-authoritative state action (Borković, 1997., p. 115). The beginning of state liability for public actions was accepted only in the 20th century (Đurić; Aleksić, 2016., p. 73). Then, liability was extended to the actions of state bodies if third parties suffered damage. A significant contribution to this is also made by jurisprudence, which guarantees efficiency in the application and interpretation of standards and legal provisions. Many violations that can be committed by states relate to public international law, which regulates relations in the international community. This means that not only states participate in international relations, but all recognized subjects of international law. Sanctions for the protection of international law are provided by states and international organizations (Rudolf, 1977., p. 2). A state is a subject of international law because it is the bearer of rights and obligations in the international legal order. Although there are other subjects of international law, states are the most important subjects of public international law.

3. OBJECTIVE AND SUBJECTIVE RESPONSIBILITY OF THE STATE

Roman law did not know the concept of protecting an individual against a group, and consequently, a longer period was needed to develop state responsibility for damage (Đurić and Aleksić, 2016., p. 72). State responsibility for damage can be exercised through administrative and civil litigation, which results in a dualistic model of state responsibility for damage, where the state appears as a public or private entity. The objective responsibility of the state for damage in Croatia is prescribed by the Law on Obligations (Official Journal of the Republic of Croatia, No. 35/05, 41/08, 125/11, 78/15, 29/18, 126/21, 114/22, 156/22, 155/23), the Law on Land Registry (Official Journal of the Republic of Croatia, No. 63/19, 128/22, 155/23, 127/24), and the Law on Liability for Damage Caused by Terrorist Acts and Public Demonstrations (Official Journal of the Republic of Croatia, No. 117/03), in which objective responsibility is linked to state responsibility based on the principle of social solidarity (Mikecin, 2017., p. 166).

Furthermore, the objective responsibility of the state for damage also exists in cases where there is state responsibility because the trial was not conducted within a reasonable time. The objective liability of the state for damage facilitates the position of the injured party because it is easier to collect damages from the state as a legal entity than from the civil servant himself (Crnić, 2010., p. 18). Despite the different views of the judicial bodies in the Republic of Croatia on the type of state liability for damage, it is clear that there is a trend towards stricter state liability. In comparative law systems, the issue of state liability is resolved differently. In France, state liability for damage is regulated by the rules of private and administrative law (Bukovac Puvača; Žunić Kovačević, 2011., p. 272). In Germany, jurisprudence considers the state to be primarily liable, and an official, who cannot be directly liable to third parties, but rather the official owes the state the amount paid if the damage was caused intentionally or through gross negligence (Bukovac Puvača; Žunić Kovačević, 2011., p. 274). The European Court of Justice established state liability in the Francovich case, and since culpability was not mentioned, the legal theory concluded that in cases where a state body does not have discretionary powers, the state's liability for damage will be objective (Bukovac Puvača; Žunić Kovačević, 2011., p. 278). However, culpability can be taken into account when analyzing the extent to which discretionary powers have been violated.

One thing is certain, namely, the current case law of the European Court of Justice takes into account whether a norm of EU law that grants an individual a subjective right has been violated, the violation must be sufficiently serious, and there must be a direct causal link between the violation of the norm and the damage suffered by the individual (Ćapeta, 2003., p. 810). In Croatia, various laws regulating the work of the state administration, courts, armed forces, police, etc. stipulate that the state is liable for damage caused to third parties in connection with their work. In such cases, the rules of the general civil law institute of liability for damage apply. According to that Law, strict liability should also be applied to the state if there is state liability for damage caused by a dangerous object or dangerous activity, regardless of the service of state bodies. The general rules of civil law on liability for damage in Croatia prescribe liability based on presumed culpability, including that of the state. The cases of strict liability must be expressly prescribed or arise from liability for a dangerous object or activity. Although the regulations governing state liability do not contain the concept of culpability, everything depends on how the concept of unlawful and improper work of state bodies will be interpreted and whether it will be viewed through the presumption of culpability.

The Constitutional Court of Croatia starts from the strict liability of the state for damage. The case law of the European Court of Justice is continuously developing and in this way contributes to the development of the acquis communautaire. The aforementioned acquis starts from the supremacy of the acquis communautaire over national law and the principle of state liability for damage caused. It should also be emphasized that the horizontal effect of directives implies the imposition of obligations on the state, not on the individual. In the case of Francovich and Bonifaci v. Italy under numbers C-6/90 and C-9/90 of 19 November 1991, the European Court of Justice established the conditions for state liability for compensation for damage, but the compensation of the damage caused should be under national rules on liability (Ćeranić, 2017., p. 93). We have seen that state liability for damage in Croatia can be assessed both subjectively and objectively. In international law, a State must be subject to international obligations and must be responsible if it fails to comply with those obligations (De Tagle, 2015., p. 115). The State must protect the fundamental rights of individuals in society. The international responsibility of a State arises when there is conduct consisting of an action or omission that is attributable to a State under international law and constitutes a breach of the State's international obligation (De Tagle, 2015., p. 119).

All human rights relating to economic, civil, social, political, and cultural aspects encompass negative as well as positive obligations of States. The classical approach analyses the responsibility of States if its agents did positive acts and omissions. The Inter-American Court sees responsibility not because of the act, but because of missing due diligence to prevent the violation (De Tagle, 2015., p. 127).

4. STATE ADMINISTRATION SYSTEM

The state must guarantee legal security on its territory (Čuveljak, 2001., p. 127). The Republic of Croatia is liable for damage to third parties due to the unlawful or improper work of state bodies according to the Law on the State Administration System (Official Journal of the Republic of Croatia, No. 66/19, 155/23). The Law on the State Administration System prescribes the liability of the state for the unlawful or improper work of state administration bodies, bodies of local self-government units and administration in the state administration tasks delegated to them, and legal entities that have public authority in the state administration tasks delegated to them. All citizens of the Republic of Croatia, all legal entities, and other parties may appear as plaintiffs.

For the plaintiff (injured party) to be able to claim compensation for damage from the Republic of Croatia, there must be a wrongful act by a person who performs a service or activity on behalf of the state, unlawful or improper work of that person, the damage caused, and a causal link between the wrongful act or omission and the damage caused (Čuveljak, 2001., p. 131). Case law in the Republic of Croatia has defined the concept of unlawful and improper conduct. Unlawful conduct is contrary to laws and other regulations, while improper conduct refers to conduct that does not follow the rules of the profession (Baretić, Brežanski, Buljan, Ćurković, Hrvoj Šipek, Klarić, Momčinović and Nikšić, 2011., p. 184). The State Administration System Law prescribes state liability in Article 14, which at the beginning of the application of the Law was interpreted according to the subjective criterion (when damage is collected from a civil servant), while the current case law since 2007 has interpreted it on the objective criterion (when damage is collected from the state) (Mikecin, 2017., p. 165).

5. ARMED FORCES

The Law on Service in the Armed Forces of the Republic of Croatia (Official Journal of the Republic of Croatia, No. 73/13, 75/15, 50/16, 30/18, 125/19, 155/23, 158/23, 14/24) establishes the liability of the Republic of Croatia if damage is caused to a third party by a member of the Armed Forces of the Republic of Croatia in the course of and connection with the performance of their duties (Law on Service in the Armed Forces of the Republic of Croatia, Art. 193, par. 1). However, the state's liability for damage caused by members of the Croatian armed and police forces during the Homeland War is regulated by the Law of the same name if the damage was caused while acting in military or police service or in connection with that service in the period from August 17, 1990, to June 30, 1996.

Therefore, for the state to be liable for war damage, the damage had to have occurred in the aforementioned period, and it had to have been committed by members of the Croatian armed and police forces in their military or police service or in connection with the performance of the same, and it had to have been committed in the period and in the area where military operations were taking place (Crnić, 2010., pp. 162-164). Given the specificity of the situation, it is always necessary to determine which damages have the character of war damages, and which damages occurred as a result of the actions of members of the domestic armed and police forces outside of service, and for which the state is not liable (Mikecin, 2017., p. 187).

The law emphasizes that the Republic of Croatia is liable for damages that are not war damages according to the general rules on liability for damages (Law on the Liability of the Republic of Croatia for Damage Caused by Members of the Croatian Armed and Police Forces during the Homeland War (Official Journal of the Republic of Croatia, No. 117/03), Art. 2). According to the established interpretation of state responsibility, a state is not internationally liable for the private acts of individuals if it did not act negligently by failing to prevent them (Greenwood, 1960., p. 401). However, Art. 3 of the Hague Convention IV proclaims that a state is liable in an armed conflict for all acts of individuals of its war forces.

6. WAR DAMAGES

The Law on the Liability of the Republic of Croatia for Damage Caused by Members of the Croatian Armed Forces and Police Forces during the Homeland War, in Article 3, proclaims that war damage in the sense of this Law is considered to be in particular: damage caused during and in the area of military actions by all means and forms of war combat operations (bombing, shelling, machine gunning, explosions, mining, troop movements, etc.); damage from direct and concrete military benefit if, given the time and place of commission, it is in the direct and immediate function of military operations, and in particular: a) damage caused as a direct consequence of any protective or preparatory measure taken by the competent military authorities with the aim of repelling or preventing the execution of any enemy attack, b) damage caused as a direct consequence of protective or preparatory measures taken by the competent military authorities in anticipation of enemy action (land works, confiscation of movable property, occupation of real estate, etc.), c) damage caused as a direct consequence of measures taken with the aim of preventing the spread or mitigating the consequences of damage; damage which, by its effects and the specific circumstances of the time and place of commission of the harmful act, is directly caused by a state of war and is directly related to war operations (direct consequences of war events related to riots, commotion, panic, evacuation and similar events immediately after war operations). It is assumed that the consequence of an act of war (war damage) is the damage caused during the Homeland War from 17 August 1990 to 30 June 1996 by members of the Croatian armed and police forces in military or police service or connection with the performance of military or police service, if it was committed at the time and in the area of military combat operations, but the injured party may prove the contrary. The Law on the Determination of War Damage (Official Journal of the Republic of Croatia, No. 61/91, 70/91), in Art. 1, regulates war damage incurred by the Republic of Croatia, its natural and legal persons, and in connection with hostilities and war operations conducted against it, counting from August 15 1990 until their cessation, determines the establishment and activities of special commissions for the inventory and assessment of war damage. War damage, within the meaning of this law, is considered to be property and non-property, indirect and direct damage, and in particular: damage caused to physical integrity, life and health of people, freedom and honor; property (movable and immovable); war expenses; loss of national income; loss of national wealth; damage to the environment and all other types of damage. War damage, within the meaning of this law, is considered damage caused by enemies, illegal groups, legal bodies of the Republic of Croatia, as well as allies of the aforementioned groups and bodies if it occurred directly or indirectly during the time to which this law applies. Various property and non-property damages arise as a result of war. Compensation for damage to victims is equally important as the prosecution of perpetrators of criminal acts. However, it is difficult to find a definition of war damage today, but it is generally understood that it refers to harmful events that occurred in service or connection with service, or due to illegal or irregular work. However, in Croatia, when laws define war damage, they state what is “especially” considered war damage, which makes it possible to determine in other cases that the damage has the character of war damage (Jug, 2018., p. 606). The Law is not limited only to enumerated damages.

The legislator uses the term “especially” uses general clause. However, to be considered war damage, the damage must be a consequence of an act of war (not necessarily a war crime) or directly related to the war. War damage is also that which was suffered during military operations by members of the armed or police forces of one’s own country based on participation in these operations (Jug, 2018., p. 608). What is specific to war damage is that war damage is not only considered to be the consequences of war activities of enemy armed forces, for which the Republic of Croatia is never responsible but also the consequences of war activities of the armed and police forces of the Republic of Croatia (Zrilić, 2004., p. 17).

6.1. War crime

For us to be able to speak of a war crime in criminal law, it must be a violation of the rules of international law, that one of the serious criminal acts against persons and property protected by the Geneva Conventions has been committed. Today, the Rome Statute of the International Criminal Court also regulates war crimes in Article 8. Although in the case of war crimes, violations of international law and international conventions are involved, all states governed by the rule of law regulate the criminal act of war crimes similarly. When analyzing liability for war damage, we always have the responsibility not only of the perpetrator but also of the state. Damages are often the result of war crimes. In the case of a war crime, the perpetrator is responsible, but also the responsibility of the state is based on responsibility for another. If the perpetrator of a war crime is finally convicted, he is liable for the entire damage caused by that criminal act based on liability for damage compensation according to the principle of culpability (Jug, 2018., p. 614). Since a war crime does not have a statute of limitation, then the claim for compensation for damage does not have a statute of limitation. The state's liability for compensation for damage committed by a war crime is based on objective responsibility for another person according to the general rules of civil liability. The statute of limitations for claims for compensation for damage is assessed in the same way as for the perpetrator, which means that it does not exist.

6.2. Justifying reasons

In a state of war, the conditions under which war is waged are also considered, for example, (self-) defense, necessity, and breach of agreement. If any of the above did not occur, then the state is liable for the damage in international law. According to the rules of civil law, the unlawfulness of a wrongful act can be excluded in cases of causing damage in the course of duty, (self-) defense, force majeure, permissible self-help, and in the case of the consent of the injured party (Klarić; Vedriš, 2012., pp. 601-603). (Self-) defense consists of an attack and defense. An attack is any injury or threat to a legally protected good of the attacked that originates from a person. An attack also exists if a person uses an animal or some other means to attack another. An attack can also be carried out by omission if it fulfills all the prerequisites of an unjust criminal act by omission (Novoselec, 2016., p. 153). The attack must also be unlawful, and it is sufficient that it infringes legal rights from any other area. The necessity consists of danger and avertion of danger. Necessity is defined as a simultaneous danger to one's legitimate interests that can be eliminated only by injuring the legitimate interests of a third party. As a last resort, the perpetrator infringes the third's legitimate interest and, at the same time, fulfills the characteristics of a criminal offense to save another legitimate interest (Herceg Pakšić, 2020., p. 78). The danger is a state in which there is a probability that a violation of some legal good will occur (Novoselec, 2016., p. 174). It must go beyond the usual situation in some areas of life, so the dangers to which the entire population or at least one part of it is exposed are excluded. In connection with danger, the question arises of how likely it is that a harmful consequence will occur for the danger to be relevant.

Certainly, a remote possibility of the consequence occurring will not be sufficient, but it cannot be required that the consequence occur with certainty. As a criterion for necessity, it is not relevant from which source the danger originates (natural forces and phenomena, animals). When three soldiers are stranded at sea because their engine has broken down, and two of them kill the third to save their lives and eat him, this example is considered in the literature through necessity. Indeed, they found themselves in danger, and danger is a higher concept and it is about necessity because danger is an element of necessity. However, the act of committing it is an attack. Two soldiers attacked a third soldier (the third's legal right is violated, which is a characteristic of necessity) and the attack is a characteristic of (self-) defense. The fact is that the three soldiers are not culpable because they remained at sea due to a malfunctioning engine. The situation they found themselves in was a necessity, and after that, they carried out the attack, as a characteristic of (self-) defense. When applying legal regulations, whether it is a case of (self-) defense or necessity, the rule lex posterior derogat legi priori and lex specialis derogat legi generali always applies, therefore the first author believes that this should be a case of (self-) defense. In the second example, if a commander on the shore leaves five soldiers in a submarine to suffocate due to lack of oxygen because their engine broke down, and a third person comes and saves the five soldiers by destroying the submarine (the third's legal right is violated (destroyed submarine), which is a characteristic of necessity), in that case it is a case of (self-) defense because the third person averted the attack of the commander of these five soldiers. Likewise, the attack can be the result of intent and negligence. Perhaps the commander thought lightly that the soldiers would be able to repair the engine themselves and that there would be no consequences (advertent negligence), or perhaps the commander abandoned them and agreed to their death because the rescue would require a great expense (indirect intent). Nowhere in the literature is mentioned that an attack cannot be carried out with negligence and omission. In the relationship between necessity and (self-) defense, a special rule should always be applied, and the special rule in the above examples is (self-) defense as a form of necessary assistance. From the above, it is evident that the elements of necessity can be attacks and the avertion of attacks. After all, we can conclude that sometimes an example can be analyzed through both (self-) defense and necessity.

7. TERORISM

In Croatia, a distinction is made between war damage and damage from a terrorist act. Therefore, in Croatia, it is necessary to distinguish between damage caused by terrorist acts and war damage and damage caused by unlawful actions of civilian and military personnel of a certain state (Jug, 2018., p. 602). Given world events, the frequency of terrorist acts is visible, which harms social security. Until 1996, this issue was regulated by the Civil Obligations Law, where Croatia was fully liable according to the objective criterion. Since 2003, the Law on Liability for Damage Caused by Terrorist Acts and Public Demonstrations has been in force, which enabled the continuation of court proceedings that were interrupted in 1996. The aforementioned law is based on the principles of the Declaration of Basic Principles of Justice for Victims of Crime and Abuse of Power) and of the European Convention on the Compensation of Victims of Violent Crimes). In this case, the state is not liable according to the rules of subjective or objective responsibility, but according to the principle of social solidarity (Law on Liability for Damage Caused by Terrorist Acts and Public Demonstrations (Art. 2)). The act of violence does not have to be undertaken only for political reasons, it is enough that the person intended to cause a sense of fear and personal insecurity among citizens. Terrorist damage and war damage have their similarities, however, they differ according to their motives and goals, and the circumstances under which they were committed (Mikecin, 2017., p. 192).

The state is obliged to compensate for the damage caused by a terrorist act, regardless of whether the perpetrator has been identified, and prosecuted, and regardless of whether the perpetrator has been found guilty. In Bosnia and Hercegovina it is sufficient that the responsibility of a legal entity is prescribed for the damage that its body causes to a third person in the performance of or in connection with the performance of its functions. Given that the state and other state bodies have the status of legal persons, this provision can also be applied to them (Sudžuka; Šimić, 2016., p. 8). Of course, compensation for damage should be based on the principles of humanity and solidarity. In Bosnia and Herzegovina, such liability is also called liability according to the criterion of causation, so it is considered what can be subsumed under a dangerous activity that would represent strict liability. According to the theory, dangerous activity includes all those human activities that create an increased risk of damage, regardless of whether the specific danger originates from a dangerous thing or the activity is dangerous in itself, without any connection with the dangerous assets (Vizner, 1979., p. 740). The Civil Obligation Law defines a dangerous thing as anything that, due to its purpose, characteristics, position, place, and method of use or otherwise, represents an increased risk of damage to the environment, and therefore should be monitored with increased attention (Klarić; Vedriš, 2012., p. 615). From the perspective of the state, this primarily refers to weapons, facilities, and other dangerous things at the disposal of the state. The liability for damage can be excluded if the dangerous thing in question was taken from it unlawfully and if it is not responsible for such taking. In that case, the person who unlawfully took the dangerous thing will be liable for the damage (Civil Obligation Law, Art. 1065).

However, in Croatia, this Law that regulates terrorist acts is considered to be an act of violence committed, as a rule, out of political motives (which means that political motives do not necessarily have to exist) with the aim of causing fear, horror and a feeling of personal insecurity among citizens. (Art. 1, par. 2 of the Law on Liability for Damage Caused by Terrorist Acts and Public Demonstrations). Liability for damage primarily includes damage caused by acts of terror and other acts of violence undertaken with the aim of seriously disrupting public order by intimidating and causing a feeling of insecurity among citizens and as a result of demonstrations and other forms of mass expression of mood in public places. The Republic of Croatia is liable for the aforementioned damage on the basis of the principles of social solidarity, equal sharing of the public burden, and fair and prompt compensation. The right to compensation for damage is not granted to injured parties who caused damage by participating in the organization, execution, instigation, assistance, or preparation of a harmful act, injured parties who, regardless of the specific harmful act, are members of a terrorist organization or group that caused the damage, or persons who unjustifiably withheld information important for the prevention and arrest of the perpetrator. The injured party is entitled to compensation only for damage resulting from death, bodily injury, or damage to health. The injured party is entitled to compensation for 60% of the amount of the determined damage, provided that the total damage cannot exceed EUR 46,400.00. When talking about terrorist acts, the goal for which these actions are undertaken is important, which is the serious disruption of public order by intimidating and causing a feeling of insecurity among citizens. The generally accepted understanding is that a terrorist act is an act that represents the use of unlawful violence or the threat of unlawful violence directed against a larger number of citizens, the state, or the authorities, to achieve certain goals that may be political, ideological, religious or some other nature (Jug, 2018., p. 610). Considering the principles of compensation for damage prescribed for committed terrorist acts, compensation for damage in this case is not based on general regulations of the Civil Obligation Law that would be objective, i.e. compensation for damage in full.

8. CONCLUSION

The article aimed to analyze the state's liability for damage to an individual. Although international law regulates relations between states, we believe that special emphasis should be placed on the rights of the individual because the rights of the individual are always most at risk. Namely, it should be considered that the state has a monopoly on physical coercion that it applies to the individual. For this reason, it is important, when analyzing the liability of the state for damage, to take this circumstance into account. Precisely because of the aforementioned relationship, we have taken the position that the rules on objective liability for damage to an individual should be applied to the state. Objective liability alleviates the disadvantageous position of the individual in relation to the state. We can also support this conclusion with the fact that the European Union specifically protects individuals for precisely the reason mentioned. Thus, in the event of non-transposition into national legislation, European Union directives enter into force and have direct effects if their provisions are unconditional, clear, and precise and grant rights to the individual. This means that individuals can invoke the directive against a member state in national courts. Furthermore, according to the analyzed Croatian legislation, when defining war damage, a general clause is used, which can be considered "in particular" as war damage. Precisely because the protection of individual rights depends on the interpretation of the general clause, when the state administration employs staff who will interpret the aforementioned terms, it should take into account the high criteria of expertise of the individual, the future employee, so that the aforementioned problem situation of compensation for damage is resolved already at the level of the state administration system, and not so that the injured individual is forced to seek protection in court. The professional staff of the state administration should anticipate problems that may arise when interpreting the terms, and in this way legally and fairly protect the rights of the individual. Namely, if the individual is forced to exercise his rights in court, then the first level of decision-making (state administration) becomes irrelevant.

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ECOLOGICAL FOOTPRINT ANALYSIS OF PORTUGUESE MUNICIPALITIES: A MULTIDIMENSIONAL ASSESSMENT OF LOCAL SUSTAINABILITY

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ABSTRACT:

This study analyzes the ecological footprint of 308 Portuguese municipalities, aiming to assess their environmental performance based on a diverse set of indicators obtained from the PORDATA and INE databases. The ecological footprint, a concept that measures human pressure on ecosystems, has become increasingly relevant as an instrument to support policymaking and sustainable resource management. The proposed methodology organizes variables into thematic areas such as energy, mobility, waste, and land use, among others, allowing for a comprehensive assessment of local sustainability. The collected data are processed using normalization and multivariate analysis techniques, leading to the construction of a composite indicator that summarizes the environmental performance of each municipality. This work aims to provide a diagnostic tool that allows local authorities and policymakers to better understand the specific environmental challenges of each territory and, thus, promote more effective and tailored interventions. The proposed analysis can support urban planning, energy efficiency, and the implementation of sustainable mobility policies, contributing to a more balanced and responsible management of natural resources.
Keywords: *ecological footprint, local sustainability, Portuguese municipalities, composite indicators, multivariate analysis*

1. INTRODUCTION

Assessing environmental sustainability at the local level is increasingly important because, although environmental issues are global, their effects are felt locally. Furthermore, each region has specific characteristics that need to be respected in terms of sustainability. Local populations are increasingly aware of their environmental heritage and are eager to protect it. Having increasingly rigorous metrics for environmental sustainability helps improve and make local government decisions more effective and helps establish quantifiable goals adapted to the local context. Therefore, sustainability assessments at the local level help attract sustainable businesses and obtain other "green" financing and support. In turn, assessing the ecological footprint is a fundamental tool for evaluating the impact of human activities on the planet's ecosystems. Assessing the ecological footprint enables better planning and efficient resource allocation, as well as the formulation of sustainable public policies at both the local and national levels. It also enables monitoring and comparison between countries and regions and serves as an indicator of sustainability. The study aims to analyze the ecological footprint of Portuguese municipalities through a multidimensional assessment of local sustainability.

This work aims to answer a set of relevant questions about the sustainability of regions and localities of various types. This type of analysis draws on similar studies already conducted in other countries and regions to gain a global perspective on ecological footprint analyses, as well as the disparities between urban and rural areas. All these environmental assessments highlight the urgent need to use and apply metrics to inform policy decisions. To analyze the ecological footprint of Portuguese municipalities from 2010 to 2022, data extracted from the PORDATA and INE databases were used. Finally, the study was structured as follows:

Section 2 presents a literature review, discussing the concept, its evolution, and relevance, as well as its limitations. Section 3 analyzes the methodology and results of the study. This section discusses the variables chosen and discusses the various tables and charts related to descriptive statistics and regression analysis. A cluster analysis is also performed for the various types of municipalities. Finally, the conclusions are presented, and the bibliography is included.

2. LITERATURE REVIEW

The Ecological Footprint: Concept, Origins, Evolution and Relevance

The concept of Ecological Footprint (EF) emerged in the early 1990s as a tool to quantify the environmental pressure generated by human activities. Developed by Mathis Wackernagel & William Rees (1996) at the University of British Columbia, the ecological footprint measures the biologically productive area required to supply the resources consumed by a population and to assimilate its wastes, considering prevailing technological conditions. In simple terms, it compares human demand for natural capital with the Earth's ecological capacity to regenerate resources and absorb emissions.

The origins of the concept are rooted in debates on carrying capacity and the limits of growth (Meadows et al., 1972), as well as in the tradition of urban metabolism studies (Wolman, 1965; Rees, 1992). By translating complex flows of energy, water, materials and waste into a single biophysical measure, expressed in global hectares (gha), the ecological footprint provided a communicable and policy-relevant metric of sustainability. Its intuitive logic contributed to its rapid diffusion in both academic and policy contexts, positioning it as one of the most widely used indicators of environmental sustainability at different scales.

Over the last three decades, the methodology has advanced significantly. Initially applied at the national level to compare ecological demand and biocapacity, it has since been adapted to multiple scales – from individual lifestyles to corporations, regions and municipalities. The GFN (Global Footprint Network, 2022) has been instrumental in refining the methodology and ensuring international comparability, while numerous local applications have tested its potential for guiding urban planning and resource management (Chambers et al., 2000; Best Foot Forward, 2002). In European contexts, cities such as London, Barcelona and Lisbon have conducted ecological footprint assessments to evaluate their dependence on external resources and to inform sustainability strategies.

The importance of the ecological footprint concept lies not only in its diagnostic capacity but also in its normative implications. By confronting societies with the mismatch between consumption patterns and ecological limits, it raises awareness of global inequalities in resource use and the risks of ecological overshoot. According to the Living Planet Reports published by Worldwide Fund for Nature (WWF, 2022), humanity has been operating in ecological deficit since the 1970s, currently demanding the equivalent of more than one Earth's regenerative capacity. At the local level, this translates into municipalities that rely on external territories for food, energy and materials, often far exceeding their own ecological endowments.

Furthermore, the ecological footprint has gained relevance as a multidimensional policy tool. While its core measure is expressed in land equivalents, contemporary applications incorporate diverse categories of indicators, such as energy, transport, water, waste, land use, consumption, governance, providing a more holistic picture of urban sustainability (Alberti, 2008; Kennedy et al., 2007). Recent approaches also highlight the role of socioeconomic and demographic variables, such as population density, income, GDP per capita, in shaping ecological impacts, thereby enriching the explanatory power of footprint analysis (York, Rosa & Dietz, 2003).

Limitations of the Ecological Footprint Concept

While EF has become one of the most widely used sustainability indicators, several methodological and conceptual limitations have been identified in the literature. These limitations do not undermine its usefulness but highlight the need to interpret EF results with caution and in combination with complementary indicators.

Simplification and Aggregation

EF reduces multiple environmental pressures into a single metric expressed in global hectares. While this makes the concept communicable and policy-relevant, it also entails a loss of detail. Complex ecological processes, such as biodiversity loss or soil degradation, are not directly captured by the metric, which primarily focuses on bioproductive land use and carbon sequestration capacity (van den Bergh & Verbruggen, 1999).

Focus on Supply and Land Area Equivalence

The methodology assumes that all resource consumption and waste generation can be translated into an equivalent land area. However, not all environmental impacts can be meaningfully expressed in terms of bioproductive land. Issues such as water scarcity, chemical pollution, or ecosystem resilience are not adequately represented (Fiala, 2008).

Treatment of Carbon Footprint

A major component of the EF is the carbon footprint, which is expressed as the hypothetical forest area required to sequester CO_2 emissions. This assumption has been criticized as unrealistic, since in practice carbon sequestration depends on technological, ecological, and temporal factors that differ significantly from the theoretical forest equivalence (Blomqvist et al., 2013).

Static Assumptions and Technological Change

The EF calculations are based on current average productivity and resource-use efficiency. They do not adequately reflect future technological innovations that may alter productivity, substitution possibilities, or efficiency gains. As such, EF results may overestimate or underestimate future ecological pressures (van Vuuren & Smeets, 2000).

Limited Policy Guidance

Although the EF highlights the extent of ecological overshoots, it does not provide detailed guidance on how to reduce footprints in specific sectors. Complementary tools such as Life Cycle Assessment (LCA), Material Flow Analysis (MFA), or carbon accounting are often needed to design actionable policies (Wiedmann & Minx, 2007).

Equity and Distributional Aspects

The EF primarily measures aggregate biophysical demand and supply. It does not account for social equity in resource distribution, nor for the qualitative dimensions of human well-being.

Therefore, it is most effective when combined with social indicators, such as the Human Development Index (HDI), to assess sustainability from both ecological and social perspectives (WWF, 2022).

The Ecological Footprint remains a powerful communication and diagnostic tool, but its methodological simplifications, reliance on land-equivalence assumptions, and neglect of non-land-based impacts mean that it should be used within a broader multidimensional framework. This is precisely why recent scholarship emphasizes integrating EF with other footprint indicators (carbon, water, material) and socioeconomic variables to provide a more holistic sustainability assessment. Nevertheless, EF is particularly relevant for municipalities, which face the dual challenge of fostering economic development and improving quality of life while reducing environmental pressures. Applying the EF framework at the municipal scale allows for a multidimensional assessment of sustainability, identifying critical areas of intervention, such as energy efficiency, mobility patterns, waste management, or land-use planning, and providing decision-makers with evidence-based insights. More than a technical metric, the ecological footprint has thus become a governance instrument, linking local action to global sustainability imperatives. In this context, there are different models for Assessing Local Sustainability.

Some models have been used for Assessing Local Sustainability. In this paper we highlight Ecological Footprint Analysis (EFA) and Urban Metabolism (UM). The first one focuses on relationship between human consumption and the regenerative capacity of ecosystems, expressed in global hectares. It has been criticized for its methodological simplifications, particularly its inability to capture the complexity of socio-economic dynamics and the spatial heterogeneity of resource flows (Fang et al., 2014). More recent applications stress that EFA is best understood as a high-level indicator that should be complemented with more detailed methods to support local sustainability planning (Galli et al., 2020). Nevertheless, EFA has become one of the most widely used tools to assess human demand on ecosystems by comparing it with the available bio-capacity. Its main strength lies in its communicative power: by expressing sustainability in terms of global hectares, EFA makes the concept of ecological overshoot clear and accessible to both policymakers and the public (Wackernagel et al., 2019). The second, Urban Metabolism (UM), by contrast, provides a more detailed and systemic understanding of how cities and municipalities consume resources and generate waste. Rooted in Wolman's (1965) early conceptualization and expanded through contemporary empirical studies, UM treats urban systems as living organisms, quantifying the inputs and outputs of energy, water, and materials (Kennedy et al., 2015). This approach highlights inefficiencies and supports strategies for improving circularity and reducing environmental pressures. While UM is less communicative than EFA for broad audiences, it offers stronger analytical depth, making it particularly useful for local authorities and planners seeking actionable insights into resource management. In this sense, EFA and UM are not competing models but rather complementary tools: the former highlights the global sustainability challenge in simple terms, while the latter enables a more granular analysis of the physical processes that drive ecological overshoot at the local level. For Portuguese municipalities, the most robust approach is a hybrid multidimensional assessment: using EFA as the ecological core, complemented by socio-economic indicators and tools such as MFA or urban sustainability frameworks. Research on the ecological footprint in Portugal has been relatively recent but has grown in importance as municipalities and regions seek to understand their environmental performance. Studies conducted at the national level, such as by Moreno Pires et al. (2020), show that Portugal consistently operates in ecological deficit, with consumption exceeding domestic biocapacity.

At the local level, research in Portuguese municipalities (Galli et al., 2020) has revealed significant spatial disparities: urbanized coastal areas tend to present higher ecological footprints per capita compared to interior rural regions, highlighting the role of urbanization and economic structure in shaping local sustainability profiles. Portugal's overall ecological situation underscores an urgent need for more local action, integrated policy, and sustained commitment to reducing resource consumption and restoring ecosystem capacities. Cities like Almada, Vila Nova de Gaia and Guimarães have high population densities, stronger purchasing power and higher consumption levels, which result in ecological footprints above or close to the national average. However, these cities have very low local biocapacity, meaning they depend heavily on resources from outside their territories. Their ecological footprints are mainly driven by food consumption and transport, especially carbon emissions from energy use, showing the environmental pressures linked to urban lifestyles. In contrast, more rural municipalities like Bragança and Castelo Branco show much lower population densities and purchasing power but have significantly higher local biocapacity thanks to abundant forests, cropland and grazing land. Despite their richer natural endowment, their ecological footprints are still above global sustainable levels, though lower than those of the main urban areas. These disparities reflect a clear territorial imbalance: urban zones concentrate population and consumption but lack local ecological resources, while rural zones hold most of the ecological assets but face economic and demographic challenges. Comparable studies in Spain provide useful benchmarks. Cano Orellana (2021) applies ecological footprint to Spain's municipalities, revealing that Spain's ecological footprint was estimated to require about 3.7 times the nation's land area to support its population's needs, indicating a significant ecological deficit. The study (with data from 2017) demonstrates that only a small fraction of municipalities - those with greater population density and income - are responsible for the vast majority of Spain's ecological footprint, underscoring the crucial influence of consumption patterns and urbanization.

The author highlights the methodological nuances of calculating the ecological footprint, such as the use of global hectares, equivalence, and yield factors, and discusses the limitations posed by data availability at the municipal level. The author argues for the integration of biophysical accounting alongside traditional macroeconomic indicators (e.g. GDP), as conventional metrics fail to capture environmental costs or resource depletion. Additionally, the study emphasizes more granular, locally relevant data to improve indicator accuracy and support effective sustainability planning. At a broader European level, research has demonstrated similar patterns. For instance, Galli et al. (2012) conducted ecological footprint studies across EU member states and concluded that all countries exhibit ecological deficits, though the magnitude varies considerably. Northern and Western European nations typically show higher ecological footprints due to more energy-intensive consumption, while Southern and Eastern countries present slightly lower footprints but remain ecologically unsustainable. These findings underline the structural nature of ecological overshoot in developed economies and the limited ability of regional ecosystems to meet local consumption demand. Taken together, these studies illustrate three main conclusions: first, that ecological footprint analysis is a powerful tool for revealing hidden environmental imbalances; second, that spatial heterogeneity—between urban and rural areas, or between regions with different ecological capacities—is a consistent finding across countries; and third, that virtually all local and national assessments point toward unsustainability, reinforcing the urgency of integrating ecological footprint metrics into policy. For Portugal, the lessons from both domestic and international research suggest that municipalities must be assessed within a multidimensional framework that combines ecological demand, local biocapacity, and socio-economic indicators in order to design effective sustainability strategies.

3. METHODOLOGY AND RESULTS

The data were obtained from Pordata, a project of the Francisco Manuel dos Santos Foundation. To ensure robustness and representativeness, the analysis draws on data from 2010 to 2022, a period that covers most of the available series and provides a solid temporal basis for inter-municipal comparisons. The variables selected for the analysis reflect multiple dimensions of municipal territorial sustainability:

EC: Energy consumption (per capita), measuring the intensity of energy use.

UW: Urban waste, reflecting waste management practices. This variable results from the simple arithmetic mean of the standardized data of the variables per capita recycling rate (UWR) and per capita urban waste generation (UWG).

MV_E&H: Number of motor road vehicles (cars, motorcycles, trucks, or tractors) per capita using fuel: electric and hybrid.

OFA: Land use/agriculture indicator, illustrating land use and occupation intensity.

GGE: Greenhouse gas emissions (per capita).

WEI: Water exploitation index or water resource management, measuring vulnerabilities associated with water resources.

EF: Composite indicator, resulting from the simple arithmetic mean of the standardized data of the previous variables.

The choice of these variables sought to cover both the supply and use of resources (energy, emissions, land use, water) and factors related to sustainability and environmental management indicators (recycling, ecological values). Table 1 presents a summary of the descriptive statistics of the variables under study, where the results allow us to identify some important trends for the period 2010 to 2022. Regarding energy consumption (EC) and greenhouse gas emissions (GGE), a general stability is observed in the averages over the period, with EC around 0.8–0.9 and emissions around 0.02. However, the standard deviations are high, indicating strong territorial disparities: some municipalities show values well above the average, while others remain at low levels. Maximum values also increased slightly until 2020, reflecting the existence of territories under particularly high environmental pressures.

With respect to urban waste, both in the recycling rate (UWR) and in per capita waste generation (UWG), the averages remain stable (0.06–0.10 for UWR and ~1.4–1.6 for UWG), but the standard deviations continue to be significant, revealing marked differences in waste management between municipalities. Moreover, the increase in maximum value shows that certain territories present waste volumes much higher than the national average. In the domain of mobility (MV_E&H), a slight increase is observed in the average number of electric and hybrid vehicles per capita after 2012, but the absolute value remains low. The standard deviations are very high (50–62), indicating a huge disparity: in some municipalities there are almost no electric or hybrid vehicles, while in others their presence is more significant.
Regarding land use and agriculture (OFA), the average remains low until 2018 (~0.018), but rises significantly from 2019 onward, reflecting more visible changes in land use. Maximum values also increase sharply in 2020–2022, surpassing 1.0, which indicates that certain municipalities experienced particularly high agricultural or territorial pressures during this period.

In the case of water stress (WEI), a clear worsening is observed after 2015. The average almost doubles compared to 2010 (from ~0.015 to ~0.03), maximum values rise above 0.53 in 2022, and standard deviations increase, signaling that problems of pressure on water resources have intensified considerably in some municipalities.

Year	Statistics	EC	UWR	UWG	MV_E&H	OFA	GGE	WEI
2010	Min	0,011056	0,000736	0,020303	0,36789	0,000228	0,000256	0,000188
	Max	14,57587	0,969995	26,76565	484,9977	0,300854	0,337164	0,247427
	Average	0,912338	0,060714	1,675325	30,35714	0,018831	0,021104	0,015487
	SD	1,488369	0,099048	2,73309	49,52401	0,030721	0,034428	0,025265
2011	Min	0,010137	0,000775	0,018887	0,41236	0,000235	0,000247	0,000302
	Max	13,51469	1,032872	25,17946	549,7343	0,313459	0,328875	0,402871
	Average	0,853896	0,06526	1,590909	34,73377	0,019805	0,020779	0,025455
	SD	1,392019	0,106386	2,593495	56,62288	0,032286	0,033874	0,041496
2012	Min	0,009919	0,001011	0,017553	0,455865	0,000212	0,00024	0,000558
	Max	13,21168	1,346972	23,37848	607,1696	0,282813	0,31997	0,743157
	Average	0,831169	0,08474	1,470779	38,19805	0,017792	0,02013	0,046753
	SD	1,359871	0,138643	2,406333	62,49561	0,02911	0,032934	0,076493
2013	Min	0,00982	0,001005	0,017108	0,364364	0,000207	0,000238	0,000294
	Max	13,0743	1,33856	22,77627	485,0981	0,275494	0,316481	0,39171
	Average	0,818182	0,083766	1,425325	30,35714	0,01724	0,019805	0,024513
	SD	1,343887	0,137588	2,341137	49,86248	0,028318	0,032531	0,040263
2014	Min	0,01021	0,001167	0,017349	0,358885	0,00022	0,000234	0,000293
	Max	13,91697	1,590511	23,64839	489,1868	0,300314	0,319149	0,399197
	Average	0,863636	0,098701	1,467532	30,35714	0,018636	0,019805	0,024773
	SD	1,425912	0,162961	2,422978	50,12134	0,03077	0,032699	0,040901
2015	Min	0,01007	0,001132	0,017442	0,355295	0,000248	0,000247	0,000496
	Max	13,97821	1,571889	24,21131	493,1934	0,344444	0,342862	0,687833
	Average	0,86039	0,096753	1,49026	30,35714	0,021201	0,021104	0,042338
	SD	1,427714	0,160551	2,472909	50,37407	0,035181	0,035019	0,070254
2016	Min	0,010281	0,001168	0,017841	0,353411	0,000255	0,000242	0,000205
	Max	14,44754	1,641284	25,07074	496,6343	0,358002	0,339942	0,287889
	Average	0,883117	0,100325	1,532468	30,35714	0,021883	0,020779	0,017597
	SD	1,472369	0,167265	2,554993	50,61268	0,036484	0,034644	0,029339
2017	Min	0,010173	0,001092	0,018169	0,350995	0,000257	0,000259	0,000472
	Max	14,49216	1,55617	25,88268	500,0064	0,36578	0,368989	0,672736
	Average	0,87987	0,094481	1,571429	30,35714	0,022208	0,022403	0,040844
	SD	1,474077	0,158287	2,632669	50,85839	0,037205	0,037532	0,068428
2018	Min	0,010411	0,00109	0,018875	0,350167	0,000213	0,000243	0,0003
	Max	14,94031	1,563896	27,08603	502,4888	0,305255	0,349324	0,431012
	Average	0,902597	0,094481	1,636364	30,35714	0,018442	0,021104	0,026039
	SD	1,518226	0,158922	2,752468	51,06265	0,03102	0,035498	0,043799
2019	Min	0,010218	0,001058	0,018679	0,342445	0,000271	0,000227	0,00032
	Max	15,10114	1,56424	27,60423	506,0775	0,399991	0,335581	0,473061
	Average	0,905844	0,093831	1,655844	30,35714	0,023994	0,02013	0,028377
	SD	1,53044	0,158529	2,797578	51,28893	0,040537	0,03401	0,047943
2020	Min	0,010853	0,001003	0,019012	0,349918	0,000301	0,00021	0,000298
	Max	15,31362	1,41519	26,82524	493,7323	0,425085	0,295711	0,420333
	Average	0,941558	0,087013	1,649351	30,35714	0,026136	0,018182	0,025844
	SD	1,579258	0,145945	2,766425	50,91746	0,043838	0,030496	0,043348
2021	Min	0,011493	0,001205	0,020212	0,37055	0,000765	0,000218	0,000316
	Max	15,1703	1,590266	26,6788	489,1114	1,010133	0,287713	0,416922
	Average	0,941558	0,098701	1,655844	30,35714	0,062695	0,017857	0,025877
	SD	1,575253	0,16513	2,770273	50,78834	0,10489	0,029875	0,043292
2022	Min	0,011679	0,001246	0,020964	0,385856	0,000797	0,000223	0,000416
	Max	15,00272	1,600997	26,93067	495,6728	1,023684	0,286271	0,534902
	Average	0,918831	0,098052	1,649351	30,35714	0,062695	0,017532	0,03276
	SD	1,545777	0,164956	2,774751	51,07071	0,105473	0,029495	0,055113

Table 1: Descriptive statistics

As mentioned earlier, the variables were standardized to a uniform scale of 0 to 100, with the purpose of enabling inter-variable comparability and making possible their numerical synthesis in the form of a composite indicator. The procedure followed the standards of the technical literature, which recommend linear normalization (min–max) as a strategy to assign values with relative meaning and to avoid distortions stemming from the original units and the range of the variables (Tangian, 2018). The choice of normalization to the [0–100] interval allows each municipality's position to be directly reflected in relation to the worst (0) and best (100) observed performance, promoting high transparency and interpretability in the final index — aligning with good practices for the construction of composite indicators highlighted by the OECD (OECD, 2005). With the variables normalized, a simple arithmetic mean was calculated to generate a municipal composite indicator, to summarize integrated performance across all considered dimensions. This approach mirrors the general recommendations for composite index construction, as outlined in the OECD handbook, which prescribes clear methodological steps: theoretical definition, variable selection, data treatment, normalization, aggregation, and robustness analysis (OECD, 2008). After constructing this composite indicator, the municipalities were analyzed over time with respect to this created variable (EF). Examining the municipalities over the years reveals that Cascais, Loures, Lisbon, Porto, Sintra, and Vila Nova de Gaia exhibit more oscillating trajectories, with 2021 and 2022 being the years with the highest EF values (lower ecological footprint), while 2015 and 2017 show the lowest EF values (higher ecological footprint). All other municipalities display a generally stable trend, with highlighted years like the municipalities, but with substantially lower volatility. Subsequently, cluster analysis (K-means) was applied using SPSS software, recognized for its efficient handling of multivariate data, user-friendly interface, and integration with complementary statistical procedures (such as ANOVA to verify the significance of inter-cluster differences). Cluster analysis is justified by its exploratory and unsupervised nature, allowing the identification of natural groupings among municipalities based on the normalized variables — without presupposing a priori category. As referenced by Maroco (2014), this approach reveals latent structures in complex, multivariate data. The results of the cluster analysis are presented in Tables 2, 3, 4, and 5. The application of the K-means cluster analysis to the variables enabled the identification of four distinct profiles of territories. The statistical robustness of the model is supported by the ANOVA results, which show highly significant differences between clusters across all considered variables ($p < 0.001$). In particular, the variables energy consumption (EC), greenhouse gas emissions (GGE), and MV_E&H contributed most to group differentiation, presenting very high F values, thereby confirming their central role in structuring the resulting typology.

Iteration history				
	Change in cluster centers			
Interactions	1	2	3	4
1	33,45	33,93	7,01	27,95
2	17,64	16,73	0,69	7,76
3	4,17	14,39	0,14	2,73
4	5,56	5,97	0,09	1,55
5	0,00	3,04	0,05	0,87
6	21,15	9,59	0,07	1,07
7	17,47	13,61	0,06	0,84
8	0,00	3,94	0,03	0,74
9	0,00	1,11	0,04	0,48
10	0,00	0,89	0,03	0,41

Table 2: Interation history

Final cluster centers				
	Cluster			
	1	2	3	4
EC	6,20	45,30	96,80	76,11
UW	47,75	48,89	49,93	49,43
MV_E&H	83,52	48,71	2,86	21,28
OFA	36,63	22,11	1,24	9,42
GGE	11,86	48,69	96,98	77,58
WEI	36,78	62,03	97,84	83,80

Table 3: Final cluster centres

Distances between final cluster				
Cluster	1	2	3	4
1		70,34	164,15	126,63
2	70,34		93,84	56,31
3	164,15	93,84		37,53
4	126,63	56,31	37,53	

Table 4: Distances between final cluster

ANOVA						
	Cluster		Erro			
	Medium Square	df	Medium Square	df	F	Sig.
EC	106038,72	3,00	13,35	4000,00	7941,51	0,00
UW	55,73	3,00	0,68	4000,00	82,02	0,00
MV_E&H	84071,13	3,00	10,84	4000,00	7758,91	0,00
OFA	16669,95	3,00	8,05	4000,00	2071,51	0,00
GGE	93375,22	3,00	12,15	4000,00	7688,01	0,00
WEI	49282,96	3,00	10,51	4000,00	4689,73	0,00

Table 5: ANOVA results

The analysis identified four main clusters (1 to 4), with cluster 3 being by far the most represented, encompassing most Portuguese municipalities. Clusters 1 and 2 appear as outliers: Lisbon stands alone in cluster 1, while Sintra, Vila Nova de Gaia, and Porto form cluster 2 in relative isolation. Cluster 4 includes district capitals, larger cities, and metropolitan areas such as Braga, Coimbra, Setúbal, Loures, and Oeiras. Municipalities in cluster 3 tend to show very low distances (between 1 and 6), which indicates high internal homogeneity. By contrast, clusters 1 and 2 present much higher distances (Lisbon exceeds 40, while Sintra and Gaia fall between 20 and 30), suggesting they are extreme cases compared to the rest of the country.

From this, some interpretations can be made. Cluster 1, which contains only Lisbon, represents a highly atypical municipality, likely due to its size, population density, or very distinct socioeconomic indicators. Cluster 2, composed of Sintra, Vila Nova de Gaia, and Porto, represents large metropolitan cities which, although not as extreme as Lisbon, still stand out from the rest of the country. Cluster 3 includes the majority of small and medium municipalities, which are relatively homogeneous. Cluster 4 corresponds to medium and large urban centers, including most district capitals, and occupies an intermediate position between clusters 2 and 3.

Cluster 1 (Lisbon): Very low energy consumption (EC 6.2) and low greenhouse gas emissions (GGE 11.8), but extremely high penetration of electric/hybrid vehicles (MV_E&H 83.5). Urban waste (UW 47.8) is close to the national average, agricultural land use (OFA 36.6) is relatively high, and water exploitation (WEI 36.8) is moderate. This makes Lisbon unique: low emissions and energy use, but a leading example in sustainable mobility.

Cluster 2 (Sintra, Vila Nova de Gaia, Porto): Moderate energy consumption (EC 45.3) and intermediate emissions (GGE 48.7). Waste levels (UW 48.9) are average, adoption of electric vehicles (MV_E&H 48.7) is moderate, agricultural land use (OFA 22.1) is moderate, and water stress (WEI 62.0) is high. There are large metropolitan municipalities with intermediate environmental profiles: not as extreme as cluster 3, but more demanding than Lisbon.

Cluster 3 (majority of municipalities): Very high energy consumption (EC 96.8), extremely high greenhouse gas emissions (GGE 96.9), and very high-water exploitation (WEI 97.8). The adoption of electric vehicles is almost nonexistent (MV_E&H 2.9). Agricultural land use is very low (OFA 1.2), and urban waste values are close to the national average (UW 49.9). This cluster represents smaller, often inland municipalities, which are less developed in sustainable mobility and present the most environmentally unsustainable profile.

Cluster 4 (district capitals and medium-sized cities): High but not extreme energy consumption (EC 76.1) and emissions (GGE 77.6), with significant water stress (WEI 83.8). Electric/hybrid vehicle adoption is still low but higher than in cluster 3 (MV_E&H 21.3). Agricultural land use (OFA 9.4) is limited, and urban waste (UW 49.4) is average. These municipalities are more environmentally demanding than cluster 2, but less extreme than cluster 3, showing some signs of transition towards sustainability.

In sum, Lisbon (cluster 1) is highly singular, with low energy use and emissions but outstanding progress in electric mobility. Large metropolitan cities (cluster 2) have an intermediate profile, with moderate consumption and emissions. Most of the country (cluster 3) shows the least sustainable profile, with very high consumption and emissions, minimal mobility transition, and intense environmental pressures. Finally, district capitals and medium-sized cities (cluster 4) have high consumption and emissions, some adoption of clean mobility, and significant water stress, situating them between the extremes of clusters 2 and 3.

After the cluster analysis, a composite indicator (EF) was constructed to represent the ecological footprint based on the previously mentioned variables. An examination of the results obtained between 2010 and 2022 highlights striking contrasts between different territorial profiles in Portugal. It is important to emphasize that, due to the way the index was built, lower EF values correspond to a higher ecological footprint, meaning greater environmental pressure resulting from energy consumption, emissions, and other factors considered.

The results show that smaller municipalities, both in territorial and population terms—many of them located in inland or insular regions—tend to present consistently high EF values. Paradigmatic cases include Corvo, Lajes das Flores, Barrancos, Santa Cruz das Flores, Alvito, Mourão, and Porto Moniz. In these territories, the EF indicator remains close to the upper limit of the scale, which reflects a relatively reduced ecological footprint. This may be associated with several factors: lower intensity of energy consumption and greenhouse gas emissions, lower pressures on ecosystems, and an economic and social dynamic that is less dependent on resource-intensive sectors. Reduced population density also contributes to this outcome, as territorial and natural resource pressures are proportionally smaller.

In contrast, large urban and metropolitan centers—Lisbon, Sintra, Vila Nova de Gaia, Porto, Cascais, Loures, Braga, Almada, Matosinhos, and Amadora—record persistently low EF values, which means that they concentrate a higher ecological footprint. These municipalities are characterized by high population density, intense urbanization, elevated energy consumption, and larger volumes of emissions, driven both by economic and industrial activity and by mobility and the concentration of services. The pressure on natural resources is amplified here by the scale of demand and the complexity of socio-economic dynamics, typical features of metropolitan areas. This contrast therefore reveals a clear territorial divide: while peripheral, rural, and insular municipalities tend to maintain higher levels of sustainability, densely populated urban municipalities face greater environmental challenges, reflected in a heavier ecological footprint. In terms of public policy, these results suggest the need for differentiated strategies: strengthening energy efficiency, sustainable mobility, and emissions reduction in large cities; and enhancing natural resources and ecological capital in smaller-scale territories, ensuring that their relative advantage in terms of sustainability can be preserved and reinforced.

4. CONCLUSION

The study aims to analyze the ecological footprint of Portuguese municipalities with a view to assessing their environmental performance based on a set of indicators extracted from the PORDATA and INE databases, covering the period from 2010 to 2022. The methodology adopted consists of analyzing a set of variables such as: energy consumption, urban waste, number of motor vehicles per capita, land use, greenhouse gas emissions (per capita), and water exploitation. Finally, a composite indicator is used, which is the simple arithmetic mean of the standardized data for the aforementioned variables. These variables were chosen to encompass both the supply and use of resources, as well as factors related to sustainability and environmental management. The analysis identified four main clusters (1 to 4), with cluster 3 being by far the most represented, encompassing most Portuguese municipalities. Clusters 1 and 2 appear as outliers: Lisbon stands alone in cluster 1, while Sintra, Vila Nova de Gaia, and Porto form cluster 2 in relative isolation. Cluster 4 includes district capitals, larger cities, and metropolitan areas such as Braga, Coimbra, Setúbal, Loures, and Oeiras. In sum, Lisbon (cluster 1) is highly singular, with low energy use and emissions but outstanding progress in electric mobility. Large metropolitan cities (cluster 2) have an intermediate profile, with moderate consumption and emissions. Most of the country (cluster 3) shows the least sustainable profile, with very high consumption and emissions, minimal mobility transition, and intense environmental pressures. Finally, district capitals and medium-sized cities (cluster 4) have high consumption and emissions, some adoption of clean mobility, and significant water stress, situating them between the extremes of clusters 2 and 3. After the cluster analysis, a composite indicator (EF) was constructed to represent the ecological footprint based on the previously mentioned variables. An examination of the results obtained between 2010 and 2022 highlights striking contrasts between different territorial profiles in Portugal. It is important to emphasize that, due to the way the index was built, lower EF values correspond to a higher ecological footprint, meaning greater environmental pressure resulting from energy consumption, emissions, and other factors considered. The results show that smaller municipalities, both in territorial and population terms—many of them located in inland or insular regions—tend to present consistently high EF values. In these territories, the EF indicator remains close to the upper limit of the scale, which reflects a relatively reduced ecological footprint. This may be associated with several factors: lower intensity of energy consumption and greenhouse gas emissions, lower pressures on ecosystems, and an economic and social dynamic that is less dependent on resource-intensive sectors.

Reduced population density also contributes to this outcome, as territorial and natural resource pressures are proportionally smaller. In contrast, large urban and metropolitan centers—Lisbon, Sintra, Vila Nova de Gaia, Porto, Cascais, Loures, Braga, Almada, Matosinhos, and Amadora—record persistently low EF values, which means that they concentrate a higher ecological footprint. These municipalities are characterized by high population density, intense urbanization, elevated energy consumption, and larger volumes of emissions, driven both by economic and industrial activity and by mobility and the concentration of services. The pressure on natural resources is amplified here by the scale of demand and the complexity of socio-economic dynamics, typical features of metropolitan areas. This contrast therefore reveals a clear territorial divide: while peripheral, rural, and insular municipalities tend to maintain higher levels of sustainability, densely populated urban municipalities face greater environmental challenges, reflected in a heavier ecological footprint. In terms of public policy, these results suggest the need for differentiated strategies. Thus, in terms of urban planning, strategies could include promoting mixed land use, requalifying degraded areas, and encouraging sustainable construction. The implementation of green corridors can contribute to reducing dependence on motorized vehicles. The ecological footprint is also reflected in high energy consumption in residential buildings. Therefore, public policies can prioritize energy rehabilitation programs for the building stock, stricter regulations regarding energy performance, and incentives for thermal rehabilitation and the use of renewable energy. Incentives for sustainable mobility should also be provided, including expanding and modernizing high-capacity public transportation networks, digitizing mobility systems, creating more cycling and pedestrian infrastructure, restricting car traffic in certain areas, etc.
The study highlights some limitations, some stemming from the ecological footprint concept itself, suggesting that its results should be interpreted with caution and combined with other footprint indicators (carbon, water, material) and socioeconomic variables to provide a more holistic sustainability assessment; others stemming from the variables used and the period analyzed. In terms of suggestions for future research, we suggest expanding the analysis period, as well as the number of variables used, and comparing them with regions in other countries within the EU.

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CONSUMER BEHAVIOUR IN THE FACE OF UNPREDICTABLE EVENTS: AN ANALYSIS OF THE COVID-19 PANDEMIC AND THE IBERIAN POWER OUTAGE

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ABSTRACT

This paper examines the impact on the consumer behaviour when driven by large-scale, unpredictable events. Using the COVID-19 pandemic and the 2025 Iberian Peninsula power outage as case studies, the authors research how perceived threats and scarcity may impact purchasing decisions. Following a literature review of consumer behaviour theories, a qualitative interview with a retail director, and a quantitative survey employed to consumers, was conducted in order to investigate the psychological and social factors which may lead to unusual, irrational even, phenomena, such as panic buying. Our findings suggest that when extreme events occur, a retreat to foundational needs, as described by Maslow, is to be expected. Furthermore, this paper highlights the influence of emotional responses over rational decision-making, as explained by bounded rationality and prospect theory. Concurrently, this research provides insights into how businesses and institutions can better understand and better respond to consumer needs during crises.

Keywords*: Consumer behaviour, Crisis management, Extreme events, Panic buying, Prospect theory, Bounded rationality*

1. INTRODUCTION

Unpredictable events, from global pandemics to regional infrastructure failures, fundamentally alter the dynamics of daily life and, consequently, consumer behaviour. These scenarios, marked by instability, fear, and anxiety, often trigger impulsive and atypical consumption patterns. This paper aims to dissect these behavioural shifts by examining two recent, impactful events: the COVID-19 pandemic and the widespread power outage across the Iberian Peninsula. Using a case study, it was possible to evaluate and determine several behavioral changes. During the pandemic it was witnessed a significant surge in online shopping and a clear pivot towards essential goods. Products like canned foods, hygiene items (especially toilet paper), and health supplies (masks) saw unprecedented demand. The logistical challenge for both the stores and its suppliers was immense. The focus was on adapting to a new reality where security and accessibility became paramount. The power outage on April 28, 2025, presented a different, more acute challenge. Information was scarce, and public anxiety was high. It was observed an immediate run from customers on items like flashlights, matches, canned goods, and bottled water, leading to stockouts. Interestingly, once power was restored, many of these impulsively purchased items were returned again to the stores. These experiences underscore the powerful role of uncertainty in driving consumers toward stockpiling essential goods as a means of regaining a sense of control.

2. LITERATURE REVIEW

2.1. Consumer behaviour

Consumer behaviour encompasses the actions and decisions individuals make when purchasing goods and services. This process is often influenced by a mix of rational and emotional factors. While traditional models assume a logical progression from need recognition to purchase, studies by Beatty & Ferrel (1998) highlight the prevalence of impulse buying—spontaneous, unreflective purchases. In the digital age, technology has further empowered consumers, giving them greater access to information and choices (Kotler, Kartajaya, & Setiawan, 2023). Understanding these dynamics is crucial for businesses to tailor their marketing strategies effectively.

2.2. Panic buying

Panic buying is an extreme behavioural reaction where individuals purchase unusually large quantities of products in anticipation of, or as a response to, a crisis. It is driven by negative emotions like fear, anxiety, and uncertainty (Lins & Aquino, 2020). This behaviour is often a self-perpetuating cycle; images of empty shelves, spread via social media, amplify fear and intensify the urge to hoard (Barnes, Diaz, & Arnaboldi, 2021). It is common for the perception or fear of product shortages to drive people to purchase more than they need, out of concern that others will buy the items to the point of stock depletion. According to Islam et al. (2021), during the pandemic, individuals' inability to tolerate fear and uncertainty led to behaviors such as stockpiling, hoarding, and panic buying. During the COVID-19 period, this type of purchasing was most clearly observed with products like toilet paper and food, particularly canned goods, due to their long shelf life. One of the implicit and most prominent features of panic buying is that individuals act in an uncoordinated, non-cooperative, and thoughtless manner during such emergencies (Glass & Schoch-Spana, 2002). The pandemic created a high level of uncertainty, which in turn led to an unprecedented surge in panic-motivated purchases. According to Yuen, Wang, Ma, and Li (2020), impulsive buying behavior is complex, with consumers making rapid purchasing decisions without carefully considering available information or alternatives. In a study by Loxton et al. (2020), it was found that during periods of uncertainty, consumer behavior theories suggest that through product acquisition and panic-driven purchases, individuals attempt to regain a sense of control. Grisham and Barlow (2005) describe panic buying as an adaptive response to scarcity and uncertainty, as securing resources is essential for survival. Parker and Lehmann (2011) argue that consumers' purchase intentions in the retail context are influenced by perceived scarcity, which helps explain both the buying process and resulting behaviors. Similarly, Laato, Islam, Farooq, and Dhir (2020) demonstrate that perceived scarcity in specific products significantly affects consumer choices. Kaur and Malik (2020) examined various factors influencing panic buying during the COVID-19 pandemic, incorporating insights from retail employees who faced challenges in stock management. Their research concluded that supply disruptions, emotional distress, and an inability to tolerate stress greatly impacted panic buying. Finally, Prentice et al. (2021) explored the influence of external factors, including the role and intervention of government institutions in managing the pandemic, company strategies to address stock shortages and excessive hoarding, and the ways in which different social groups can shape panic buying behaviors.

2.2.1. Perceived threat & scarcity

A key driver of panic buying is the perceived threat to one's well-being or access to resources. This can be a fear of illness, economic instability, or product shortages. To relieve this anxiety, consumers tend to purchase goods to feel more secure (Arndt, Solomon, Kasser, & Sheldon, 2008).

This is closely linked to perceived scarcity, the belief that essential products will soon be unavailable. This perception, whether real or imagined, creates a sense of urgency and competition among consumers, leading to impulsive purchasing (Singh & Rakshit, 2020).

2.2.2. Fear of the unknown

The inability to predict the future, often due to limited information, can trigger anxiety and drive excessive purchasing. During crises, fear of uncertainty leads individuals to seek control over their emotional and physical security, often through compulsive consumption (Yuen, Wang, Ma, & Li, 2020).

2.2.3. Copying behaviour

In crisis situations, consumers may imitate the purchasing patterns of others, either rationally or irrationally. Environmental cues, such as empty shelves, can create a perception of scarcity, prompting consumers to replicate excessive buying of perceived essentials. This behaviour reflects the uncritical imitation of others' actions (Ogunlade, 1979).

2.2.4. Social influence

Combines fears of scarcity and the unknown with the tendency to copy the behaviour of others. This creates a contagious effect where panic spreads through a community.

2.2.5. Social trust

Acts as a countermeasure; when trust in institutions and fellow citizens is high, anxiety is reduced. Conversely, low trust amplifies the perception of threat, making compulsive and irrational buying more likely.

2.3. Bounded rationality

Developed by Herbert Simon (1955), the theory of Bounded Rationality posits that human decision-making is limited by cognitive capacity, available information, and time constraints. Instead of making optimal choices, individuals tend to make "satisficing" decisions—ones that are good enough. During crises, this limitation is amplified. Overwhelmed by confusing information and emotional pressure, consumers often abandon rational analysis in favour of heuristics, such as copying the behaviour of others. The purchase of toilet paper during the pandemic is a classic example of a decision driven by social cues rather than actual need. (Mais Retorno, 2021)

2.4. Motivation theory (Maslow's Hierarchy of Needs)

Abraham Maslow's hierarchy of needs proposes that individuals are motivated to fulfil basic needs before moving on to more advanced ones. The pyramid structure places physiological needs (food, water) and safety needs (security, health) at its base. During crises like a pandemic or a blackout, consumers tend to regress to these foundational levels (Loxton et al., 2020). The focus shifts from self-actualization or esteem to ensuring survival and security. This explains the surge in demand for essential goods, as consumers prioritize securing the resources necessary to meet their most basic needs. (Escola ELBS, 2022)

2.5. Prospect theory

Prospect Theory describes how individuals make decisions under uncertainty. A core tenet is loss aversion: the pain of losing is psychologically about twice as powerful as the pleasure of gaining. In a crisis, the fear of losing access to essential items (a perceived loss) is a much stronger motivator than the prospect of a future gain.

Consumers, therefore, act to avoid the potential negative outcome of scarcity, even if it means overspending or buying unnecessary items. This emotional calculation often outweighs a rational assessment of risk. (Exame, 2022)

3. RESEARCH MODEL AND HYPOTHESES

This study investigates how unexpected large-scale disruptions impact consumer behaviour, focusing on the acquisition of essential goods.

3.1. Case study 1: COVID-19

The global pandemic created a prolonged period of uncertainty, affecting health, supply chains, and economic stability. Government-imposed lockdowns and social distancing measures fundamentally reshaped daily routines and purchasing habits, leading to a dramatic increase in online shopping and a focus on products for home consumption and safety.

3.2. Case study 2: Iberian Peninsula Electrical Shutdown

On April 28, 2025, a major electrical grid failure resulted in a widespread power outage across Portugal and Spain. While short-lived, the event caused significant disruption and public anxiety, triggering consumer behaviours reminiscent of the early days of the pandemic. Initial reports pointed to grid oscillations caused by temperature fluctuations, but the event highlighted the vulnerability of modern infrastructure and its immediate impact on consumer psychology. The shutdown's impact on businesses and media coverage amplified the sense of crisis.

3.3. Research question and hypotheses

This paper poses the following research question: In what ways do unexpected crises, such as a pandemic and a large-scale power outage, shift consumer purchasing behaviour back towards essential needs as defined by Maslow's hierarchy?

To explore this, the authors developed an interview and a survey to test the following hypotheses:

- **H1:** During crises, consumers prioritize the purchase of essential goods (food, water, hygiene) over non-essential items.
- **H2:** Purchasing decisions during crises are more heavily influenced by emotion (fear, anxiety) than by rational factors like price.
- **H3:** The act of purchasing essential goods provides consumers with a sense of control over an uncertain situation.

4. INTERVIEW FINDINGS

To gain an industry perspective, the authors conducted an in-depth interview with a director of a large commercial supermarket. Key insights include:

- **Immediate Behavioural Shifts:** During the blackout, there was an instant surge in demand for water, batteries, canned goods, candles, and even battery-powered radios, driven by a lack of information. In contrast, the pandemic triggered a broader, more sustained wave of stockpiling, starting with food and famously extending to toilet paper.

- **Price Elasticity:** The director noted that during the peak of the crises, "price ceased to be a decisive factor." Consumers were willing to pay more for essential items like masks and hand sanitizer, prioritizing availability over cost. This emotional response, driven by the fear of scarcity, temporarily suspended typical price sensitivity.

- **The Role of Digital:** The digital channel was crucial for communicating safety measures and updates to the public. The director emphasized that consumers were "hungry for information," and digital platforms became the primary means of reassuring them. Online shopping, especially home delivery, grew exponentially as people sought to avoid physical stores.

- **Operational Challenges:** Managing a large retail operation during the pandemic was a significant challenge, marked by "instability, uncertainty, and fear." The company had to manage supply chain disruptions, implement strict safety protocols (like plexiglass barriers), and handle high rates of employee absenteeism while trying to reassure both staff and customers.

The interview revealed that, during both the pandemic and the blackout, consumer behavior was strongly driven by emotional factors, particularly the fear of scarcity. In such situations, purchasing decisions shifted away from rational, price-oriented considerations and were instead driven by the urgency to secure essential goods, even at significantly higher prices. During the blackout, demand surged for immediate survival items such as water, canned goods, candles, batteries, and radios, while in the pandemic, the initial priority was food, followed shortly by products like toilet paper, masks, and gloves. For the company, the challenge was a sudden and massive spike in demand for specific items, while also navigating logistical constraints and severe staff shortages, at times with half of the team absent. This required sourcing from alternative suppliers, placing advance orders, and adapting operations, both in-store (through safety measures, entry control, and space reorganization) and online (home delivery services and digital communication about safety measures and product availability). Overall, the interview highlights that the store's resilience stemmed from its ability to respond quickly, manage scarce resources effectively, and care for both employees and customers, maintaining a balance between supply, safety, and trust. These crises demonstrated that, in extreme circumstances, consumption is driven primarily by emotion and immediate necessity, and that operational agility and clear communication are essential for navigating periods of instability.

5. DICUSSION OF RESULTS

A survey was conducted to gather quantitative data on consumer behaviour, yielding 61 responses. The majority of respondents were aged 17-27 (42.6%), had a monthly income below €1000 (77%), and were males (59%), as can be observed below, on Table 1.

Table 1 Respondents' descriptive data

Age	No.	%	Gender	No.	%	Income	No.	%
17-27	26	42,62	Female	25	40,98	0-1000	47	77,05
28-38	17	27,87	Male	36	59,02	1000-2000	11	18,03
39-49	11	18,03	-	-	-	2000/+	3	4,92
50/+	7	11,48	-	-	-	-	-	-
Total	61	100	-	61	100	-	61	100

In terms of main results obtained from the questionnaire, the overall results can be observed on the following Table 2, shown below.

Table 2. Main scores obtained from the questionnaire

Question	Totally disagree (%)	Partially disagree (%)	Not sure (%)	Partially agree (%)	Totally agree (%)
1-I consider that my purchase decisions have become more rational	16,4	11,5	11,5	36,1	24,6
2-I consider that my purchase decisions were more influenced by emotions	32,8	21,3	14,8	26,2	4,9
3-Safety was the most important criterion for me when deciding what and where to buy	18,3	20	8,3	31,7	21,7
4-Convenience was the most important criterion for me when deciding what and where to buy	6,7	15	13,3	45	20
5-Price was the most important criterion for me when deciding what and where to buy	5	11,7	6,7	48,3	28,3
6-During the pandemic and the blackout, I changed my consumption behavior	28.3%	23.3%	6.7%	28.3%	13.3%
7-I started buying more certain types of products (e.g., basic food, hygiene items)	32.8%	18.0%	16.4%	24.6%	8.2%
8-I became more concerned about rising prices	11.5%	8.2%	14.8%	31.1%	34.4%

The analysis that was done for the first question, *"I consider that my purchase decisions have become more rational,"* shows that the respondents may not agree with this perception. The research developed for this paper revealed that, during the period analyzed, purchasing behavior tended to become more emotional rather than rational. This finding is reinforced by the second question, *"I consider that my purchase decisions were more influenced by emotions,"* where the results align with the first. The state of panic and uncertainty led many consumers to make more impulsive and emotionally driven choices. Regarding the third question, *"Safety was the most important criterion for me when deciding what and where to buy,"* the authors do not disagree with the responses, as safety was indeed a priority during the COVID-19 pandemic. This concern went hand in hand with the results from the fourth question, *"Convenience was the most important criterion for me when deciding what and where to buy,"* where convenience emerged as another key factor. The persistent fear of spending extended periods outside the home heightened the importance of easy and quick access to goods. For the fifth question, *"Price was the most important criterion for me when deciding what and where to buy,"* the authors conclude, based on the research and an interview with the director of a major retail chain, that price was, at the time, a secondary factor. The priority for consumers was securing the goods they considered most essential, even if that meant paying more.

In the sixth question, *"During the pandemic and the blackout, I changed my consumption behavior,"* responses were more dispersed. However, the authors believe that many people did in fact change their habits, at least temporarily, during these events, even if they later returned to their previous consumption patterns. Similarly, the seventh question, *"I started buying more certain types of products (e.g., basic food, hygiene items),"* confirms that while demand for essential goods increased, most other consumption habits remained largely unchanged. Finally, the eighth question, *"I became more concerned about rising prices,"* reveals two perspectives that the authors acknowledge. On one hand, rising prices are inherently concerning for consumers. On the other, during unpredictable events such as a pandemic, price becomes less of a deciding factor, with the main focus shifting to obtaining the products perceived as truly necessary. This view is also supported by the insights shared in the interview with the retail director. When analyzing the results, the respondents' demographic and economic profiles reveal clear patterns of behavior in the face of unpredictable situations. Most participants were between 17 and 27 years old (26 out of 61 respondents) and had predominantly low incomes, with the majority (47 respondents) earning between €0 and €1,000. Based on the questionnaire charts, it was observed that younger respondents were the least affected by the pandemic and blackout, maintaining their consumption habits and displaying less emotional behavior compared to older participants. Older respondents, often parents, tended to act more emotionally due to the responsibilities of caring for an entire family. This emotional tendency was also evident in the replication of other consumers' purchasing behavior, with 13.3% of "Partially Agree" responses coming from older participants. The survey further revealed that convenience and ease of purchase were decisive factors for respondents. These aspects are closely linked to anxiety, fear, and stress during events such as those addressed in the study, with the security of being able to purchase essential goods being highly valued.

The findings from the interview and the questionnaire present a nuanced, and at times contradictory, picture of consumer behaviour. The interview with the retail director strongly supports the academic literature, confirming that in the heat of a crisis, consumers act emotionally, prioritize essential goods regardless of price, and seek a sense of control through purchasing. This aligns perfectly with theories of panic buying, bounded rationality, and Maslow's hierarchy. However, the questionnaire results, gathered from a predominantly young demographic well after the events, suggest a different self-perception. Respondents reported being more rational, price-sensitive, and less influenced by emotion. This discrepancy can be interpreted in several ways. Firstly, there may be a difference between actual behaviour in a moment of panic and recalled perception of that behaviour later on. Consumers may rationalize their past actions or may not want to admit to being influenced by panic. Secondly, the long-term economic strain of the pandemic likely did lead to increased price sensitivity, a behaviour that may overshadow the memory of initial impulse buying. Ultimately, both data sources confirm that crises force a re-evaluation of priorities. While the immediate response is often an emotional, security-driven scramble for essential goods (as seen in the interview and personal experience), the lasting effect appears to be a more cautious and economically rational approach to consumption (as reflected in the survey).

6. CONCLUSION

Crises like the COVID-19 pandemic or systemic failures like power outages challenge consumer rationality and expose vulnerabilities both individually and collectively. Faced with uncertainty, anxiety, and a fear of the unknown, consumer behavior tends to deviate from rational and predictable patterns. Instead, it gives a way to impulsive decisions driven by panic, urgency, and a perceived scarcity of goods. Concerning H1 for the most part, people maintained their usual purchasing habits.

While there was a clear increase in the purchase of essential goods, the overall shopping patterns themselves did not undergo any drastic changes. About H2 although the responses did not fully align, both in the interview and in the study conducted, it was emphasized throughout this paper that, in situations such as those discussed, people tend to act based on emotional impulses, placing rational considerations to the side. Predicting consumer behavior during unpredictable events faces several limitations. Traditional forecasting models are based on the assumption that consumers act in a rational and stable manner, which does not hold true during periods of high uncertainty. In crises, emotions and impulsive decisions take precedence, rendering these models less effective. Furthermore, the complexity of variables significantly influences consumer decisions, as psychological, emotional, and social factors interact in intricate ways, making it challenging to identify clear behavioral patterns. The unpredictability of events, such as economic crises or natural disasters, adds another layer of difficulty, as consumers may react very differently depending on the nature and severity of the event. Additionally, there is the forgetting effect, as reactions and perceptions may evolve over time, making it harder to accurately capture behaviors. Lastly, a limited sample size in the survey may compromise the representativeness of results, as it may not reflect the full diversity of the affected population. Studying consumer behavior during crises provides a deeper understanding of human reactions to major events, such as economic crises, natural disasters, pandemics, or political shifts. This research sheds light on how emotional factors, risk perception, and resource scarcity influence purchasing decisions. Furthermore, it offers valuable insights into consumer psychology under stress, laying the foundation for future studies on human behavior under pressure. Additionally, this knowledge can lead to improvements in marketing strategies and logistical operations, refining offerings and communication channels to better meet the evolving needs of consumers. For governments, this research is crucial in developing effective public policies, as it helps to understand how consumer behavior can be shaped during crises, enabling the implementation of measures to ensure social and economic well-being.

A comprehensive approach to consumer behavior during crises should be multidisciplinary, incorporating not only marketing, but also sociology and psychology. Understanding psychological and emotional factors is crucial, as emotions such as anxiety, fear, and a desire for security significantly influence purchasing decisions. Enhancing the analysis of these emotions can lead to more effective strategies in both marketing and public policy. This can be achieved through methods such as in-depth interviews, sentiment analysis on social media, or even psychological testing, providing a richer and more detailed understanding of consumer behavior. Theories such as bounded rationality and prospect theory help explain why, in crisis situations, individuals make choices that don't always promote their well-being. This can be seen in panic buying, stockpiling unnecessary items, or making poor financial decisions. Maslow's hierarchy of needs also offers a useful lesson: during these times, the focus shifts to basic needs like food, health, and security, leading to defensive and potentially irrational behavior.This all highlights the critical role companies, the media, and even the government play in communicating clearly and responsibly during fragile moments. The way they choose to communicate can either mitigate or intensify consumers' irrational behavior. In fact, while fear-based marketing tactics might lead to immediate gains for a business, they ultimately compromise long-term customer trust. In conclusion, consumer behavior in unpredictable contexts is shaped by a complex mix of psychological, social, economic, and digital factors. Understanding these behaviors allows us to not only anticipate future reactions but also to craft more composed, balanced, and sustainable responses from both businesses and public institutions. It's crucial for consumers to feel secure, informed, and capable of making rational decisions, even when facing the unknown.

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"TOWARDS SUSTAINABLE VITICULTURE IN THE MEDITERRANEAN: INSIGHTS FROM A SYSTEMATIC REVIEW OF AGROECOLOGICAL TRANSITIONS IN THE DOURO REGION"

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ABSTRACT

Agroecological transition represents a promising approach to addressing the complex challenges of sustainability in agriculture, particularly in territories of high ecological and cultural sensitivity. The Douro region, given its unique landscape and socio-cultural heritage, presents a valuable opportunity to serve as a living laboratory for agroecological innovation. A systematic review of agroecological transition practices in Mediterranean viticulture is presented, with a particular focus on the Douro context. Its alignment with European policy frameworks—such as the Green Deal, the Common Agricultural Policy (CAP), and the Sustainable Development Goals (Agenda 2030)—further reinforces its relevance. A total of 44 articles were analysed using the PRISMA protocol. The results reveal a a strong emphasis on the biophysical and ecological dimensions of sustainability, particularly soil conservation, water-use efficiency, biodiversity enhancement, and climate change adaptation. However, there is limited incorporation of participatory methodologies, integrated modelling, scenario development, and in the consideration of sociocultural and institutional dynamics. While trade-off analyses are referenced in several studies, they are often implicit and rarely supported by formal multi-criteria assessment frameworks. The study concludes that integrating trade-off analysis, participatory methods, and holistic assessment tools can enhance the resilience and sustainability of Mediterranean viticulture, supporting transition pathways that are more equitable, effective, and territorially grounded. The findings highlight the need for more interdisciplinary and place-based approaches that effectively bridge scientific research with local knowledge, enabling more informed and context-sensitive decision-making in agroecosystems

Keywords: *Agroecological transitions; Ecosystem services; Landscape management; Sustainability; Territorial governance*

1. INTRODUCTION

Mediterranean viticulture plays a central role in the agricultural economy and cultural heritage of the regions where it is established, particularly in countries such as Portugal, Spain, Italy, and France. However, the intensification of agricultural practices associated with this sector has raised significant concerns regarding environmental sustainability, economic resilience, and the social cohesion of winegrowing communities (Altieri et al., 2015; Hannah et al., 2013). Key challenges include soil erosion, biodiversity loss, water scarcity, and increasing vulnerability to climate change—phenomena that are particularly acute in mountain viticulture regions (Silva & Diniz, 2022). In this context, agroecological transitions have emerged as a fundamental strategy for promoting more sustainable and resilient viticulture. Agroecology, by integrating ecological principles within systems' management, seeks to reconcile natural resource conservation with the economic viability of farms and the social well-being of rural communities (Guzmán et al., 2018). However, achieving such transitions requires integrated approaches tailored to territorial contexts, capable of articulating multiple dimensions of sustainability while actively involving local actors in the decision-making process (Mier y Terán Giménez Cacho et al., 2018).

The Douro World Heritage Site represents a paradigmatic case of the need to develop agroecological strategies adapted to ecologically and culturally distinctive territories. Viticulture in this region is characterized by steep slopes, extreme climatic conditions, and an aging farming population, while facing increasing pressure to reconcile environmental conservation objectives with economic activity and territorial valorization (Silva & Diniz, 2022; Polita & Madureira, 2021). International policy and strategic frameworks—such as the European Green Deal, the Farm to Fork Strategy, and the Sustainable Development Goals (SDGs)—reinforce the urgency of reorienting agricultural systems towards more sustainable practices. These include reducing pesticide use, protecting biodiversity, and enhancing the resilience of rural communities (European Commission, 2020). These instruments call for the integration of scientific and local knowledges, the use of multi-criteria assessment tools, and the analysis of trade-offs between competing objectives to inform policy and management decisions (Antle & Valdivia, 2021). Against this backdrop, the present systematic review aims to assess the state of the art in research on agroecological transitions in Mediterranean viticulture, with a particular focus on the Douro region.

Specific objetives include identifyng key methodological approaches, the dimensions of sustainability considered, the degree of local actor participation, and the modeling and trade-off analysis tools employed. In the end, the authors would like to contribute to a more integrated understanding of agroecological transition dynamics, highlighting existing research gaps and proposing directions for future investigations and more effective, territorially adapted public policies. The structure of this article is as follows: following this introduction, Section 2 presents the theoretical framework on agroecological transitions in Mediterranean viticulture. Section 3 details the methodology adopted for the systematic review and bibliometric analysis. Section 4 presents the results, including the bibliometric characterization of the literature, a qualitative analysis of the selected studies, and an assessment of modeling, participation, and trade-off methods. Section 5 provides a critical discussion of the findings, linking them to public policies and the Douro context. Section 6 concludes with recommendations and implications for future research.

2. AGROECOLOGICAL TRANSITIONS IN MEDITERRANEAN VITICULTURE: APPROACHES, MODELING, AND PARTICIPATION

Agroecological transitions are understood as processes of transforming agricultural systems towards more sustainable, resilient, and socially just production models (Altieri et al., 2015; Guzmán et al., 2018). This transition intends to integrate ecological, economic, social, and institutional dimensions, requiring interdisciplinary and transdisciplinary approaches to understand the complex interactions among the various factors involved (Mier y Terán Giménez Cacho et al., 2018). In Mediterranean viticulture, agroecological transitions are particularly relevant given the vulnerability of vineyard ecosystems to soil degradation, water scarcity, and climate change (Prosdocimi et al., 2016; Rocher et al., 2024). Agroecological practices applied in this context include the use of cover crops, integrated pest management, reduction of agrochemical inputs, and the promotion of functional biodiversity, aiming to increase system resilience and conserve natural resources (Altieri et al., 2015). Despite advances in ecological approaches, the integration of social and economic dimensions in agroecological transitions remains limited. Recent studies emphasize the importance of considering institutional frameworks, markets, and local social dynamics as central components for the adoption and sustainability of agroecological innovations (Schneider & Niederle, 2010; Guzmán et al., 2018). Modelling has played an important role in assessing agroecological transitions, by simulating the impacts of different practices and management scenarios. However, most existing models are static and quantitative, focused on ecological and productive indicators, with limited integration of social and economic aspects (Antle & Valdivia, 2021; Breure et al., 2024). The incorporation of dynamic and participatory modelling, which integrates local actors' knowledge and explores alternative futures, is considered a promising pathway to enhance the relevance and applicability of research (Vervoort et al., 2015). The participation of local actors is fundamental for ensuring the social legitimacy of innovations and for adapting solutions to territorial realities (Pretty, 1995; Reed et al., 2009). Participatory approaches—such as workshops, interviews, and scenario co-construction processes—enable the integration of local knowledge into the design and evaluation of transition strategies, leading to more robust and adaptive solutions (Dias et al., 2021; Andres et al., 2022). Finally, trade-off analysis emerges as a key tool for understanding the compromises between different sustainability objectives, particularly those involving productivity, environmental conservation, and social well-being (Antle & Valdivia, 2021; Breure et al., 2024). This approach provides a basis for informed decision-making and public policy design, ensuring that proposed solutions are balanced and responsive to the diverse needs of wine-producing territories. In summary, the theoretical framework on agroecological transitions in Mediterranean viticulture highlights the need to integrate ecological, social, and economic approaches, promoting participatory methodologies and dynamic modeling to support more sustainable and context-specific transition pathways.

3. METHODOLOGY

This systematic review search based on the PRISMA guidelines, was conducted on the Web of Science (WoS) and Scopus databases, using key terms “Agroecological transitions” OR “Sustainable viticulture” OR “Agroecological practices” OR “Organic viticulture” OR “Regenerative viticulture” OR “Biodiversity in vineyards” OR “Ecosystem services in viticulture” OR “Climate change adaptation in viticulture” OR “Soil and water conservation in vineyards” OR “Pesticide reduction in wine production” OR “Trade-off analysis in viticulture” OR “Multi-criteria decision analysis in agroecology” OR “Carbon sequestration in vineyards” OR “Social acceptance of agroecological practices in the wine industry”, combined with: “Douro” OR “Portugal” OR “Mediterranean vineyards” OR “Wine sector sustainability”.

The search strategy combined three thematic clusters of terms articulated through Boolean operators: (i) agroecological transitions and sustainability in viticulture; (ii) analytical tools and participatory methods; and (iii) geographic delimitation. No time restrictions were applied, ensuring comprehensive coverage of the literature up to March 2025. The search yielded 40 articles from the Web of Science and 30 from Scopus. After removing duplicates, 52 unique articles were obtained for screening. Titles, abstracts, and keywords were reviewed, resulting in the exclusion of 8 articles that, although containing terms from the search strategy, did not specifically address viticulture or agroecological practices. This process led to a final selection of 44 articles for full-text review. Inclusion criteria encompassed studies addressing agroecological practices in Mediterranean viticulture, employing participatory methodologies, or involving stakeholder integration processes. Studies applying modeling tools, trade-off analyses, or sustainability assessments of viticultural systems were also included. Exclusion criteria eliminated articles focused solely on enological aspects, wine quality, or market issues without any connection to agroecological transitions, as well as non-systematic reviews and documents without full-text access. Data collection and analysis were performed using RStudio and the Bibliometrix package (Aria & Cuccurullo, 2017), which enabled an initial bibliometric analysis, including keyword co-occurrence, temporal trends in publication, collaboration networks between authors and institutions, and the geographic distribution of studies. Complementarily, a qualitative analysis was conducted on the selected articles, systematizing the methodological approaches adopted, the sustainability dimensions considered (ecological, social, economic), the degree of local actor participation, and the territorial focus, with particular attention to the Douro and other comparable Mediterranean regions. The combination of bibliometric and qualitative analysis allowed for the integration of quantitative and qualitative data, providing a comprehensive and critical overview of the state of the art in agroecological transition research in Mediterranean viticulture. This methodological procedure establishes a solid foundation for identifying emerging trends, research gaps, and guidance for the development of more integrated, participatory, and territorially adapted strategies, particularly for the Douro region.

4. RESULTS

Section 4 presents the main findings of the systematic review, structured into two complementary strands. Subsection 4.1 provides a bibliometric characterization of the literature, outlining the body of scientific work on agroecological transitions in Mediterranean viticulture. This analysis considers temporal dynamics, collaboration networks, prevailing keywords, and the geographical distribution of studies, thereby facilitating the identification of key themes and the temporal development of the field. Subsection 4.2 deepens the qualitative examination of the selected articles, offering a structured account of methodological approaches, the sustainability metrics applied, the categories of trade-offs addressed, and the extent of local actor involvement. Integrating these two dimensions—quantitative (bibliometric) and qualitative (content)—delivers a holistic understanding of the scientific dynamics and assessment practices shaping agroecological transitions in Mediterranean viticulture, with particular emphasis on the Douro region.

4.1 Bibliometric Analysis of the Literature

The bibliometric analysis shows a sharp rise in scientific output on agroecological transitions in Mediterranean viticulture over the past five years. This trend reflects the growing alignment of research with global sustainability and climate change agendas. Keyword analysis (Figure 1) highlights “climate change,” “sustainability,” “cover crops,” “biodiversity,” and *Vitis vinifera L.* as the most frequent and interconnected terms, underscoring their central role in the current debate. The co-occurrence network further reveals their organization into thematic clusters, reflecting the field’s main research lines.

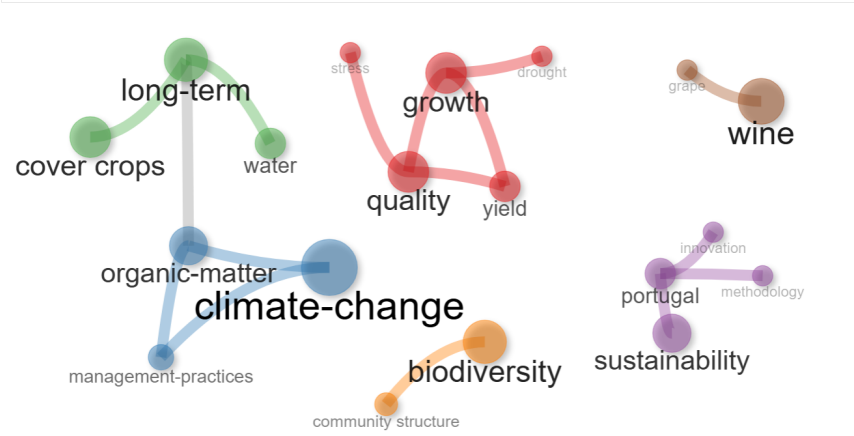

Figure 1: Keyword co-occurrence network in the literature on Mediterranean viticulture and agroecology.

The thematic map categorizes research topics according to their degree of development and relevance. "Climate change," *Vitis vinifera L.*, and "sustainability" are positioned as motor themes—characterized by both high density and high centrality—indicating scientific maturity and a consolidated debate. In the lower-left quadrant, "grapevine" and "impact" are classified as either emerging or declining themes, suggesting limited development or possible avenues for future research. Finally, the topics "sustainability," "management," and "Portugal," located in the lower-right quadrant, are identified as basic themes, with moderate centrality but lower density, pointing to areas that remain under consolidation.

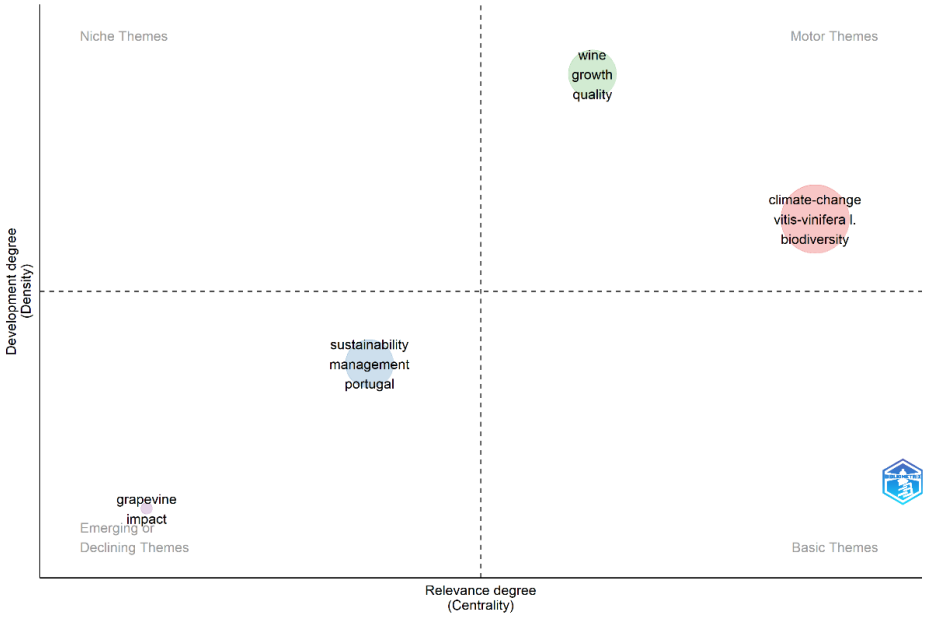

Figure 2: Thematic map.

The temporal analysis of keyword frequency (Figure 3) reveals a marked increase over the past five years in the use of the terms "climate change" and "sustainability," confirming their growing relevance in the scientific agenda. This trend underscores the need to integrate robust and systemic approaches to address the complex challenges of climate adaptation and sustainability in Mediterranean viticulture (Altieri et al., 2015; Antle & Valdivia, 2021).

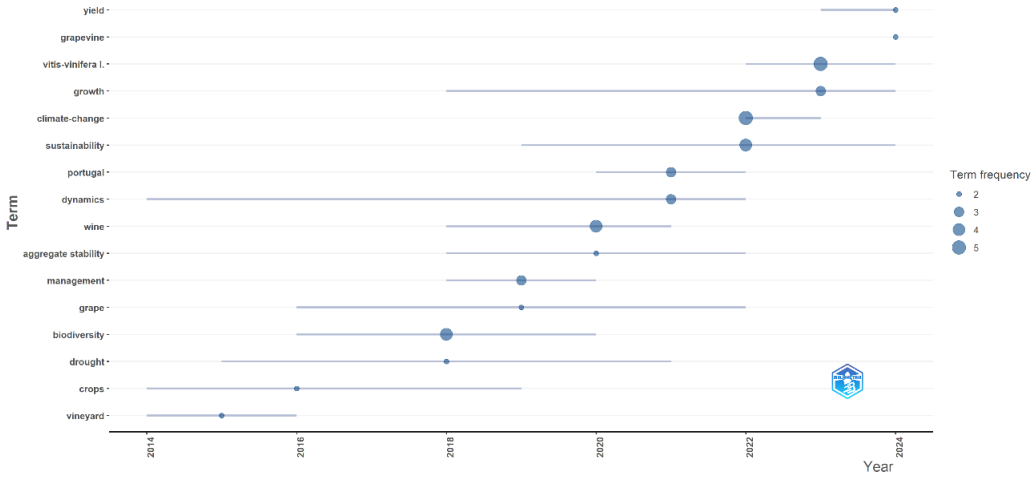

Figure 3 – Temporal evolution of keywords associated with research on Mediterranean viticulture and agroecology.

The analysis of global citations (Figure 4) indicates that the most frequently referenced studies address core themes such as soil conservation (Prosdocimi et al., 2016) and microbial biodiversity (Valero et al., 2007), underscoring the relevance of ecological issues in the field of sustainable viticulture.

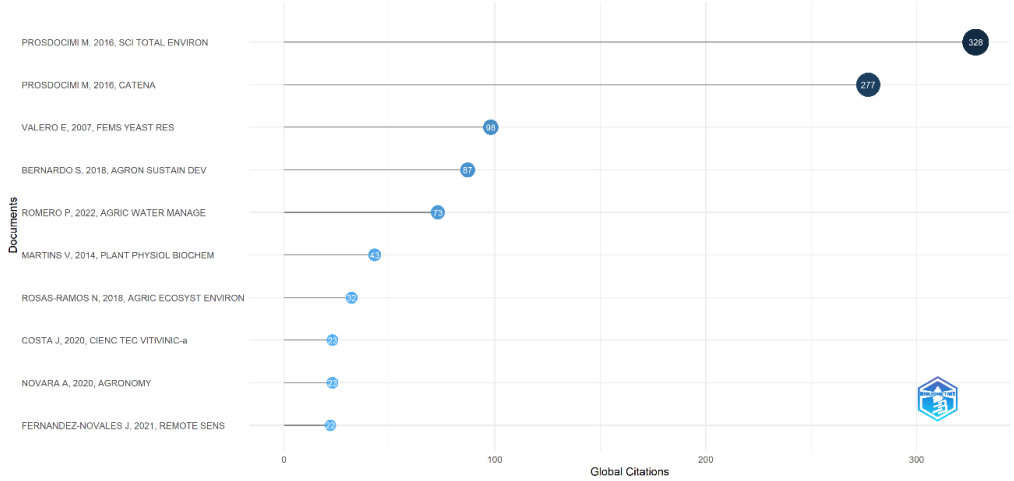

Figure 4 – Global citations.

Geographically, scientific production is concentrated in Italy, Portugal, and Spain, which emerge as the most cited countries. Figure 5 highlights Italy with 648 citations, followed by Portugal (271) and Spain (266), reflecting the centrality of these nations in the agroecological viticulture debate, supported by the historical and economic relevance of regions such as Tuscany, the Douro, and La Rioja.

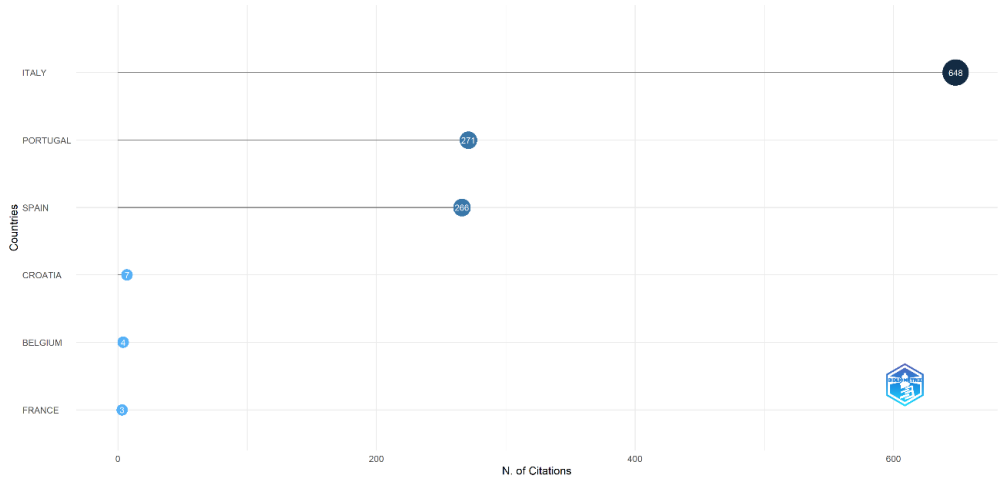

Figure 5 – Most cited countries in the analyzed literature.

The chart in Figure 6 reveals a clear upward trend in scientific production from 2015 onwards, with a marked intensification after 2020. Italy stands out with an exponential increase in publications in recent years, assuming a leading position. Portugal and Spain also show continuous growth, reflecting their emerging role in research on viticulture and agroecology.

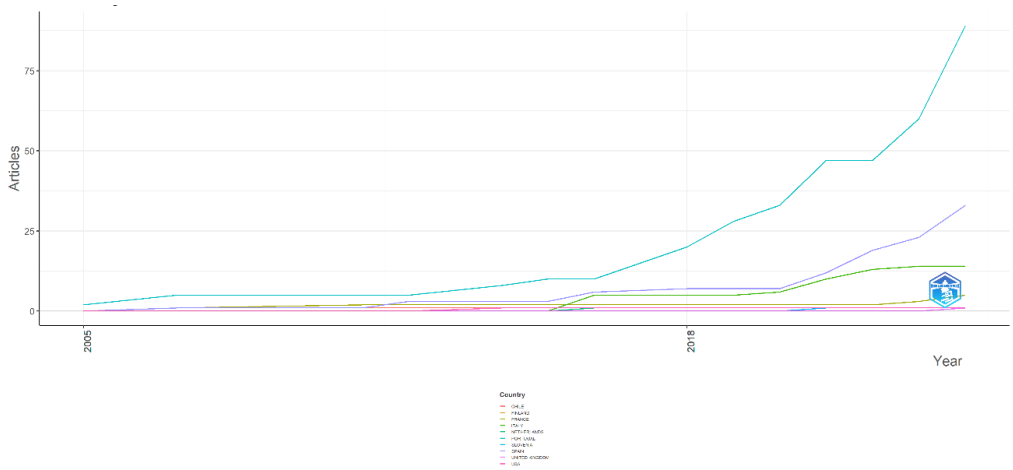

Figure 6 – Temporal evolution of scientific production by country in the field of Mediterranean viticulture and agroecology.

The chart of annual scientific production, shown in Figure 7, reveals a trajectory marked by two distinct phases. In the early years of the period analyzed, between 2004 and 2015, production remained irregular and scattered, with several years of low or no publication. This initial phase reflects a still limited interest in Mediterranean viticulture and agroecology, mostly confined to isolated studies or more traditional areas of agricultural research. From 2016 onwards, a significant shift is observed, with progressive growth that intensifies in recent years. This upward trend becomes particularly evident after 2020, culminating in 2024 with the highest number of articles published in the period analyzed. The sharp increase signals growing scientific attention to issues related to sustainability, climate change, and agroecological transitions in viticulture. The accelerated rise in research output in this field is consistent with priorities defined by European public policies, such as the European Green Deal and the Farm-to-Fork Strategy, which promote more sustainable and resilient farming practices. This context has fostered investigations that approach viticulture not only from a productive perspective but also in connection with environmental and social dimensions.

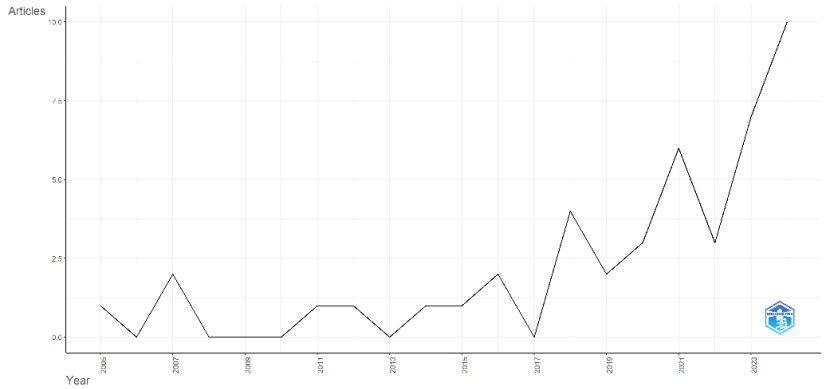

Figure 7 – Annual scientific output on Mediterranean viticulture and agroecology.

Despite this expansion, bibliometric analysis suggests that research remains fragmented, with limited connections between ecological, social, and economic dimensions, and a restricted integration of participatory approaches.

4.2 Qualitative Assessment

The qualitative analysis of the reviewed literature provid a characterization of the studies analyzed by synthesizing the winegrowing region under study and the main objective of each investigation. This systematization makes it possible to identify research priorities across different territories, particularly those focused on water resource conservation (Romero et al., 2022; Costa et al., 2020), biodiversity and ecosystem services (Gonçalves et al., 2016; Rocher et al., 2024), and climate change adaptation (Fonseca et al., 2024; Dinis et al., 2024), as illustrated in Figure 8.

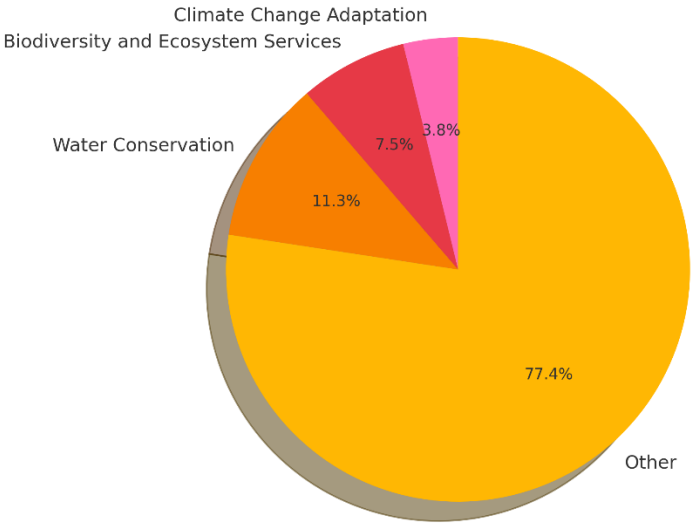

Figure 8 – Thematic distribution of the reviewed studies.

The methodological diversity represented in Figure 9 and observed in the analyzed studies reflects the plurality of approaches applied to the assessment of agroecological transitions in Mediterranean viticulture. The categorization of Trade-off Analysis (TOA) approaches into methodological macro-themes reveals a predominance of ecological approaches, representing the largest share of studies (around 36%).

These approaches include biophysical and bioecological methodologies aimed at evaluating agricultural practices and their impacts on natural resources such as soil, water, and biodiversity (Prosdocimi et al., 2016; Rocher et al., 2024). Social approaches, encompassing sociotechnical and sociocultural methodologies, account for approximately 16% of the sample, reflecting interest in the analysis of the dynamics of agroecological practice adoption, institutional barriers, and the motivational factors of winegrowers (Andres et al., 2022; Dias et al., 2021). This group highlights the focus on understanding social contexts, actor networks, and innovations within the agroecological transition. Political or systemic approaches, representing about 4% of the studies, focus on the analysis of public policies, regulatory frameworks, and institutional conditions that shape agroecological transitions, although they remain a minor share of the literature (Buratti-Donham et al., 2023). Despite the relevance of formal approaches, a significant proportion of studies (around 30%) do not apply an explicit TOA methodology, instead relying on implicit analyses based on qualitative descriptions or empirical comparisons without the formalization of analytical models. This category highlights a gap in the systematic integration of tools to explore trade-offs across ecological, economic, and social dimensions, limiting the robustness of evaluations (Altieri et al., 2015; Antle & Valdivia, 2021). Other approaches, such as integrated agroecological (11%) and technological (4%), are emerging alternatives. The former combines participatory and multi-criteria assessments, considering multiple dimensions of sustainability (Costa-Pereira et al., 2024), while the latter focuses on the application of digital solutions and decision-support tools to improve farm management (Fernandez-Novales et al., 2021).

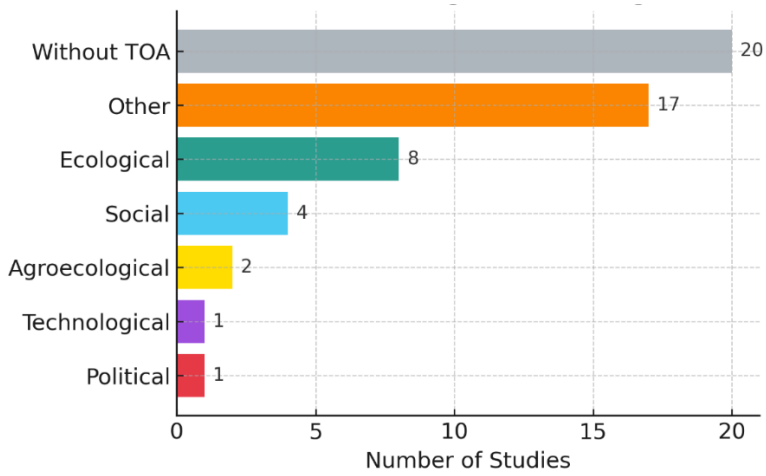

Figure 9 – Methodological macro-category distribution (TOA).

The analysis of modelling methods used in the 44 selected studies reveals a significant presence of quantitative approaches and analytical tools, although empirical and descriptive methods still predominate, often without the integration of dynamic simulations or participatory scenario-building processes. Among the studies analyzed, 23 incorporated some form of modeling, while 20 did not apply formal methods, relying instead on qualitative, comparative, or experimental analyses. Beyond this division between studies with and without modeling, considerable methodological diversity is observed among those that applied modeling. Figure 10 synthesizes the main types of modelling identified in studies with a quantitative approach, highlighting the predominance of statistical modeling, followed by spatial analyses with GIS tools, biophysical modeling, and decision-support systems.

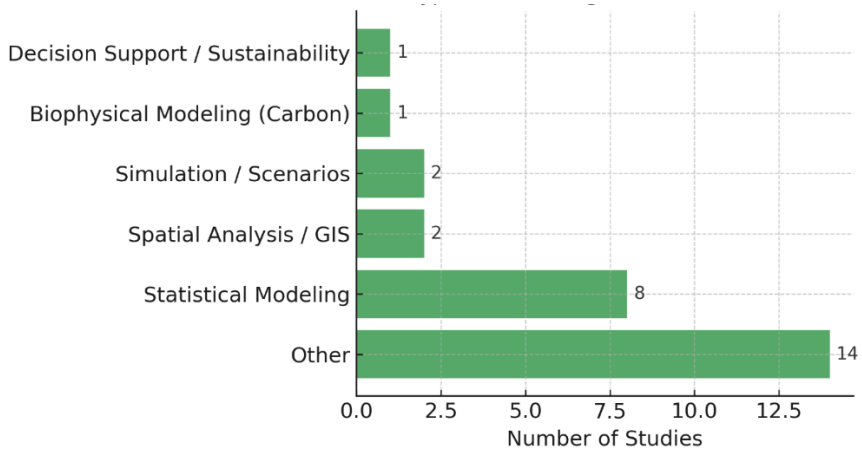

Figure 10 – Main types of modelling

This methodological distribution reflects a multiplicity of approaches: from ecological statistical models, such as multivariate analyses and beta diversity, applied to examine the composition of biological communities and the impacts of agricultural practices on biodiversity and soil health (Rocher et al., 2024; Cabrera-Perez et al., 2023), to field experiments with empirical measurements, such as those evaluating the effect of cover crops on erosion in Douro vineyards (Prosdocimi et al., 2016) or the use of vermicompost on soil quality (Nascimento-Gonçalves et al., 2024). In addition, more complex methodologies stand out, including multi-criteria spatial analyses using GIS tools (Fonseca et al., 2024) and biophysical modeling of soil carbon balance (Novara et al., 2020). Decision-support tools and sustainability assessments based on multi-criteria indicators have also been applied in studies assessing the agroecological performance of different management practices (Costa-Pereira et al., 2024; Correia et al., 2023). The data obtained from this systematic review reveal the presence of participatory methods, the use of scenario construction, and the main trade-offs identified in the analyzed studies. This synthesis allows for the evaluation of the degree of participatory integration and the methodological capacity for anticipation in the literature on agroecological transitions in Mediterranean viticulture.The results show that, although reserach employs participatory tools and scenarios, experimental or descriptive approaches prevail, often limited in terms of local actor involvement or the formalization of scenario-building processes. Moreover, many studies address trade-offs in an implicit or partial manner, which constrains a full understanding of interactions across different dimensions of sustainability. These findings reinforce the need for more integrated and collaborative methodologies capable of combining modelling, participation, and scenario building to more effectively guide agroecological transitions in Mediterranean viticulture. The analysis of the studies included in the systematic review highlights the low integration of participatory methods and formal scenario-construction processes in research on agroecological transitions in Mediterranean viticulture. Although the participation of local actors is widely recognized as an essential component for the co-creation of context-specific knowledge and the social legitimacy of transition strategies (Reed et al., 2009; Schneider & Niederle, 2010), only about one quarter of the analyzed studies incorporated structured participatory methods, such as interviews, surveys, or collaborative processes. These studies, exemplified by Andres et al. (2022), Dias et al. (2021), and Correia et al. (2023), demonstrate an explicit concern with integrating the perceptions, experiences, and knowledge of winegrowers and other stakeholders into research and assessment processes.

In contrast, most studies rely on experimental or descriptive approaches without the direct involvement of local actors, which limits the practical relevance and applicability of the results. This trend reflects a broader pattern in agroecological research, where participation is often treated as complementary or absent, undermining the adaptive capacity and acceptance of proposed solutions (Pretty, 1995; Kloppenburg et al., 2000). With regard to scenario building, a predominance of comparative approaches between agricultural practices is observed, with scenario design rarely being formalized. Only a few studies employed structured scenario-building processes, such as climate simulations (Fonseca et al., 2024), narrative scenarios developed with winegrowers (Andres et al., 2022; Dias et al., 2021), or territorial planning strategies (Rochard et al., 2011). The widespread absence of alternative future projections limits the capacity of research to anticipate cumulative impacts, assess long-term dynamics, and identify robust adaptive strategies (Vervoort et al., 2015).

Despite these limitations, the identification of trade-offs is present in most studies, albeit in a heterogeneous and sometimes implicit manner. Ecological–economic trade-offs, particularly those between the conservation of natural resources (such as water, soil, and biodiversity) and agricultural productivity, are the most frequent, reflecting the inherent tensions in the pursuit of sustainability in Mediterranean viticulture (Romero et al., 2022; Ramos et al., 2019). Some studies also highlight social and economic trade-offs, such as tensions between agroecological practices and market demands (Andres et al., 2022; Vizcote et al., 2024), or between technological innovation and local adaptive capacity (Correia et al., 2023; Buratti-Donham et al., 2023). However, the absence of quantitative modeling and formal scenario building limits the depth of analysis of these trade-offs and the ability to inform more effective policies and practices (Antle & Valdivia, 2021; Klapwijk et al., 2014).

The analysis of trade-offs identified in studies on agroecological transitions in Mediterranean viticulture reveals a predominance of compromises between ecological and productive objectives. This category accounts for around 68% of the cases analyzed, reflecting the inherent tensions between the management of natural resources—such as water, soil, and biodiversity—and the maintenance of agricultural productivity, as illustrated in Figure 11. Examples include Romero et al. (2022), who explore trade-offs between water-use efficiency and grape quality under climate change, and Prosdocimi et al. (2016), who assess the balance between soil conservation and the management costs of spontaneous vegetation in Douro vineyards. Socioecological trade-offs represent 23% of the studies, highlighting tensions between agroecological practices and socio-economic factors such as farm economic viability and the acceptance of new practices by winegrowers.

For instance, Andres et al. (2022) identify compromises between long-term sustainability and the initial costs of agroecological transition, while Vizcote et al. (2024) examine tensions between the preservation of landscape heritage and the need for the economic viability of farming systems. Finally, 9% of the studies address trade-offs between technological innovation and local adaptation. These compromises emerge, for example, in studies such as Correia et al. (2023) and Fernandez-Novales et al. (2021), which analyze the balance between the adoption of advanced technologies (such as monitoring systems or automation) and the adaptive capacity of local producers, who may face financial or technical barriers to integrating these innovations into their production systems.

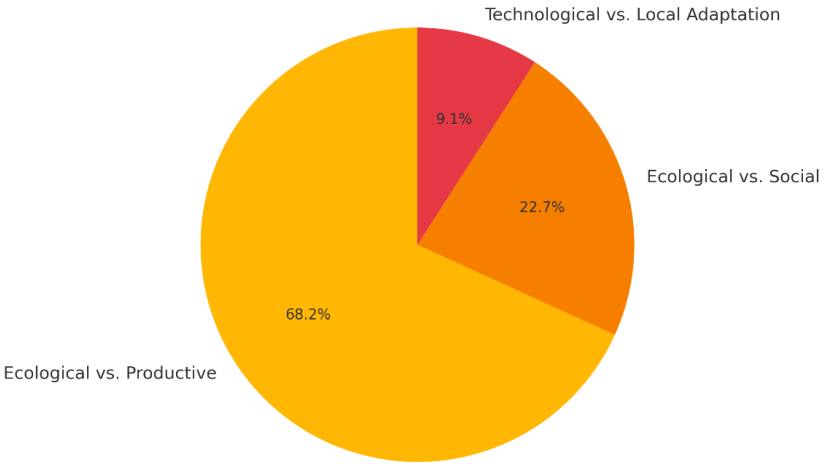

Figure 11 – Types of trade-offs identified.

The main indicators mobilized in the analyzed studies were also synthesized, the data sources used, the scale of analysis adopted, and their relevance to the Douro context. The diversity of identified indicators reflects approaches that prioritize different dimensions of sustainability. From an ecological perspective, key metrics include functional biodiversity, soil quality, water-use efficiency, and carbon sequestration (Prosdocimi et al., 2016; Rosas-Ramos et al., 2018; Novara et al., 2020). In the economic domain, studies generally examine productivity, production costs, and profitability under different management systems (Cabrera-Pérez et al., 2023; Correia et al., 2023). The social dimension is less frequently addressed, although indicators related to the social acceptance of agroecological practices, farmers' perceptions, and territorial impact are present (Andres et al., 2022; Vizcote et al., 2024). Data sources range from empirical field measurements, surveys and interviews, to statistical analyses and spatial or biophysical modeling techniques. These approaches are applied at different scales: plot, farm, landscape, or region. The choice of scale directly influences the type of conclusions that can be drawn and their applicability to specific territories such as the Douro. Studies conducted at the plot scale tend to emphasize biophysical measurements and experimental results, whereas regional or national-scale studies allow for the identification of broader patterns with greater potential to inform public policies.

5. DISCUSSION

The results of this systematic review highlight significant progress in research on agroecological transitions in Mediterranean viticulture, while also revealing methodological limitations and gaps in the integration of essential dimensions for a holistic and contextualized assessment. The predominance of ecological and biophysical approaches, focused on soil conservation, functional biodiversity, and climate change adaptation (Prosdocimi et al., 2016; Rocher et al., 2024; Fonseca et al., 2024), demonstrates the maturation of an agenda concerned with the environmental impacts of intensive viticulture. However, this trend also exposes a weaker articulation between the social, economic, and institutional dimensions of sustainability. The Douro region, although present in some studies, remains underrepresented in approaches that take into account its territorial specificities, such as mountain viticulture, pressure on natural resources, and an aging agricultural social structure (Silva & Diniz, 2022). The absence of approaches adapted to the Douro context limits the capacity of research to support informed and adaptive decision-making in this territory. From a methodological perspective, the review highlights the prevalence of conventional statistical analyses, with few examples of integrating dynamic modeling or participatory scenarios.

This limitation reduces the capacity to anticipate impacts and to formulate robust adaptive strategies, hindering the identification and negotiation of trade-offs between ecological, economic, and social objectives (Antle & Valdivia, 2021; Breure et al., 2024). The adoption of integrated and transdisciplinary methodologies—combining biophysical modeling, social analysis, and policy evaluation—is identified as fundamental for advancing the development of sustainable and socially legitimized strategies (Altieri et al., 2015; Guzmán et al., 2018). The bibliometric analysis reinforces these findings by revealing a low frequency of categories such as "local actor participation" and "social impacts," as well as the peripheral positioning of themes such as "management" and "sustainability" in the thematic map.

This trend underscores the predominance of technical and ecological approaches, with limited integration of social and institutional dimensions that are essential for the effectiveness of agroecological transitions. Participatory approaches, recognized as fundamental for the social legitimacy and local adaptation of agroecological innovations (Reed et al., 2009; Pretty, 1995), are present in only about one quarter of the analyzed studies, mostly relying on interviews or limited collaborative processes (Andres et al., 2022; Dias et al., 2021). This underrepresentation undermines the capacity of research to capture territorial dynamics, cultural barriers, and opportunities for local innovation, which are particularly relevant in complex contexts such as the Douro (Polita & Madureira, 2021).

With regard to scenario building, empirical comparisons between agricultural practices predominate, while the use of formal tools to anticipate alternative futures remains scarce. Only a few studies employ climate simulations or narrative scenarios co-constructed with stakeholders (Fonseca et al., 2024; Dias et al., 2021), limiting the potential of research to inform long-term adaptive strategies (Vervoort et al., 2015). The identification of trade-offs is recurrent but often implicit or restricted to the relationship between productivity and ecological indicators such as water-use efficiency, soil conservation, and yield (Romero et al., 2022; Ramos et al., 2019). Social trade-offs, such as transition costs, the acceptance of sustainable practices, and conflicts with market demands, as well as technological trade-offs associated with the adoption of digital innovations, remain largely underexplored (Andres et al., 2022; Correia et al., 2023; Fernandez-Novales et al., 2021).

This review highlights the need for integrated methodologies that combine participation, scenario modeling, and explicit trade-off analysis to strengthen the assessment of agroecological transitions in Mediterranean viticulture. Advancing such approaches is crucial to align research with real-world challenges and to foster solutions that balance productivity, ecology, and social well-being.

6. CONCLUSION

This systematic review identified both advances and limitations in research on agroecological transitions in Mediterranean viticulture, with particular emphasis on their relevance to the Douro region. The analyzed studies demonstrate a growing concern with environmental sustainability, especially soil conservation, biodiversity, and climate change adaptation. However, they also reveal a limited integration of social, economic, and institutional dimensions, which are essential for achieving an effective agroecological transition. The Douro context—characterized by mountain viticulture, climate vulnerability, and socio-economic challenges—requires tailored solutions that combine environmental sustainability, economic resilience, and social cohesion. This review highlights the need to strengthen transdisciplinary approaches that integrate dynamic modeling, participatory scenario building, and explicit trade-off analysis, in order to support more informed and socially legitimized decisions.

The recommendations emerging from this analysis align with major international and European strategic frameworks, including the European Green Deal, the Farm-to-Fork Strategy, and the Sustainable Development Goals (SDGs). Specifically, the review underscores the following priorities:

- Integrating local and scientific knowledge, promoting solutions adapted to territorial specificities and producer needs.
- Developing participatory scenarios that anticipate the impacts of global changes and strengthen the resilience of viticulture systems.
- Adopting modeling tools and multi-criteria assessment frameworks to ground decision-making in sustainability indicators.
- Including explicit analysis of social, economic, and ecological trade-offs, ensuring fair and balanced solutions.
- Strengthening the articulation between agroecological practices, public policies, and markets, with particular emphasis on short supply chains, certified products, and territorial branding strategies.

In conclusion, the agroecological transition in Douro viticulture is not only desirable but also strategic. Reinforcing applied research and public policies—aligning them with the imperatives of sustainability and resilience—is essential to building wine systems that are more robust, equitable, and environmentally responsible. Despite the methodological advances identified, this review reveals the need to integrate more robust and participatory approaches into research on agroecological transitions in Mediterranean viticulture. In particular, the articulation between participatory modeling tools and collaborative scenario-building processes remains underexplored, limiting the capacity of viticulture systems to anticipate and adapt to global challenges. The carbon sequestration dimension, although recognized in some studies (Novara et al., 2020), remains methodologically isolated and weakly connected to the socio-economic objectives of agroecological transitions. Incorporating multi-criteria analyses with active stakeholder involvement would allow for a more balanced assessment of trade-offs between productivity, environmental conservation, and territorial cohesion. In this regard, the construction of transdisciplinary methodological frameworks that combine technical-scientific knowledge, local actor participation, and adaptive projections is reinforced as a research priority. Such an approach could contribute not only to more informed decision-making but also to solutions that are fairer, more resilient, and socially legitimized.

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