Hidden Champions of Romania

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Abstract Romania offers a unique combination of promising opportunities and challenging risks. The National Recovery and Resilience Plan (NRRP) budget is €28 billion, structured on seven pillars. The national GDP per capita has reached 80% of the EU average. Additionally, the country faces a series of vulnerabilities and emerging risks related to large government deficits, as highlighted by the European Commission in its in-depth review. Data from the three hidden champions was collected through direct interviews with the key decision-makers behind the companies during on-site visits to manufacturing firms.

Cătalin and Oana love wool. They make high-quality duvets in different sizes and thicknesses to provide comfort and a good night's sleep. Sanodor gets about 40% of its revenue from exports.

Electra has 35 years of experience in designing and making access control systems. It has expanded internationally thanks to its R&D and integrated manufacturing system, which can produce in-house 90% of its products, enhance quality, and reduce costs using industrial robots.

Romsoft is integrated into its clients' software solutions. It operates in the medical industry, blockchain technology, artificial intelligence, and desktop and mobile add-ons for PowerPoint. Its positive working environment and high-quality workforce make it a reliable software solution provider.

Success depends on a good company culture, talented staff, R&D based on customer needs, and modern equipment. The core lessons learned on the path to success, pandemic's impact, and effects of Ukraine War are analyzed for each hidden champion.

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Overview
Official name: Romania.
Type of government: semi-presidential republic.
Population in 2023: 19.1 million.
Land area: 238,397 km2 (92,046 miles2).

History

1940	Romania allies with Nazi Germany after general Ion Antonescu seizes power.
1944	Romania switches sides and joins the Allies. In 1945 a Soviet-backed government is installed.
1965	Nicolae Ceaușescu becomes the Communist leader. Its foreign policy frequently diverged from Moscow's guidance while increasing repressive rule and personality cult in Romania.
1989	Romanian "revolution" started the transition from communism to democracy.
1993	Romania applies for membership of the European Union.
2004	Romania joins NATO.
2007	Romania becomes a European Union Member state.
2024	Romania joins Schengen Area for air and sea travel.

1 Introduction: Context and History

Since its accession to the European Union, Romania has been demonstrating a notable advancement in terms of GDP per capita and productivity, aligning itself with the rest of the member states. Nevertheless, despite notable advancements, with GDP per capita increasing from 59% of the EU average in 2016 to 80% in 2023 (Eurostat, 2024, June 19). In 2021, Romania continued to demonstrate a considerable prevalence of individuals residing below the poverty line, with a proportion of 21.2%. Additionally, the country is distinguished by an unequal distribution of economic opportunity and poverty across regions and between urban and rural areas. Additionally, Romania is among the most rural countries in the EU (De Rosa et al., 2018). Nevertheless, the Romanian capital, Bucharest, has surpassed the EU average income per capita, thereby exacerbating the already considerable disparity between regions.

On May 31, 2021, Romania submitted its National Recovery and Resilience Plan (NRRP), valued at €29.2 billion, to the European Commission. On September 8, 2023, Romania submitted an amended NRRP containing a REPowerEU chapter. While no existing measures were removed, the amendment introduced changes to 56 measures, including a reduction in investment and the transfer of certain investments to the REPowerEU chapter (Mileusnic and Killmayer, EPRS, March, 2024). The NRRP, in conjunction with foreign direct investment, constituted the primary sources of external funding for the Romanian economy. There are seven pillars of the Romanian NRRP.

1. "Green transition" aims to decarbonize energy and transport through renewable energy, efficiency, water and waste management, biodiversity, and sustainable mobility. The latter represents half the cost of the pillar, due to investments in railways and the Trans-European Transport Network (TEN-T). This pillar will support the green transition across all sectors and is funded by 13.1 billion Euros of RRF funding which represents nearly half of the Romanian RRF. (European Commission, SWD (27.09.2021) 276) and (European Commission SWD (21.11.2023) 382).
2. "Digital transformation" aims to develop digital public services for citizens and businesses. Planned reforms and investments address connectivity, cybersecurity, and digital skills.
3. "Smart, sustainable, and inclusive growth" covers tax administration, the tax system, the budget, and the sustainability of the pension system. It also aims to improve the business environment, especially in R&D&I.
4. "Social and territorial cohesion" aims to implement green and digital policies in urban mobility, tourism, culture, and other areas, enhancing territorial cohesion.
5. "Health and economic and social resilience" entails measures to enhance healthcare quality and accessibility, modernize health infrastructure, reform public administration, and enhance governance of state-owned enterprises.
6. "Next generation" proposes reforms in education and training sector. It aims to enhance quality and align with labor market requirements.
7. "REPowerEU" initiative advances Romania's green energy economy through renewable energy, diversified supplies, efficiency, and green energy training, while eliminating fossil fuel reliance.

The Romanian economy experienced a period of considerable stability between 2023 and 2024, characterized by a remarkably stable exchange rate and political stability despite the energy price shock and turbulence caused by Russia's war of aggression against Ukraine (European Commission, Institutional Paper 275, March, 2024). The report also exhibited a series of macroeconomic vulnerabilities. The Romanian economy slowed in 2023 but should grow again in 2024. However, downside risks remain. Real GDP grew 2% in 2023, below 2022's 4.1% and 2021's 5.7%. Inflation, tighter financial conditions, and lower global demand slowed growth.

In 2023, gross fixed capital formation drove economic growth, benefiting from EU-funded public infrastructure. The rate of inflation fell to 7% in December 2023, down from a peak of over 14% in November 2022. Core inflation declined less than expected, due to rapid wage increases, particularly in the private sector. By the end of 2023, the rate remained just above 10%. Real wage increases remain in excess of productivity growth, posing a risk to external competitiveness.

The current account deficit is projected to decline from 9.3% to 7.0% of GDP. The general government deficit remained high in 2023, contributing to the current account deficit. The Commission forecasts 3% growth in 2024 and 2025. Households' real disposable incomes are set to grow thanks to lower inflation and improved financial conditions. However, the economic outlook is currently characterized by a greater degree of uncertainty. This is due to a number of potential

factors, including lower-than-expected growth in Romania's trading partners and slower disinflation. These factors could have a negative impact on growth (European Commission, Institutional Paper 275, March, 2024). Comparing inflation across EU member states, in August 2023 Romania had 9.5% (Eurostat, Euro Indicators, 18 September 2024).

Human Development Index (HDI) assesses average achievement in three dimensions of human development: life expectancy, access to knowledge, and standard of living. In 2022, Romania's HDI value was 0.827, placing it in the Very High category and 53rd out of 193 countries (HDI, 13.03.2024).

The main indicators of the Romanian economy are presented in Exhibit 1.

Among the most successful companies are those that have prioritized research and development (R&D) and have developed innovative products and services based on customer needs. Similarly, companies that have invested in software development and the use of artificial intelligence (AI) have also demonstrated remarkable growth and resilience. These companies are all led by individuals with a strong background in manufacturing or software, who possess the passion and commitment necessary to drive success in their respective fields. As they all engage in competition within the EU and international markets, they have come to recognize the value of their human resources and have focused on reducing costs while improving the quality of their goods and associated services. This study examines a number of exemplary cases of hidden champions that display these characteristics.

2 Case Study 1

2.1 Sanodor

Overview

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Company Information

Industry: Manufacture of made-up textile articles (except apparel and underwear)
Year of Establishment2014
Sales Revenues in 2017: 140,000 Euro
Sales Revenues in 2023: 1,3 million Euro
Average number of employees in 2023: 16
Brainer(s) behind the company: Oana and Cătălin Tatu

Exhibit 1 Core economic indicators for Romania

	2017	2018	2019	2020	2021	2022	2023
GDP per capita (current US$)	10.728	12.494	12.958	13.047	14.947	15.692	18.419
GDP per capita growth (annual %)	8.82	6.65	4.40	−3.15	6.50	4.52	2.10
Long-term unemployment rate (% of total unemployment) [a]	2.4	2.2	2.0	1.8	2.0	2.2	2.2
Foreign direct investment, net inflows (% of GDP)	2.83	3.02	2.93	1.43	4.11	3.84	..
GDP (current US$, mio)	210,147	243,316	251,018	251,363	285,810	298,892	351,003
Exports of goods and services (current US$, mio)	88,964	101,078	100,910	92,694	116,013	129,342	137,336
Exports of goods and services (% of GDP)	42.33	41.54	40.20	36.88	40.59	43.27	39.13
Merchandise exports (current US$)	70,761	79,660	76,871	70,718	87,388	96,699	100,612
Merchandise exports to high-income economies (% of total merchandise exports)	78.51	80.25	79.66	80.98	..	..	..
Merchandise exports to developing economies in Europe & Central Asia (% of total merchandise exports)	13.07	12.50	13.35	13.06	..	..	..
Ores and metals exports (% of merchandise exports)	2.11	2.23	2.19	2.30	2.80	2.79	2.48
Agricultural raw materials exports (% of merchandise exports)	1.17	1.11	1.07	1.20	1.32	1.16	0.83
Food exports (% of merchandise exports)	10.13	9.46	10.34	11.14	12.71	12.92	13.04
Fuel exports (% of merchandise exports)	3.77	4.10	3.78	2.42	3.52	7.63	5.31
Manufactures exports (% of merchandise exports)	80.48	82.25	81.72	82.36	79.05	74.31	76.23
High-technology exports (% of manufactured exports)	9.78	10.08	11.07	11.94	11.49	11.61	..

Source: World Bank, (09, 2024), [a] Trading Economics, (09, 2024 computed as average from quarter values

2.1.1 Nature of Market Leadership

Sanodor's expertise in wool allows the production of high-quality wool duvets that provide optimal comfort and quality sleep through effective thermoregulation,

draping, and sustainable practices. The product filling is light, warm, and odorless. The products are meticulously crafted to precise technical specifications to facilitate the transfer of moisture outside the bed, thereby regulating body temperature. While they cannot compete with the larger duvet manufacturers, they have identified and filled a niche market that is underserved by other manufacturers. They offer the highest quality wool duvets that are 100% natural, comfortable, durable, and sustainable.

2.1.2 Nature of Competitive Advantage

Sanodor designs and manufactures high-quality wool duvets that provide comfort and quality sleep through excellent thermoregulation, drapability, and sustainability.

The main factors contributing to the company's success can be attributed to three key areas: innovation, responsiveness to customer needs, and fostering collaboration with small, family-owned businesses in Germany for both wool processing and linen. In addition, the company has developed customized equipment for removing odors from wool and offers a comprehensive range of duvets and bed linen in various sizes and thicknesses, tailored to the typical sleeping habits observed in the European Union.

2.1.3 Core Lessons Learned on the Path to Success

There are four key lessons:

1. Long-term success comes from serving the customer.
2. Develop a reliable system to collect feedback and involve your partners in the process (Sanodor use it every six months and randomly survey minimum 100 customers every year about their experiences).
3. Analyze your feedback and survey data. Sanodor reduced return and replacement rates.
4. Develop and adapt your products and services after listening to your customers (whether they buy directly or virtually, including social-media).

2.1.4 Management and Leadership Development Needs

As Sanodor grows, the extended product lines, customized sizes, and number of export countries, it needs to implement adequate systems to deal with high diversity/number of products and dimension range, according to country and sleeping habits. Now the number of customers and product portfolio is very large compared to a decade ago. As a result, it has become almost impossible to manage them using Excel files, purchase orders, and email. This increased complexity has also made

financial and performance analysis more difficult, and Sanodor will invest in an ERP system to improve its operations. Both employees and managers will learn, adapt, and make a successful transition that will increase the efficiency and effectiveness of daily operations.

Piatra Neamț is a county capital, but relatively small. The city lacks professionals in finance, sales and marketing. There are few young, educated graduates. It's hard to find locals with expertise in digital design, image editing, and online marketing for sustainable products. These people should have the knowledge and expertise to manage relationships with international brands that work with Sanodor.

2.1.5 Financing and Regulatory Environment Development Needs

One of the main challenges for Sanodor is to adapt its business model and operations to price increases. Due to the very high inflation rate in Romania (9.7% in 2023 and projected to reach 5.9% in 2024 (European Commission, 2024, May 15), banks charged high interest rates for investment loans, and investment tax credits are disadvantageous compared to those from Germany. This made it difficult for Sanodor to compete in exports.

Romania had the highest annual inflation rate in August 2024 (5.3%), along with Belgium (4.3%) and Poland (4.0%). The countries with the lowest annual inflation rates were Lithuania (0.8%), Latvia (0.9%) and Ireland, Slovenia, and Finland, which all registered 1.1% (Eurostat—Euro Indicators, 2024 September 18).

Over the past decade, the price of online advertising has increased tenfold. As more and more customers are now buying online, companies are allocating higher budgets for marketing and advertising. If in the first years of its existence Sanodor had a budget of 5% of its turnover for marketing; in 2024 it uses about 200,000 Euros, representing about 15% of its turnover. The company estimates that it would need 25% of its revenue for online promotion and marketing, but such an amount is not accessible. Sanodor would also benefit if universities became bridges between academic learning and the needs of the private sector for practical application of knowledge, needs that include the Small and Medium Enterprises (SMEs) sector.

2.1.6 Pandemic's Impact on "Hidden Champions" Business Approach

The first two weeks of the closure were very difficult as people stopped buying and Sanodor went into "survival mode." However, Sanodor saw an opportunity in the closure of brick-and-mortar stores such as Ikea, JISK, and City Mall, as there were significant transportation difficulties. Many companies tried to cut costs and stopped online advertising, which was a great opportunity for Sanodor. They started online advertising with simple messages such as "Comfort from your home" and "A good night's sleep." But they were able to support local efforts to supply hospitals with masks, medical protective suits for surgeons, and surgical suits for hospitals; using raw materials from the Piatra Neamț community. It was all quiet online. But even

without export, by producing face masks and medical garments used during the SARS-CoV-2 pandemic, Sanodor had a higher turnover in 2020 than in 2019.

2.1.7 Effects of the Ukraine War on "Hidden Champions" Business Operations

Just after Sanodor invested in the new premises located in an industrial park on the outskirts of Piatra Neamț, the war in Ukraine started. The world stopped. Their foreign partners were frightened by the lack of information and uncertainty. They were kind and supportive, inviting Oana and Cătălin to come over as refugees. It was not necessary because everyday life in Romania was not affected by the war. There was a lot of stress, but not because of the conflict, which took place outside the country's borders. Probably the main causes were ambiguity, lack of clear and trustworthy information, which in turn fueled possible alarming and intimidating scenarios regarding fighting so close to the Romanian borders. It took some time to convince export partners to continue placing orders and that life in Romania was normal. Export kept them busy, especially from Canada and the UK. Soon online orders recovered and the company could function normally.

2.1.8 "We Love Wool"

Founded in 2014 by Oana and Cătălin Tatu as a family business, the company produces duvets, pillows, mattress protectors, and bed linen using natural, high-quality raw materials, unbleached and undyed. After 1990, everything that was imported was considered better by most Romanians. Thus, the 5-cm thick woolen blankets used by our grandparents disappeared. But Oana and Cătălin saw that wool was used in USA, France, Australia, UK, Spain, Denmark, and all over Europe. They decided that through education, it should become popular also among Romanians living in houses and apartments. But wool was associated with bad smell (like naphthalene used to protect it from clothes moths) and prickling. So, they started their journey to improve wool duvets, benefiting from Cătălin's knowledge and expertise as a textile engineer.

Their first customers were people over 60-years old who could no longer buy from the old village workshop that used to make thick wool duvets, as they all closed down for lack of customers. This market segment was happy to find a high-quality equivalent wool product that was 100% natural, lighter, odorless, beautifully designed, and incredibly comfortable. Based on their experience, they repeated the purchase and sent the product to their children abroad in Italy, Spain, and the UK; to name just a few EU countries. And the kids loved it, so Sanodor decided to open its online stores.

They started working with a Romanian wool specialist and together they developed the first wool filling for duvets according to Sanodor's technical specifications.

The result had a spectacular effect on the quality of the product, which has since been continuously improved.

Many customers who ordered a duvet found it to be far beyond their expectations. They did not believe that it could provide so much comfort, as their reaction was "I have not slept so well since I was a child." Such sincere and emotional feedback on the websites gave Oana and Cătălin a positive, vibrant energy that made them eager to come to work every day.

A decade ago, the investment was small and the price of the product was high compared to salaries, rent, and taxes, allowing the company to be self-financing.

Their love for wool and successive improvements based on research and innovation allowed them to develop a duvet that is light, warm, and odorless. It wicks moisture out of the bed and regulates body temperature. In order to design and manufacture the highest quality duvet, they compared competitive products in terms of comfort, durability, sustainability, and health hazards.

To continue to grow in international markets, Sanodor needed a larger volume of high-quality wool filling. It had to be produced according to their technical specifications and certified in the EU and worldwide. The challenge they faced was to find a strategic partner who could reliably supply high-quality wool according to Sanodor's design requirements. They identified and developed a strategic partnership with a small German family business with a long tradition in wool processing. There were several iterations from the first sample of filling provided to the German partner until, based on Sanodor's feedback, they produced an excellent wool filling that met all the technical criteria. Sanodor uses only natural, high-quality materials for the linen.

It has a very specific density/m^2, physical structure, and composition. This gives the filling a high thermoregulatory capacity, which is the main function of the duvets. This combination also enables excellent draping as the ability to stay in contact with the human body. The only duvets that have a higher draping capacity are those with silk fillings, but silk has a lower thermoregulatory capacity compared to Sanodor's wool. Goose down fillings have excellent thermoregulatory capacity, but poor draping.

Comfort includes both thermoregulation and drapability. Innovation has allowed them to design specific densities/m^2 for thin and thick duvets adapted to specific temperature ranges (i.e., 18^0–22 °C, 23^0–26 °C, or four seasons sets) with excellent thermoregulating and draping capacity. They are superior to quilts made of goose down, cotton, silk, polyester, or microfiber.

Wool also has a natural fire resistance and low price for the technical proprieties that it provides.

Conventional sewing machines used in the manufacturing process were a technical limitation to increase sales and growth of the company. Therefore, in 2018, the company purchased a CNC quilting machine with EU funding, which improved quality, productivity, and product variety.

Although it is a significant cost for the company, attending important trade fairs such as Heimtextil in Frankfurt every year has given Sanodor the opportunity to see and be seen, to learn about the latest trends in colors and materials, and to attract

export customers. Today, about 40% of the company's turnover comes from exports to the UK, the USA, and EU countries.

The key factors for success are innovation to solve customer needs, cooperation with small family businesses in Germany for both wool processing and linen, custom-made equipment to remove odor from wool, and a large range of duvet and linen sizes and thicknesses based on EU sleeping habits.

There are over 30 duvet sizes in Europe, with significant differences from northern to southern countries. Analyzing different cultures shows that people sleep in different bed sizes, some use a single large bed mattress while others use two single mattresses to allow for different softness and duvet. Some like their house to be very warm in winter, while others keep it cold. Sanodor has seen this range of behavior as an opportunity to adapt to customer needs and increase its product diversity to respond to market diversity. Unable to compete with the large duvet manufacturers, they focused on niches that were not well served. They concentrated on high-quality duvets with wool filling.

Finding and educating customers about comfort and a good night's sleep is one of the company's future challenges, as sometimes people decide to buy based on price alone.

The company encourages employee involvement and responsibility for quality. They will report any problems on the production line that may affect the quality of the duvet. If they can, they will be adequately addressed and resolved or will ask for help and technical support.

The company now serves a large customer base and offers a wide range of products. As a result, it has become increasingly difficult to manage these processes using Excel files, purchase orders, and email. The increased complexity has also made financial and performance analysis more difficult. In response, Sanodor is ready to invest in an ERP system to improve operational efficiency.

Piatra Neamț, where Sanodor is located, is a county capital, but is relatively small compared to larger cities. As a result, the city fails to attract a significant number of highly qualified professionals in finance, sales, and marketing. There is a lack of young, well-educated graduates choosing to work and live in the city. It is difficult to find locals with expertise in digital design and image editing, content creation, and online marketing for sustainable products. These individuals should be able to manage the interface and relationships with international brands and online stores where the company operates online. Sanodor has developed a system to collect customer feedback through a variety of channels, including social media, online stores, and direct requests for feedback at specific intervals, namely sixty days, one year, three years, and five years from the date of purchase. On an annual basis, they and their international partners conduct surveys of 100 new and existing customers. Using a random sample, they ask for feedback and satisfaction using standardized questions. The data is then analyzed with the goal of improving the quality of their products. This includes reducing the number of returns or product replacements.

3 Case Study 2

3.1 Electra Group

Overview

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Company Information

Industry: Manufacture of loaded electronic boards (loaded printed circuit boards), manufacture of communication equipment (door phones)
Year of Establishment: 1991
Sales Revenues in 2017: 7.31 million euros
Sales Revenues in 2023: 8.44 million euros
Average number of employees in 2023: 126
Brainer behind the company: Marian Berdan, CEO

3.1.1 Nature of Market Leadership

As it enters its 35th year of operations, Electra Group maintains its position as the dominant player in the Romanian access control market. The company's product range includes access control, interphone systems, and door phones, which it designs, manufactures, and provides services for. With an 80% market share in Romania, the company has expanded its operations internationally, with exports accounting for approximately 30% of its total revenue. The company has established an office in Vienna, Austria (ELEKTRA Building Communications GmbH), through which it oversees the international distribution of BELLCOME products. The company's products are available for purchase via the online platform Conrad. The group is currently active in Austria, Germany, Switzerland, Belgium, Northern Africa, Great Britain, Poland, and the Republic of Moldova.

3.1.2 Nature of Competitive Advantage

The competitive advantage of the Electra Group is shaped by a combination of technological and cultural factors.

Technological drivers include research and development (R&D) and in-house manufacturing capabilities.

The company's expertise and experience in R&D are crucial factors that contribute to its competitive advantage and enable it to maintain a strong presence in the market, particularly in the context of a shrinking product lifecycle. The Electra Group allocates approximately half a million euros annually to its research and development team. The products were designed with aesthetic appeal and user-friendly features and interfaces. Over the years, the company has been awarded several patents and certificates of industrial design by the State Office for Inventions and Trademarks (OSIM Bucharest).

It is a daunting task to manufacture products to the requisite specifications, and the challenges faced by engineering companies in integrating their production systems are often undervalued by the general public. For Electra, the context is even more challenging due to the lack of alternative small suppliers in its geographical vicinity that could provide parts and sub-assemblies, thereby supporting horizontal integration.

Prior to the advent of the pandemic, Electra made a substantial investment and relocated to its new 11,000-square meter, state-of-the-art facilities. The modern design facilitated the integration of workflows within the company's specialized compartments, with each compartment benefiting from new and highly efficient machinery and industrial robots. These endeavors enhanced operational efficacy and enabled the company to effectively compete against East Asian rivals.

From a cultural standpoint, the company benefits from Mr. Berdan's personality and leadership style. The company's success can be attributed to its vision and perseverance in achieving its goals. He recognized the necessity of a competent human resources (HR) workforce and implemented effective policies to recruit and retain individuals with a proclivity for technical pursuits. There is no other engineering company in Iași that offers its employees the opportunity to express their creativity, flourish, and take pride in their achievements.

The company's business model enabled it to design and manufacture high-quality products and to install and service its systems through key partners in various locations throughout Romania. Electra has established robust internal mechanisms for monitoring customer needs and complaints. In the event that such monitoring identifies the need for assistance, the company is equipped to provide customers with fast and reliable customer service. A comparable operational model is employed in the company's international markets.

For 35 years, Electra has served as a trusted access point for Romanian customers "in Romanian pockets—as access key," as evidenced by the company's reputation for reliability and trustworthiness. Its interphones and control access systems have been instrumental in fostering this perception, establishing the brand as a reliable and dependable partner in the Romanian market.

3.1.3 Core Lessons Learned on the Path to Success

The company's culture is guided by six core values:

1. Passion—The company's dedication to the design and manufacture of video and audio door phones and access control systems is a reflection of its substantial experience and the multitude of potential avenues for growth. The company is thus prepared for new opportunities and growth, ensuring that the Electra Group will be ready to capitalize on these developments when they arise.
2. Innovation is a prerequisite for progress. In order to maintain a competitive advantage, it is essential to continuously monitor customer needs, emerging technologies, and design trends.
3. Quality—The path to achieving it is not one that can be bypassed. Such a strategy necessitates a long-term commitment and investments in order to ensure survival and success in the marketplace.
4. Simplicity and elegance—the products were designed by professionals to be aesthetically pleasing, elegant, and modern, while also being technically sophisticated, Electra's products are "complex but not complicated."
5. Authenticity is another key aspect of our design philosophy. We endeavor to create a 100% Romanian product that reflects pride and quality, and is worthy of the Romanian reputation for excellence.
6. Respect for people—Electra places a premium on the value of its human capital and is committed to ongoing HR investment, ensuring that employees are a primary asset for the company. These factors enable the company to provide customers with superior products across the R&D, manufacturing, and support phases. The use of state-of-the-art technology allows for the reduction of costs while simultaneously minimizing the number of defects.

3.1.4 Management and Leadership Development Needs

Although there are no apparent deficiencies in terms of knowledge, competencies, or skills, CEO Marian Berdan is preoccupied with the company's succession, which is a family business (as he owns 80% of the company). One potential avenue for consideration is the listing of the company on the Bucharest Stock Exchange.

3.1.5 Financing and Regulatory Environment Development Needs

Electra is currently pursuing further development based on an analysis of market knowledge and growth potential. The company has access to modern manufacturing equipment, a highly qualified workforce, and optimized production flows.

While robust domestic demand is fueling growth, ongoing wage increases and a projected high government deficit, according to EU forecasts (European Commission, 2024, May 15), are posing challenges. In light of the aforementioned

economic projections, which indicate a lack of legislative and fiscal predictability, Mr. Berdan has chosen to refrain from pursuing any further investment opportunities or projects funded by the European Union.

In its ongoing pursuit of growth, Electra is seeking to extend its product range to encompass small buildings. This strategic decision is based on the company's substantial expertise in the domain of large-scale residential complexes. In the context of the ongoing conflict in Ukraine, the company has become increasingly aware of the necessity for enhanced data protection and digitalization for video interphones, which now encompass data transmission, sound, and video stream. In order to address these needs, it is imperative that more robust security protocols and protection against cyber-attacks be implemented. In addition to the imperative of incorporating novel and enhanced functionality into its product range, Electra must persist in its endeavors to further reduce production costs through the implementation of design principles aimed at facilitating automated assembly and automation.

3.1.6 Pandemic's Impact on "Hidden Champions" Business Approach

The company demonstrated resilience and adaptability during the SARS-CoV-2 pandemic by maintaining continuous operations. All recommended measures for preventing virus transmission were implemented, and the company became compliant with medical protocols. Furthermore, the company was fortunate to have a sufficient supply of raw materials, which allowed it to focus on manufacturing.

Conrad Electronic offered the company the opportunity to expand its reach into the European market, where at that time its larger Chinese rivals such as Hikvision and Huawei were not present. Throughout the majority of the pandemic, Electra was the sole Eastern European supplier. Consequently, individuals with access to the Conrad distribution system procured and installed Electra systems in their residences. Detailed instructions were developed to facilitate customer-driven installation of the systems, eliminating the necessity for external technical assistance. The equipment was aesthetically pleasing and dependable, performing admirably in the domestic settings in which it was installed.

3.1.7 Effects of the Ukraine War on "Hidden Champions" Business Operations

The conflict in Ukraine had no discernible impact on the Electra Group, either in terms of its operations in Romania or its global customer base. As a consequence of the company's policy of self-reliance in terms of in-house manufacturing, the potential impact of any disruption in the supply chain is minimal.

3.1.8 Tenacity and Determination in Pursuing a Dream

As it enters its 35th year of operations, Electra Group remains the dominant player in the access control market. The company has maintained its market share of over 80% in Romania based on the superior quality of its products, which have over time been perceived as reliable and trustworthy by end users. In order to adequately manage and coordinate the complexity of the R&D and manufacturing system, the Electra Group was formed in 2008 through the division of the production facilities into three specialized firms. The Electra Group comprises three distinct entities:

1. ELECTRA, a producer of video door phones and access control systems,
2. PCB-ELECTRA, a producer of printed circuit boards, and.
3. EMS-ELECTRA, a supplier of SMD & THT electronic assembly services.

The group has since expanded and now operates an office in Vienna, Austria (ELECTRA Building Communications GmbH), as well as a BELLCOME international products brand, which has enabled the creation of an international distribution network. The company operates in Austria, Germany, Switzerland, Belgium, Great Britain, Poland, and the Republic of Moldova.

The company's product range has evolved from the PASS Analog to the PASS Digital and, most recently, the Touch Line (comprising the Smart+, Extra and Security models) and Access Line ranges. This evolution is the result of the company's innovative design capabilities.

The latest developments incorporate more complex functions, such as access control (including video interphone) to a specific apartment from a large residential compound using any of multiple entrances/access points. The Touch Line—4 Wires system may be installed in residential buildings with one to eight families and apartment buildings with up to 40 apartments. The Touch Line—Residential system may be installed in buildings with up to 255 apartments and provides solutions for residential centers. The product range is designed to appeal to both Romanian and international customers, offering a sophisticated yet accessible selection of items characterized by a natural and enduring elegance. The product is manufactured from chemically toughened glass, which ensures that it is resistant to scratching and shocks, impermeable, easy to maintain, and retains its polished appearance over time. Its minimalist design combines intuitive functionality with advanced technical specifications. The slim design, premium appearance, and accessible prices of these products provide appropriate solutions for houses, apartment buildings, and residential centers.

The company's success can be attributed to two key factors: innovation and passion. Marian Berdan, the company's founder and CEO, is an advocate of resilience. In order to achieve one's aspirations, it is imperative to persevere in the pursuit of one's goals.

Romanian customers are aware that, over time, should their existing Interphone system require servicing, they can rely on Electra to dispatch a team to address the issue. Moreover, customers have the option to upgrade their access control system with a new, state-of-the-art Electra model.

Operating from a new, modern, aesthetically pleasing, and functionally efficient 11,000-square meter facility, Electra allocates a significant portion of its resources toward innovation, with approximately half a million euros dedicated to research and development salaries. Additionally, the company manufactures over 90% of its products internally across all three specialized entities that comprise the group. The facility contains a number of specialized compartments, some of which serve the entire Electra Group. The most significant of these is the research and development (R&D) department, which comprises mechanical engineers specializing in die design and manufacture, electrical and electronics engineers responsible for circuit board design, and technicians.

PCB-Electra is responsible for circuit design, while the shop floor is equipped with machinery that manufactures and tests circuits prior to and following the assembly of electronic components. This process significantly reduces the incidence of defects. EMS-Electra has access to specialized equipment and robotic systems for electronic and mechanical assembly.

A dedicated area on the production floor is allocated to injection molding, while another is designated for mechanical operations involving presses and dies, which are used to manufacture mechanical parts and various types of cases or enclosures for electronic devices.

The integration of production facilities has enabled Electra to become self-reliant, reduce product manufacturing time, defect rates, and costs. It is regrettable that other smaller Romanian producers of interphones and access control systems were unable to withstand the competition from eastern Asian manufacturers and subsequently ceased operations.

A portion of the research and development team is dedicated to the advancement of robotized assembly design. Such endeavors are oriented toward reducing costs and enhancing quality, necessitating that Electra invest in cutting-edge equipment and technology. The products are now designed with the objective of facilitating automatic assembly, and the plant has six operational robots. Plans have been made to introduce another six robots over the next couple of years, including robots for plastic molding. In order to maintain its competitive advantage, the Electra Group must enhance functionality with new features while simultaneously reducing costs and improving quality through automation and robotization.

Furthermore, Electra regularly exhibits at international trade fairs, including Light + Building in Frankfurt and Expo Seguridat in Mexico. Such attendance offers the opportunity to gain insight into the latest products on the market, to learn from the experience of exposure to these products, and to gain an understanding of the needs and desires of potential customers. Such interactions provide a robust foundation upon which to base future product redesigns and improvements.

One of the challenges currently facing the Electra Group is the introduction of a product range for houses and small buildings, based on the company's considerable expertise in the field of large residential complexes. Another challenge that has emerged since the onset of the Ukraine war is the protection of data and the digitalization of video interphones, which now include data transmission, sound, and video streams. These systems require enhanced security protocols and protection

from cyber-attacks. One of the future challenges for Electra is identifying an appropriate successor who will continue and build upon Mr. Berdan's values and results, as he owns 80% of the business. One potential outcome is listing the company on the Bucharest Stock Exchange (BSE).

4 Case Study 3

4.1 Romsoft

Overview
Address: Chimiei 2 bis, Excel Business Center, 700391 Iasi, Romania
Tel: +40 332 800002
Fax: +40 232 266831
Email: office@rms.ro
Web: http://www.rms.ro

Company Information
Industry: Computer programming activities
Year of Establishment2001
Sales Revenues in 2017: 2.63 million euros
Sales Revenues in 2023: 5.66 million euros
Average number of employees in 2023: 117
Brainer behind the company: Dorin Cristea, CEO and founder

4.1.1 Nature of Market Leadership

Romsoft is a provider of unique, customized software development solutions for its clients. As the software packages are integrated into their clients' applications, he can be considered a "hidden" champion. Approximately 40% of the company's sales turnover is derived from the medical industry. Its scope encompasses applications tailored to specific laboratories, automated robots deployed within medical laboratory settings, and blockchain technology in the medical industry. Additionally, the company produces specific software programs for the management of medical data for a big medical company in Germany, a branch of a Japanese corporation. Such collaboration necessitated adherence to all pertinent quality standards for software in the medical industry. Additionally, the applications developed for desktop, software as a service (SaaS), mobile, and add-ons to PowerPoint for Office Timeline, which accounts for approximately half of its revenue, are also classified as "hidden." The remaining 10% is derived from their participation as partners or beneficiaries in international and national research grants.

4.1.2 Nature of Competitive Advantage

The company demonstrates considerable expertise in the application of artificial intelligence (AI) and machine learning (ML) for image recognition. Such examples include quality control in the automotive industry for sub-assemblies that require visual inspection and medical Imagistics that may support physicians' diagnoses and decision-making processes. Moreover, the company possesses expertise in blockchain technology, which facilitates information sharing within a business network. This sophisticated database mechanism stores data blocks that are linked together in a chain.

The medical laboratory industry provides a reliable source of revenue, exhibiting minimal fluctuations in sales during periods of economic downturn or expansion.

With over two decades of experience, competitive pricing, a highly skilled workforce, reliable software solutions and maintenance, and a commitment to long-term customer relationships, Romsoft has established itself as a reliable partner in the industry.

4.1.3 Core Lessons Learned on the Path to Success

The companies for which the software is being developed tend to be discreet regarding their suppliers, particularly if the supplier provides excellent value for money and maintains a competitive edge. Consequently, Romsoft proceeded to further develop its ecosystem in collaboration with its major customers, with a view to grasping and anticipating the needs and requirements of the end user. The value created is contingent upon a company culture that is predicated on a positive work environment, wherein human resources (HR) are duly compensated in terms of personal development, flexibility, and performance-related pay. A system of compensated time off is made available to employees who require time to acquire new knowledge and skills.

Engaging Romsoft as a partner in international research programs in collaboration with foreign universities and research entities not only generates revenue for the company but also has a beneficial impact on its human resources. Such involvement offers opportunities for professional growth, learning, and new challenges that would make the participating employees proud of their achievements, enhance their esteem, and facilitate their self-actualization.

4.1.4 Management and Leadership Development Needs

Romsoft maintains a competitive position by remaining well integrated within the ecosystems of its key clients. However, considering the particularities of their services and the company's integration within their ecosystems, Romsoft does not have a sales department. Just a business development unit, with an underdeveloped sales

subdivision that needs further development based on enhanced cooperation with Romsoft key customers.

4.1.5 Financing and Regulatory Environment Development Needs

While the Romanian government implemented a substantial increase in taxation for the Information and Communication Technology (ICT) sector in 2018, the primary challenge confronting the company is the imperative to enhance remuneration for HR, which elevates operational expenses. This phenomenon persists even when all HR personnel originate from Romania, as stipulated by major clients for personnel engaged in their projects. While inflation does not represent a concern for the company, the lack of legislative stability, predictability, and the extremely high deficit based on borrowing must be addressed for the benefit of a healthier Romanian economy.

Although the company recruits some graduates who are pursuing doctoral studies or have already obtained a doctoral degree, it would be advantageous if the legislative framework were less conservative and permitted universities to update their curricula more rapidly, thereby aligning them with the frequent changes occurring across industries. In the field of information and communication technology (ICT), it would be advantageous for curricula to encompass the most recent software (such as Java) and technologies, as some of the taught material is three to five years old.

4.1.6 Pandemic's Impact on "Hidden Champions" Business Approach

For a considerable proportion of employees in the ICT sector, the option of working from home has become a standard expectation. However, over time, there has been a notable shift in staff behavior, with only 10% of them currently reporting to the physical office. This transformation has been propelled by a desire for enhanced autonomy over both personal and professional domains. Notwithstanding the apparent reduction in physical contact, work performance has remained consistent. One challenge associated with remote work is the potential for employees to feel less connected and engaged with the company, given the lack of regular physical interaction. Such circumstances could conceivably result in feelings of alienation.

4.1.7 Effects of the Ukraine War on "Hidden Champions" Business Operations

The conflict in Ukraine had no discernible impact on the company's operations. Neither their established and loyal customer base nor their research partners in international projects exerted any influence on business activities. However, in the ICT market, a prospective major client from the US tourism industry, who had previously engaged in discussions and appeared to be prepared to enter into a

contractual agreement, likely became deterred by the proximity of the conflict to the Romanian border and ceased negotiations.

4.1.8 "Hidden" in Key Customers' Ecosystem, Swelling in International Research Projects

Founded by Dorin Cristea and Nicu Popescu in 2001, Romsoft benefited from their expertise, enthusiasm, and professionalism. The software company has a unique blend of stability and engagement in challenging projects by providing custom-made software and applications for its clients. Their major areas of expertise include the medical industry, office applications for desktop, mobile, add-in and participation in international research projects whereas a partner Romsoft holds specific knowledge and expertise.

The custom-made software for medical analysis focuses on automatization in laboratory work, blockchain, and health data collection and analysis integrated in various medical data management applications. Romsoft is responsible for developing software solutions and it is recognized as a stable and reliable provider. Being "Hidden" with SYSMEX Europe' ecosystem. Therefore, any of the classical marketing mechanisms cannot be applied because are not relevant. Due to its cooperation within SYSMEX Europe, its quality management system is compliant with specific standards required by software for medical devices such as IEC 62304 and ISO 13485 and was successfully audited, as part of Sysmex Integrated Quality Management System.

Romsoft success bases on competitive prices for software solutions in Eastern Europe, long-term cooperation with key customers, know-how and integration in software development processes, and excellence in software quality. The company does not make specific efforts to maintain its major clients. It just focuses on doing a job well done day after day.

There are mechanisms to identify and understand customer and end user's needs, which are transformed into specific features and included in the software, so the computer program does what the customer expects it to do. These continuous improvement steps provide stability, trust and reliability built in its 24 years of existence leading to confidence in future symbiosis and cooperation.

Software quality would not be possible without excellent HR. They are creative, satisfied with their flat and flexible culture and benefits. There are opportunities for personal development, growth, and performance-based promotions; employees being proud of the results of their work.

Partnership in many projects since 2008 (see Fig. 1), the company provided expertise in three categories of research: eHealth, data privacy and blockchain, and others.

EMIM is a free online management platform developed by Romsoft for doctors, patients, and pharmacists. It is designed to simplify data administration and management, providing quick access to patient medical information and improving collaboration between healthcare professionals.

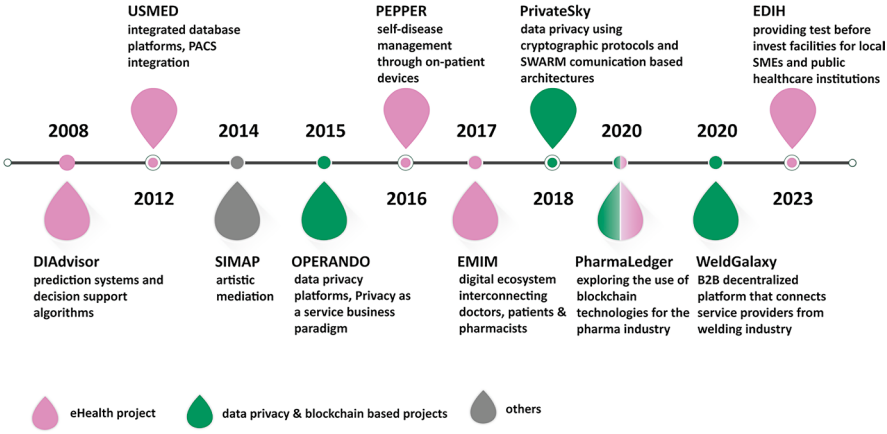

Fig. 1 International projects where Romsoft was involved since 2008 classified on their specific expertise. (Source–Rom soft internal document)

The platform primarily serves doctors who want to manage their practices in a virtual, integrated environment. EMIM allows the creation of a virtual practice from scratch and offers features such as appointment scheduling, service management, payment tracking, inventory control, and online communication with laboratories. Both doctors and patients can access the platform directly from a browser, without the need to install any software. With patient consent, doctors can securely share medical records with other practices. Moreover, EMIM supports telemedicine for remote consultations.

Coordinated by Alexandru Ioan Cuza University from Iași, Romania, the PrivateSky project aims to develop an open-source, decentralized platform for secure data sharing and privacy management.

It seeks to enable individuals and organizations to maintain control over their data while sharing it in a secure, trusted environment. By leveraging advanced cryptographic techniques and blockchain technology, PrivateSky facilitates privacy-preserving decentralized applications (dApps), addressing the needs of privacy-sensitive sectors such as healthcare, finance, and supply chain management. Romsoft provided essential technical support in designing the platform's architecture and implementing various decentralized applications. Their expertise ensured the platform's scalability, security, and user-friendliness, allowing it to serve real-world use cases. Romsoft's contributions helped bridge the gap between the theoretical framework and practical solutions, bringing blockchain-enabled privacy tools to a wide range of industries.

WeldGalaxy is a European initiative designed to create a digital marketplace that connects manufacturers, suppliers, and end users in the welding industry. The platform facilitates the exchange of welding equipment, consumables, and services while fostering collaboration and innovation. Leveraging PrivateSky technologies, WeldGalaxy ensures secure and decentralized data sharing, allowing stakeholders

to conduct business with trust and transparency. Romsoft developed a decentralized tendering/bidding application for materials used in the welding industry. This dApp, powered by blockchain, enables suppliers and buyers to securely submit and manage bids, ensuring the confidentiality and integrity of sensitive business information throughout the process. Romsoft's contributions provided a robust solution for streamlining procurement and bidding while maintaining privacy and security within the WeldGalaxy ecosystem.

PharmaLedger is a collaborative initiative that involves various stakeholders across the healthcare industry, including pharmaceutical companies, regulators, healthcare providers, and technology firms. The project's primary focus is on using blockchain technology to improve transparency, security, and efficiency within the healthcare ecosystem. It aims to create a blockchain-based platform that addresses key challenges like counterfeit drugs, supply chain inefficiencies, patient data security, and clinical trial management. By leveraging blockchain's decentralized and immutable nature, it seeks to build trust among all participants while promoting innovation in healthcare solutions. As a key technology partner, Romsoft brings in its expertise in software development and healthcare technology and supports the design and implementation of blockchain-based solutions within the project's framework. Its primary focus is to create the technical architecture that supports various healthcare applications using blockchain technology.

The DiZ-EDIH (Digital Innovation Zone—European Digital Innovation Hub) project is part of the European Commission's initiative to establish a network of hubs that drive digital transformation across Europe. These hubs provide small and medium-sized enterprises (SMEs) and public organizations with access to cutting-edge digital technologies, expertise, and support. The goal of DiZ-EDIH is to foster the adoption of advanced digital solutions such as artificial intelligence, cybersecurity, and big data, helping businesses improve efficiency, innovation, and competitiveness. The project is particularly focused on underdeveloped regions, aiming to bridge the digital divide and promote innovation in key sectors like healthcare, manufacturing, and agriculture.

RomSoft plays a key role in the DiZ-EDIH project, bringing its extensive expertise in software development and healthcare technology to support the digital transformation of the healthcare sector. RomSoft collaborates with healthcare providers such as clinics to create innovative digital solutions that improve patient care and streamline administrative processes. These solutions include systems that enable personalized medicine, allowing healthcare providers to offer more targeted treatments based on individual patient data. RomSoft also focuses on enhancing communication between doctors and patients through digital platforms that simplify appointment scheduling, facilitate real-time consultations, and provide easy access to medical records.

As part of DiZ-EDIH, RomSoft is also involved in helping healthcare providers integrate emerging technologies into their practices. By leveraging artificial intelligence and big data analytics, RomSoft enables clinics to gain deeper insights into patient health trends, optimize treatment plans, and improve overall patient outcomes. Through its involvement in DiZ-EDIH, RomSoft is helping to drive the

Table 1 Detailed budgets for projects where Romsoft was partner since 2027

No.	Project Name	Business description	Grand Amount	RMS contribution	Total budget
1	EMIM	eHEALTH	€ 535,337	€ 392,173	€ 927,510
2	PrivateSky	blockchain and data privacy	€ 139,862	€ 47,933	€ 187,795
3	WeldGalaxy	blockchain	€ 347,375	€ 132,192	€ 479,567
4	PharmaLedger	blockchain	€ 1,058,561	€ 0	€ 1,058,561
5	DiZ-eDIH	eHEALTH	€ 240,750	€ 0	€ 240,750
TOTAL BUDGET			€ 2,321,885	€ 572,298	€ 2,894,183

digital revolution in healthcare, ensuring that both public and private healthcare organizations can harness the full potential of digital innovation to provide better, more personalized care to patients. Since 2017, Romsoft was a partner in five projects with a company's budget of 2.89 million euros and a total contribution of 0.57 million euros (see Table 1).

In Romsoft, there are no periodic re-qualifications as all staff engage learning whenever new customer requirements, technologies, and software requires it. Many have experience in working in international projects with distributed teams and all have and European Engineering Mindset. While the pressure on higher salaries affected Romsoft, the ICT industry is now affected by the economic crisis from other industries. Massive layoffs from large software companies including the giants from United States had reduced the pressure on salary in Romania. Now the company can recruit highly skilled personnel much more easily. The company has excellent collaboration with universities from Iași for recruiting graduates, PhD students, providing internships placements, and benefiting from specific development programs. Some of the HR come from Faculty of Automatic Control and Computer Engineering part of "Gheorghe Asachi" Technical University and Faculty of Computer Science at "Alexandru Ioan Cuza" University.

5 Conclusions and Recommendations

Sanodor's possesses considerable expertise in the design and manufacture of wool filings that adhere to exacting technical specifications, including density per square meter, physical structure, and composition. The entrepreneurial spirit of Cătalin and Oana has fostered a company culture that prioritizes innovation, sensitivity to customer needs, and robust manufacturing capabilities, including the use of CNC quilting equipment. Their strategic alliance with a small German enterprise that specializes in wool products has provided them with a competitive advantage in the niche market for high-quality duvets that promote a good night's sleep. The product range encompasses a multitude of sizes and thicknesses, catering to diverse sleeping habits within and beyond the European Union. Approximately 40% of Sanodor's

revenue is derived from exports. The company's products are distinguished by thermoregulation, drapability, and proprietary technology for odor removal; rendering them challenging to replicate. Sanodor engages in ongoing customer feedback collection through standardized questionnaires, enabling them to refine their products in accordance with customer preferences. The necessity for a new ERP system arises from Sanodor's expansion of product lines, introduction of customized sizes, and increase in export countries. Beyond the financial implications, the implementation of this system will necessitate proficiency in its use among both management and staff. The company's operating environment is becoming increasingly challenging, with Romania experiencing a significant inflationary pressure compared to the EU average and the cost of online advertising rising exponentially over the past decade, reaching approximately 200,000 Euros in 2024.

For the past 35 years, Electra has been engaged in the design and manufacture of access control systems, interphone systems, and door phones. The products are designed with an elegant minimalist aesthetic and are intuitive to operate, offering a balance between sophistication and simplicity. The company has expanded its operations internationally, with approximately 30% of its revenue generated outside of Romania, where it currently holds an 80% market share. The company's competitive advantage is largely attributable to its robust research and development (R&D) operations, which are allocated a budget of approximately half a million euros annually. The company's new, state-of-the-art facilities, spanning 11,000 square meters, facilitate the integration of advanced manufacturing capabilities, including the use of robots. The company is capable of manufacturing approximately 90% of its products internally, integrating research and development, design, manufacturing, and testing and assembly of printed circuit boards, injection molding, and case manufacturing. Another crucial factor contributing to its success is Mr. Berdan's personality and leadership style, which fostered a sense of pride among employees while simultaneously enhancing quality and reducing costs.

Romsoft is not readily identified as a software solutions provider due to its practice of integrating its offerings into the applications and ecosystems of its clients. The company provides bespoke software development solutions for the medical industry, including tailored applications for specific laboratories, automated robots within laboratory settings, blockchain technology and the management of medical data. Additionally, the company offers a range of applications for desktop, software as a service (SaaS), mobile and add-ons for PowerPoint. Additionally, the company has demonstrated expertise in the application of artificial intelligence (AI) and machine learning (ML) for image recognition in the context of quality control for visual inspection in both automotive and medical imaging, with the potential to support diagnostic and decision-making processes. The company's expertise has been utilized in international research projects, contributing approximately €three million to its budget since 2017. Of this amount, Romsoft's total contribution exceeded €500,000. The company's human resources are a significant contributing factor to its success, fostering a culture of excellence and innovation in new technologies. Based on a positive working environment, Romsoft promotes personal and professional development, flexibility, and adequate rewards that instill a sense of pride in

employees. Over two decades in business, the company has established itself as a reliable and stable provider, offering excellent value for money to its customers.

By addressing the financial deficit and adjusting spending, the Romanian government will foster a more favorable business environment, thereby reducing inflation and other identified vulnerabilities (European Commission, Institutional Paper 275, 2024, March).

It is evident that all manufacturing firms would benefit from specific measures aimed at increasing their export competitiveness. Such measures could include the provision of appropriate legislation and financial support for investment tax credits, which in Romania are currently disadvantageous compared to those available in Germany. Hidden Champions encounter challenges in recruiting highly qualified human resources. The recruitment of graduates who have undergone training and gained practical experience through internships would enhance the competitiveness of all companies. Universities should serve as interconnecting entities, facilitating the application of practical knowledge between the private sector (including SMEs) and academic learning. The legislative framework for higher education should be more flexible to allow for a more rapid alignment of curricula with changes in all business sectors.

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healthcare

MDPI

Article

The Impact of Moral Hazard on Healthcare Utilization in Public Hospitals from Romania: Evidence from Patient Behaviors and Insurance Systems

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Abstract: Background/Objectives: Moral hazard represents a significant challenge in healthcare systems globally, reflecting the tendency of insured individuals to over-utilize medical services when shielded from the full costs of care. Methods: This paper investigates the dynamics and implications of moral hazard within the Romanian public hospital sector, offering practical recommendations for healthcare policymakers to mitigate the financial risks associated with excessive healthcare utilization and ensure long-term sustainability. To achieve the objectives of this study, a quantitative research approach utilizing vignettes was employed. Vignettes allow for the simulation of real-world decision-making under conditions of insurance coverage, capturing nuanced behaviors that traditional surveys may overlook. Results: The study examined patient behaviors in the context of moral hazard in public hospitals in Romania, employing a quantitative approach based on vignettes. A total of 303 valid responses were collected. The findings indicate a significant tendency among insured patients, both publicly and privately insured, to opt for more expensive treatments compared to uninsured patients, who preferred more affordable options such as medication or physiotherapy. In the case of treatments for severe conditions, insured patients frequently chose combinations of higher-cost therapies, while uninsured individuals either delayed treatment or opted for less expensive alternatives. These results highlight the impact of moral hazard, driven by a reduced sensitivity to costs in the presence of insurance, and underscore the need for cost-sharing policies to mitigate the overutilization of medical resources. Conclusions: This paper uniquely contributes to the understanding of moral hazard by integrating insights from both Romanian public hospitals and international case studies, offering practical policy recommendations for mitigating the financial risks associated with excessive healthcare utilization.

Keywords: moral hazard; healthcare; Oregon Medicaid Experiment; insurance; healthcare policy

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1. Introduction

Moral hazard in healthcare refers to the tendency of individuals to alter their behavior due to the protection provided by health insurance, potentially leading to inefficient utilization of medical resources. Insured individuals become less concerned about the costs of care, thereby fostering overuse of services and neglect of preventive measures. This concept, introduced by Kenneth Arrow, highlights the increased demand for healthcare services as a result of insurance coverage [1,2]. In this context, moral hazard manifests in costly and sometimes unnecessary treatments, exacerbating healthcare system expenditures [3].

While moral hazard has been extensively studied in developed countries, limited research has addressed its manifestation in transitioning economies such as Romania, where public insurance plays a central role. This study analyzes the manifestations of moral hazard within the specific context of Romanian public hospitals and proposes strategies to mitigate its impact on service utilization and system sustainability. In contrast to the well-funded healthcare systems of many Western European countries, the Romanian public healthcare system faces significant challenges due to chronic underfunding and systemic inefficiencies, rendering it particularly vulnerable to moral hazard. Operating under a social health insurance model financed through employer and employee contributions, Romania's healthcare system remains under-resourced compared to other member states of the European Union. Public hospitals contend with inefficiencies that result in elevated healthcare costs and disparities in access to essential services. These structural vulnerabilities create conditions conducive to moral hazard, wherein both patients and healthcare providers may engage in practices that exploit insurance coverage, exacerbating service overutilization and further straining the already burdened system. International studies suggest that reducing out-of-pocket costs through insurance results in a significant increase in the consumption of healthcare services, including non-essential ones [4,5].

Einav and Finkelstein suggest that the term "moral hazard" is widely used to describe the notion that insurance coverage, by reducing the marginal cost of care for the individual (often referred to as the out-of-pocket cost of care), can lead to increased healthcare utilization. Health insurance may also incentivize individuals to exert less effort in maintaining their health. This shift in economic incentives not only promotes greater consumption of healthcare services but also discourages personal responsibility in maintaining health [1]. For instance, health insurance may diminish the perceived financial consequences of unhealthy behaviors, such as smoking or a sedentary lifestyle, thereby reducing individual motivation to adopt preventive health measures [5].

In addition to patients, health insurance also influences healthcare providers. Cutler and Zeckhauser [6] argue that providers may choose more expensive treatments or diagnostic tests, knowing that insurance will cover the costs, a phenomenon known as "supplier-induced demand" [3]. This behavior increases system costs and negatively impacts the sustainability of insurance schemes, particularly for low-income individuals [7].

The dual influence of moral hazard on both patients and providers highlights its critical role in the sustainability of healthcare systems. By mitigating financial risks, insurance can unintentionally promote riskier behaviors and heightened demand for services [8]. Addressing and managing this issue is essential for designing equitable and sustainable healthcare systems that ensure access without undermining financial viability.

Moral hazard arises when insured individuals can influence either the likelihood of an insured event occurring or the magnitude of the resulting financial loss. It manifests in two distinct forms: ex-ante moral hazard and ex-post moral hazard [9].

Ex-ante moral hazard refers to the tendency of insured individuals to adopt riskier behaviors, given that insurance reduces the financial burden associated with adverse health outcomes [3]. Behaviors such as unhealthy eating, physical inactivity, or smoking become more prevalent because individuals perceive that potential medical expenses will be covered by insurance. This phenomenon is particularly pronounced in systems offering comprehensive coverage with minimal cost-sharing by patients [10]. Studies indicate that insured individuals exhibit higher hospitalization rates for preventable conditions, reflecting reduced incentives to maintain a healthy lifestyle [11].

However, the actual impact of ex-ante moral hazard on individual behavior remains a topic of debate. Nyman argues that, while some individuals may take greater health risks, many are deterred by the non-financial costs of illness, such as income loss, physical suffering, and reduced quality of life [3]. For instance, the decision to smoke despite the risk of lung cancer cannot be entirely attributed to the mere existence of insurance, as the health consequences remain a significant deterrent [12].

In Romania, ex-ante moral hazard manifests as reduced engagement in preventive measures, such as regular medical check-ups or the adoption of a healthy lifestyle. Patients tend to prioritize reactive treatments, knowing that these are covered by insurance. This tendency reflects a broader pattern of neglecting prevention, a characteristic of transitioning economies.

The specialized literature offers limited empirical studies on ex-ante moral hazard, partly due to the challenges of quantifying the economic consequences of risky behaviors. This underscores the complexity of the relationship between the financial incentives provided by insurance, individuals' behavioral choices, and the broader psychosocial costs of illness [1]. Addressing this phenomenon requires a deeper understanding of how financial incentives influence health behaviors and amplify inefficiencies in the utilization of medical resources.

Ex-post moral hazard arises after the onset of an illness or injury, when insured patients become less attentive to the costs of treatment decisions, relying on insurance to cover most expenses [1]. This form of moral hazard encourages more expensive treatment options, such as newer medications, over equally effective generic equivalents. Combined with ex-ante moral hazard, this behavior significantly contributes to rising healthcare costs and the overburdening of public resources [13].

In Romania, ex-post moral hazard is evident in the increased demand for diagnostic procedures and costly tests once patients are covered by public insurance, despite the availability of less expensive alternatives. Unlike ex-ante moral hazard, which influences behavior prior to the onset of illness, ex-post moral hazard is driven by needs that arise after the condition has manifested [6]. This behavior leads to the overutilization of medical resources, resulting in higher healthcare system expenditures and increased insurance premiums, which undermine the sustainability of public insurance schemes.

Research by Einav and Finkelstein highlights that the financial impact of ex-post moral hazard is significantly greater than that of ex-ante moral hazard. Patients often utilize insurance coverage to access more expensive treatments, even when the additional benefits are marginal. For instance, patients may opt for minimally invasive surgeries, which are costlier, over traditional procedures that are equally effective, perceiving reduced financial risk [1]. This tendency is also observed in Romania, where patients favor innovative treatments despite their higher costs, reassured by the certainty that insurance will cover these expenses.

While both forms of moral hazard contribute to inefficiencies in healthcare systems, ex-post moral hazard has an immediate and substantial impact on costs. Addressing these challenges requires integrated strategies, including cost-sharing mechanisms, patient education, and aligning incentives between healthcare providers and patients to promote efficient resource use and ensure long-term sustainability.

This paper provides a novel perspective on moral hazard in Romania by examining the impact of public and private insurance on patients' medical decisions within public hospitals. Unlike general studies on moral hazard in developed economies, this research addresses a relatively unexplored topic in transitioning economies. A significant contribution of this study is the use of a vignette-based methodology, which enables the simulation of medical decisions across different insurance scenarios. This approach provides a detailed understanding of how insurance status influences treatment choices, thereby contributing to the development of policies aimed at enhancing the sustainability of Romania's healthcare system.

2. Healthcare Insurance Experiments

2.1. The Oregon Experiment

Over the years, various experiments have been conducted to investigate the effects of moral hazard within healthcare systems. One of the most renowned is the Oregon Health Insurance Experiment [1]. This experiment, conducted in 2008, provided a unique opportunity to study the impact of health insurance on healthcare utilization, particularly among low-income individuals. Oregon's Medicaid program used a lottery system to

randomly select uninsured citizens for Medicaid coverage, ensuring that selection was independent of participants' health status [14]. Out of 74,922 individuals who applied, 29,834 were randomly selected to receive Medicaid benefits, allowing researchers to observe a naturally occurring randomized controlled trial in healthcare coverage [15].

The Oregon Health Insurance Experiment yielded several notable findings over the two-year observation period. While Medicaid coverage did not result in significant improvements in physical health outcomes—such as control of hypertension, cholesterol, or diabetes—it led to increased healthcare utilization and other key benefits. Participants experienced higher rates of diabetes detection and management, reduced rates of depression, and alleviated financial strain associated with healthcare costs [15]. However, a prominent result was the 40% increase in emergency department visits, even for conditions that could have been treated in outpatient settings or prevented altogether [16]. This increase in emergency department usage is often cited as evidence of moral hazard, illustrating how individuals, once insured, may overutilize certain healthcare services regardless of the necessity for those services.

The Oregon Experiment has been instrumental in illustrating the complexity of moral hazard within the healthcare sector. It highlights the trade-offs between providing essential financial protection for vulnerable populations and the unintended consequences of increased healthcare consumption, particularly in emergency settings.

2.2. The RAND Health Insurance Experiment

Preceding the Oregon experiment, the RAND Health Insurance Experiment (HIE) remains one of the most comprehensive studies to date on the relationship between insurance structure and healthcare utilization. Conducted from 1974 to 1982, the RAND experiment was designed to rigorously assess how different cost-sharing structures in health insurance affect the demand for healthcare services [17]. Unlike the Oregon Experiment, which focused on the expansion of Medicaid, the RAND study evaluated a range of cost-sharing plans, providing a broader view of consumer behavior under varying financial incentives.

In the RAND experiment, over 5800 participants from six U.S. regions were randomly assigned to insurance plans with differing levels of cost-sharing, ranging from full coverage (with no out-of-pocket costs) to plans requiring substantial co-payments [18]. The study demonstrated a clear inverse relationship between the level of cost-sharing and the utilization of healthcare services: participants with full insurance coverage (zero cost-sharing) utilized significantly more healthcare services than those in high cost-sharing plans. The elasticity of healthcare demand in response to out-of-pocket costs was evident, as individuals with higher cost-sharing obligations reduced their use of both necessary and unnecessary medical services [17].

However, the RAND experiment also emphasized that factors beyond direct medical costs, such as transportation and time spent accessing care, play a crucial role in determining healthcare utilization [18]. These additional costs—often overlooked in discussions of moral hazard—affect healthcare decisions as much as, if not more than, financial cost-sharing.

The RAND Health Insurance Experiment conclusively demonstrated the existence of moral hazard in healthcare: as consumer cost-sharing decreases, healthcare utilization and overall spending increase [1]. This moral hazard effect becomes particularly pronounced in the context of comprehensive insurance plans, where patients are more likely to consume healthcare services that they might otherwise forgo if they had to bear the full costs themselves. Notably, the experiment also showed that while cost-sharing reduced the use of medical services, it did not lead to significant negative health outcomes for most participants, challenging assumptions that higher utilization necessarily correlates with better health outcomes [17].

In summary, both the Oregon and RAND experiments provide critical insights into the complex relationship between insurance coverage, healthcare utilization, and moral hazard. While increased coverage improves access to care and alleviates financial stress, it also promotes the overuse of services, underscoring the need for carefully balanced policy

interventions that account for both the benefits and risks associated with comprehensive health insurance.

3. Romanian Healthcare System

The Romanian healthcare system operates on a social health insurance model, primarily funded through mandatory contributions made by both employers and employees [19]. In 1997, Romania adopted the Bismarck model, a system rooted in compulsory health insurance and the principle of solidarity, ensuring access to healthcare services through a decentralized structure. This model is prevalent across several European Union countries, including Belgium, Germany, France, the Czech Republic, Estonia, Lithuania, Luxembourg, Poland, the Netherlands, Slovakia, Hungary, and Slovenia [20]. The adoption of this model marked a significant shift in Romania's healthcare financing, aiming to enhance the efficiency and equity of healthcare delivery.

The primary challenge for the Romanian healthcare system, as for many other healthcare systems, is cost management. Healthcare costs in Romania are influenced by numerous factors; however, the present study focuses exclusively on the impact of health insurance within public hospitals in Romania [21]. The rising costs in Romania's healthcare system are driven by a multitude of factors, including demographic changes, increasing demand for services, and inefficiencies in resource allocation. This study, however, narrows its focus to explore the role of health insurance in shaping healthcare utilization within Romanian public hospitals, where moral hazard plays a critical role [22].

Theoretically, insurance reduces the monetary cost individuals pay for healthcare services. However, this reduction may also contribute to "moral hazard," whereby individuals engage in riskier behaviors due to the shared or absorbed nature of the financial risk [1]. The phenomenon of moral hazard is particularly relevant in public healthcare systems like Romania's, where both patients and providers may alter their behaviors due to the presence of insurance coverage.

Insurance beneficiaries may be tempted to utilize healthcare services more frequently or request costly procedures and treatments excessively, often without medical justification. Similarly, healthcare providers or physicians may prescribe unnecessary or excessive tests, procedures, or treatments, knowing that the costs will be covered by insurance, thereby generating higher profits [23].

Such behavior can lead to increased healthcare system costs, as excessive use of medical services may become financially unsustainable and could limit access to essential services for other individuals [24,25].

The objective of this study is to assess whether the effect of health insurance on health-related behaviors in Romania aligns with findings reported in the existing literature. In other words, the study aims to explore a relatively under-researched area: moral hazard and the behaviors exhibited by individuals in Romanian public hospitals regarding the consumption of healthcare services.

4. Materials and Methods

To achieve the objectives of this study, a quantitative research approach utilizing vignettes was employed. Vignettes allow for the simulation of real-world decision-making under conditions of insurance coverage, capturing nuanced behaviors that traditional surveys may overlook [26]. As Finch (1987) defines them, vignettes are short, descriptive stories that outline hypothetical situations under specific conditions to which participants are invited to respond. This approach proves particularly useful in exploring sensitive topics that participants might otherwise find difficult to discuss openly [27].

Vignette methodologies have been increasingly adopted in healthcare research to assess decision-making under various scenarios, offering a robust way to capture nuanced patient behaviors that might not be evident through traditional survey methods [28]. Vignettes are also recognized as an effective method for assessing clinical decision-making,

particularly in healthcare contexts, where they provide insight into complex professional judgments [28,29].

Vignettes have been widely employed to evaluate the quality of care both within and across countries, enabling comparative analyses of healthcare standards on an international scale [30]. Their ability to mimic realistic clinical scenarios makes them a valid and powerful tool for assessing healthcare outcomes and behaviors. In the present study, vignettes were constructed to depict common medical conditions in Romania, wherein potential patients were required to make decisions while considering three different insurance statuses: public health insurance, private health insurance, or no insurance at all. Figure 1 illustrates the structure of the vignette, including the three variables used.

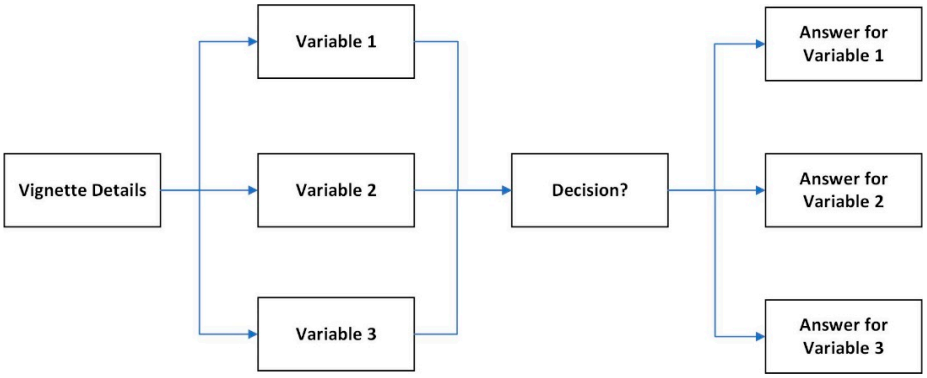

Figure 1. Vignette structure with three variables (adapted from [31]).

To capitalize on the strengths of both experimental and traditional research methods while minimizing their limitations, they were integrated into a questionnaire-based survey (see Supplementary Materials). This hybrid approach allowed for the collection of nuanced data on healthcare decisions while ensuring broad accessibility and ease of response.

The questionnaire comprised three distinct sections. In the first section, participants who were employees of the public healthcare system were provided with an informed consent form detailing the study's procedures, the time commitment required, the risks and benefits of participation, the nature of the information requested, and their right to withdraw from the study at any time. These participants were selected because of their familiarity with the medical terminology presented in the vignettes. Participants were also assured that their responses would be confidential, their anonymity preserved, and that all personal data would be handled in compliance with European data protection regulations (GDPR). Those who responded to the survey verbally consented to participate, acknowledging their understanding of the study's terms and conditions. Following a review of the responses provided, no respondents were identified as failing to complete the vignettes; thus, no exclusions from the sample were necessary.

The second section focused on collecting socio-demographic information. Participants were required to respond to six closed-ended questions with predefined response options to ensure the consistency and comparability of data.

In the third section, respondents were presented with three distinct vignettes, each depicting a medical situation in narrative form. The vignettes were developed by the authors, drawing upon both the studies available in the specialized literature and their personal experience, with three of the four authors actively working in the Romanian public healthcare system. These scenarios were carefully designed to simulate real-world healthcare decision-making processes and were constructed based on both relevant literature and clinical expertise, particularly with respect to issues such as autonomy, responsibility, and clinical outcomes [32]. The validity of vignette-based surveys depends heavily on the quality of the vignette design, including clarity, structure, and the methods used to present the vignette questions [33].

The vignettes included key components such as the patient's medical history, the management of the condition up to the present, diagnostic test results (where applicable), and the costs associated with various treatment options. These components ensure that respondents can make informed decisions in the hypothetical scenarios. The selection of pathologies was informed by their high prevalence among patients in contemporary healthcare settings. Osteoarticular conditions, which are increasingly common, represent a significant clinical concern due to their painful nature and the necessity for timely intervention to prevent progression to advanced stages. Similarly, ENT (ear, nose, and throat) pathologies affect individuals across all age groups, ranging from neonates to older adults, and can substantially diminish the quality of life if appropriate medical measures are not implemented promptly. The vignette on renal tumors was designed to place respondents in a scenario where the disease threatens both quality of life and survival. While renal tumors are not among the most common cancers in Romania, they are recognized as particularly difficult to treat, emphasizing their clinical significance. Also, urological conditions are frequent in both men and women. Table 1 provides a summary of the vignettes used in the study.

Table 1. Summary of presented vignettes

Condition	Proposed Treatment	High-Cost Scenario	Low-Cost Scenario
Herniated Disc	Surgery/Physiotherapy	Surgery costing 20,000 RON	Delay surgery; intensive medical treatment and physiotherapy
Renal Cancer	Standard Treatment/New Medication	Chemotherapy with an 80% survival chance	Chemotherapy + new medication costing 15,000 RON/month
Hearing Loss	Traditional/Implantable Prosthesis	Implantable prosthesis costing 25,000–40,000 RON	Traditional hearing aid costing 10,000 RON

The questionnaires were distributed electronically through the WhatsApp platform in August and September 2023, following the approval of the hospital's Ethics Committee, which was granted in May 2023. Potential participants received the investigator's contact information (phone and email) to facilitate communication and confirm their participation in the study. For non-responders, the questionnaire was re-sent after one week to encourage participation. The decision to utilize WhatsApp for electronic delivery was motivated by the convenience and broad accessibility of this platform, especially for reaching participants in remote areas who might otherwise be difficult to contact. In addition, electronic data collection offers the advantage of minimizing errors during database construction and enhances data accuracy through automated processes [34]. Following a review of the responses provided, no respondents were identified as failing to complete the vignettes; thus, no exclusions from the sample were necessary.

5. Results

Following the administration of the questionnaires, 303 valid responses were obtained for analysis.

Scenario 1 explored treatment options for a herniated disc, providing participants with a choice between less expensive treatments (such as physiotherapy or medication) and a more costly surgical intervention. The results reveal significant variations based on the participants' insurance status. Most respondents who opted for the more expensive surgical treatment were those covered by public health insurance, followed closely by those with private insurance. Figure 2 highlights the difference in treatment choices between insured and uninsured patients, illustrating the potential presence of moral hazard among insured individuals. Insured participants were more likely to select surgical intervention as an immediate solution, knowing they would not bear the financial burden. Conversely,

uninsured participants were least likely to choose surgery, opting instead for more affordable alternatives such as medication and physiotherapy. This behavior suggests the presence of moral hazard to some extent, as insured individuals, aware that their health insurance would cover the costs, tended to choose the safer, faster, but more expensive treatment option.

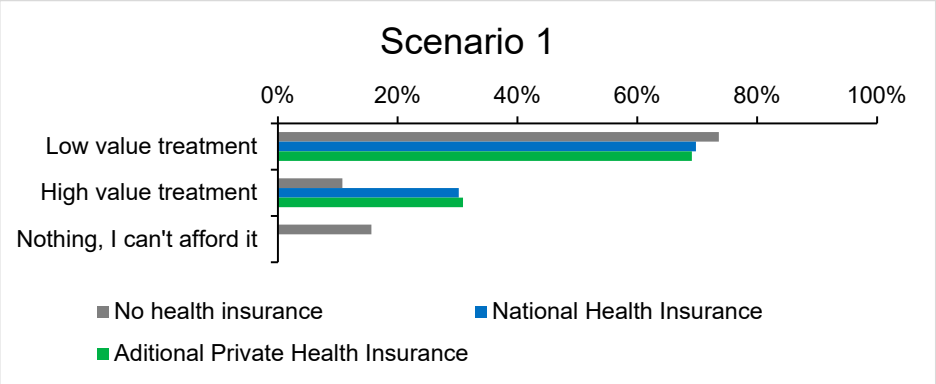

Figure 2. Selection of affordable vs. expensive treatment based on insurance type in Scenario 1.

On the other hand, a significant proportion of respondents—irrespective of insurance status (uninsured, publicly insured, or privately insured)—chose the combination of medication and physiotherapy. This decision does not necessarily imply the absence of moral hazard; rather, it may be influenced by personal factors such as fear of surgery, mistrust in the effectiveness of invasive treatments, or financial constraints, especially for uninsured individuals as shown in Figure 3. Furthermore, it may reflect a general preference for less invasive treatment options, even among insured individuals, who might choose to exhaust non-surgical avenues first. In this scenario, respondents' choices may have been influenced not only by cost but also by a range of other factors, which can vary between individuals depending on the status of their condition. It is important to emphasize that any choice not medically justified contributes to the manifestation of moral hazard.

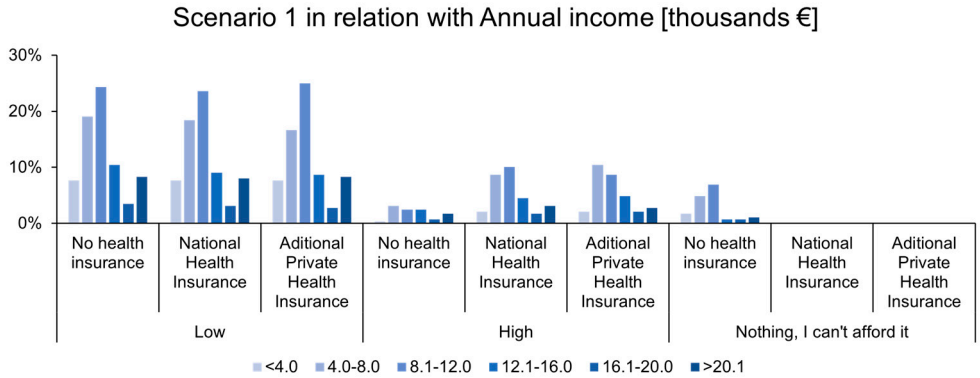

Figure 3. Results by annual income [thousands €].

Interestingly, 6% of respondents indicated that they would take steps to obtain public health insurance to avoid paying out-of-pocket for healthcare services. This indicates that uninsured individuals recognize the financial barriers to treatment and may view insurance as essential for accessing adequate care.

The proportion of respondents who expressed interest in seeking a second medical opinion was notably low, at only 2%. However, none of these individuals were uninsured, suggesting that patients with insurance are more likely to pursue additional consultations as they know that their insurance will cover the cost. The low rate of uninsured patients seeking second opinions suggests limited accessibility and perceived futility in additional

consultations, reflecting deeper healthcare equity challenges. In contrast, uninsured patients were less inclined to consider this option, likely due to the increased financial burden of out-of-pocket payments for a second opinion.

These findings imply that uninsured individuals may not fully explore all available medical options, potentially leading to suboptimal health outcomes. Addressing financial barriers could improve equity in healthcare utilization and ensure that all patients can make informed decisions about their care.

Scenario 2 presented a hypothetical case involving the treatment of renal tumors following an MRI diagnosis. Respondents had to choose between standard chemotherapy (a less expensive option) and a more expensive treatment that involved combining chemotherapy with a new medication costing 15,000 RON per month. Figure 4 illustrates how uninsured patients predominantly opted for the less expensive chemotherapy, while insured patients preferred the more expensive combination therapy, highlighting the influence of insurance on decision-making and moral hazard. Some uninsured respondents explicitly stated that they chose standard chemotherapy due to financial constraints, while insured individuals selected the full treatment, confident that they would not need to bear the costs themselves.

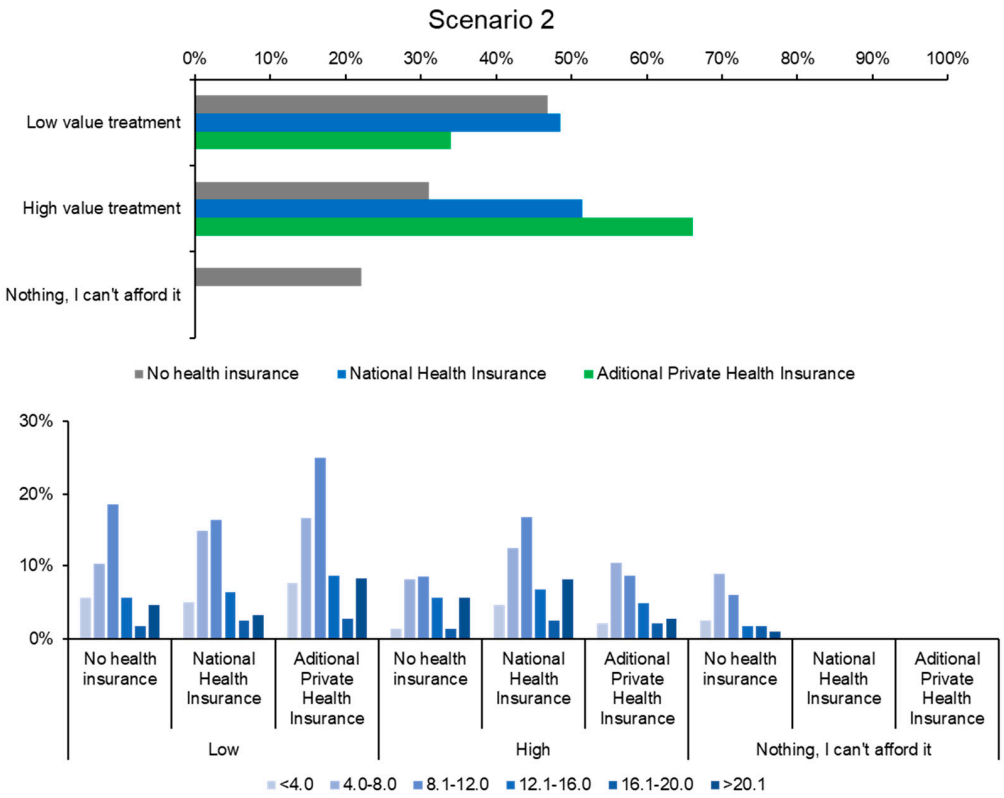

Figure 4. Selection of affordable vs. expensive treatment based on insurance type in Scenario 2.

Given the severity of the diagnosis, a small percentage of respondents chose to delay treatment. Only 1% of privately insured and 2% of publicly insured participants indicated that they would postpone treatment, primarily to seek additional medical opinions. In contrast, 7% of uninsured respondents delayed treatment, citing financial limitations as the main reason for postponement.

This higher delay among uninsured patients may lead to worse health outcomes, as timely treatment is critical in life-threatening conditions like cancer as shown in Figure 5. The implication is that lack of insurance not only affects treatment choices but also impacts the timing of care, potentially exacerbating health disparities.

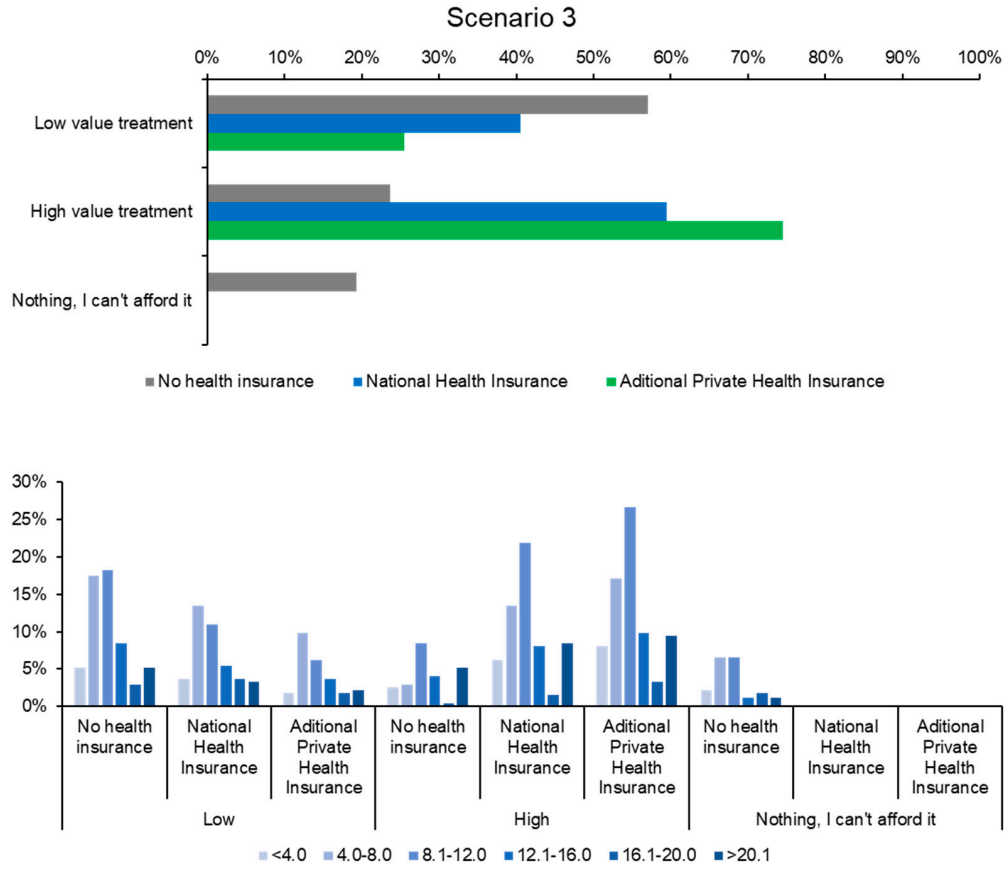

Figure 5. Selection of affordable vs. expensive treatment based on insurance type in Scenario 3.

The findings from this scenario highlight the manifestation of moral hazard among insured individuals, who tended to opt for combination therapy, which may or may not have been medically justified depending on the case. In other words, insured respondents readily chose the more complex and expensive treatment without significant hesitation, relying on varying degrees of information or understanding regarding potential risks or adverse effects.

Of the total 303 respondents, 10% of uninsured participants indicated they would seek to obtain insurance to access treatment at a reduced cost compared to the expense of paying for care out of pocket. This suggests that severe health conditions can motivate uninsured individuals to obtain insurance, highlighting the role of insurance in facilitating access to necessary but expensive treatments.

When it came to seeking a second medical opinion, the percentage remained low, at only 1% across all categories (publicly insured, privately insured, and uninsured). This low rate may reflect a lack of awareness or trust in the healthcare system or cultural factors affecting patient autonomy and decision-making. Enhancing patient education about the benefits of second opinions could improve healthcare outcomes.

Given the life-threatening nature of Scenario 2, 22% of respondents stated that they would pursue any means necessary to afford treatment, including taking out loans or selling personal assets such as cars or houses. This figure is significantly higher compared to Scenario 1, where only 6% of respondents indicated they would seek additional financial resources. The willingness to incur significant financial burdens underscores the critical value placed on life-saving treatments and highlights the risk of catastrophic health expenditures for those without sufficient insurance.

Scenario 3 focused on hearing loss, with respondents asked to choose between a partially implantable Baha prosthesis (costing between 25,000 and 40,000 RON) and a conventional hearing aid (costing approximately 10,000 RON). Analysis of the responses

revealed that uninsured participants overwhelmingly opted for the less expensive conventional hearing aid. In contrast, the more costly Baha prosthesis was the majority choice among those with public or private insurance, as shown in Figure 5. This scenario underscores the manifestation of moral hazard, as insured respondents assumed that the more expensive option was the best choice for regaining their hearing despite being unaware of whether this decision would provide superior clinical benefits compared to the alternative presented.

Although some insured respondents also chose the less expensive hearing aid, their decision was influenced by the fact that only the hearing aid would be reimbursed by insurance, while opting for the Baha prosthesis would entail additional out-of-pocket costs. Uninsured respondents, meanwhile, were largely driven by financial constraints, opting for the more affordable option despite its limitations as shown in Figure 5 This indicates that even among insured patients, the extent of coverage significantly affects treatment decisions, suggesting that partial coverage may not fully mitigate the impact of cost on healthcare choices.

Regarding treatment delays in Scenario 3, 13% of respondents indicated postponing the treatment. Among this group, 8% were uninsured individuals who explained that they would have to pay for hearing restoration out of pocket, which they either could not afford or deemed too expensive. Delaying treatment for non-life-threatening conditions like hearing loss can affect quality of life and social participation, showing how financial barriers can defer care and increase long-term healthcare costs. This highlights a common theme: uninsured individuals, in an attempt to access medical care without bearing the costs directly, often seek to obtain insurance coverage, underscoring the presence of moral hazard.

The percentage of respondents who would resort to alternative financial resources to fund treatment was 6%, lower than in Scenario 2 (9%) but higher than in Scenario 1 (3%) as shown in Figure 6. This indicates that respondents' decisions are also shaped by psychological and behavioral factors, with varying degrees of risk tolerance depending on the severity of the situation. In life-threatening cases such as Scenario 2, a larger proportion of uninsured patients (9%) stated that they would pursue any means necessary to secure additional income for treatment. This was not the case in Scenarios 1 and 3, where the conditions posed no immediate threat to life, leading many uninsured patients to delay or forgo treatment. These findings emphasize the critical role that perceived severity of illness plays in healthcare decision-making and the potential for financial barriers to result in delayed or forgone care for less acute conditions. This observation suggests that moral hazard arises when insured individuals select more expensive treatments. However, such decisions do not constitute moral hazard if the chosen treatment demonstrates clinical superiority or offers distinct therapeutic advantages over the alternative.

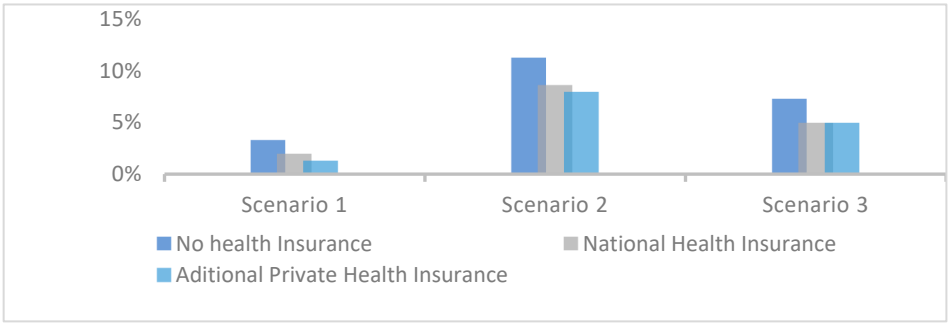

Figure 6. Percentage of patients resorting to alternative financial sources for treatment.

6. Discussion

This study has addressed several key questions regarding the influence of health insurance on medical behaviors and healthcare consumption in public hospitals in Romania. The first question explored whether the effect of insurance on health-related behaviors in

Romania aligns with findings reported in the specialized literature. The empirical results indicate that individuals in Romanian public hospitals make medical decisions primarily based on their annual personal income and the direct costs associated with treatment.

The data revealed that individuals with higher annual incomes were more likely to choose more expensive treatment options, regardless of their insurance type. Conversely, individuals with lower annual incomes opted for costlier treatments only if they were covered by public or private insurance. When treatments involved out-of-pocket expenses that exceeded insurance coverage, patients either postponed their decision or selected treatments that were fully reimbursed by their insurance, indicating a financial constraint in decision-making.

Moreover, when health insurance covered both the basic treatment and supplementary options, the majority of insured individuals preferred the more comprehensive and safer treatment, disregarding the associated costs. This behavior underscores the moral hazard phenomenon, where individuals consume more expensive healthcare services, knowing that the financial risks are mitigated by insurance.

The study also answered the second key question: insured individuals in Romanian public hospitals tend to use more medical services, sometimes to an excessive degree, and are more inclined to opt for costlier treatment options. This is a clear indication of moral hazard in the Romanian healthcare system, where patients overutilize services and make potentially costly and risky healthcare decisions, driven by the knowledge that their insurance will absorb a significant portion of the costs.

Excessive medical service consumption contributes to rising healthcare system costs, limits access to essential services for other patients and poses long-term financial challenges for the sustainability of public healthcare. These behaviors not only strain healthcare resources but also raise broader concerns about healthcare equity and access for uninsured or underinsured populations.

This study confirms that moral hazard significantly shapes health-related behaviors in Romanian public hospitals, reflecting trends seen in broader healthcare systems. A complex interplay of social, economic, and psychological factors, including income levels, insurance status, and perceptions of financial risk, drives the behaviors observed.

Furthermore, developing a tiered insurance model that distinguishes between essential medical care and elective procedures could lead to more judicious use of healthcare services. Requiring greater financial participation for non-essential treatments would help patients make more informed and prudent choices. Enhancing patient education about treatment decisions' financial and health-related implications is also crucial. Empowering patients with transparent information on costs and outcomes can mitigate moral hazard effects by promoting more thoughtful decision-making.

However, this study's scope has been limited to identifying the presence of moral hazard and assessing the impact of health insurance on healthcare utilization. Further research should explore regional disparities in healthcare consumption within Romania and potential cultural factors influencing patients' healthcare decision-making and moral hazard behaviors. Addressing these variables in future studies would provide a more comprehensive understanding of how to mitigate moral hazard and promote more efficient and equitable healthcare delivery.

7. Conclusions

To address these challenges, policymakers in Romania should consider several key actions. First, introducing targeted cost-sharing measures, such as co-payments or deductibles for elective treatments, could help reduce the overutilization of healthcare services among insured patients. This approach would discourage the unnecessary use of high-cost treatments, balancing service demand with cost containment. Additionally, implementing preventive care incentives could be instrumental in reducing ex-ante moral hazard. By encouraging patients to adopt healthier behaviors through reward programs or reduced insurance premiums, the need for reactive healthcare services would likely diminish.

Strengthening regulations on provider behavior is equally important in addressing healthcare inefficiencies. By establishing clear guidelines for healthcare providers and conducting regular audits, the overprescription of unnecessary procedures and treatments—driven by provider-induced demand—can be mitigated, ultimately curbing rising healthcare costs.

By implementing these reforms, Romania's healthcare system could achieve a better balance between accessibility and sustainability, ensuring essential services remain available without encouraging the excessive use of medical resources. Given the significant impact of moral hazard on the system's sustainability, it is imperative for policymakers to prioritize the introduction of co-payment systems and to strengthen provider accountability to ensure efficient use of public resources.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/healthcare12242519/s1.

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Article

Characterizing Managerial Decision Making in Public Hospitals: A Case Study from Romania

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Abstract: Background/Objectives: Our study investigates the primary characteristics of managerial decision-making processes in the public hospital units in Romania, particularly in the Northeast region. This research aims to delineate the decision-making model applied by managers in these units, considering the multitude of legislative, economic, technical, ethical, and organizational changes prompted by the pandemic. Methods: A mixed-method research approach was utilized, combining semi-structured interviews and autoethnography, to capture experiences, attitudes, perceptions, motivations, and ethical considerations of decision-makers within the healthcare system. Results: The findings revealed that managerial decisions in public hospitals were influenced by unique elements such as the vulnerability and support needs of patients, the absence of a clear hierarchy, the personalized nature of healthcare services, the complexity of care processes, and the use of advanced technology. External factors, notably political and economic influences, alongside internal ethical dilemmas, significantly impacted decision making. Conclusions: This study identifies the reliance on evidence-based decision making and a consultative managerial style as key to addressing these challenges. This research contributes theoretically by comparing decision-making models and practically by identifying a decision-making model that includes forms, techniques, and tools that could guide managers in decision making in Romanian public hospitals.

Keywords: managerial decision making; decision-making triangulation; autoethnographic methodology; managerial ethics in healthcare; resource allocation in hospitals; strategic healthcare reforms

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1. Introduction

The healthcare system encompasses the provision of all health services, involving medical and auxiliary staff, institutions, and organizations dedicated to ensuring universal access to high-quality medical care. Due to the complexity of the healthcare system, decision making in this field is a challenge for management. On one hand, medical professionals must quickly decide on the appropriate course of action when people's lives are at risk, and on the other hand, managers of hospital units must provide quality care with limited resources while simultaneously generating significant and sustainable revenues. In this context, decision-makers are compelled to comply with existing legislation and to understand and effectively manage competition [1].

Hospital unit managers operate within an increasingly comprehensive and multilateral system. Taking into account the multitude of legislative, legal, economic, technical, ethical,

and organizational changes, the managerial decision-making process has a direct impact on the institution's performance, its staff, and the community it serves, being influenced by a series of other factors that could result in financial success, patient satisfaction, and the long-term viability of the organization. Although decisions are made at all managerial levels, those made by top-level managers have a wider applicability, affect more people, and have a greater impact [2,3].

After the 1990s, Romania's healthcare system was involved in a reform process, when it changed its organization and operation mode, with significant efforts being made to make it more efficient and to offer the best possible services to the population. Currently, the performance of Romania's healthcare system and public hospitals is not a major national objective; it is not evaluated through a comprehensive model, but mainly conditioned by the manager's expertise. The performance indicators of the Romanian healthcare system, although improving, remain below the average levels of the European Union, reflecting a deficient management unable to meet the increasingly diverse health needs of the population [4].

In this sense, the performance of public hospitals is influenced by elements such as managers' reluctance to use modern management techniques and methods for evaluating employee performance, medical technology in hospitals, and the quality of services. At the same time, there is a lack of managerial vision to use additional sources of funding, such as sponsorship contracts, hospital space rentals, medical equipment rentals, medical research contracts, etc. Despite these limitations, there is increased pressure on managers of public hospital units to use available resources as efficiently as possible to achieve remarkable results. In addition, they are forced to ensure high-quality care at a lower and more competitive cost and to achieve a performance and offer medical services similar to hospitals abroad, and are constrained by often-insufficient material resources, political involvement, economic uncertainties, as well as an arsenal of norms and regulations that involve lengthy procedures [5].

We consider that the efficiency of hospital activities and the increase in their performance are closely related to the way in which the manager adopts strategic decisions. Such decisions may concern the recruitment of employees, the acquisition of new technological elements, the allocation and use of financial resources, etc. Within public hospital units, decision-makers must decide how to guide and organize the institution and how to control the processes in the system, making decisions frequently based on collected information. The decisions made by managers focus not only on providing the best services to patients but also on meeting the performance objectives set. Ultimately, the performance of the hospital unit is affected by the decisions adopted by its management [6].

Healthcare decision-makers engage in three distinct types of decision making: public policy decisions, which define the range of services to be provided; clinical policy decisions, which determine the recipients of clinical services; and administrative policy decisions, which address the allocation of service locations and the framework for their support and management [7].

Healthcare managers establish the strategic direction of their institutions through critical decisions in key areas, including staff recruitment and training, technology acquisition, and the allocation and management of financial resources. Regularly tasked with decision making based on systematically gathered data, managers must determine how to administer, guide, and organize personnel, manage operational processes, and facilitate decision making within their teams. These managerial decisions extend beyond the immediate objective of delivering high-quality patient care; they are also integral to achieving the institution's established performance benchmarks.

In this context, the objective of this study is to identify and describe the specific characteristics that define the managerial decision-making model used in public hospital units in Romania, with a particular focus on the Northeast region of the country. To meet this objective, a mix of qualitative research methods (through triangulation) was used, namely the survey method based on interviews and the autoethnography method. In

this sense, this paper theoretically contributes to the development of the literature on a little-explored phenomenon regarding how managers of public hospital units in Romania make decisions and the significance they attribute to managerial activity, and also makes a comparison of the decision-making models used in hospital units. Thus, we identified opinions, attitudes, perceptions, and motivations regarding the factors that influence the managerial decision-making process, what are the criteria for adopting certain decisions, what are the sources of evidence, what are the stages gone through for making a decision, how managers of public hospital units in Romania use information flows, who are the people they consult with, if they consult, as well as the impact that ethical aspects have on the managerial decision-making process [8].

This paper is organized to align with the stated research objectives. Section 2 outlines this research's methodological framework, providing a comprehensive overview of both theoretical and practical aspects that align with the research aim and the targeted data. It details each stage of implementing the qualitative methods employed. Section 3 presents the findings, initially through an analysis of semi-structured interviews, followed by insights gathered from autoethnographic techniques. Section 4 is dedicated to discussing these results, comparing insights gained from both methods, and contextualizing them within relevant scholarly literature. Lastly, Section 5 concludes this study by emphasizing the critical findings, particularly focusing on the managerial decision-making model applied in Romanian hospital units [9].

2. Materials and Methods

In this research, the purpose of using interviews was to gain a deep understanding of managers' experiences regarding how they make decisions and the significance they attribute to managerial activity. The choice of mixed research methodology is justified by the nature of the phenomenon studied, which reflects a complex reality and depends on how managers relate to the challenges this reality implies. Subsequently, to improve the reliability and validity of the information, analyses, interpretations, and conclusions collected through the survey based on interviews, we chose to compare the data obtained through the analysis of interviews with data generated by autoethnography, a comparison that actually involves data triangulation. Thus, with the help of the two qualitative methods, the survey method based on interviews and autoethnography, comparisons could be made between the researcher's own experiences, in his capacity as a manager, and the analysis carried out on the data collected through interviews, thus allowing through induction the shaping of a theoretical model regarding the decision-making process of managers in Romania. In other words, the premises extracted from the qualitative analysis (based on the interview) form the basis for formulating the theoretical model, which is validated with the help of autoethnography. The methodological scheme of the present research is shown in Figure 1.

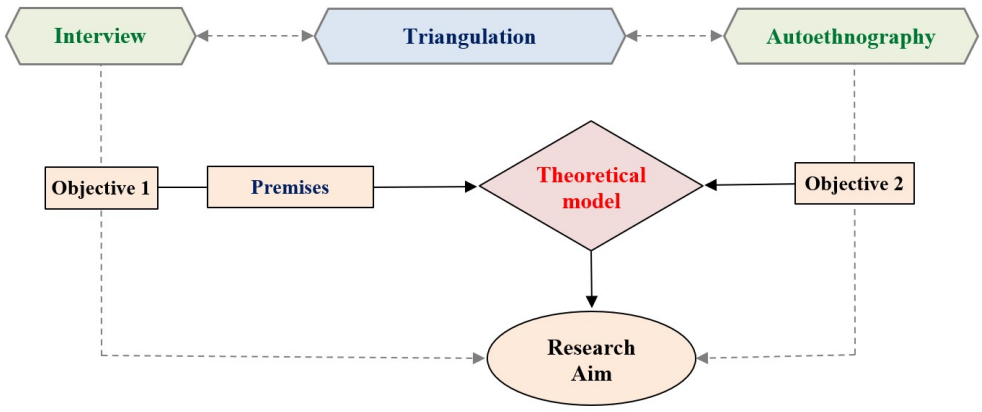

Figure 1. Research methodology scheme.

Aligned with the fundamental objective, this research's operational framework is outlined, including the formulation of specific theoretical and methodological objectives. The first specific objective involves generating a theoretical model regarding the characteristics that define the decision-making process at the level of public hospital units in Romania. The second specific objective aims at verifying the validity of the theoretical model defined in the first stage of this study.

Given the opinion that findings resulting from two or more methods increase the confidence that the results are valid and do not represent a methodological artifact [10], the two qualitative methods were used, whose mixing was made possible through triangulation. Thus, deducing premises from the interview analysis forms the basis for formulating the theoretical model of this research, which is validated through autoethnography.

2.1. Study Design and Population

We conducted qualitative research using semi-structured, one-on-one interviews with 10 managers of public hospitals in Romania to gain in-depth insights into their decision-making processes. This design enabled a comprehensive exploration of the participants' perspectives and experiences. Sampling was carried out through a combination of purposive sampling, to ensure participants met the criteria of being public hospital managers, and the snowball method, which facilitated the identification of additional qualified participants through referrals. The process continued until data saturation was achieved, meaning no new or relevant information emerged from additional interviews, thus signaling a thorough understanding of the subject. This approach aligns with qualitative research standards, emphasizing the depth and richness of the collected data over sample size. The interview guide was developed to cover key topics relevant to managerial decision making and was validated by two experts from the Alexandru Ioan Cuza University of Iasi. This study was conducted between 2018 and 2022. The study design is illustrated in Figure 2, which outlines the methodological framework and key steps followed in this research.

Figure 2. Study design.

For the construction of the interview guide, all changes deduced from the pretesting stage were taken into account. In this sense, the interview guide was structured in two parts, the first part including questions related to the personal characteristics of the interviewed managers, and the second part consisting of 15 open-ended questions regarding the issues of the current research (see Supplementary Materials S1).

2.2. Interview Procedures and Data Collection and Analysis

In this stage of the research, data on the managerial decision-making process at the level of hospital units in Romania were collected through the use of the interview-based survey method. Among the types of interviews existing in the literature, we chose the semi-structured in-depth interview. The choice of this qualitative research method is justified by its use for deeply probing opinions, attitudes, and motivations of managers to identify possible unconscious information [11]. In other words, the aim was to identify opinions, attitudes, perceptions, and motivations of the participants invited to discuss factors that influence the decision-making process, what are the criteria for adopting certain decisions, what are the sources of evidence, what are the stages gone through for making a decision, how information flows are used, who are the people they consult with, if they consult, as well as the impact that ethical aspects have on the managerial decision-making process.

A first step in the analysis of the interviews was their transcription, resulting in approximately 162 pages of transcription. Thus, each interview was transcribed separately,

and each line was numbered. Then, the analysis of the information was started, which, according to [12], is the directly acquired information, in fact, the information obtained from the interviewees. Based on this information, the first stage of data analysis is approached, namely the stage of open or initial coding [13], which involves the systematic reading of the data and making memo-type notes. In other words, each interview was read line by line, on the margins of which the researcher made annotations and reflected on the meanings of different discursive elements of the participants [14]. Ref. [12] considers this step the beginning of the interpretative stage.

Subsequently, the data thus obtained were synthesized and processed using thematic–categorical content analysis, which presupposes a text analysis technique. In this context, content means words, images, meanings, symbols, ideas, etc. [15]. This method involves a series of steps: coding each statement taken from each interview; classifying the data based on the themes and/or concepts prevalent in the discourse of the interviewed persons; axial coding, which involves classifying themes and/or concepts into semantic categories; and selective coding, which aims to unite all themes and semantic categories into a single fundamental category or domain, which will underlie the definition of the theoretical model.

2.3. Ethical Considerations

The interview guide was accompanied by an informed consent form in which relevant information about this study's proceedings was presented: the research theme, requested information, time to be allocated to the interview, risks, benefits of participating in this study, the possibility of withdrawing at any moment from this study, as well as maintaining anonymity and respecting personal data in accordance with European legislation in the field.

All data were treated confidentially and pseudonymized with due care throughout the entire research. Depending on our research questions, the recorded interviews were only listened to and typed by the researcher. The interviews were transcribed anonymously. The audio recordings and transcriptions were recorded in a secure manner, and these files were saved on a password-protected personal computer. This study was conducted on a voluntary basis, and no compensation was offered. This research was approved by the Ethics Committee from the Clinical Rehabilitation Hospital Iaşi on 13 December 2018. The approval does not have an approval code as the process in Romania does not always provide one; instead, it has an approval date.

To minimize potential researcher bias, the interview guide was subjected to expert validation. During the interviews, the researcher refrained from intervening in participants' responses, actively listened, and maintained an impartial stance, avoiding any validation of interviewees' statements. This approach helped ensure objectivity in data collection and analysis.

2.4. Autoethnography

In the last decade, there have been many publications on the topic of autoethnography, covering various disciplines, including those in the health field [16]. However, this methodology is still very new in the health sector in general, and in hospital management in particular.

Autoethnography is a qualitative research method defined by [17] as the method "that uses the researcher's personal experience to describe and critique cultural beliefs, practices, and experiences". Autoethnography is a form of ethnography in which the researcher becomes the subject of study to understand a cultural experience [18]. Ref. [19] considers that one's own experiences are spaces for exploration, examination, and representation in qualitative research. In addition to highlighting personal experience, the researcher analyzes these experiences using a set of theoretical and methodological tools, as well as specialized literature in the field. Therefore, the researcher contextualizes their own personal experiences and those of others within the socio-cultural context to reveal the

meanings of the theme analyzed. Thus, the social and cultural context can be understood from the perspective of a group of individuals with similar experiences [20].

As a qualitative methodology, autoethnography offers several advantages. One primary benefit is that it provides access to the researcher's inner world, thereby generating rich, in-depth data [21,22]. Another advantage is the accessibility of data, as the researcher uses their own experiences as a source for analyzing a phenomenon. However, this reliance on personal narrative also presents a limitation, as it can constrain the scope of the research findings. Additionally, autoethnography holds the unique potential to engage and resonate with external stakeholders, encouraging them to reflect on and empathize with the presented narratives [23]. By examining cultural or social accounts of experience, autoethnography serves as a valuable research approach, uncovering previously unrecognized realities.

In the present research, the justification for choosing this method stems from the professional position of the researcher, who has held the position of manager of a public hospital for over 14 years and leadership positions in public hospital units in Iași County, Romania, for over 20 years. Consequently, the phenomenon studied, namely the specifics of the managerial decision-making process in the sphere of public hospital units in Romania, is very familiar to the researcher.

The researcher's personal memory was the most important source of data, creating an autobiographical chronology of events, lived experiences, and decisions made as a manager. Systematically, self-observation, introspection, and self-analysis were conducted through recording the behaviors, thoughts, and emotions of the researcher. In this context, the researcher was interested in presenting his reality alongside that of the interviewees and to see what version of reality would emerge from the analysis. The researcher thus brought into the analysis interpretive frameworks, concepts, and knowledge regarding the managerial decision-making process that are part of his experience and professional positioning.

3. Results

3.1. Characteristics of Study Participants

The 10 interviews were conducted in the Northeast region of Romania with managers of public hospital units in the Counties of Iași, Suceava, Neamț, Focșani, and Vaslui. The interviewed managers were aged between 35 and 63 years, of which six were male, and four were female, with professional training in the medical (five respondents), economic (three respondents), or legal (two respondents) field. Out of all respondents, seven had higher education, and the other three had postgraduate studies. Also, all 10 interviewed individuals had undergone management training. Regarding the number of years of work in a healthcare unit, six of the respondents reported seniority between 5 and 15 years, and the remaining four had between 20 and 25 years of work. According to the number of years they had held a leadership position in a hospital unit, the 10 interviewed individuals were distributed as follows: one person with 1 year as manager; three respondents with 2 years in the manager position; one person with a seniority of 5 years; three of the interviewees had been managers for 8 years; and only two of the respondents had a seniority of 9 years as managers in a hospital unit.

3.2. Results of the Thematic Analysis of the Interviews

The results obtained from the thematic analysis of the data collected through the interview survey highlighted five essential dimensions, as well as the corresponding subdomains, of the decision-making process of the interviewed managers (see Supplementary Materials S2). The five categories refer to: (1) areas of managerial decision; (2) unique elements of hospital units; (3) factors influencing managerial decision; (4) sources of evidence in the managerial decision-making process; and (5) models of managerial decision making. Additionally, each domain and subdomain are elaborated upon in the subsequent sections and synthesized with the most pertinent quotes from the interviews, which are presented in Supplementary Materials S3–S6.

3.2.1. The Domain of Managerial Decision

Regarding the first identified category, namely the domain of managerial decision, the findings from the content analysis of the interviews showed that the decision-making process is a matter of great responsibility for the managers of public hospital units in Romania. The interviewed managers stated that they usually make decisions based on collected information, decide how to administer, guide, and organize others, how to manage processes in the system, and how to help others make their own decisions. At the same time, they highlighted that they are constantly under pressure to make the best use of available resources to achieve the best results for both the unit itself and other stakeholders. In summary, the managers' responses indicate that the most frequent decisions taken are related to (a) adopting the budget and allocating resources, (b) recruiting, training, and developing staff, (c) acquiring technology, and (d) strategic planning.

3.2.2. Unique Elements of Hospital Units

The analysis of the collected data allowed for the formulation of conclusions related to the unique elements of hospital units and the outline of several related subdimensions: (a) the state of vulnerability and the need for support of patients; (b) the personal and personalized nature of healthcare services; (c) the absence of a clear hierarchy; (d) the complexity of the care process; and (e) the highly advanced technology.

Firstly, the responses of managers during interviews showed that patients are often the most vulnerable, due to the asymmetry of power and information in the relationship between them and the medical staff, being much less capable of acting independently. Moreover, patients are emotionally fragile in the face of detection and communication by the doctor of a medical diagnosis, but also physically weakened by the experience of illness or the effects of treatment. The need for support, the lack of information, and the impact of the diagnosis most often cause them fear, dissatisfaction, and anxiety. At the same time, patients are not content to be passive recipients of healthcare services; they expect to be consulted, informed, and involved in any decisions that have to do with their own health.

Secondly, it emerged that the care process is a complex one, with the interviewed managers emphasizing the special responsibility to compensate for the inevitable asymmetry of power and information in doctor–patient relationships by providing services that are patient-centered, ensuring good communication, understanding, and involvement of the staff.

Thirdly, the responses highlighted deficiencies regarding the existence of a clear hierarchy and the assumption of responsibility by higher hierarchical bodies, in a context where hospital units are facing increasingly significant challenges generated by the lack of staff, the pace of technological innovation, changing patient expectations, and rising costs.

3.2.3. Influencing Factors of Managerial Decision Making

In the interviews, the influence of both external and internal factors in managerial decision making is highlighted. Among the external environmental factors, the political factor was the most frequently mentioned, followed by the economic factor, and to a much lesser extent, the social and geographical factors (which is why they were excluded from the content analysis). The interviewed managers mentioned that the political factor plays an essential role in the hospital units they lead. Some decisions, which involve the presence of multiple actors in their adoption and entail significant changes, are likely to provoke public disputes. In this context, the challenge for managers is to succeed in obtaining political support without losing the support of important groups within the unit and the community, while also being efficient in the decision-making process. Additionally, the economic factor is considered determinant in managerial decision making, as all interviewed managers mentioned this aspect at least once during the interview. They highlighted the restrictive nature of economic and financial resources on the adoption of decisions, which direct, or rather limit, the actions and measures that will be taken, to the detriment of a compromise that, ultimately, has an impact on the population's health.

Regarding the influence of internal environmental factors, the study results highlighted the presence of aspects related to the moral and ethical side of the decision-making process. The interviewed managers touched on a series of sensitive topics, generated by value conflicts between different stakeholders with different needs, interests, expectations, backgrounds, and personalities, different cultural environments, strategic contexts and/or situational circumstances of uncertainty, pressures from the internal and external environment, insufficient resources, lack of competence and/or experience, and legislative ambiguities. Moreover, the situation generated by the COVID-19 pandemic has revealed the sensitivity and fragility of hospital units that were faced with unknown, unpredictable situations that often involved ethical aspects. For example, medical staff had to choose between adhering to the visiting regulations in therapy and the insistence of relatives who wanted to be given the opportunity to see the patient in a serious condition. Another ethical dilemma presented was choosing between adhering to current protocols that stipulated a certain period of hospitalization and certain criteria that had to be met for discharge and the insistence of the patient who did not want to be discharged because they did not yet have wood at home for heating.

3.2.4. Sources of Evidence in the Managerial Decision-Making Process

The most important sources of evidence in the decision-making process by the interviewed managers include (a) professional experience and (b) the judgment of the members of the executive committee and the members of commissions and committees. Another part mentioned (c) the hospital information system, (d) the management dashboard, and (e) internal evidence and stakeholder expectations observed through participation in on-call reports or meetings in the administrative area. Equally, the interviewed managers considered (f) legislation, reports, and national, regional, or local plans as important sources of evidence. Very few managers mentioned (g) ethics and (h) religious beliefs as sources that guide them in making decisions.

3.2.5. Managerial Decision-Making Models

From the analysis of the data regarding the last category identified in interviews, namely the models of managerial decision making, it emerged that the majority of the interviewed managers use (a) the administrative model, followed by (b) the evidence-based model, (c) the adaptive model, (d) the DECIDE model, and (e) the incremental decision-making model.

Regarding the use of the administrative model, managers emphasized that to ensure that problems are clearly defined and the evaluation of potential alternatives is easier, they opted for choosing the best solution together with their subordinates. Thus, to install a second generator in the hospital, which required interrupting the hospital's electricity supply with all associated risks, the interviewed manager relied on his subordinates in making the decision: the medical staff, who had to monitor and ensure there was no risk to patients or that the patients were stable at that time, and the administrative staff, who ensured that backup aspects were functional and could intervene at any moment.

One of the examples given that supports the use of the evidence-based model was the acquisition of equipment. All managers who touched on this topic mentioned that in order to make the decision to buy new equipment or replace one that was no longer functional, they first had to have a report from a service company and a memorandum justifying the need for the purchase. The request was discussed in the executive committee and the medical council where the history was evaluated, and it was analyzed to what extent the purchase is implementable and what benefits it could bring to the hospital, both in terms of medical academic reputation and material benefits, such as revenue at the hospital level.

From the responses of the interviewed managers, it was deduced that they make a series of decisions in a rational, thoughtful, calculated, and measured manner. They also employ the adaptive model, which is characterized by flexibility and intuition in making decisions that involve the adoption of urgent measures, such as procuring blood for a

patient scheduled for surgery and for whom the blood transfusion center has not supplied the requested blood products.

Another model used that emerged from the analysis of the interviews is the DECIDE model. In making their decision, the managers adhered to the six steps of the decision-making model: Defining the problem, Elaborating the criteria, Considering all alternatives, Identifying the best alternative, Developing and implementing an action plan, and Evaluating and monitoring the solution. One of the interviewed managers faced the departure of the only doctor in a particular specialty, which led to the closure of the department. To avoid losing patients to competitors and to continue offering services within the department, the first phase considered the alternative of entering into a collaboration contract with one of the specialty hospitals in Iasi County and transporting patients by minibus for specific treatments. The procedure was quite difficult to implement, given the distance and the health condition of the patients. In the second stage, recruiting doctors from the Republic of Moldova was considered, but this was unsuccessful due to difficulties in equating their qualifications. In the third stage, efforts were made to provide opportunities and facilities for doctors to motivate them to take up employment. Apartments were purchased with the assistance of the County Council and offered as service accommodations. Additionally, for those who did not mind commuting, a coach was purchased to transport them to work every morning and take them home at 3:00 PM. By choosing the last alternative, a considerable number of doctors were attracted to participate in the competition, thus solving the problem and making the best decision, obtaining positive feedback from both doctors and patients.

The interviewed managers also use the incremental model for decision making, characterized by the nature of political negotiations and the condition of compromises existing among the stakeholders involved in the decision-making process. The situation generated by the COVID-19 pandemic has provided examples where hospital managers used the incremental model in making decisions, being forced at certain times to admit oxygen-dependent patients when their number exceeded the oxygen supply capacity of the hospital's oxygen station, a fact known both at the unit level and at the level of the County Public Health Directorate.

3.3. Defining the Premises Underlying the Theoretical Model

Based on the previously discussed five categories/dimensions, and implicitly the themes identified in the responses of the 10 interviewed managers regarding decision making, it is possible to identify the fundamental category of the current research, namely the peculiarities of the managerial decision-making process in public hospital units in Romania. This underpins the theory of this research, which is based on a series of research premises:

Premise 1: The unique elements of hospital units in Romania influence managerial decisions.

Premise 2: Managerial decisions in hospital units in Romania are influenced by political and economic factors, and ethical dilemmas and values.

Premise 3: Managers of hospital units in Romania practice a consultative managerial style.

Premise 4: Managers of hospital units in Romania make evidence-based decisions.

To enhance the credibility of the research premises reached regarding the peculiarities of the managerial decision-making process within public hospital units in Romania, autoethnography has been used.

3.4. Results of Autoethnography

Through autoethnography or the method of personal experience, the researcher has outlined the challenges faced in the capacity of a hospital manager, how actions were taken to solve problems, the factors that influenced decision making, the sources used to gather information, or the people consulted. Moreover, the researcher connected the present with the past, recognized the relationships between the self and others, compared personal professional experiences with those of other managers, and matched the findings from this analysis with ideas and constructs from the specialized literature.

The situation generated by the COVID-19 pandemic represented one of the greatest challenges for managers of public hospital units in Romania and implicitly for the researcher in their capacity as a public hospital manager. In this context, the researcher, as a manager, made a variety of decisions. These decisions are detailed in the following sections.

3.4.1. Compliance with Legal Provisions and the Institutional Hierarchy

In this regard, in the action plan approved and updated at the unit level by decision no. 754/18.10.2021, it was stipulated that "admission to the COVID sector on floors 6, 7, 5, 4, section E is done only after obtaining the approval from the Public Health Directorate (DSP)", the hospital being nominated as a COVID-19 support hospital by Order 1343/29.07.2020.

The decision to take in patients infected with the SARS-CoV-2 virus involved, firstly, organizing the spaces, as outlined in the updated action plan: "the technical service staff will completely reorganize the space in the shortest possible time in accordance with Annexes III.1, III.2, III.3, III.4 [. . .] the arranged workspace, clean area [. . .] will be equipped with a desk, chairs, 1 refrigerator, 1 medicine cabinet, 1 protective equipment cabinet, 1 telephone, 1 computer, 1 printer".

3.4.2. Recruitment, Training, and Development of Staff

The researcher, in the capacity of a manager, made decisions to ensure the availability of medical and auxiliary staff necessary for providing care to both COVID-19 and non-COVID-19 patients by consulting current legislation, the executive committee, the head of human resources, as well as the epidemiologist.

At the same time, the researcher, in their role as manager, mandated that both the medical and auxiliary staff of the unit must participate in training courses. These courses are to be conducted by the department head at the department level, "identifying specific COVID symptoms, donning/doffing PPE, and dissemination of the PS 16 procedure Managing patients in the context of the spread of infections with the SARS-CoV-2 virus". To increase protection measures for all staff, it was decided by the department head to conduct "staff training based on a schedule of all SOPs developed by the Hospital Infection Control and Antimicrobial Stewardship Program".

3.4.3. Adoption of the Budget, Allocation of Resources, and Acquisition of Technology

The decisions adopted in the context of COVID-19 also targeted the identification of financial resources necessary for the acquisition of personal protective equipment needed for efficient prevention and the equipping with medical devices for rapid diagnosis, facilitating optimal medical care to all patients of the unit. In this regard, the researcher, in their capacity as a manager, decided to access non-repayable European funds. Thus, the unit they manage succeeded in implementing between 2020 and 2022 a project co-financed by the European Regional Development Fund through the Operational Programme Infrastructure. The project aimed at the acquisition of medical equipment, namely ventilators, medical monitors, syringe pumps, infusion pumps, ICU beds, and protective and disinfection materials such as gowns, masks, shoe covers, gloves, coveralls, disinfectants, antiseptic products, and germicidal lamps.

3.4.4. Use of Evidence Sources

In deciding to purchase the drugs necessary for the treatment of patients with COVID-19, the researcher, in their capacity as a manager, primarily relied on current legislation and international research studies. According to the action plan, "the treatment used in treating patients with COVID-19 admitted to the Iasi Clinical Recovery Hospital will follow the National Treatment Protocol for SARS-CoV-2 infection approved by Order 533/2021".

For treating patients infected with the SARS-CoV-2 virus, although the hospital did not have in its portfolio the provision of infectious diagnostic treatment services, the researcher, in their capacity as a manager, decided to enter into a service contract with an infectious

disease doctor who "will collaborate with the attending/on-call doctors, as well as with the coordinating doctor of the COVID area for the prescription of specific medication".

Considering the risks involved in using oxygen for most patients infected with the SARS-CoV-2 virus, in circumstances where the hospital's infrastructure was not designed for this purpose, the researcher made decisions, in their capacity as a manager, to limit these risks. Firstly, additional oxygen concentration sensors were acquired and distributed in each room designated for treating COVID-19 patients, and secondly it was stipulated in the action plan applicable at the unit level that "staff working in areas where oxygen is administered are required to monitor the O2 concentration sensors and to ventilate the rooms frequently, at least once every 3 h".

Making decisions in areas such as resource allocation, staff training, budget adoption, strategic planning, or technology acquisition was influenced by economic factors in that financial deficiencies played the most significant role in decision making, which was not always optimal, and by political factors that either constrained or provided opportunities for change in the short or long term.

3.4.5. Values and Ethical Dilemmas

Equally, the focus on values and ethical dilemmas was much more pronounced throughout the COVID-19 period, with the researcher, who serves as a manager, often being put in vulnerable positions from this perspective. In the context of the action command Order no. 9490/04.10.2021, they were forced to "suspend admissions that were not emergencies" at a time when the schedule list was quite large, and patient dissatisfaction regarding access to medical services was increasingly manifesting. Patients who seek care at the unit are generally individuals with chronic diseases and numerous comorbidities, for whom any delay in investigation, prescription, and therapy administration leads to a decreased chance of recovery. Therefore, the patients' grievances were justified given the healthcare unit's positioning in the Northeast region of Romania, the personalized nature of the services offered by the unit, the complexity of the care process, and the patients' need for support.

The researcher recalls specific moments when, as a manager, they had to choose between complying with the law and facing pressures from patients or relatives who saw the hospital as their only salvation. These moments were filled with feelings of compassion, responsibility, emotion, and, importantly, civic and social duty.

Throughout the COVID-19 period, the number of beds allocated to patients infected with the SARS-CoV-2 virus in the unit managed by the researcher as a manager fluctuated both among ICU beds and among the beds belonging to medical departments, as also presented in the unit's action plan.

Every time, the researcher, as the manager of the hospital unit, had to decide on the organization of the unit by taking into account the decisions made at the county or national level, the permits and approvals obtained at a certain moment, as well as the constraints of time and resources.

4. Discussion

In the present research, data triangulation involved comparing the data obtained through interview analysis with the data generated through autoethnography. This validation technique was used to gain more insights into the peculiarities of the managerial decision-making process at the level of public units in Romania, to recognize and eliminate inconsistencies, and to minimize inadequacy. In other words, through data triangulation, we managed to test the consistency of the findings obtained through the two research methods, adding mutual value and thus enhancing the quality of qualitative research [24].

Therefore, in what follows the results of the qualitative analysis are interpreted in relation to the themes identified based on the evaluation of the interviews, in relation to the researcher's experience as a manager of a public hospital institution, but also in relation to the theoretical concepts and results of other researchers found in the specialized literature.

4.1. The Field of Managerial Decision Making Resulting from Research

The information obtained from the interviews regarding the field of managerial decision making has confirmed the initial framework, prefigured by the study of specialized literature. Managers play a decisive role in approving budgets and in allocating resources for information, with the aim of improving quality [25]. Embertson's study [26] shows that managers of hospital units are the deciding factor in the unit's strategy and are responsible for the strategic and financial management of the unit.

Refs. [27,28] have highlighted the importance of managerial decisions regarding technology acquisitions, which can have significant effects on the hospital unit. Ref. [29] found that top healthcare managers make decisions regarding the recruitment and training of staff, conducting performance evaluations, promotions, and demotions, designing and organizing the workload, setting standards, guidelines, and interacting with external entities.

The researcher's experience as a manager of a public hospital unit reinforces and supports this study's findings. With over 14 years of activity as a manager of a public hospital, the researcher was placed in the position to make simple or complex decisions related to planning, organizing, allocation, acquisitions, personnel, leadership, or control, with short or long ranges of action, flexible or inflexible, and even decisions in crisis situations.

The situation generated by the COVID-19 pandemic is the prime example where the researcher, in their capacity as a manager, had to make decisions in a context filled with gaps, uncertainties, and unforeseen circumstances. These decisions primarily focused on identifying financial resources for the acquisition of personal protective equipment (disposable masks, FFP2/FFP3 masks, coveralls, face shields, shoe covers, etc.), disinfectants, cleaning materials, medications, medical supplies, as well as supplementing oxygen concentrators, cylinders, and oxygen detectors. Another challenge was making the best decisions to train, prepare, and ensure the necessary medical and auxiliary staff for providing medical care to both COVID-19 and non-COVID-19 patients, at the hospital level as well as at the hospitals within the county for which the Public Health Directorate Iasi requested support. Additionally, there was a need to plan and organize spaces, reorganize circuits, work flows, and adapt work schedules.

Consequently, the results obtained from the analysis of data collected through interviews, on one hand, and the theoretical and practical studies found in the specialized literature, as well as the experiences of the researcher as a manager of a public hospital unit in Romania recorded through autoethnography, on the other hand, all highlight that the managerial decisions adopted target four major areas: budget adoption and resource allocation, recruitment, training, and development of staff, technology acquisitions, and strategic planning.

4.2. Unique Elements of Hospital Units Emanating from Research

The study conducted by Walshe and Smith [30] and the analysis of the results obtained from conducting interviews provide the opportunity to identify the following unique elements characterizing hospital units: (a) the state of vulnerability and the need for support of patients; (b) the absence of a clear institutional hierarchy; (c) the personal and personalized nature of healthcare services; (d) the complexity of the care process; and (e) highly advanced technology.

Throughout their managerial activity, the researcher reflected on the specificity of the hospital unit they manage, which primarily stems from its social mission to offer recovery services adapted to the specific pathologies of the patients. The process of medical care for patients needs to be complex, supporting patients who place their entire trust in the unit they turn to and expect to find a hospital environment free from hostility, an environment that provides them with physical and psychological comfort and diminishes their state of vulnerability.

People accessing medical services at the unit managed by the researcher are generally older individuals with chronic diseases and multiple comorbidities for whom complex treatments are necessary, along with investigations using the most advanced technological

equipment. All these factors imply increasing costs and contribute to the constant pressure for greater funding of the hospital unit, which is often difficult to achieve due to the institutional hierarchy.

The conclusion drawn from corroborating theoretical studies in the specialized literature and the experience gained from the researcher's activity as a manager is that the personalized nature of healthcare services, the complexity of the care process, the vulnerabilities and need for support and sustenance of patients, the absence of a clear hierarchy, as well as the advanced nature of the technologies used contribute to outlining particularities regarding the decision-making process in public hospital units in Romania.

4.3. Influencing Factors of Managerial Decision Making Identified Through Research

The results of the analysis of responses from interviewed managers regarding the implications of politics and economics in the decision-making process at the level of hospital units, as well as the presence of ethical aspects (see Section 4.3), are supported by the specialized literature. In this context, ref. [31] showed that the decisions of hospital managers in European countries like Poland are dependent on the political environment. Similarly, ref. [32] demonstrated that politics, along with national directives, ethics, common knowledge, the economy, and organizational and institutional complexity, are the main contextual factors influencing the decision-making process of resource allocation in the health system of Australia.

The study results from [33] indicated that information on clinical efficacy and economic aspects were considered the most relevant when deciding on investments in new health technologies in European hospitals.

Walker's study [34] highlights the fact that ethical values form the basis of ethical decisions. These fundamental values include trust (including honesty), respect, care, responsibility, justice and fairness, civic virtue, and citizenship. Similarly, ref. [35] explores managers' experiences and views on ethical issues in the decision-making process. In this context, he observes that a rigorous qualitative analysis of experiences, strategies, and responses observed to ethical problems led to the classification of competencies associated with judgment, integrity, courage, and humanity.

Over the 14 years of managing a public hospital unit, the researcher was often in situations where they had to understand the political dimensions of problems and proposed solutions, thus managing to better anticipate both short-term constraints and long-term change opportunities. Equally, the financial deficiencies they frequently faced have limited the adoption of certain decisions that could have contributed to improving the quality of medical services offered by the unit they manage.

During the COVID-19 pandemic, the researcher, as the manager of a public hospital unit designated as a COVID-19 support facility, had to manage vulnerable situations that involved ethical dilemmas and values. Thus, they were forced on one hand to face pressures from relatives and the local press accusing the unit of not providing information about hospitalized COVID-19 patients, and on the other hand to comply with current legislation. Moreover, the treatment of patients infected with the SARS-CoV-2 virus by medical staff from specialties other than infectious diseases, the isolation and hospitalization of asymptomatic patients, as well as providing medical care to minors infected with COVID-19 allocated to the hospital managed by the researcher without having a pediatric department represented other ethical dilemmas. Throughout this period, the researcher, in their capacity as a manager, made decisions guided by a set of ethical principles and values. In this sense, to show respect and care for patients, they concluded contracts with a Catholic priest and Jewish Rabbi for patients in critical condition and for whom the family requested religious support.

The conclusion emerging from the previously shared experiences is that the political and economic factors are very important in the managerial decision-making process at the level of public hospital units in Romania, and that managers need to be aware of their influence in order to make the best decisions [36]. Moreover, they must be guided by a

series of ethical values and principles. This involves, besides the rationalist analysis of alternatives, considering the ethical aspects of these alternatives. Aligning the interest of the healthcare unit with the patient's interest often leads to ethical dilemmas in the managerial decision-making process, thus reflecting the sensitivity of the healthcare system [36].

4.4. Sources of Evidence in the Managerial Decision-Making Process Resulting from Research

The results of the content analysis of data collected through interviews are in line with the study by [37], which shows that there are six main sources of evidence used by hospital unit managers: (a) scientific evidence published in academic journals; (b) dashboards, the informational system as well as the internal evidence of the hospital unit; (c) socio-political development plans; (d) professional experience and judgment of hospital administrators; (e) ethics and religious beliefs; and (f) expectations of stakeholders.

Similarly, ref. [38] conducted a study in hospitals in the United States of America to examine whether healthcare unit managers use evidence-based management when faced with major decisions and what types of evidence they consult for decision making. The study results indicated that 90% of the participants responded that they had used evidence-based management for decision making in the last 6 months. Professional experiences (87%), organizational data (84%), stakeholder values (63%), and the opinions of colleagues/experts were the top four types of evidence consulted daily and weekly for decision making.

The use of evidence sources in decision making is supported through autoethnography in which the researcher, acting as a manager during the COVID-19 pandemic, made decisions regarding the procurement of drugs for treating COVID-19 patients using the SARS-CoV-2 infection treatment protocol issued by the Ministry of Health as the primary evidence source. When the unit he leads was designated a COVID-19 support unit, decisions were made regarding budget planning and resource allocation for purchasing equipment by firstly analyzing the specialized literature, European market catalogs, and international databases, and secondly the medical team members involved in treating COVID-19 patients. Considering that the unit he manages is a rehabilitation hospital, that specialized studies have demonstrated the presence of respiratory sequelae after infection with the SARS-CoV-2 virus, and that the number of patients presenting for post-COVID-19 rehabilitation was increasing, the researcher, in his capacity as a manager, decided to purchase special physiotherapy equipment for post-COVID-19 respiratory recovery. Furthermore, the researcher, in his role as a manager, decided to hire a psychologist to support both the COVID-19-infected patients and those presenting psychological sequelae post-COVID-19. In making this decision, the researcher relied on the specialized articles studied and the medical staff's expertise. One of the major challenges faced by hospitals treating COVID-19 patients was the burnout syndrome among the medical staff, a phenomenon widely publicized by the press and observed in staff required to work for 8 h in protective, but not necessarily comfortable, equipment. In this context, the researcher, as a manager, decided to establish training and education centers within the unit to teach the medical staff how to best manage their working time in the COVID-19-contaminated red zone, to provide the best care to patients in that area, and at the same time to preserve their physical resources so necessary in this context.

Concluding the above, we can assert that the obtained data provided information to generate one of the research premises, namely that managers of hospital units in Romania make evidence-based decisions.

4.5. Managerial Decision-Making Models Resulting from Research

The results obtained from the analysis of the statements of the 10 interviewees regarding the use of managerial decision-making models are in accordance with the specialized literature. In this context, ref. [39] developed the administrative decision-making model to address the time constraints that exist in healthcare units. The model is largely based on a decision-making process, a hybrid of normative, descriptive, and naturalistic models that allows managers to make better decisions concerning clinical and administrative issues.

Ref. [40] defines the evidence-based model as decision making through the conscientious, explicit, and judicious use of four sources of information: the expertise and judgment of managers, evidence from the local context, critical evaluation of the best available research evidence, and the perspectives of the population. Furthermore, ref. [37] highlights the fact that the evidence-based model represents a guarantee of effective management.

Ref. [32] considers the adaptive decision-making model to be similar to what healthcare decision-makers actually do, more than evidence-based decision-making models, with the potential to emphasize flexibility and adaptability over rationality and reductionism.

Ref. [41] presents the DECIDE model as a decision-making model that describes a step-by-step decision-making process, created with the aim of assisting managers in hospital units.

Among the existing decision-making models, da Cunha Pacheco Junior and Gomes [42] consider that the incremental model is the best fit for the healthcare system. Throughout his activity as a manager, the researcher made numerous decisions using the evidence-based model, the DECIDE model, the administrative model, the adaptive model, as well as the incremental model.

When organizing the permanent supervision of the oxygen station, the decision was made using the administrative model. The researcher, acting as the manager of a hospital designated as a COVID-19 support facility, faced a situation where the continuous use of the oxygen station posed major risks to patient safety. In this context, he involved the stakeholders in solving the problem, taking their proposals into account to reach a consensus, which was subsequently communicated to the medical staff who had to observe the work environment, record this on the specific form, and immediately report any problems noticed, and to the technical staff who were organized in shifts so that they could constantly monitor the work station and take immediate action in the case of a malfunction.

When preparing the budget for medications, it was based on the evidence resulting from the analysis of consumption, as well as on the national catalog of prices for prescription human-use medicines. Additionally, a meeting of the steering committee and the drug committee was requested, during which the managerial board, together with the medical staff, analyzed the opinions and knowledge gained at conferences and congresses both in the country and abroad, the opportunity of acquiring new drugs, and the elimination or replacement of drugs that no longer comply with therapeutic protocols.

Moreover, when making changes to the organizational structure, this possibility was discussed in the steering committee and the Board of Directors, in order to obtain the approval of the local council. In this regard, the performance indicators from the unit's dashboard, the evolution of migrant morbidity, as well as the Ministry of Health's database were analyzed to see if there were specialized personnel in a certain field.

In the decision to reorganize activities following the handover of a building to the constructors, the researcher, acting as a manager, used the adaptive model. He faced incomplete information, time constraints, and resource limitations in which he had to weigh the costs and benefits of possible solutions from an institutional, ethical, economic, and clinical perspective and to establish priorities. After going through all the steps, the decision was made to keep all specialties, by reducing some activities or orienting services towards outpatient care and day hospitalization.

An example in which the researcher, acting as a manager, made decisions using the DECIDE model was during the pandemic when he faced the issue of staff redistribution. In this regard, he tried to maintain the quality of care for both COVID-19 and non-COVID-19 patients while simultaneously motivating the staff. In the first stage, he analyzed to see if he had employees with the skills for treating COVID-19 patients. Then, he reviewed the legislation to see if financial incentives were provided that he could communicate to the medical staff, later giving them the opportunity to volunteer. In this way, he managed to voluntarily redistribute skilled personnel to the COVID-19 red zone, who provided quality medical services, confirmed by the patients admitted and treated within the unit.

The incremental model was used when the hospital managed by the researcher was designated as a COVID-19 support facility by the Ministry of Health's order. Essentially, this required organizing the unit to receive patients infected with the SARS-CoV-2 virus without having any other alternatives or certainties regarding the outcomes.

Political factors, such as adherence to Ministry of Health directives or alignment with local council approvals, often dictates operational boundaries, priorities, and resource allocations within hospitals. These factors can place pressure on managers to comply with top–down decisions while still ensuring ethical obligations towards patient safety, quality care, and staff welfare. Managers should use decision-making models like DECIDE or the adaptive model to balance political directives with ethical considerations, especially when addressing resource limitations or reallocating staff to new priorities. Hospital managers should foster transparent communications with all stakeholders to ensure that political constraints are addressed collaboratively and in line with ethical standards.

The conclusion emerging from the data obtained through interviews, specialized literature, and the events and experiences lived by the researcher as a manager is that the administrative model, the evidence-based model, the adaptive model, the DECIDE model, and the incremental model are all used in making various managerial decisions within public hospital units in Romania.

5. Conclusions

Through data triangulation using interview-based surveys and autoethnography, this study compared the researcher's experience as a public hospital manager with data from interviews and the literature. This analysis identified key characteristics of the decision-making model in Romanian public hospitals, with managerial decisions often focusing on four areas: (a) budget and resource allocation, (b) recruitment and staff development, (c) technology acquisition, and (d) strategic planning.

Hospital decision making, more complex than in other organizations, is shaped by unique healthcare challenges, including personalized care, treatment complexities, system vulnerabilities, patient support needs, lack of clear hierarchy, and advanced technology [39]. These insights led to this study's first premise: (P1) Unique aspects of Romanian hospitals influence managerial decisions.

This study also revealed that decisions are influenced by political, economic, moral, and ethical factors, leading to a second premise: (P2) Managerial decisions are shaped by external and ethical factors. Additionally, an evidence-based and consultative approach was identified, resulting in premises (P3) Managers make evidence-based decisions and (P4) Managers practice a consultative style.

Various decision-making models—including the administrative, evidence-based, adaptive, DECIDE, and incremental models—further delineate the specificities of decision making in Romanian public hospitals.

By outlining these characteristics and influencing factors, this study offers a framework not for prescriptive decision-making patterns but for supporting progress in hospital management to address increasingly complex challenges. This foundation can help guide improvements in managerial practices and performance within Romania's healthcare system.

5.1. Research Limitations

The qualitative component of this study is constrained primarily by the potential influence of researcher biases on the analysis. This limitation arises from pre-existing assumptions and opinions, as well as the natural empathy that can develop between an interviewer and interviewee, which is a factor that may introduce risk in qualitative analysis [43]. Additionally, interviewee responses may be shaped by social desirability, leading them to answer questions in a favorable manner. To address this, the researcher adopted an open yet critical stance, engaging in active listening without providing feedback on the interviewees' statements, thereby reducing the influence of such biases on data interpretation.

Another significant limitation pertains to the use of autoethnography as a complementary tool to reinforce interview findings. While autoethnography can deepen insights, it has been criticized in the literature for being "self-indulgent, narcissistic, introspective, and overly individualized" [11,44]. To enhance the reliability and validity of data collection, analyses, interpretations, and conclusions, data triangulation was employed, incorporating both analytical autoethnography and relevant scholarly literature. This approach aimed to mitigate limitations inherent to the qualitative methods and reinforce this study's findings.

The sample of healthcare professionals interviewed is relatively small and geographically confined to the Northeastern region of Romania, which may limit the generalization of the findings.

5.2. Future Research Directions

This study offers relevance and utility to a broad spectrum of stakeholders, including researchers, academics, educators, doctoral candidates, hospital administrators, and health sector policymakers. Given its focus on the intricacies of managerial decision making in Romanian public hospitals, this work may serve as an important reference for public hospital management analysts, offering insights into the unique decision-making context within this sector in Romania.

An important avenue for future research involves using this study's methodological framework to compare decision-making models in Romanian public hospitals with those implemented in countries recognized for exemplary hospital management practices. Such comparative analyses could reveal potential solutions to current national management challenges, highlight both convergences and divergences in decision-making approaches, and identify effective managerial decision-making patterns applicable across healthcare systems.

The strength of this study lies in its potential to generate fresh perspectives for future research by introducing new factors, exploring novel variables, or redefining existing ones within the managerial decision-making domain. This adaptability enables a comprehensive exploration of hospital management, unconfined to a single facet, thereby advancing a deeper and more nuanced understanding of effective managerial practices in healthcare.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/healthcare12232395/s1. Supplementary Materials S1: Interview Guide. Supplementary Materials S2: Synthesis of Interviews. Supplementary Materials S3: Themes and subthemes of the "managerial decision-making" domain. Supplementary Materials S4: Themes and subthemes of the "elements of uniqueness of hospital units" domain. Supplementary Materials S5: Themes and subthemes of the "influencing factors of managerial decision" domain. Supplementary Materials S6: Themes and subthemes of the "sources of evidence in managerial decision-making" domain. Supplementary Materials S7: Themes and subthemes of the "managerial decision-making models" domain.

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11

Small- and Medium-Sized Enterprises and Total Quality Management: Experiences in Post-Communist Romania

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Introduction

The importance of small- and medium-sized enterprises (SMEs) in terms of their contribution to Gross National Product (GNP) in a market-based economy cannot be denied.[1] Similarly, they are an important source of employment. In the United Kingdom, for example, they account for 20 per cent of GNP and 40 per cent of employment.[2] That the number of SMEs in Romania has increased during the last decade should therefore be welcomed. Prior to 1989 there were no private companies in Romania. Following the collapse of the Ceauşescu regime the situation changed rapidly. By the end of 1990, the number of private companies had reached 100,000.[3] By 1994, the figure had risen to 570,000 companies employing over one million people and producing nearly 30 per cent of GNP.[4] With very little start-up capital the entrepreneurs behind many of these companies focused their efforts on street trade, small service utilities and tourism. Most of the companies included in their legal registration documents numerous areas of possible activity. These varied from retail, import and export activity, to production engineering, printing and consulting. Most of these companies appear to have survived. A report from the Romanian government in 1997 suggests that less than one per cent of companies have folded since 1992. There are two main reasons for this: many registered companies have not been active at all; and there have been no incentives to de-register.[5] More recent figures suggest that the number of companies has stabilized. At the end of 1996, there were 546,511 registered SMEs. Of these,

93.4 per cent were micro-companies (with fewer than 10 employees), 5.5 per cent were small companies (with 10 to 99 employees), and 1.1 per cent were medium-sized companies (with 100 to 250 employees). The structure of private SMEs by sector consisted of 70.9 per cent in trade, 16.9 per cent in services, 9.9 per cent in industry, and 2.3 per cent in construction.

These companies provide a stark contrast to the traditional state-owned enterprises in terms of jobs and income security, the number of working hours in a day, the quantity and quality of work, the approach to risk, and the flexibility of the business. Their existence also represents a significant element of Romania's progress towards establishing a fully-functioning market-based economy. Moreover, the number of SMEs helps promote competition. For the purpose of this chapter, the important consequence of this is that the question of quality is emerging as a major concern of many SMEs, particularly in the industrial and service sectors. This does not mean that SMEs are fully aware of and eagerly focusing on the principles of total quality management (TQM). The transition period is a difficult one in which to address and apply all the principles of the TQM concept. However, TQM is important and deserves attention. Its integrated implementation may lead to a considerable improvement in the quality of products and services offered by Romanian SMEs, as well as an increase in their competitive position.

Prior to 1990, there were a number of factors associated with Romania's centralized economy which worked against the production of high-quality goods and services on a large scale. The first of these was the centralized economic plan. This dominated economic activity, subordinated it to political authority, and led enterprises to focus on quantity to the detriment of quality. A 'dictatorship of producers' existed with purchasers in most situations finding it impossible to refuse goods priced and delivered according to a plan.[6] This is not to say that Romania lacked companies producing high-quality goods. Most of these produced for export, however, and worked under conditions approaching those found in a free market environment. Yet for the vast majority of companies, sales depended on the centralized plan. Attention was therefore focused not on the production process but on meeting production schedules and allocated quotas. Full employment exacerbated the situation, contributing to employees' docility and a lack of motivation in promoting creativity within the companies.[7]

TQM therefore represents a fundamental change from the 'traditional' management practices towards increased flexibility and quick

reaction to changes in both customers' needs and overall market conditions. For these reasons, TQM represents an important step towards the market economy through customer focus, company-wide efforts towards quality promotion, continuous improvement, and a new approach to work based on teams and the empowerment of employees. As such it is a major challenge for SMEs as well as larger enterprises. Romanian SMEs have to prove themselves capable of identifying and following opportunities, satisfying customer needs and adapting quickly to changes within the market. Romanian entrepreneurs need to adopt the same behaviour as their Western counterparts.

The decision to chose SMEs for the purpose of evaluating experiences of TQM reflects the pioneering role they have played as expressions of private initiative in Romania and the extent to which they have sought to respond to customer needs, increase flexibility, solve problems and improve both products and processes. It is worth noting that most large private companies in Romania have developed from SMEs. This does not mean that SMEs are particularly familiar with TQM as a phrase. For many it has no meaning, especially in the English form. Even translated into Romanian it is not a buzzword. However, the principles underlying it represent good business practice, and some of them are used despite ignorance of the concept. The research presented in this chapter seeks to identify the reasons behind the application of certain TQM principles and the lack of usage of others, and analyse the impact and consequences on the competitiveness of some Romanian small companies.

TQM particularities for SMEs

Defining TQM

Different definitions of TQM exist. All, however, share a number of common features. Wilkinson et al. provide an extensive review of the TQM literature and highlight three major approaches. The first stresses the importance of 'soft' qualitative characteristics such as 'customer orientation, a culture of excellence, the removal of performance barriers, teamwork, training and employee involvement'.[8] A suitable TQM definition reflecting the soft side is that proposed by Dean and Evans:

> A total, company-wide effort that includes all employees, suppliers, and customers and that seeks continuously to improve the quality of products and processes to meet the needs and expectations of the customers.[9]

A second approach concentrates on minimizing the process variation through systematic measurements, performance indicators and the use of statistical process control. The British Quality Association (BQA) suggests an appropriate definition of TQM as:

> a set of techniques and procedures used to reduce or eliminate variation from a production process or service delivery system in order to improve efficiency, reliability and quality.[10]

The third approach is an amalgam of the first two and emphasizes quality, the need for a scientific approach to quality, and the involvement of all employees. For the purposes of the research conducted for this chapter, the following the TQM definition proposed by BS 7850 standard was used:

> A management philosophy and company practices that aim to harness the human and material resources of an organisation in the most effective way to achieve the objectives of the organisation.[11]

Adopting such a definition is appropriate here since it is this definition which can be found in the Romanian standard SR ISO 8402 adopted in 1994.[12] This is designed to provide an important element supporting quality improvement in Romania.

Using the BS 7850 definition and drawing on relevant literature, ten key features of TQM can be identified.[13] These are presented in Figure 11.1 and are used below to provide the framework for analysing the research findings.

TQM and SMEs

Most of the literature on TQM concerns itself with large companies, implying that the concept lacks relevance for small enterprises.[14] However, various authors have shown an interest in TQM and SMEs.[15] Davies points out that TQM as a concept is the same no matter what size the business.[16] There are, though, important differences between large and small companies which affect the approach adopted towards TQM.[17] Hence awareness of Ghobadian and Gallear's comprehensive list of differences between large and small companies is useful.[18] These focus on structure, procedures, behaviour, processes, people and contact. Among the main differences are that small companies have fewer layers of management; a more flexible structure; greater informa-

Figure 11.1 The key features of TQM

1. Top management commitment.
2. Focus on delivering customer value.
3. Suppliers' quality management.
4. Design quality management.
5. Continuous improvement of the system and its processes.
6. Solve the root cause of the problems to prevent further occurrence.
7. Collect data and use science for analysis.
8. The people in the organization are viewed as the primary resource.
9. Work in teams to execute processes efficiently and effectively.
10. Manage processes not just people.

tion flows; higher visibility of top management; less standardization and formalization of processes; and fewer decision-makers. They are also more organic, with operations and the behaviour of employees being influenced by the ethos and outlook of owners/managers. Moreover, planning and control systems are simpler, while informal evaluation, control and reporting procedures are result-oriented, thus encouraging individual creativity. These features sustain and support the 'soft' approach towards TQM. Fewer decision-makers and a direct attention to customer needs as expressed by the owner/manager convey to all employees a clear message of commitment to quality and establish a culture of excellence provided the owner/manager perceives this to be an opportunity. The latter also has a significant impact on employees' behaviour, being able to encourage and support their involvement and teamwork. However, a considerable amount of training and guidance may be required for both the owner/manager and the employees, depending on the specific characteristics of each individual company. This approach underlines the importance of the mental determination of the owner/manager to the constant improvement of the quality of the systems and processes within the company.

However, the technical side of TQM must receive an appropriate level of attention, in order to maintain and improve the efficiency and effectiveness of processes. Small companies are result-oriented, with their traditional lack of resources requiring them to monitor performance criteria more closely than larger companies. This facilitates quality improvement. SMEs should have a good knowledge of traditional tools and techniques for continuous improvement. The decision in selecting certain improvement projects should be based on data systematically gathered and analysed. Such a process may lead to the identification and removal of the root causes of quality problems. If

the small company's evaluation, control and reporting system is very informal, the 'hard' approach to TQM may be difficult to implement due to the associated cultural change required. If more than lip-service is to be paid to TQM, the owner/manager must be the first to use the analytical techniques and procedures aimed at reducing or eliminating variation from a production process. There is a delicate balance between the 'hard' and 'soft' sides of TQM, especially when taking into account the chronic lack of time available to owners/managers to focus on process. A simple solution adopted by many SMEs is to counterbalance small deficiencies in efficiency and process variation with 'soft issues' such as extra care for the customer. This is evident from the research findings.

TQM – the Romanian experience

For the purpose of evaluating SMEs' experiences of TQM in Romania, the focus here is on the ten criteria identified in Figure 11.1 and the findings of research carried out in 1998. Initial informal interviews were carried out with the owners/managers of various SMEs during the spring.[19] There then followed company visits and in-depth interviews. These were conducted with either the owner/manager or a key person in the company. The interviews focused on each of the main elements of the TQM concept. In addition, owners/managers were asked to identify themselves with the characteristics associated with either traditional or process-oriented managers. The characteristics used were those advanced by Bounds et al. (see Figure 11.2). During the interviews, the owner/managers were also asked to discuss the duality of each of the ten criteria.

In this chapter the focus is on the experiences of three companies located in Iaşi, a city with 350,000 inhabitants and a large industrial base. Two of the companies provide photocopying services to the public and are referred to here as CO1 and CO2. They are competitors and leading providers in the local photocopying market. The comparison between them offers insights into the use made of TQM principles for competitive advantage. The third company (CO3) manufactures protective and working equipment. The two companies providing photocopying services are both part of larger family businesses. CO1 was founded in 1990 as part of a company which also runs a few food shops. It has undergone sustained development due to the direct involvement of the owner. As a member of the family which owns the overall business, he takes direct responsibility for CO1. In 1998, CO1

Figure 11.2 Characteristics of traditional and process-oriented managers

Traditional Manager	**Process Manager**
Employees are the problem	The process is the problem
Doing my job	Help to get things done
Understanding my job	Knowing how my job fits into the total process
Measuring individuals	Measuring the process
Change the person	Change the process
Can always find better employee	Can always improve the process
Controlling employees	Developing people
Don't trust anyone	We are all in this together
Who made the error?	What allowed the error to occur?
Bottom line driven	Customer driven

Source: G.M. Bounds et al., *Management: a Total Quality Perspective* (Cincinnati: South Western College Publishing, 1995), p. 87.

employed fewer than 30 people and had an annual turnover in the range of 500–1,000m lei in 1997. CO2 began operating in 1993 as part of a larger company which included a stockbrokerage. Initially, it had a single photocopier. It has since expanded, and by 1998 had 18 units divided between two sites, one close to the city centre, and the other close to the city court house. Managed by the owner of the overall company, CO2 employs less than 30 people and in 1998 had a sales turnover in the range of 200–500m lei. CO3 has been operating since 1992, and employs fewer than 20 people. It is located on the ground floor of a block of flats, and in 1998 it had a sales turnover in the range of 200–500m lei. A family business, CO3 has experienced managerial change with the eldest son leaving the company for three years. During this period the father took over the management, bringing to the company his experiences of working in a state-owned company before 1989. CO3 faces various challenges resulting from Romania's transition towards a free market. Existing customers include the state-run railway, mining and power companies. These are now in the process of restructuring and face financial problems. This had led to delays in the placing of new orders and the paying of existing debts.

1. Top management commitment

The owner of CO1 is a dynamic person in his early thirties with a passion for the more technologically advanced photocopy machines

which have enabled his company to develop a competitive position compared to other copy centres in the city. His desire to see the business grow and his commitment to quality have led to high investment in advanced photocopy equipment and a good recruitment policy. Here, it was clear that quality improvement has been driven personally by the manager. The quality of the technology and people employed enables the company to promote a good-quality image. This is evinced by the customers queuing for the service. The situation contrasts with that in CO2. Here, the manager is also a dynamic individual who acknowledges the importance of dedication and expresses a commitment to excellence. However, in 1998 the technological level of his equipment was considerably lower than that of CO1. This can be explained in part by the fact that his second business, a stockbrokerage, diverts some of the owner's attention away from the copy centres. During the interview, he mentioned the need for greater control over and direction/leadership of the photocopy business, as well as the need to focus employees on the customer and provide a uniform level of service.

In CO3, the son clearly sees the potential for and benefits from emerging markets. Smaller and more dynamic companies also need protective clothing. These new customers require higher-quality garments and better fabrics. This requires investment in new machinery. It also involves larger volumes of work, and higher payments. There are some differences over the main target markets between the father and son. The son's direct involvement clearly orientates the business towards a more competitive market requiring higher-quality products and associated services. Managerial training received by the son in a North American university appears to have influenced his approach.

2. Focus on delivering customer value

The main market targeted by CO1 is the student market. This is characterized by a demand for high quality and high volume with exceptionally high peaks at the end of each semester. In order to satisfy the large demand, the company increases its flexibility by opening for longer hours (06.00 to 20.00) and including a night shift whenever enough orders require delivery within 24 hours. Additional value is provided by polite employees who showed initiative when responding to various unusual customer requirements. The employees are permanently encouraged to 'look carefully to understand the needs and expectations of the customers'. The personal example of the owner plays an important role. Indeed, the owner of CO1 proudly reported his continuous

efforts in changing employees' behaviour towards understanding and satisfying customer needs and requirements.

The commitment to value was also evident in the approach adopted by CO2. The company charges the same price per copy as CO1, the competition between the two copy centres being determined by the availability of service, the quality of the copy, and the convenience of the location. In 1998, CO2 had a differential pricing system according to location and target market, charging twice as much for the photocopying of legal documents. In order to sustain a low price in the city centre, funds had on occasion to be redistributed between locations. The availability of service was assured through 14 copy machines, about twice as many as CO1, and longer opening hours including Sunday opening. The intensity of the competition was evident a year later when both CO1 and CO2 opened copy centres close to the students' halls of residence and the university. Continuous efforts are made by both companies to identify and fulfil customers needs, and provide additional elements of service, such as speed, high quality and reasonable prices.

Value for money is also central to the philosophy of CO3. Here price differences are determined in part by certification from authorized bodies. Other successful clothing companies also visited during the survey provided clear evidence of customer needs identification. One problem widely reported by SMEs in the clothing industry is, however, fabric quality. One manufacturer specializing in clothes for newborn babies described his continuous efforts to convince a large state-owned fabric manufacturer to change the colours and patterns of the fabric so that he could respond to parental demands. Garments made from imported fabrics, even of lower quality but with different patterns, sell very well. They are not always available, however.

3. Suppliers' quality management

For the copy centres, high-volume orders and prompt payments stimulate the interest of companies supplying paper, consumables and spare parts in forming a closer working relationship. Such cooperation enables fast and reliable delivery capable of sustaining low costs and a low price per copy. However, CO1 is constantly searching for cheaper suppliers and this sometimes leads to high variation in paper and toner quality. It has, however, sustained a cost-leadership strategy. During transition, the price as opposed to the quality of products and services plays a very important role in the purchase decision. CO2, for example, noted his constant search for an 'acceptable level of consumables',

meaning reasonable quality at low cost. This approach leads to high levels of variation in the process of providing the service which can be measured in the number of dissatisfied customers, the poor quality of the copy and jammed machines.

With regard to CO3, cost tends to determine supplies and by implication quality. High-quality imported fabrics and accessories raise the price of protective equipment to limits beyond that which traditional customers would be willing to pay. Hence, domestic and seemingly inflexible suppliers have to be used. This has implications for quality. CO3's manager reported that in response to his complaints about quality, existing domestic suppliers threatened to cease deliveries in the future. Such a situation contrasts with that experienced by a shirt manufacturer who proudly told the story of his success in contacting directly a foreign supplier and negotiating a very competitive price. He reported that the producer, a large Turkish fabric manufacturer, was prompt in replacing the defective fabrics and cooperative in the provision of customized patterns and colours. This experience provides evidence of how the Romanian market is opening up to international trade. Such incidents are also milestones for Romanian entrepreneurs since they expose them to the high standards of quality and service in the European market. This entrepreneur in particular can draw on the experience when negotiating with domestic suppliers.

4. Design quality management

The adjustments made to existing services, and the new opportunities spotted by owners/managers are not based on a formal planning procedure. Nevertheless CO1 pays special attention to increasing its flexibility and developing associated service activities. Driven by a desire for growth, the company has bought new equipment. It differs from the competition in that it has purchased a 'state of the art' colour copy machine which meets the needs of academic staff at the university to produce high-quality transparencies and medical textbooks. Two new high-volume, high-quality printers have also been purchased for those requiring editing and printing facilities (for final year dissertations and booklets, for example) and associated binding devices. By contrast, the quality of the copy equipment in CO2 in 1998 was varied. To overcome this, the company 'invited' all its customers to walk among the machines and pick the one they considered the best in meeting their quality requirements. This innovative approach shows respect for customer needs. It also forced clients into talking to the operators about the quality of the copy. This represented an

important breakthrough in that it involved customers directly in the service provision process. It also supported a horizontal information flow between operators and customers and empowered operators to make decisions and give advice.

In CO3, a young and dynamic design team identifies customer needs, expectations and comments and seeks to incorporate them into new garment designs. Each change in garment design means a new certification so as to conform with legal requirements. Looking at other SMEs in the clothing industry, many of them have 'cut, make, trim' (CMT) contracts and lack any design capabilities.[20] Other small clothing companies use their design capabilities as a strong selling point.

5. Continuously improve the system and its processes

Each time the owner of CO1 updates his photocopy equipment, he buys five or six identical machines, a couple of them being for spare parts. He purchases second-hand machines but insists on good brand names. These are robust professional photocopy machines which work well but need the constant attention of the service team. No formal methods of continuous improvement are used, but the manager claims that he continuously instils respect for the customer, courtesy, and high quality of service in employees. There appears to be a better quality of service provision in the location where the owner spent most of his time. The employees seem to be better trained, pay more attention to customer requirements, take the initiative and make decisions when providing service. In the case of CO2, the manager requires employees to report any problems or dissatisfaction experienced by the clients. He encourages them to make suggestions by asking periodically for their opinions. However, due to initial equipment lacking an automatic feeder, he had to employ twice as many operators. He later upgraded the photocopy machines and achieved the same performance as CO1, providing a very similar service.

The same concern for process improvement exists in the clothing industry. All the companies interviewed constantly seek ways to increase efficiency through better machinery. However, none of the companies visited could provide evidence of either systematic process improvement or the use of scientific tools and techniques for continuous improvement. Yet, CO3 is just one example where employees are encouraged to suggest changes in the garment design and manufacturing process to reduce workload and increase productivity. Any change can only be made if the end product continues to meet legal require-

ments and is acceptable to the customer. All supervisors and engineers from the workshop analyse employee suggestions, accepting all those changes in the manufacturing process which increase productivity without significantly altering the design. Short production runs varying from a few dozen to several hundred garments lead to frequent changes in the manufacturing process. Such flexibility places considerable strain on the design team, but opens up opportunities for small improvements proposed by employees.

It is certainly not possible to improve the processes or working system without top management commitment. SMEs are, however, in a privileged position compared to larger companies, given the result-orientation of entrepreneurs, their capacity to sustain higher risk levels and the flexibility found within smaller companies.[21] All these factors support a proactive approach to continuous improvement. However, the lack of resources and the absence of training in the methods needed to identify improvement possibilities limit the opportunities to be gained by adopting a scientific approach to the use of management tools and techniques for quality improvement.

6. Solve the root cause of the problems to prevent further occurrence

Aware of the importance of prevention, CO1's manager blamed inconsistencies in quality on materials, consumables and the age of his machines. Frequent breakdowns mean quick fixes to keep the service running. Against TQM philosophy, fire-fighting appears to be good practice in the manager's opinion. The priority is to keep the machines working and customers coming in. The manager of CO2 also acknowledges the existence of high inconsistencies in the quality of consumables and the ages of the machines as real causes of problems. He claims that for the moment he can do very little about it. To counterbalance frequent breakdowns of the equipment he has set up a special service team and purchased a spare photocopy machine. Yet preventive maintenance takes place only during periods with lower workloads. The manager could not, however, adequately tackle the real cause of the problem: the absence of sufficient capital to pay for much-needed new spare parts to increase reliability. However, if the low-level expectations of customers are considered, the situation did not look bad.

Limited capital prevents companies from solving the root cause of the problems in the clothing industry as well. CO3 reported dissatisfaction with fabric quality, expressing distress at the apparent impossibil-

ity of solving the problem. There are no alternative suppliers, and imports are far too expensive for its market segment.

7. Collect data and use science for analysis

There is no evidence of systematic data collection concerning failures and breakdowns in CO1. The owner reported as useless the time spent on data collection. As with many entrepreneurs, he runs his business personally, taking most of the decisions himself without any formal analysis. Comparing CO1 with a large company, he stated that his decisions are fast, accurate and put into practice almost instantly. If, for example, he needs a very good new printer, he does not have to go through the administrative system and delay the purchase decision by many weeks. However, in a large company, money is not the problem it is in the case of CO1, where the owner has to think twice before deciding to purchase.

Data collection was also perceived as useless in the eyes of CO2's manager. This is due to the high variation in the service provision processes, the age of the equipment, the lack of time, the large variation in the employees' qualifications and the attitude towards work. It was, however, acknowledged that doing nothing about these problems was not the best option in the long run. Hence equipment was updated and recruitment policy changed within a year. Data collection and scientific analysis played no role, however, in the decision. Similarly, CO3's manager placed little importance on data collection as long as the company was fighting for survival due to the lack of orders.

The main barrier in employing data collection and scientific analysis by SMEs does not seem to be the time to do it. A more persuasive reason is a lack of specific education and training in business and management. The large majority of Romanian owners/managers from this research possess degrees received before 1989, when formal education failed to stress the importance of returns on investments and problem-solving tools and techniques.

8. The people in the organization are viewed as the primary resource

CO1's employees provided strong evidence of their empowerment in satisfying the customer through their initiatives and through proactive behaviour in customizing the service. Some of them have a university degree. The manager argued that a good employee, well motivated, will

take good care of the equipment, and he in return will take good care of their personal needs and individual problems whenever these occur. Employees fix machines by themselves whenever possible, otherwise they await the service team. Yet all employees are aware of the cost implications of mishandling key components of the photocopiers. Damage entails the costs of both a replacement part and lost revenue, especially during the peak periods.

In CO2, the manager appreciates good employees, but argues that they should not have the responsibility and authority to make decisions: 'decisions must be taken by one person, otherwise there may be delays on the technical side'. Most employees have only high-school qualifications. The manager considers some of them to be lazy, unwilling to work, and therefore that they must be closely controlled to improve their performance. He makes inquiries about day-to-day operations of the business and considers unacceptable situations where he is not informed about all events.

In the CO3, the son clearly agreed on the importance of people, remembering previous times of 'one big family' when there was no fierce competition, no market and no barriers between the workers and staff. He attributed the present tense climate to the administrative role assumed by his father. This had lowered trust levels and thus demotivated the employees. However, he admitted that it was not possible to pay the employees good wages, and accepted a certain level of employee turnover. Such a situation is not uncommon elsewhere in the clothing industry. Low revenue means employee turnover, with the best employees being among the first to be recruited by competitors, if they are not properly cared for. The larger private companies working CMT for export use a formal recruitment policy. These companies still experience some employee turnover and need to use in-house training for new employees. But better wages and working conditions diminish the employee turnover problem. This suggests that companies do reassess the role of employees. However, high unemployment, a lack of training in modern developments in human resource management among owners/managers of SMEs, as well as the cultural legacy of the Communist period are still important barriers to perceiving the employees as a primary resource.

9. Work in teams to execute processes efficiently and effectively

In CO1 there is little room for teamwork due to the nature of the business. In CO2, some of the employees who have a better education work

harder and are dedicated to serving the customer. Within the company it is considered that there is no teamwork, and the employees should not help each other. This is because the manager 'is not the collectivist type', and collective decision-making is not viewed positively.

In the clothing company, team efforts are limited to workforce involvement in process improvement. No evaluation of the common purpose of the workforce has taken place. Other clothing manufacturers also revealed that teamwork was limited to employees' suggestions on process improvement. During economic recession the major concern of most of the companies is survival, restricting their own learning process and the adoption of new ways of operating, including teamwork.[22]

10. Manage processes not just people.

This particular part of the research drew the attention of owners to the contents of Figure 11.2. When asked to select the most valid set of descriptors in their eyes, most indicated process orientation. The majority, however, also revealed the need to measure individual performance more than process performance.

Leadership style will influence any shift towards employee or process focus. It is not a peculiarity of the Romanian transition that many managers perceive participative leadership – defined by Johnson and Scholes as 'the commitment of the total team to the problem solving, decision-making process that powers organisational performance on a continuous basis' – as a sign of weakness, or a surrender of power and control.[23] Many SMEs are like a big family. This is reflected in process orientation. However, fear and tradition also exist in Romania, inhibiting the use of participative leadership. The lack of training of both employees and managers in team-building, decision-making and teamwork are important factors shifting the management style towards that of traditional management (see Figure 11.2).

Conclusions

It would be inappropriate to argue that most Romanian SMEs understand TQM and have embarked on a route toward its implementation. Whilst SMEs are the first to break from the command economy in employing market principles, there is still a long way to go before use of TQM becomes widespread. One of the first steps to be taken must be the development of an effective quality assurance system and the employment of appropriate quality management tools and techniques. Many small companies employ intuitively some of the TQM principles

in their continuous efforts to improve competitiveness. The brief presentation of each TQM principle reveals that SMEs favour several of the 'soft' criteria such as customer focus and top management commitment to quality.

TQM, however, is also a philosophy and attitude. It is therefore understood, applied, and implemented according to individual characteristics, and differences exist. Furthermore, each company will have its own culture. This has an impact on the understanding of both individual concepts and their integrative use.[24] Employees, too, play a significant role in the differentiation process as a result of variations in their education, skills and knowledge, their use of quality management principles, tools and techniques, and their ethical behaviour during transition.

Clearly, SMEs pay less attention to the 'hard core' of TQM. The management of suppliers' quality is a difficult process because many of them are large state-owned companies reacting slowly to market forces, and the cost of imports is prohibitive. Many entrepreneurs perceive design quality management as an important competitive opportunity. They show less interest in data collection, scientific analysis and the use of specific tools and techniques for continuous improvement. Their limited knowledge of these issues and lack of a long-term vision for their company's development all contribute to a poor business culture. Economic recession adds to these problems, focusing the minds of owners/managers on short-term survival.

Overall, there is very little evidence of systematic efforts to set up and improve the design process. These case studies highlight the advantages of those companies developing and managing their own design capabilities based on market needs. The lack of new designs, especially of new products, may have its roots in the pre-1989 system. Low levels of competition in the economy did not put pressure on companies to launch new products, thus limiting consumer choice.

Romanian SMEs are not alone, however, in being slow to adopt TQM principles. Convey draws attention to the slow pace of adoption in the United States. He notes three reasons for this:

> First – we are not hurting enough … second – we don't want to change our life-style …, and third – even the best US companies tend to regard quality as a program, a department. It's not integrated in their structure, systems, style and so forth.[25]

Such reasons are applicable within the Romanian context. However, there are a number of other reasons and peculiarities of the transition

process which create an environment hostile to the development of SMEs and act as a deterrent for quality improvement. These include a lack of capital; prohibitive interest on loans; unstable and contradictory legislation; the unethical behaviour of many companies; and the insufficient development of institutions such as banks, control bodies, watch-dogs and customer protection agencies. In addition, very few Romanian SMEs have much business experience.

Despite such barriers, the case studies analysed do provide evidence of top management vision for quality improvement within SMEs. They also show the direct involvement of management in day-to-day operations, and employees' support in articulating the company's vision and putting it into practice. There is clear evidence too of a responsiveness to customer needs (both quantitative and qualitative). Subtle differentiation in the identification of customer needs and expectations, as well as their fulfilment, should ensure the sensible positioning of each company in the market. But as long as the market does not have a high level of competitiveness, such differences will not generate company response towards an increase in product and service quality.

What appears to promote TQM is the direct involvement of owners/managers in the day-to-day operation of the business and their commitment to quality improvement. All employees saw company performance clearly and linked it with decisions made by management. Yet the limited resources available to most SMEs forces them to focus on delivering customer value. This underlines the importance of new and innovative designs, and of continuous improvements in the company's processes and quality assurance systems. Only some enterprises considered employees as primary resources.

Romania as a state has responded with great difficulty to the needs of SMEs. The processes of economic restructuring and privatization have been delayed, and large, unprofitable, state-owned companies have continued to receive subsidies, thus acting as a considerable drain on national resources. Frequent changes in legislation, the lack of commitment to long-term policy decisions and insignificant support for SMEs from organizations and governmental bodies created to help them have all helped restrict the economic development of the SME sector. Since 1996, Romania has been engaged in a process that is accelerating large-scale economic restructuring and privatization. Provided the reforms are successful and Romania moves further towards the development of a functioning market-based economy, it is likely that an increasing number of companies will embrace and adopt the principles underlying the TQM concept. The academic environment certainly

plays a role in promoting quality management, through postgraduate provision offering specialized training for enterprises. The first results can be seen in the launch of new products and services (such as tourism). It has to be accepted, however, that in the medium term there are unlikely to be spectacular results.

Notes

1 The definition of SMEs used here is that proposed by the 1971 Bolton Report. This details various criteria: the number of employees is less than 200; the company must have a relatively small share of the market; the company must be managed in a personalized way by its owner/manager and not through the medium of a formalized management structure; and the company must be independent and not part of a larger enterprise. See Bolton Committee, *Report of the Committee of Inquiry on Small Firms*, Cmnd 4811 (London: HMSO, 1971).
2 P. Burns, 'Introduction', in P. Burns and J. Dewhurst (eds), *Small Business and Entrepreneurship* (London: Macmillan Education, 1989), p. 1.
3 C. Rusu et al., *Managementul Afacerilor Mici şi Mijlocii* (Chişinău: Editura Logos, 1993).
4 N. Drăgulănescu, *De la calitatea controlata, la calitatea totală* (Bucureşti: Editura Alternative, 1995).
5 Government of Romania, *The Private Sector of Small and Medium Sized Enterprises in Romania, Annual report 1997* (Bucharest: Government of Romania, 1997), p. 20.
6 See Drăgulănescu, note 4 above.
7 C. Mereută et al., *Tranziţia managementului societăţilor comerciale româneşti în perioada 1990–2000* (Bucureşti: Editura Tehnică, 1995).
8 A. Wilkinson et al., *Managing With Total Quality Management: Theory and Practice* (London: Macmillan Business, 1998), p. 11.
9 W.J. Dean and J.R. Evans, *Total Quality Management, Organization and Strategy* (New York: West Publishing Company, 1994).
10 D.S. Steingard and D.E. Fitzgibbons, 'A Postmodern Deconstruction of Total Quality Management', *Journal of Organizational Change Management*, 6, 5 (1993), 27–42.
11 The preparation of this standard was entrusted by the UK government's Quality Management and Statistics Standards Policy Committee to the Technical Committee QMS 22. Details of the standard can be found in British Standards Institute, *BS 7850: Guide to Management Principles, Part 1* (London: British Standards Institute, 1992).
12 Comitetul tehnic CT 56 (Technical Committee 56), *Quality Management and Quality Assurance Vocabulary: a New Romanian Standard, SR ISO 8402* (Bucureşti: Institutul Român de Standardizare (IRS), 1995). The *SR ISO 90004–4: Guidelines for Quality Improvement* (Bucharest) is the equivalent of *BS 7850–2: Guidelines for Quality Improvement*.

13 G.M. Bounds, G.H. Dubbins and O.S. Fowler, *Management: a Total Quality Perspective* (Cincinnati, Ohio: International Thompson Publishing, 1995) – provided seven out of the ten principles. The author added the other three: 'Top management commitment, Suppliers quality management, Design quality management.'
14 T.H. Berry, *Managing the Total Quality Transformation* (New York: McGraw-Hill, 1991); M.E. Joyce, *How to Lead Your Business Beyond TQM* (London: Pitman, 1995); J. Oakland, *Total Quality Management* (London: Butterworth Heinemann, 1995); M. Olaru, *Managementul calităţii* (Bucureşti, Editura Economică, 1995)
15 C. Haksever, 'Total Quality Management in the Small Business Environment', *Business Horizons*, March–April 1996, 33–40; J. Shea and D. Gobeli, 'TQM: the Experience of Ten Small Businesses', *Business Horizons*, Jan.–Feb. 1996, 71–5; L.A. Sanjay and D.Y. Golhar, 'Quality Management in Large vs Small Firms', *Journal of Small Business Management*, 34, 2 (1996), 1–13.
16 P. Davies, 'TQM in Small Firms', *Total Quality Management Magazine*, 5, 2 (1990), 251–2.
17 J. Welsh and J. White, 'A Small Business is not a Little Big Business', *Harvard Business Review*, July–Aug. 1981, 18–32.
18 A. Ghobadian and D. Gallear, 'TQM and Organisation Size', *International Journal of Operations and Production Management*, 17, 2 (1997), 121–63.
19 At a general level, the research revealed that most Romanian SMEs have little knowledge of TQM terminology. It was assumed therefore to be counter-productive to use the word TQM during interviews. The principles underlying the concept were evaluated during primary data collection without using the associated 'articulated technical language'.
20 CMT involves customers in providing the design, distribution channels, accessories and often the fabric. The producers' input is limited to supplying the workforce.
21 See Ghobadian and Gallear, note 18 above; Sanjay and Golhar, note 15 above.
22 A survey by the author of 94 SMEs in the clothing industry in the UK revealed a very similar pattern regarding the use of teamwork. Only a handful of companies reported that the work process was organized on a team basis.
23 R.S. Johnson, *TQM: Leadership for the Quality Transformation*, vol. I of the American Society for Quality Control's Total Quality Management Series (Milwaukee, Wis.: ASQC, 1993), p. 121.
24 Additional differences affecting Romania, but not examined here, include income levels (low in comparison with other central and eastern European countries); the cultural peculiarities of each major geographical region; variations between town and village in consumer needs and behaviour; and the legal system.
25 S.R. Convey, *Principle Centered Leadership* (New York: Firestone, 1992), p. 260.

nutrients

MDPI

Review

Winter Holidays and Their Impact on Eating Behavior—A Systematic Review

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Abstract: (1) Background: There has been a growing interest in understanding the causes of obesity and developing effective prevention strategies. Lifestyle change programs are often considered the gold standard for weight reduction, and they can help individuals with obesity achieve an annual weight loss of around 8–10%. The aim of this review was to evaluate the effect of food during the winter holidays. This knowledge will serve as a valuable foundation for the development of targeted interventions and prevention programs. (2) Methods: We conducted a systematic search of the literature via one database (PubMed). The search was limited to studies published in English in the last 10 years, with adult participants, but without specifying limits regarding the study design. We excluded articles that addressed intermittent fasting diets or weight loss intervention methods during the holidays through various diets. (3) In separate sections, we analyzed the psychological causes of gaining weight during the winter holidays, behavioral patterns, prevention strategies and the nutritional composition of the different types of food served during the festive period. Results: Using the combination of the terms "holiday and obesity", "holiday and weight gain", "festive season and obesity", and "festive season and weight gain" we obtained 216 results involving the addressed topic. Thus, only ten articles remained after screening, with a total of 4627 participants. Most participants experienced weight fluctuations during the study period, particularly during holidays. One concerning observation was that most of the weight gained during these periods was maintained even after the end of the studies, especially in those with obesity. A supervised exercise program and a controlled diet at work over the Christmas period are effective strategies for avoiding weight gain and its deleterious effects in people with metabolic syndrome or weight problems. (4) In addition, attention must be focused on the psycho-social factors during the holidays because for some people it is a stressful period and can cause a much higher caloric consumption. The simplest method to approach during the holidays is to implement small tips and tricks during this period that will prevent individuals from gaining extra pounds. Conclusions: It is essential to acknowledge that obesity is a multifaceted condition that requires a comprehensive and multidisciplinary approach to address its underlying factors and provide ongoing assistance to individuals in their weight-management endeavors. Even the most effective short-term interventions are likely to produce continued positive outcomes with persistent intervention and support.

Keywords: overeating; holidays; obesity; weight loss

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1. Introduction

1.1. Background/Rationale

Obesity poses a significant challenge to public health, with its prevalence rapidly rising globally. It is currently the fifth leading cause of death worldwide [1].

In Europe, the prevalence of overweight and obesity among adults is 34.8% and 12.8%, respectively [2]. Even more alarming is the fact that over the past few decades, the occurrence of obesity has tripled, resulting in over two-thirds (70.2%) of the adult population in the United States being overweight or obese. Additionally, nearly half of adults (48.5%) are affected by prediabetes or diabetes, conditions strongly associated with obesity. Unfortunately, young adults are the most affected ones [3].

There has been a growing interest in understanding the causes of obesity and developing effective prevention strategies. Lifestyle change programs are often considered the gold standard for weight reduction, and they can help individuals with obesity achieve an annual weight loss of around 8–10% [4–6].

While these programs can initially lead to significant weight loss, sustaining this over time remains challenging for many individuals. Various factors, such as genetic predisposition, physiological changes, and environmental influences, can contribute to weight regain. This makes weight maintenance challenging and often leads to weight regain over time [7].

Incorporating lifestyle modifications, including maintaining a balanced diet, participating in regular physical activity, and making sustainable behavior changes, is crucial for preventing weight gain and promoting a healthy weight. These aspects should be seamlessly integrated into daily routines and maintained over the long term to achieve lasting results. When individuals are unable to achieve and sustain significant weight loss over an extended period, it is often attributed to their perceived failure to adhere to the recommended lifestyle changes. This attribution can potentially perpetuate the stigma surrounding the patient, implying a lack of willpower, motivation, or determination to lose weight. It is common for individuals to focus more on what they have not achieved rather than acknowledging their accomplishments. Unlike weight loss, where visible progress on the scale and improvements in clinical measures can boost motivation, the maintenance phase often lacks these explicit rewards. To support motivation and reinforce satisfaction with outcomes, it is important to draw attention to patients' progress, which can sometimes be overlooked [8].

Even when the patient complies with the proposed strategy, there is a tendency to abandon the rules of a balanced diet during vacations or holidays. These periods are associated with relaxation, indulgence, and a break from regular routines, leading to unhealthy eating habits, reduced physical activity, and other behaviors contributing to weight gain. The period encompassing the last week of November and the first or second week of January poses a significant risk, as people worldwide engage in celebrations such as Christmas, New Year, and various social gatherings where high-calorie foods are consumed. These include desserts, sugary drinks, sweets, and alcohol. Moreover, during this period, physical activity tends to decrease.

According to a study published in the New England Journal of Medicine, the average American gains just under 1 pound during the holiday season. While this might not seem significant, research indicates that this weight is often not lost as the seasons change. In fact, it can account for more than 50% of the total weight gained throughout the year [9]. When holiday weight gain is not reversed, it can contribute to a cycle of gradually putting on extra pounds over a person's lifetime. This can increase the risk of various diseases, including diabetes and heart disease.

We consider this systematic review of valuable importance due to its extensive research, and, as far as we know, it is the first to evaluate the importance of nutritional patterns during the holidays.

1.2. Objectives

In the current world context, it is crucial to develop effective strategies for preventing obesity since it is challenging to reverse once it becomes established. An essential step in developing these strategies is gaining an understanding of the specific periods in a person's life cycle that are particularly vulnerable to weight gain.

In particular, the aim of this review was to evaluate the effect of food during the winter holidays. This knowledge will serve as a valuable foundation for developing targeted interventions and prevention programs.

2. Materials and Methods

2.1. Electronic Search Strategy

Considering these aspects, a search was conducted in PubMed using the keywords "holiday/holidays", "weight gain", "festive season" and "obesity".

1. (holiday) AND (obesity)„in the last 10 years",((""holidaying""[All Fields] OR ""holidays""[MeSH Terms] OR ""holidays""[All Fields] OR ""holiday""[All Fields] OR ""vacation""[All Fields] OR ""vacationed""[All Fields] OR ""vacationing""[All Fields] OR ""vacations""[All Fields]) AND (""obeses""[All Fields] OR ""obesity""[MeSH Terms] OR ""obesity""[All Fields] OR ""obese""[All Fields] OR ""obesities""[All Fields] OR ""obesity s""[All Fields])) AND (y_10[Filter])".

2. (festive season) AND (obesity)„in the last 10 years", ((""festive""[All Fields] OR ""festivities""[All Fields] OR ""festivity""[All Fields] OR ""holidays""[MeSH Terms] OR ""holidays""[All Fields] OR ""festival""[All Fields] OR ""festivals""[All Fields]) AND (""season s""[All Fields] OR ""seasonability""[All Fields] OR ""seasonable""[All Fields] OR ""seasonably""[All Fields] OR ""seasonal""[All Fields] OR ""seasonalities""[All Fields] OR ""seasonality""[All Fields] OR ""seasonally""[All Fields] OR ""seasonals""[All Fields] OR ""seasons""[MeSH Terms] OR ""seasons""[All Fields] OR ""season""[All Fields]) AND (""obeses""[All Fields] OR ""obesity""[MeSH Terms] OR ""obesity""[All Fields] OR ""obese""[All Fields] OR ""obesities""[All Fields] OR ""obesity s""[All Fields])) AND (y_10[Filter])".

3. (holiday) AND (weight gain)„in the last 10 years", ((""holidaying""[All Fields] OR ""holidays""[MeSH Terms] OR ""holidays""[All Fields] OR ""holiday""[All Fields] OR ""vacation""[All Fields] OR ""vacationed""[All Fields] OR ""vacationing""[All Fields] OR ""vacations""[All Fields]) AND (""weight gain""[MeSH Terms] OR (""weight""[All Fields] AND ""gain""[All Fields]) OR ""weight gain""[All Fields])) AND (y_10[Filter])".

4. (festive season) AND (weight gain)„in the last 10 years", ((""festive""[All Fields] OR ""festivities""[All Fields] OR ""festivity""[All Fields] OR ""holidays""[MeSH Terms] OR ""holidays""[All Fields] OR ""festival""[All Fields] OR ""festivals""[All Fields]) AND (""season s""[All Fields] OR ""seasonability""[All Fields] OR ""seasonable""[All Fields] OR ""seasonably""[All Fields] OR ""seasonal""[All Fields] OR ""seasonalities""[All Fields] OR ""seasonality""[All Fields] OR ""seasonally""[All Fields] OR ""seasonals""[All Fields] OR ""seasons""[MeSH Terms] OR ""seasons""[All Fields] OR ""season""[All Fields]) AND (""weight gain""[MeSH Terms] OR (""weight""[All Fields] AND ""gain""[All Fields]) OR ""weight gain""[All Fields])) AND (y_10[Filter])".

2.2. Study Selection

The search was limited to studies published in English in the last 10 years, with adult participants, but without specifying limits regarding the study design.

The exclusion criteria were the age of the participants < 18 years, associated comorbidities, articles that addressed intermittent fasting diet or weight loss intervention during the holidays through various diets, and articles that did not address the topic studied in detail.

We decided to eliminate the studies that include children and adolescents, since both their caloric needs and their food patterns are different from those of adults.

2.3. Study Appraisal

The screening process, including title, abstract, and full-text review, was conducted by three independent reviewers (I.M.A., A.M., G.P.) in duplicate. Full texts of selected articles were carefully examined, and papers from the same study were collected. Disagreements that arose during the data abstraction phase were resolved through discussions between the independent reviewers. If a consensus could not be reached, a fourth reviewer (M.M.L.) made the final decision on the disagreements.

3. Results

Figure 1 highlights the screening and selection process regarding the articles included in this systematic review. Using the combination of the terms "holiday and obesity", "holiday and weight gain", "festive season and obesity" and "festive season and weight gain" we obtained 216 results involving the addressed topic. Thus, after screening, we included only ten articles that addressed the topic of interest.

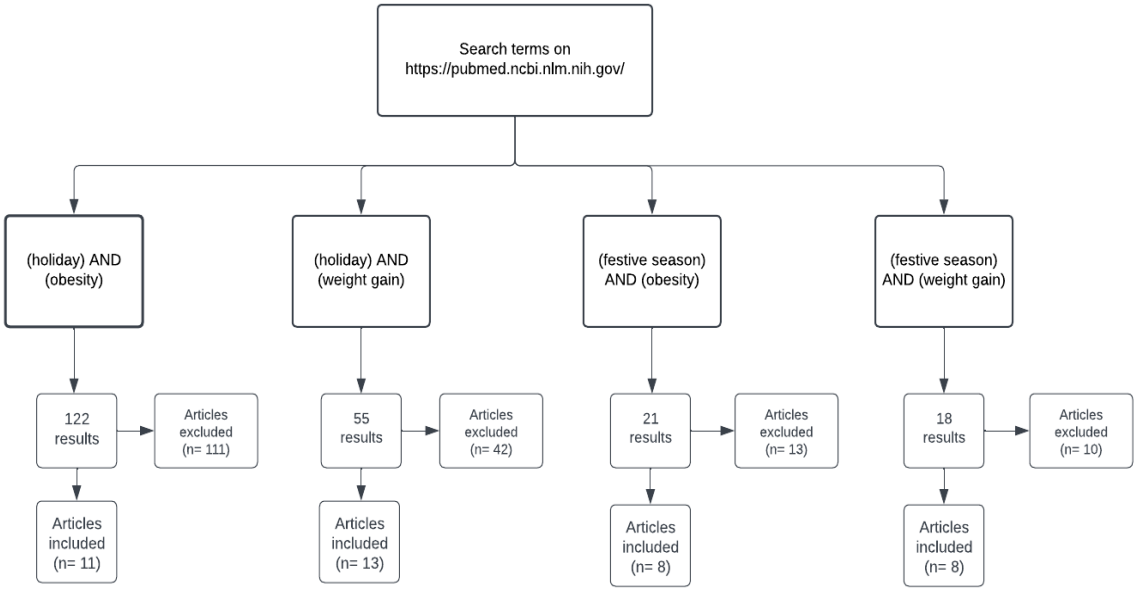

Figure 1. Flow diagram showing the selection process.

The characteristics and demographic data for each study are presented in Table 1.

Out of the ten studies, nine were single-sided: USA (6/10), Spain (2/10), UK (1/10), and one took place in multiple countries: USA, Germany, and Japan.

A total of 4627 participants were included in the studies. From ten studies, only seven mentioned the percentage of males/females. Among the seven studies, in six of them, female participants predominate (65–90%), and only one study enrolled mainly men (66–74%).

The mean age of the patients was 40 years in three studies, 55 years in two studies, between 18 and 65 years in three studies, and between 21 and 50, respectively, over 32.2 years in another two different studies.

Regarding the method used, the participants of eight studies had to make at least two visits with the aim of accumulating data. One of them analyzed the change in body weight through wireless scales and another through the self-weighing method.

The participants of five studies were recruited through flyers, advertisements, or emails. For one study, patients from the National Weight Control Registry were approached, and for the rest, conventional methods were used.

Table 1. General characteristics of the studies included in the systematic review.

Author, Year, and Country	Study Duration	Number of Participants	Age, Sex,	BMI, Prevalence of Overweight/Obesity	Date of Measurements	Mean Weight Changes ± SD
Helander EE et al. (2016); USA, Germany, and Japan [10]	Thanksgiving (USA), Christmas (Germany), Golden Week (Japan); 1 year (2–6 months)	2924 (1781 USA, 760 Germany, 383 Japan);	USA: 42.4 years, 34% F. Germany 42.9 years, 34% F Japan: 41.6 years, 26% F.	USA: 24% obese; Germany:19% obese; Japan: 11% obese	1 August 2012–31 July 2013	Significant increases in weight pre- and post-Christmas across all three countries (0.4% in the USA; 0.6% in Germany; 0.5% in Japan). Significant weight increases occurred over Thanksgiving in the USA (0.2%), Golden Week in Japan (0.3%), and Easter in Germany (0.2%). Annual weights increased by 0.7% (0.6 kg) in the USA and 1.0% (0.8 kg) in Germany over the Christmas-New Year period, and 0.7% (0.5 kg) in Japan over Golden Week.
Cooper and Tokar, 2016, USA [11]	Between the months of March and August.	122	Mean age 32.2 ± 13.0 years 65% women (n = 79) and 35% men (n = 43),	57 normal weight—46.7%, 46 overweight—37.7%, 10 obese—15.6%, average BMI 25.8 ± 0.3 kg/m^2	1 week before vacation, 1 week after vacation and 6 weeks after vacation	People with normal weight accumulating 0.28 ± 0.13 kg, while overweight people gained 0.39 ± 0.14 kg, and obese people gained 0.48 ± 0.27 kg
Bhutaniet al., 2020, Madison Metropolitan area [12]	15 September–15 January	23	Age 21–50 years	BMI: 30–39.9 kg/m^2	15–30 September to 9–25 November (three visits) 9–25 November to 4–15 January (three visits)	A decrease of 0.86 kg during the pre-holiday period vs. an increase of 0.41 kg during the holiday period. Non-significant change with estimated energy intake in the expected direction (+80 kcal/day in holiday period vs. pre-holiday period)
Viñuela, et al., 2023, University of Castilla-La Mancha [13]	23 December–13 January	67, 10 men (14.9%) and 57 women (85.1%)	Mean age 19.00 ± 1.63 years for the males and 20.61 ± 4.33 year	BMI measurement (21.7 ± 3.1) and the second (21.9 ±3.1) and between the second and third (21.7 ± 3.9), observing a decrease	Four measurements: 23 December, 30 December, 6 January, 13 January	Over the Christmas holiday period, the overall weight tended to increase, from an initial weight of 59.6 ± 10.7 kg to 60.2 ± 10.6 kg at the end of the period, whereas 1 week after returning to university, the mean weight was 59.6 ± 9.9 kg. An increase between the first BMI measurement (21.7 ± 3.1) and the second (21.9 ± 3.1) and between the second and third (21.7 ± 3.9), observing a decrease in the return to university (22.6 ± 5.9) to values that were almost the same as at the start of the period but with a slight increase.

Table 1. *Cont.*

Author, Year, and Country	Study Duration	Number of Participants	Age, Sex,	BMI, Prevalence of Overweight/Obesity	Date of Measurements	Mean Weight Changes ± SD
Olson, et al., 2020, USA [14]	November 2018–January 2019	683	54.6 years [SD: 13.2]	69% female, 93% white, BMI: 26.9 kg/m^2 [SD: 5.5]	November 2018, January 2019	Participants gained 0.66 kg (SD: 1.85) from pre- to post-holiday and reported using an average of 12/18 strategies. More strategies were associated with less weight gain (F [1, 670] = 4.28). Daily self-weighing and prioritizing food choices were individually associated with less weight gain.
Mason et al., 2018, Birmingham, UK [15]	November 2016–February 2017	272 (136 were randomized to a brief behavioral intervention and 136 to a leaflet on healthy living)	Mean age: 43.9 years	BMI of ≥20 kg/m^2 78% women, 22% men	Baseline assessments were conducted in November and December, with follow-up assessments in January and February (4–8 weeks after baseline)	The mean weight change was −0.13 kg (95% confidence interval −0.4 to 0.15) in the intervention group and 0.37 kg (0.12 to 0.62) in the comparator group. The adjusted mean difference in weight (intervention−comparator) was −0.49 kg (95% confidence interval −0.85 to −0.13). The odds ratio for gaining no more than 0.5 kg was nonsignificant.
Kaviani, et al., 2019, USA [16]	November–April	111	18–65 years	BMI ≥ 18.5 kg/m^2	V1: before Thanksgiving, V2:after New Year's Day, and the follow-up visit V3: 14 weeks after V2	There was no change in weight with DSW + GF, whereas the control group gained weight from v1 to v2 (−0.13 ± 0.27 kg vs. 2.65 ± 0.33 kg), respectively. In the control group, weight change was similar between individuals with overweight or obesity (OW/OB) vs. individuals with normal weight (2.71 ± 0.48 kg vs. 2.62 ± 0.43 kg, not significant, respectively). For DSW + GF, individuals with OW/OB lost weight, whereas those with normal weight-maintained weight during the holidays (−1.46 ± 0.62 kg vs. 0.33 ± 0.27 kg, respectively). The control group lost weight during the follow-up (−1.14 ± 0.43 kg; v2 to v3) but retained 57% of weight gain; therefore, weight gain from v1 to v3 was significant (1.51 ± 0.39 kg).

Table 1. *Cont.*

Author, Year, and Country	Study Duration	Number of Participants	Age, Sex,	BMI, Prevalence of Overweight/Obesity	Date of Measurements	Mean Weight Changes ± SD
Wilson et al., 2019, USA [17]	2015–2016	239 (100 employees in year 1 (2015–16) and 139 employees in Year 2. 36 repeated participants	47.1 years (+10.46)	Mean weight: 196.7 lb/89.2 kg. Approximately 90% of the participants were female. A majority of respondents were African-American (71%), followed by white (24%) and others (5%)	End of October to mid-January (weight was measured every two weeks during the program (at 2, 4, 6, and 8 weeks) as part of the intervention)	During the program, participants lost a significant amount of weight (from 196.7 lb/89.2 kg to 192.3 lb/87.2 kg), losing weight at each weigh-in. To examine weight maintenance between programs, data were analyzed from the 36 repeat participants (who participated in both years of the program). Participants, on average lost 6.9 lb (3.1 kg) in Year 1, gained 8.7 lb (4.0 kg) between the programs, and lost 4.3 lb (2.0 kg) in Year 2 of the program resulting in a net loss of 2.5 lb (1.1 kg)
Stevenson, et al., 2013 [18]	57 ± 0.5 days (2013)	148	Age 18–65 years	48 males and 100 females, mean body mass index of 25.1 ± 0.5 kg/m^2	Mid-November (visit 1) and early January (visit 2)	Participants showed significant increases in BW (0.78 ± 0.1 kg), BF% (0.5 ± 0.2%,) systolic blood pressure (SBP; 2.3 ± 1.2 mm Hg), and diastolic blood pressure (1.8 ± 0.8 mm Hg. Obese participants (35.2 ± 0.8 kg/m^2) showed a greater increase in BF% compared with normal weight participants (21.7 ± 0.2 kg/m^2) and a trend vs. overweight participant (26.8 ± 0.3 kg/m^2). Exercise (4.8 ± 0.6 h per week) did not protect against holiday weight gain and was not a significant predictor for changes in BW or BF%.
Ramirez-Jimenez, et al., 2020, Barcelona, Spain [19]	November–January	38 (TRAIN group, *n* = 16, HOLID group, *n*= 22)	57 ± 8 years	BMI 32 ± 5 kg/m^2 and metabolic syndrome	20 December (visit 1) and 10 January (visit 2)	HOLID group increased body weight (91.3 ± 13.0 to 92.0 ± 13.4 kg), mean arterial pressure (94.0 ± 10.6 to 97.1 ± 8.9 mmHg, blood insulin (10.2 ± 3.8 to 12.5 ± 5.4 μIU·mL^{-1}) and HOMA (3.2 ± 1.3 to 4.1 ± 2.3). In contrast, TRAIN prevented those disarrangements and reduced total (170.6 ± 30.6 to 161.3 ± 31.3 mg·dL^{-1}) and low-density lipoprotein cholesterol (LDL-C, 104.8 ± 26.1 to 95.6 ± 21.7 mg·dL^{-1}.

4. Discussions

Do we gain weight during holidays?

Overeating during the Christmas and New Year period is a widespread practice that can be challenging to modify. Various factors contribute to dietary changes during the holidays, including social norms, gatherings with loved ones, and the desire to showcase a favorable material situation. Individuals tend to consume significantly more food in a 24 h period than they would typically, often motivated by the intention to begin the new year with a fresh and healthy lifestyle [20].

Furthermore, festive periods often align with public holidays in many countries, providing ample opportunity for sedentary behavior and overeating. On Christmas days, for instance, individuals may consume up to 6000 calories, which is three times the recommended daily caloric intake. This excessive caloric consumption further contributes to weight gain during this time [15].

In 2016, Elina E. Helander and colleagues, using data provided by wireless scales, obtained information on weight fluctuations of 2924 participants from three countries over a 12-month period (1 August 2012–31 July 2013). The study included 1781 residents of the United States with an average age of 42.2 years and BMI = 27.7 kg/m^2, of whom 34% were women, and 24% were obese (BMI $\geq$ 30.0 kg/m^2), 760 residents of Germany with an average age of 42.9 years and mean BMI = 26.6 kg/m^2, of whom 34% were women, and 19% were obese, and 383 residents of Japan with an average age of, 41.6 years and mean BMI =24.7 kg/m^2), of whom 26% were women and 11% were obese.

Participants consistently monitored their weight, and the weight change pattern showed a linear trend until the holiday period. The study specifically focused on the 10 days leading up to Christmas and the 10 days following Christmas. The measurements revealed a weight gain of 0.4% in the United States, 0.6% in Germany, and 0.5% in Japan during this time. Additionally, in Japan, a 0.3% increase in weight was observed during Golden Week, while Germany and the United States saw a 0.2% increase during Easter and Thanksgiving, respectively.

In summary, the study found that participants in all three countries experienced weight fluctuations during the study period, particularly during holiday periods. One concerning observation was that approximately half of the weight gained during these holiday periods was maintained until the end of the study. This suggests that holiday-related weight gain can have long-term effects on individuals' weight [10].

Another article from 2016 talks about how people can gain weight during holidays and how the number of pounds gained can contribute to annual weight gain. One hundred and twenty-two (122) people were included in this study, and most of them had an above-average body mass index (57—normal weight, 46—overweight, 19—obese). To be included, participants had to be going on a short vacation (7 days to 21 days) to a destination other than their primary residence. The latter were the most prone to weight fluctuations because people with normal weight accumulated 0.28 $\pm$ 0.13 kg, while overweight people gained 0.39 $\pm$ 0.14 kg, and obese people gained 0.48 $\pm$ 0.27 kg. In addition, the stress level before the holiday is high, while during it, the level of activity increases; therefore, the main cause leading to the accumulation of extra kilos would be the caloric intake during this period [11].

Even though in the mentioned study, the weight gain does not seem significant; Dale A. Schoeller analyzed several studies where he observed that overweight or obese people are more prone to gain weight on vacation compared to those of normal weight, which over time can increase the risk of an "obesity epidemic" [21]. He mentions that both Yanovski et al., and Hull et al. reported that subjects who had a BMI $\geq$ 25 kg/m^2 were more likely to gain extra pounds. For example, in the study by Hull et al., normal-weight participants gained 0.4 kg while the others gained 0.8 kg [22], and in that of Yanovki et al. at the end of the vacation, normal-weight individuals had a weight gain of 5%, and those with BMI $\geq$ 25 kg/m^2 over 11% [9].

Surabhi Bhutani and colleagues followed 23 adults aged 21 to 50 years and BMI 30–39 kg/m^2 from the Madison metropolitan area, without pathologies or eating disorders, for 16 weeks in a study that aimed to quantify changes in body weight, body composition, energy balance and eating behavior during two consecutive periods: 1. a period of 8 weeks before the holiday (15–30 September–9–25 November) and 2. a period of 8 weeks during the holiday (9–25 November–4–15 January).

The research involved six visits to the study center, three before and three during the holiday period. Initially, anthropometric data were collected, stable isotope-labeled water was administered, urine samples were collected to measure total body water after a night of fasting, and blood samples were collected. In addition, data on participants' appetite and food preferences were recorded using questionnaires. In week 3, urine samples were collected to assess total energy expenditure, and in week 8, the percentage of adipose tissue was quantified. During the holiday week, the same analysis protocol was used.

In the end, the data obtained in the two periods of the study were compared, and a weight loss of 0.86 kg was observed before the holiday vs. an increase of 0.41 kg during the holiday. Although it was initially thought that the weight change was due to the increase in the energy intake, no significant changes in this direction were observed (+80 kcal/day). However, there seems to be a strong correlation between the change in caloric intake and dining out, a usual habit during the holidays [12].

Another study that investigated the association between increasing BMI and eating out showed that a person does this 1.86 times a week. After analyzing data obtained from participants from smaller metropolitan communities in the Midwest, it was concluded that a positive association exists between BMI change and eating at fast food or restaurants (0.8 kg/m^2 and 0.6 kg/m^2) [23]. Even though the study did not show statistically significant fluctuations in weight during the two time periods, there is still a risk that, in the future, the extra caloric intake will contribute to the permanent accumulation of extra pounds [12].

In recent decades, the obesity rate has increased rapidly among young people aged between 18 and 29 years, most of them students. It seems that the first year of college can determine a weight gain of up to 6 kg due to major changes that can increase stress levels. In addition, during the holidays (summer, Easter, Christmas), the social activities include a large quantity of food as a main socialization component, along with excessive consumption of alcohol. A pilot study involving 67 first-year university students at the University of Castilla-La Mancha (10 men, 57 women) with a mean age of 20.4 $\pm$ 4.1 years attempted to examine the changes occurring in young people's lives during the Christmas holidays. Data on initial weight, waist circumference, BMI, and place of residence during the first academic year were collected. During the study, participants weighed themselves four times—December 23, December 30, January 6, and January 13. During Christmas, the body weight tended to increase from an initial mean of 59.6 $\pm$ 10.7 kg to 60.2 $\pm$ 10.6 kg, but with a decrease to 59.6 $\pm$ 9.9 kg in the first week after returning to college. Likewise, BMI showed an upward evolution during the holidays, 21.7 $\pm$ 3.1 at the first measurement, 21.9 $\pm$ 3.1 at the second, and 21.7 $\pm$ 3.9 at the third.

The results, therefore, showed that the students' weight changed during the holiday, with a similar trend for both men and women. Overall, students with a higher initial weight tended to gain even more weight than those who initially were normal. People who gained weight during this period were able to shed the extra pounds by the end of the follow-up period, but again in the case of those with an increased initial BMI, this decrease was not as evident.

Again, it must be emphasized that the events during this period create an environment prone to the risk of weight gain. Eating high-calorie, high-sugar, high-fat foods is encouraged. The number of calories ingested during a day is not only because the frequency of meals is increased, but also because the amount of food is larger [13]. The social factor is very important, and some studies have shown that sometimes the environment in which lunch is eaten can increase portions by up to 44% [24].

Traditional christmas foods and calories

In Romania, the Christmas meal is always plentiful and contains several dishes. Key items include sarmales, periwinkle soup, roast pork, pickles, boeuf salad, house wine, 'țuică' and 'cozonac' (sweet bread) with walnuts [25].

A British Christmas dinner often includes prawns (shrimp), mince-meat pies, and a roasted turkey as the main centerpiece. In contrast to American traditions of garnishing the turkey with herbs, stuffing, or citrus, the British tradition involves topping the turkey with a bundle of sausages. For dessert, a typical choice is a fruit-packed Christmas pudding, which is a rich and dense steamed or boiled pudding [26].

In Greek households, it is common to celebrate Christmas dinner with roasted lamb as the main dish. However, in the northern regions of Greece, a traditional Christmas food called yiaprakia is also popular. Yiaprakia are brined pork-stuffed cabbage rolls that add a unique flavor and variation to the festive meal. On Christmas Eve, Greeks have a tradition of making Christopsomo, which is a rustic sweetbread. This bread is filled with ingredients such as raisins, nuts, cardamom, and cloves, giving it a rich and aromatic taste. It is often decorated with a cross and becomes a centerpiece on the Christmas Day table [26].

Italy is renowned for its delicious desserts, and during Christmas, different regions have their own specialties. In much of Italy, Christmas Day lunch often ends with panettone, a sweet bread filled with chocolate or raisins. However, in Sicily, the traditional dessert is buccellato, a round cake made with dried figs, almonds, and pine nuts. The distinctive flavor of buccellato comes from the addition of marsala, a fortified wine named after the Sicilian city of Marsala, which is incorporated into the pastry dough before baking. Another famous Christmas tradition in Italy is the Feast of the Seven Fishes, also known as Festa dei Sette Pesci. This dinner consists of a seven-course menu featuring various seafood dishes, such as carp, octopus, clams, mussels, and even fried eel. The final course of this feast is reserved for classic Italian desserts, including panettone or homemade tiramisu [26,27].

In the Catalonia region of Spain, Christmas lunch starts with a traditional dish called sopa de galets. This soup features pasta shells known as galets, which are a beloved specialty in Catalonia. The soup is a labor-intensive dish that requires simmering a broth made from a combination of beef and ham bones, chicken breast, pig's trotters, and vegetables for several hours. Bite-sized meatballs made from freshly minced beef and pork are then added to the broth along with the galets, creating a delicious and satisfying start to the Christmas meal [28].

On the west coast of Norway, a popular Christmas dish on 24th December is pinnekjøtt. This traditional dish consists of wood-fired lamb ribs that are first dried, cured, or smoked before being slow-cooked over birch wood. The result is juicy and tender meat with a delightful smoky flavor. Pinnekjøtt is typically served with traditional accompaniments such as swede and carrot mash, which adds a touch of sweetness to complement the rich flavors of the lamb. Lingonberry jam, a sweet and tart condiment, is often served alongside to balance the savory taste of the meat. To complete the meal, a shot of akevitt, a Scandinavian spirit infused with fennel, caraway, and star anise, is often enjoyed as a traditional pairing with pinnekjøtt [28].

In Germany, roasted duck, goose, or rabbit are popular choices for the main course of Christmas dinner. These meats are often accompanied by delicious side dishes such as sausage stuffing, potato dumplings, and red cabbage, which add a savory and hearty element to the meal. Feuerzangenbowle, which translates to "fire tong punch", is a unique and extraordinary version of mulled wine. This special drink is commonly served in German Christmas markets throughout December. It begins as a typical glühwein, which is warm red wine infused with flavors such as orange peel, cinnamon, and cardamom [26,28].

Foie gras is indeed a delicacy that is closely associated with Christmas in France. It is a rich and creamy dish made from the liver of a specially fattened duck or goose. During the holiday season, foie gras is often enjoyed in various ways.

One popular way to savor foie gras is by spreading it on different types of bread toasts. Whether it is a simple baguette slice or a more decadent brioche bread or gingerbread, the buttery texture and unique flavor of foie gras pair well with the crispy or soft bread.

Baked turkey is also a popular and classic Christmas dish. Side dishes include green beans wrapped with bacon, truffle mashed potatoes. A large cheese platter with a variety of different kinds of cheese is a must-have during Christmas celebrations. Bûche de Noël, also known as the Yule log, is a classic dessert that holds a special place in French culinary traditions during the holiday season. The dessert is typically made by rolling a sponge cake into a cylindrical shape, often filled with flavored creams or mousses. The exterior is coated with buttercream or ganache, resembling the bark of a tree. The log is then decorated with festive touches, such as powdered sugar to resemble snow, chocolate shavings, or tiny figurines depicting Christmas scenes [29].

The traditional Christmas dinner in America has its roots in British cuisine. It typically includes roasted root vegetables as a side dish, mashed potatoes, gravy, and a stuffed roasted bird as the centerpiece. In the Southern region, which has a significant population with British ancestry dating back centuries, Christmas is celebrated with various variations of country ham or Christmas ham. Moreover, different regions across America offer diverse regional meals during Christmas. For example, in Virginia, there are oysters, ham pie, and fluffy biscuits, which pay homage to the English founders who settled there in the 17th century [30].

Japan, although not historically a Christian country, has a predominantly atheist population. As a result, some Christian events are celebrated in Japan mainly for commercial reasons. Due to the difficulty in obtaining turkey, chicken has become a popular choice for Christmas day meals. In the 1970s, KFC began offering Christmas chicken deals, which further popularized the tradition of eating chicken during the holiday season. Various chicken dishes such as kara-age, teriyaki chicken, or fried chicken are commonly prepared for Christmas. Additionally, potato salad is a common side dish, possibly influenced by German culture as about 40% of Germans eat potato salad on Christmas Eve. Another popular dish served during this time of the year is cream stew, a Yōshoku dish consisting of meat (usually chicken or pork), mixed vegetables, onion, carrot, potato, and cabbage cooked in a thick white roux. Cream stew is considered a winter dish in Japan as it provides warmth during the cold season. It is believed to be a Western meal and is served on Christmas due to its origins in Western countries. After the main meal, it is customary to serve a layer cake topped with strawberries. The tradition of Christmas cakes in Japan dates back to 1910 when a cake shop called Fujiya started selling decorative Christmas cakes, which became popular among the Japanese population [31].

In Colombia, the month of December is dedicated to celebrations, and the Christmas season officially begins on December 7th, known as the Day of the Small Candles (Día de las Velitas). Since the main Christmas meal is typically eaten close to midnight, it is common to serve snacks throughout the 24th. Fried cheese balls (buñuelos), cheese puffs (pandebonos), tamales (a dish made of meat, vegetables, and corn puree steamed in banana leaves), and natilla (a custard-like dessert) are popular options. Tamales are also commonly served for breakfast. For Christmas dinner, Colombians often enjoy a pork roast or a dish made with pork, as beef is usually consumed more frequently throughout the year. If the family gathering is large enough, a lechona may be served. This is a whole pig that is roasted for hours and stuffed with vegetables and rice. Ajiaco, a chicken and potato soup from the capital city of Bogotá, can be served as an alternative.

Side dishes typically include potato salad (made with potatoes, peas, and mayonnaise), boiled potatoes, and rice. Desserts often consist of natilla (the milk custard), manjar blanco (a thick caramel cream made from sugar and milk), or torta negra (a dense fruit cake similar to German stollen, prepared well in advance to develop its flavor) [32].

All of the above dishes and their nutritional information can be observed in Table 2.

Table 2. Nutritional information of traditional Christmas foods.

Country	Dishes (100 g)	Proteins	Carbohydrate	Fat	Calories	Citation
UK	Christmas pudding	5 g	49.3 g	7.1 g	279	[33]
	British roast turkey	26 g	4 g	2.1 g	116	[34]
	Prawn cocktail	6.5 g	21.5 g	1.2 g	125	[35]
France	Pate de foie gras	11.4 g	4.67 g	43.8 g	462	[36]
	Scallops in orange-butter sauce	14.7 g	7.1 g	8 g	163.2	[37]
	Smoked salmon mousse	12 g	6 g	20.9 g	248	[38]
Greece	Roasted lamb	23.93 g	-	18.15 g	266	[39]
	Dolmadakia	3.5 g	23.8 g	4 g	599	[40]
	Christopsomo	10.9 g	18.1 g	8 g	308.2	[41]
Italy	Panettone	6 g	45 g	13 g	320	[42]
	Cannoli	8.7 g	28.8 g	11 g	254	[43]
	Cassata	2.5 g	23.1 g	9.5 g	182	[44]
	Artigianale gelato al pistacchio	5 g	24.4 g	9.6 g	204	[45]
	Buccellato	5.1 g	66.7 g	11.3 g	397	[46]
	Tiramisu	4.7 g	34.1 g	16.4 g	317	[47]
Spain	Sopa de galets	11 g	72 g	1.5 g	354	[48]
	Polvoron	9.2 g	55.5 g	23.3	470.3	[49]
	Mantecados	5.7 g	54.2 g	31.4 g	525.7	[50]
	Roscon de reyes	5.4 g	45 g	14 g	333	[51]
Norway	Pinnekjøtt	29.8 g	-	37 g	452.2	[52]
	Swede and carrot mash	0.8 g	11.5 g	3.3 g	83	[53]
	Ribbe	13.6 g	-	34.7 g	367.8	[54]
	Lutefisk	5.71 g	0.5 g	0.1 g	25	[55]
	Aquavit (100 mL)	-	-	-	244	[56]
Germany	Feuerzangenbowle (100 mL)	-	14 g	-	127	[57]
	Roasted duck	18.9 g	-	28.2 g	336	[58]
	Sausage stuffing	5.6 g	24.2 g	8.8 g	195.7	[59]
	Potato dumplings	4.2 g	27.5 g	2.8 g	153.3	[60]
	Red cabbage	1.2 g	8 g	-	46	[61]
	Stollen	5 g	7.7 g	63.2 g	336.7	[62]
USA	Prime rib	25.9 g	-	17.3 g	266	[63]
	Cranberry sauce	-	-	44.7 g	186.7	[64]
	Cornbread	6.7 g	42.2 g	9.4 g	282	[65]
	Mashed potato	1.8 g	15.7 g	3.5 g	100	[66]
	Sweet potato casserole	2 g	32 g	3 g	160	[67]
	Gingerbread cookies	4,7 g	71.4 g	14,2 g	428.5	[68]
Japan	Strawberry shortcake	2.3 g	18.5 g	10.1 g	171.5	[69]
	Cream stew	5.2 g	8.6 g	4.6 g	94.9	[70]
	Creamy Japanese potato salad	6 g	17 g	14 g	215	[71]
Romania	Pork cabbage	8.4 g	10.7 g	12.2 g	186.2	[72]
	Sweet bread (Cozonac)	9 g	51 g	5.1 g	298	[73]
	Smoked ham	16.9 g	-	35 g	388	[74]
	Salty bacon	3.9 g	-	85 g	781	[74]
	Leberwurst	17.5 g	0.7 g	24.2 g	302	[75]
	Tobă	23 g	-	22 g	299	[75]
	Țuică 25%	9 g	-	-	175	[74]
	Wine 8%	-	-	-	60	[74]
Colombia	Bunuelos	8 g	48.6 g	26.2 g	426	[76]
	Empanadas	11.3 g	31.2 g	18.4 g	335	[77]
	Ajiaco Colombiano	5.1 g	5.3 g	2.3 g	62.2	[78]
	Colombian sancocho	3.71 g	4.9 g	9.2 g	117.5	[79]
	Natilla	3.9 g	17.6 g	4 g	122	[80]
	Aguardiente (100 mL)	-	-	-	222	[81]

Behavioral patterns

The academic holidays, particularly Christmas, are periods in which weight gain is often more pronounced. During Christmas, individuals tend to consume larger quantities of food and drinks compared to the duration of the holiday period. In Spain, the Christmas holiday typically lasts for 2 weeks, which is shorter compared to the summer break that lasts between 8 and 10 weeks. However, during this shorter holiday period, people often have frequent gatherings and reunions with family and friends, where food plays a central role in the celebrations. This can contribute to increased consumption and potential weight gain during the Christmas season [82].

Some very interesting articles investigate the underlying behavioral patterns that may lead to overindulgence that provide overall and context-specific explanations of people's behavior regarding food choices during holidays.

The way we perceive food involves multiple senses, as our experiences are shaped by the interplay of different senses throughout the process of consumption [83]. It is not just the taste or aroma of the food itself that affects our enjoyment of a meal (intrinsic factors), but also various contextual elements such as the arrangement of the table, the background music, the ambiance of the dining area, and even the specific scents associated with the location (extrinsic factors) [84].

A good example is an early study that has identified an external cue that plays a role in guiding the food intake of obese individuals, as compared to those with normal weight [85]. This cue is related to the smell and palatability of food rather than their internal bodily states. In 2010, Ferriday and Brunstrom conducted a study that demonstrated how a brief exposure to the sight and smell of pizza resulted in increased salivation and a stronger desire to consume pizza and other foods in overweight participants, in comparison to those with normal weight [86].

In a 2023 study conducted by Tran et al., the researchers examined how the multisensory aspects of eating experiences are influenced by seasonal changes in two countries: Colombia and Norway. Interestingly, the results showed that Colombian participants associated salty and fried foods with the cold season, considering them to be energy-dense options. On the other hand, they associated sweet beverages, such as soda, with the hotter months. These findings were somewhat consistent with the associations made by participants from Norway, who also associated colder months with salty and fattier food [87].

In 2016, Suzanne Higgs and Jason Thomas draw attention about other important aspect: social context that influences the amount of food intake [88]. They cite a series of studies regarding the impact of social influence on eating. Thus, some reveal that we are likely to model the behavior of the person we are eating with. Therefore, if they are eating a large amount, we are more likely to consume more than we would have eaten alone. Other studies, based on food diaries, observation, and experimental studies, revealed that we are more likely to eat more if we are in a group compared with eating alone.

Christmas dinner is all about reuniting the family, food celebration, and the way the house, room, and table look, smells, and attracts everyone around it. Considering that appearance, taste, odor, texture, temperature, and flavor, along with taste, all impact the amount of food intake, Wadhera Devina and Calapdi-Phillips Elizabeth propose a review that identifies various visual factors associated with food, such as proximity, visibility, color, variety, portion, size height, shape number, volume and the surface area that affect foot acceptance and consumption [89]. The authors used the combination of dietary intake and visual cue keywords to generate scientific, peer-reviewed articles from prestigious databases, such as Medline, Nutrition, PsychINFO, and marketing databases and included both children and adults.

The review depicts the results from many articles clustered on key themes that affect food intake. Thus, regarding proximity and visibility, if the food looks attractive, then increasing visibility will result in greater energy intake compared with one that is unappealing. Another article deals with how much food has already been eaten, which affects food

intake. Thus, the amount of chicken wings or pistachios consumed is higher if the empty bones or pistachio empty shells were removed from the subjects' sight. Another report shows that increasing proximity to food can also increase food intake because it is more visible to consumers. These findings impact the amount of food consumed on Christmas meals, as it is on the table very close to family and guests.

The variety of types of food on the Christmas meals in appearance, texture, taste, and flavor also affect intake, according to the research cited above, by changing perceived, quantity estimators.

Portion size is another key contributor to energy intake and body mass index (BMI). According to the authors, people eat more if larger food portions are served rather than smaller portions. People also take large bites when served larger portions of food. This leads to gorging. This does not allow sufficient time to release regulatory peptides required to develop satiety. If you do not feel full, you will continue to eat, increasing thus the food intake.

Another factor that influences judgment of the amount of food consumed is the area occupied on the plate. If served on larger plates or bowls, food may be displaced away from the edge of the plate, resulting in a significant underestimation of food amount (contrast effect). However, if served on smaller plates, a substantial overestimation of food (assimilation) will occur. These effects arise due to an optical illusion called the Doelboeuf illusion, as cited in in the review.

A study published by Laurier and Wiggins provides an extended review of the interactions during the family meal focusing on completion and expression of satiety. It is based on qualitative research that uses 90 h of audio tapes, family meal time conversations, and an additional eight hours of videotaped family meal times. While focusing on children of different ages (preschool, primary school, and teenagers) on three occasions (a barbecue routine meal and Christmas), some of the behaviors and routines described are very well suited for understanding overeating and obesity. The family transmits and transforms many eating practices to children, including whether and how to comply (or not) with the request to finish. Some of these learned things will stay with the child during adulthood. The plea to finish described in the article is a series of requests of decreasing amounts from 'little piece' to 'very, very little' and to 'crumbs'. This, in turn, is replicated by children when requesting the 'reward' of the marzipan of the Christmas cake. In adults, during Christmas meals, sometimes filing to finish the portion may lead to being interrogated, persuaded, and worried about (whether you may not like the food) [90].

Social motivation, such as risk-taking and conformity, affect food intake. Kimura et al. explored whether partner presence (pair vs. individual) would affect unfamiliar food intake based on a series of experiments [91]. The study included students from Tokyo, Denki University, with a total of 19 pairs (38 participants, eight females, and 30 males) and 19 individuals (five females and 14 males) with an average age of 20 years. The study did not control the gender combination within pairs because it focused on all pairs consisting of friends, not acquaintances or strangers. The research method measured the amount of participant food consumption and subjective evaluation of food. It was based on an experiment that had a 2 (food familiarity, unfamiliarity vs. neutral within subjects) $\times$ 2 (partner presence, pairvs. individual: between subjects) mixed design. It was interesting to find that the ratio of participants who consumed all three kinds of unfamiliar foods was higher in the paired condition compared with the individual situation. The results also showed that in pairs, the participants tried unfamiliar snacks, even after the pair expressed a negative evaluation of the snack. Such results prove that social motivation and conformity affect unfamiliar food intake in co-eating situations. We also believe, as the authors highlighted, that the extension of time spent at the meal by the presence of a companion is one determining factor of social facilitation in the amount of food consumed.

This research is essential for a better understanding of food intake during Christmas, as the Christmas meal would contain at least some unfamiliar dishes (rarely prepared and served outside Christmas dinner). The results described support the behavioral patterns

of increased food intake when you have companions and spend a longer time around the table during the meal.

Food consumption patterns exhibit seasonal variation, especially in countries with significant seasonal changes in climate. An analysis of factors affecting seasonal differences in food consumption has been addressed in an extensive review. Charles Spence revealed in his publication that cultural and ritual factors combined with ever-increasing sophisticated data and driven marketing could prove to be more important than nutritional, environmental, or psychological factors when explaining why we eat different food in different seasons. From the first lines of the article, he builds the explanations that consider the cultural/ritual associations, especially when we analyze food rituals that have been shown to enhance consumption. Beyond these, the climate has a very important role to play. This is due to the environmental modifications that imply changes in ambient temperature and humidity, perceptual and psychological factors, especially in mood change during the cold winter with little light. Of equal importance may be the period of fasting occurring in some cultures before Christmas, which might instill in some people the desire to have a healthy start at the beginning of the year. Nowadays, with the impact of globalization, it is much simpler to buy, especially in Western civilization, almost any kind of food all year round.

Therefore, the climate/psychological factors, which, some time ago, played an essential role in determining what we ate and when we ate it, have a diminishing effect [92]. This increases the impact of culture/ritual and human psychology due to the importance of food culture and ritualized eating occasions such as Christmas and other ritualistic religious celebrations. The size and significance of behavioral change in the population around Christmas provide marketers with a great opportunity to promote specific foods that may differ from the typical fayre that is consumed during the rest of the year. Some articles cited in the review [92] report a decrease in the sale of ready-to-eat cereal by 10–20% and an increase between 50 and 225% of piecrust in the week before and during Christmas holidays.

Several research results provide strong evidence that people adjust their food intake, aligning with perceived eating norms, in order to convey positive impressions of themselves to other people and that they eat more when eating with friends and family, compared to when eating alone [93]. Through social facilitation, some individuals may eat as much as the person in the group who is eating the most in order to maximize their intake of palatable food. Another possibility is that some people may overestimate the amount eaten by other people around the table, and they increase the amount of food to match the perceived intake of others.

Reviewing the research literature, the paper explores "social facilitation of eating" defined as the augmentation of food intake in the presence of co-eaters, reported in a series of food diary studies conducted by John de Castro. Such social facilitation is essential because it proves that the tendency to eat larger meals is not restricted to particular social occasions (such as family gatherings, events, or celebrations, such as Christmas, etc.). Evidence of social facilitation of eating was reported for meals consumed during weekdays and weekends, across all types of meals (breakfast, lunch, dinner), and for meals eaten with and without alcohol.

Evidence shows that people do not fully compensate for additional intake, and therefore, eating socially will increase calorie intake and promote weight gain [93]. So, people need to acknowledge the impact of social influence on food intake. Participants watched a video of someone else or themselves eating with another person. They successfully recognized (through mimicking) the role of social influence when they watched someone else eating but did not when they watched themselves. While further research may be required, the consequences for Christmas dinner and meetings are important because some people would need to be made aware of the increased food intake due to social eating.

The research of Helen K. Ruddock et al. also highlights some interesting results related to mood and appetite processes. Meals are more enjoyable when eaten socially, and therefore, people will consume larger portions. This was proven through the idea that a

positive mood is more likely to be reported during a social eating occasion. Christmas meal comes with a positive food, and therefore, people are likely to indulge in higher amounts of food intake. The appetite process is affected by social leading through distraction. Research has shown that eating while engaging in distraction, such as engaging in a social environment or watching television, attain weight, feeling of fullness, and sensory of specific satiety, causes people to have larger intakes of food compared to eating without distraction [93].

Moderation or seasonal dieting?

To prevent weight gain, even in small amounts, it is important to practice moderation when consuming snacks and calorie-dense beverages such as eggnog. Additionally, increasing physical activity levels, such as going for brisk walks after meals or dancing on New Year's Eve, can help stabilize blood sugar levels and burn extra calories. A recent study has even suggested that low-volume, high-intensity interval training can effectively reduce hyperglycemia in individuals with type 2 diabetes [94].

The term "seasonal dieting" refers to a pattern of changes in dieting behaviors that typically start or become more intense during the spring season. This is often driven by individuals anticipating heightened body dissatisfaction as summer approaches. People may feel pressure to achieve a certain body shape or size in order to conform to societal ideals associated with the summer season, such as wearing swimsuits or revealing clothing. As a result, they may engage in dieting or restrictive eating practices to try and attain their desired appearance [95].

In a study conducted by Park et al., searches for the term "diet" on Google and Naver (a popular search engine in South Korea) were analyzed in different countries in the Northern Hemisphere and Southern Hemisphere from 2004 to 2018. The findings revealed that searches for "diet" were at their lowest in December and January. The authors interpreted this pattern as being influenced by the New Year period, during which people typically make resolutions, often focusing on weight loss, following the Christmas holidays [96].

Deeper understanding of psychological reasons

Desire to indulge

One's pursuit of sensorial or experiential enjoyment is often labeled as "*hedonic consumption*". Hu and Min highlight the importance of not mis-defining or mis-operationalizing the term "indulgent consumption" as simply being hedonic (such as having a snack, eating ice cream and cookies, or enjoying a dessert). The authors adopted a definition proposed by an author they cited, which defines "*indulgent consumption*" as "time-inconsistent preferences, or a tendency to overweight short term's rewards relative to more distant ones and the tendency in the short term to ignore the cost of one's actions".

The fundamental difference between the two concepts is due to the goal conflict. In order to examine its impact on individuals' subsequent cognitive and affective processes, the authors designed a scenario-based quasi-experiment with 2 (goal conflict yes vs. no) $\times$ 2 (justification for consumption yes vs. no) groups. Goal conflict has been manipulated based on the health status of a fictitious character called Sam, who had health issues and needed to control intake, or he was perfectly healthy and not on a diet. Consumption manipulation was based on consumption occasions (regular dinner vs. birthday celebration). The participants, who were randomly assigned to one of the four conditions, had to respond to questions regarding their perception of the consumption, such as perceived enjoyment indulgence and self-control failure, after they were given a scenario to read.

The study revealed that hedonic consumption is perceived as self-control failure only when goal conflict exists and, therefore, recognized as less enjoyable and more indulgent [97].

While the research [97] addressed the hospitality industry, its findings may be relevant for people eating during the Christmas holidays. Thus, if family and guests recognize a goal conflict, a legitimate reason for gratification (an extra portion of the delicious but high-calorie food on the table) over long-term goal pursuing effort (losing weight), they may enjoy the hedonic consumption more than those without goal conflict.

Another interesting study on altruistic indulgence explored how and why people in certain social contexts are altruistically motivated to consume high-calorie foods to make other people feel comfortable and pleasant, especially for those with whom they are friends and family [98].

Altruistic indulgence refers to the voluntary consumption of high-calorie foods by someone with the altruistic motive of making other people feel comfortable and pleasant. It manifests as a "healthy-causes-guilt" context [98]. It depicts all situations in which, before making a food choice, someone is aware that their choice of a healthy food will elicit negative feelings of guilt from another person.

The paper is based on a field study that included 649 transaction receipts from a coffee shop during one week. There were some solo, and the rest were dyad purchases. There were four types of purchases: (1) solo, (2) first-orders of dyad purchases, (3) second-orders of dyad purchases that started with a low-calorie diet, and (4) the healthy-causes-guilt context where second-order purchases started with a high-calorie choice [98].

Whilst the study took place in a coffee shop and revealed that altruistic indulgence was more likely to occur with a friend, such behavior may also occur during the Christmas table where some family members (as an indulgent companion—the one that makes first the choice of unhealthy food) may influence the other to also choose higher amount/unhealthy food.

Through awareness of such a phenomenon, people around the table may understand the mechanism and make better decisions for themselves.

Stress associated with celebration

In order to analyze stress related, eating, the research analyzed 158 subjects that self-completed daily records of stress in eating for 84 days [99]. As a response to daily stressful problems, the subjects were more likely to eat less than usual than to eat more than usual. The results revealed a substantial increase in the likelihood of eating, less as the severity of stress increased, while the likelihood of eating more did not change with an increase in the severity of stress. Many individuals use larger amounts of food as a source of comfort in the face of stress [99], therefore programs for obesity and eating disorders include relaxation and stress management approaches. Other researchers reported that stress increases eating in some cases and decreases eating in others. Such behavior could be due to environmental factors that may lead some humans to eat less when stressed. If an individual's primary means of coping with stress is eating, that would lead to an increase in intake during stress. However, those individuals who use other means of coping may have limited attention to devote to eating and, therefore, may eat less [99]. These results are supported by a study that analyzed smoking, stress eating, and body weight [100].

Emotional eating

Researchers defined emotional eating (EE), a state that is often encountered during the winter holidays as "*the tendency to overeat in response to negative emotions, such as anxiety or irritability*". Highly palatable foods are those with low nutritional value, but high in fat, sugar and salt. Empirical evidence indicates that by suppressing the hypothalamic-pituitary-adrenal axis response, highly palatable foods protect against stress [101].

Research also revealed that loneliness is associated with preferences for palatable over healthy food [102].

A persons' behavior will depend to a great extent on two key variables: the situation (or context), and the person (their own characteristics and available resources).

There are three important coping strategies with stress: avoidance, emotion-oriented and task-oriented coping strategies. Engaging in a substitute task (also known as avoidant distraction) or via social diversion, represents avoidance coping strategies. Elevating negative emotions associated with a stressor represents emotion-oriented coping, and addressing and dealing with a stressor are the task oriented coping strategies. Music was reported as a commonly used strategy for coping of people who engage in EE [101] which has important implications for advising people who engage in EE to listen to music for discharge. Such strategies may also be used during Christmas.

Sometimes parents feed their children in order to relieve the child's emotional distress, which is also called emotional feeding which may be considered as part of EE. This may cause recurring emotional eating is the child has been taught to use food as a coping mechanism [103]. Another important coping mechanism with EE is mindfulness. This is an awareness that emerges through deliberately paying attention to the present moment without judgment. Mindful eating practices may decrease emotional eating behaviors through interventions on parent, mindful eating and parent mindfulness. Being aware of the power of mindfulness, such strategy for coping could be taught and used during Christmas.

A study on eating pathology in infertile woman revealed that both perceived, stress and avoidant coping styles are important factors that influence the eating pathology. There were six avoiding coping styles used in the research: self-blame, disengagement, venting, substance abuse, self-distraction, and denial that mediated the relationship between perceived stress and eating pathology. Restrained, eating concern, weight concern, shape concern, and disordered eating behaviors were the eating pathologies used in the research [104].

Increased eating associated with stressors also represents an important method of coping, even if it has negative consequences [105]. The research shows that EE as a coping mechanism may be triggered by unsupportive social interactions, especially if one considers that eating might actually be a way of coping with adverse events as well as the propensity to adopt a coping style that does not requires reliance on others, such as emotional or avoidant coping. Christmas family meetings may sometimes provide an environment favorable for the occurrence of unsupportive social interactions among some of the friends and family members and thus to induce EE as a coping mechanism.

Nutritional patterns during COVID19 pandemics

The worldwide implementation of strict non-therapeutic measures during the lockdown had a notable effect on not just people's mental well-being, but also their personal dietary habits and lifestyle. This included changes in access to and availability of food, patterns of food consumption, as well as the type and amount of physical activity undertaken including the cold season [106,107].

In the absence of effective medications for COVID-19, incorporating nutritional dietary supplements that contain essential elements and vitamins may be the most effective way to boost immunity in adults. However, the lockdown imposed during the pandemic has had significant repercussions on various health aspects. These include irregular or unhealthy eating habits, lack of physical exercise, and substance use, all of which can increase the risk of contracting the disease and contribute to feelings of fear, anxiety, depression, and other mental disorders [108]. The emotional strain associated with COVID-19, such as anxiety and depression, can also lead to excessive consumption of carbohydrate-rich foods through "food cravings" or "emotional eating" [109]. Additionally, the prolonged confinement at home can create a sense of monotony, leading to overeating as a means to alleviate boredom or dullness [110].

In addition to the existing global health concerns of lower physical activity levels and increased obesity, the COVID-19 pandemic has further highlighted the need to address these issues. Uncontrolled unhealthy food consumption and limited physical activity can have a significant impact on overall health and increase the risk of various diseases such as obesity, diabetes, cancer, and cardiovascular conditions, as observed in other developing countries [111,112].

Due to the disruption of work routines caused by quarantine, individuals may experience boredom, which has been also linked to increased consumption of fats, carbohydrates, and proteins [113]. Additionally, the constant exposure to pandemic-related information without respite during quarantine can lead to stress, prompting individuals to seek solace in sugary "comfort foods" and potentially overeat. This specific desire for certain types of food is referred to as "food craving", which encompasses emotional (intense desire to eat), behavioral (seeking food), cognitive (thoughts about food), and physiological (salivation)

processes. Interestingly, there is a gender disparity in food craving, with higher prevalence observed in women compared to men [114].

During the pandemic, there has been a greater focus on home-based exercises to maintain physical health, as movement outside the home has been strictly discouraged. Additionally, it has been predicted that the COVID-19 pandemic could disrupt the availability and accessibility of food due to restrictions placed on transportation systems, potentially resulting in increased food insecurity [115].

Prevention strategies for weight gain

It is common to say, "I'm too occupied with Christmas preparations to find time for exercise", or "I receive numerous invitations to indulgent Christmas parties". "While we may enjoy the holiday season, we are allowed to overindulge in food and drink". These are just a few examples of the excuses some use to justify their behavior during the winter holidays, even for those who maintain a regular exercise routine throughout the rest of the year. The permissiveness of this period when it comes to various foods and the consumption of alcohol (also rich in calories), does not completely exclude a minimum of measures that can be taken easily.

Self-monitoring

An excellent strategy to prevent the accumulation of extra pounds during the holidays would be to implement small lifestyle changes, even if attention is directed to other aspects of life during this period, but also to be aware of the effects of an unbalanced diet even on a short period of time.

From the National Weight Control Registry, 683 people were recruited [24]. They had an average age of 54.6 years and BMI of 26.9 kg/m^2, lost at least 13.6 kg (30 pounds) at one point, and maintained their weight for at least a year afterward. Participants were given a list of 18 weight management strategies from which to choose a top three, based on their goals for the festive period. To quantify the effectiveness of the preferences, the participants were measured, weighed, and questioned about the self-imposed goals for the next period. Seven (7)% had no weight loss goals, 47% wanted to maintain their weight, 11% hoped to limit the accumulation of extra kilograms, 35% had a weight loss plan, and 0.3% did not have any objective. In addition, for the pre-holiday assessment, participants placed themselves either in the "I plan to use it" category or in the "I don't plan to use it" category.

After the holiday, each strategy was placed into a new category based on how often it was applied. The strategy with the highest applicability rate (100%) was choosing healthy snacks while traveling, although a small number of people planned to approach this strategy. Focusing on other aspects of the festive period and not on food ranked second in the list of participants' choices (95.8%). In contrast, daily weighing (90.5%) and healthy food choices (93.7%) were the strategies associated with weight changes. This is not surprising, as a high level of attention to meals helps manage caloric intake simply by prioritizing healthy foods over those considered unhealthy.

It is important to note the fact that all choices were made according to the participants' preferences in relation to the goal they wanted to achieve. Thus, those who aimed to maintain/lose weight approached 12/18 strategies, those who tried to limit the accumulation of extra kilograms 11/18, and those who had no objective nine/18 strategies. So, it seems that the prevention of obesity during this period depends not only on the number of strategies we have at hand and can easily approach, but also on the degree of involvement of people in this endeavor [14].

Another study, the Winter Weight Watch Study, looked at the influence of minor lifestyle changes among 272 adults over 18 with a BMI $\geq$ 20 kg/m^2. The participants were divided into two equal groups: one that received a leaflet with information on how to approach a healthy lifestyle but no diet advice, and one in which members received ten tips on maintaining their body weight, and were encouraged to weigh themselves regularly and given information about the type of exercise they could do to burn off the extra calories consumed at the festive meals. Baseline assessments took place in November and December, with follow-up assessments in January and February (4–8 weeks post-baseline). The aim of

this study was that during the festive periods, the participants should not gain more than 0.5 kg. At the end of the study, it was observed that in the intervention group, the mean unadjusted change in weight was −0.13 kg, and in the control group, which only received the leaflets, it was +0.37 kg.

By monitoring their weight regularly, participants reflected much more on the food and drink they consumed. Individuals in the intervention group were more restrained than those in the control group in consuming high-calorie foods and alcoholic beverages. To the question "Have you consumed alcohol in the last week?" positive responses were found in 70% of the people in the control group, compared to 61% among those in the intervention group. Therefore, it seems that small changes in this period could help avoid the accumulation of extra pounds and thus prevent obesity [15].

To test the effectiveness of daily self-weighing (DSW) using a visual graph as feedback, Sepideh Kaviani et al. recruited 111 participants older than 18 years and with BMI $\geq$ 18.5 kg/m^2 online or using advertisements displayed in restaurants or shopping centers. As in the anterior study, participants were equally divided into a control group and a target group. The target group was instructed to weigh themselves daily and not exceed their average weight since the beginning of the study period, but without receiving instructions on how to reach this target. The control group did not receive this kind of training. In addition, all participants underwent anthropometric measurements, biological samples were taken for lipid metabolism analysis, and their blood pressure was measured before and after the study. There were three evaluations during the study, one before the holidays (after Thanksgiving), the second after New Year's Day, and the third 14 weeks after the second evaluation.

The awareness of weight and possible fluctuations had, it seems, a particular impact, so that participants who weighed themselves had better control over the frequency of meals and the amounts served. Moreover, in the target group, there was a decrease of -1.46 ± 0.62 kg among overweight/obese people and a maintenance of weight in normal weight of 0.33 ± 0.27 kg, opposite to the control group. Likely, participants with a BMI above the normal were much more influenced by their weight during the experiment, which could help them over time and prevent the accumulation of extra pounds during the festive period. In the control group, a substantial increase in weight of $+2.65 \pm 0.33$ kg was observed, but most of the accumulated kilograms were lost by the end of the study (57%). Interestingly, men lost 95% of the total accumulated up to the last visit, compared to women, who managed to lose 77% of the total.

In conclusion, even if self-monitoring does not seem to be such an important tool, it can eventually become an addition to the strategy of maintaining an ideal weight [16].

Prevention at work

Jobs offer a unique opportunity to promote a healthy lifestyle. People working in the same place interact a lot with each other and create close relationships; as a result, some policies can be much easier to implement than in the community.

Diet and lifestyle improvement programs are often recommended when employees are already obese, instead of emphasizing the importance of prevention. As previously mentioned, the holiday season is problematic for weight. Accordingly, Mark G Wilson et al. conducted a pilot study that included 239 state workers, with an average age of 47.1 years, from the same department. The test was divided into two phases, each running for 10 weeks, from the end of October to mid-January (2015–2016). In the first stage, 100 employees participated; in the second, 139 employees, of whom 36 were also in the first stage.

The study was based on teamwork, self-monitoring, regular weighing, and implementing positive habits. Employees met with a kinesiology staff member and were given a list of activities designed to promote healthy eating habits and physical activity. In order to achieve the goal of compensating for the increased caloric intake and reduced physical activity, the participants were proposed a caloric deficit of 500 kcal/day.

After the initial weigh-in, teams were formed, and each group received points throughout the study for participating in the weekly activities and for completing the bi-weekly weigh-ins. At the end of the 10 weeks, awards were given to celebrate achievements.

Participants were weighed at the beginning and end of the study, measured every two weeks, and participated in a pre-and post-study survey related to dietary habits and physical activity.

Weight loss was significant throughout the program (from a mean weight of 196.7 lb/89.2 kg to 192.3 lb/87.2 kg), increased time spent on physical activity, reduced fast food consumption, and implementing more fruit and vegetables into the diet.

To examine weight maintenance between programs, the data of the 36 participants who agreed to repeat the test were analyzed. On average, they lost 6.9 lb/3.1 kg in the first year, gained 8.7 lb/4.0 kg between programs, and lost 4.3 lb/2.0 kg in the second year, resulting in a total loss of 2.5 lb/1.1 kg. It appears that of 31% who maintained or lost weight, 44% gained less than 10%, and 25% of them gained 10% or more throughout this period between programs.

Therefore, teamwork that aims for a healthy lifestyle, including at work, can be an excellent way to prevent the accumulation of extra pounds during the festive periods of the year [17].

Physical activity

Even though it may feel challenging to exercise during the holiday season, incorporating brief moments of physical activity throughout the day can contribute to maintaining the physical and mental well-being. It is important to remember that fitness during this time should not be a source of stress or obligation. Taking rest days and allowing time off to spend with loved ones is just as important.

In 2013, Stevenson et al. conducted a study that included 148 participants (100 women, and 48 men aged 18–65 years old, with an average BMI of 25.1 $\pm$ 0.5 kg/m^2) in order to evaluate whether exercises performed regularly during Christmas have an effect on body weight. The initial assessment was performed in mid-November, and the final evaluation was in early January. Characteristics analyzed were weight, body fat percentage, blood pressure, and self-reported physical exercise. Depending on the time devoted to physical exercise throughout the study, the participants were divided into two groups: "athletes", who did physical exercise of moderate intensity > 150 min per week, and "non-athletes" who did physical exercise more less than 150 min per week.

During the entire festive period, the participants gained 0.78 $\pm$ 0.1 kg, and their fat percentage increased by 0.5 $\pm$ 0.2%, without significant differences between non-athletes and athletes (BW: 0.86 $\pm$ 0.2 kg vs. 0.70 $\pm$ 0.1 kg; BF%: 0.7 $\pm$ 0.3% vs. 0.3 $\pm$ 0.3%; BMI: 0.3 $\pm$ 0.1 kg/m^2 vs. 0.2 + 0.1 kg/m^2). A considerable difference was observed in the case of systolic blood pressure (SBP), as non-athletes showed an increase of +4.8 $\pm$ 1.6 mmHg, compared to athletes +0.3 $\pm$ 1.6 mmHg.

It should be noted that obese subjects showed a greater increase in fat percentage compared to normal weight and overweight subjects: 1.6 $\pm$ 0.5% vs. 0.2 $\pm$ 0.2% vs. 0.5 $\pm$ 0.4%. Moreover, the SBP value of the obese participants increased by 6.6 $\pm$ 2.3 mmHg, compared to 0.7 $\pm$ 1.6 mmHg in the normal weight group.

Therefore, more than lack of exercise, initial body weight influenced changes over the holiday period, with exercise not having a protective role against accumulating extra pounds, especially among people with a BMI above the normal limit. However, regular physical activity may have a protective role against blood pressure changes, as there was a trend towards increased SBP in those who were sedentary throughout the examination [18].

On the other hand, in a randomized controlled study, an attempt was made to evaluate the effect of HIIT physical exercises on a cycle ergometer during the three weeks that include the winter holidays (December 20–January 10) on 38 men with an average age of 57 $\pm$ 8 years, BMI 32 $\pm$ 5 kg/m^2, that had diagnostic criteria for metabolic syndrome.

To be classified as metabolic syndrome, participants had to present 3/5 risk factors: increased abdominal circumference, high blood pressure, elevated fasting blood glucose, hypertriglyceridemia, and low high-density lipoprotein values.

Initially, all participants performed 12 weeks of high-intensity training on a bicycle, a week before Christmas were evaluated, and the first part of the experiment ended. Later they were divided into two groups—22 people who continued to train (TRAIN) and 23 people who stopped training (HOLID), but all were encouraged to maintain their eating habits and lifestyle.

The workouts lasted 43 min, which included a 10 min warm-up (70% of maximum HR), four repetitions of 4 min of exercises in which 90% of maximum HR was reached, 3 min of recovery with 70% of maximum HR, and 5 min of recovery three times a week for three weeks.

Weight, height, abdominal circumference, and body composition by bioimpedance were assessed by the same researcher at the start and end of the program. The participants had their systolic, diastolic, and mean blood pressure values measured after 15 min of rest. A blood sample was taken to analyze blood glucose, insulin, and lipid profile (HDL-cholesterol, triglycerides, total cholesterol).

At the end of the study, the participants were questioned about the calories consumed and physical activity during the festive period. No differences were observed between the two groups. On average, the subjects consumed 2596 $\pm$ 93 kcal/day in the last three days of the experiment and estimated a physical activity of 1810 $\pm$ 1524 MET/min/week.

When comparing before and after the holiday, a significant increase in mean blood pressure was observed in the HOLID group 94.0 $\pm$ 0.6 mmHg vs. 97.1 $\pm$ 8.9 mmHg, compared to those in the TRAIN group, where no significant changes were recorded at 97.7 $\pm$ 7.9 mmHg vs. 95.3 $\pm$ 8.2 mmHg. In the sedentary ones, the abdominal circumference increased from 108.1 $\pm$ 10.3 to 110.1 $\pm$ 9.4 cm. Mean weight increased from 91.3 $\pm$ 13.0 kg to 92.0 $\pm$ 13.2 kg in the HOLID group, while in the TRAIN group, it decreased from 99.2 $\pm$ 19.6 to 98.98 kg. Body weight change was correlated with increased LDL-cholesterol, SBP, and worsening lipid oxidation capacities during exercise. Reduced lipid oxidation capacities were also correlated with increased SBP, and high triglycerides with decreased insulin resistance.

In conclusion, a supervised exercise program over the Christmas period is an effective strategy for avoiding weight gain and its deleterious effects in people with metabolic syndrome or weight problems [19].

Even if the effectiveness of sports cannot be demonstrated for a short period of time such as the winter holidays research demonstrates that participating in regular moderate-to-vigorous physical activity provides many health benefits. Some benefits of physical activity can be achieved immediately, such as reduced feelings of anxiety, reduced blood pressure, and improvements in sleep, some aspects of cognitive function, and insulin sensitivity. Other benefits, such as increased cardiorespiratory fitness, increased muscular strength, decreases in depressive symptoms, and sustained reduction in blood pressure, require a few weeks or months of participation in physical activity. Physical activity can also slow or delay the progression of chronic diseases, such as hypertension and type 2 diabetes. Benefits persist with continued physical activity.

It has been estimated that people who are physically active for approximately 150 min a week have a 33 percent lower risk of all-cause mortality than those who are not physically active. Physical activity and caloric intake both must be considered when trying to control body weight. Because of its role in energy balance, physical activity is a critical factor in determining whether a person can maintain a healthy body weight, lose excess body weight, or maintain successful weight loss [116].

Geriatric population

Eating problems can be frequently observed in the elderly. Researchers include chewing and swallowing complications, xerostomia, poor appetite or oral health related eating problems as some of the most prevalent causes for this problem [117].

The act of eating together "at the same table" is an important concept of commensality, well established among food studies scholars. This important human ritual provides benefits that goes beyond the biological need for food [118]. It is important to understand what happens beyond the food offered through the engagement with the material and affective elements of cooking and eating together, with special impact on social, isolation and loneliness. About 10% of the elderly in the UK report that they feel cut off from society and mainly say that the television is their main form of company.

The Christmas meal, as an exceptional commensality, must be analyzed through three main dimensions: first, eating together is in active communication between participants, regarded as interactional; second, "the staging of norms carried out by dinners and the control over those norms" is the normative dimension, and finally the symbolic dimension embracing the wide range of meanings attributed to eating together in different societies. Thus, the Christmas dinner may be analyzed in relation to several functions of establishing exchanges, social hierarchies and a sense of belonging to a group, which can unite and consolidate relationship, but also offer an occasion for differentiating and excluding social groups [118].

The lack of studies on this topic that include the geriatric population is another aspect we faced in trying to include a range of the adult population as large as possible. There is a limited number of studies that talk about the involvement of the elderly at the Christmas table, the women who prepare various types of food and the significance of the whole family on Christmas Eve [119]. However, there are no clear data related to caloric intake or the number of meals.

We consider it opportune to create a line of research in this direction, since the elderly constitute a growing segment of the world's population, and syndromes such as frailty, depression along with social isolation influence the evolution of the elderly, especially at these times of the year.

Tips and tricks

1. Indulging in a special celebratory meal is unlikely to have a significant impact on your overall health. However, if you find yourself having multiple celebratory meals, it may be beneficial to adjust your other meals. For example, you could opt for a lighter evening meal, possibly you can choose to consume smaller portions of food or only one course at a festive meal.
2. To complete a meal, whether you are dining out or at home, consider enjoying a cup of coffee or tea while others indulge in a dessert. Alternatively, you can choose to eat a green appetizer before the meal, for example a salad, which will bring you a rich supply of fiber, which will reduce your sweet tooth, or if you also choose dessert, the glycemic curve will be flatter, so your sweet tooth will be less in the future and you can skip dessert at your next meal [120].
3. When drinking alcoholic beverages at home, it is easy to lose track of your consumption, so it is important to make a conscious effort to keep track of how much you are drinking because drinks add extra calories. In a study of 3327 men aged 60 to 79 years, without a history of myocardial infarction, stroke or diabetes, from general practices in 24 UK cities, men who consumed > or = 21 units/week showed higher levels of central adiposity than occasional drinkers or nondrinkers, regardless of the predominant type of beverage consumed (wine, beer, spirits, or mixed). The highest correlation was most clearly observed in beer and spirits consumers. It seems that the positive association was maintained regardless of whether the alcohol was drunk with or separate from the meals [121]. However, even non-alcoholic drinks can be high in calories, so, if possible, choose sugar-free beverages or water.
4. Exploring alternative activities with your loved ones can be a great way to avoid unhealthy food options and even save money. Instead of solely focusing on meals, you can suggest going for a winter walk together. An interesting idea is the one addressed in a pilot randomized controlled trial in which 107 inactive adults from the UK aged between 18 and 75 were included through social media platforms, workplaces and

community groups. Participants received an email with a Christmas-themed physical activity idea to complete that day. Each physical activity idea was presented in three intensity formats, including Easy Elf (light intensity), Moderate Mrs. Claus (moderate intensity) and Strenuous Santa (vigorous intensity). This type of activity not only encourages physical activity, but also provides an opportunity to enjoy quality time with family and friends in a healthy and fun way [122].

5. Many times during holidays, high-calorie snacks are served between meals. If you feel the need to get a boost of energy between meals, opt for a salty snack that will not cause spikes in your glucose levels. For example, you can choose a Greek yogurt with a handful of pecans, some baby carrots with a spoonful of hummus or apple slices with cow's cheese [120].
6. The winter evenings spent in front of the TV watching our favorite movies with the family tempts us to eat on the couch and this makes us unable to keep track of the calories consumed [15]. Eating while watching TV can lead to increased food intake and a possible explanation lies in the multidimensional nature of distraction. It has been argued that once distracted from internal cues such as hunger and satiety by various external factors, an individual will eat mindlessly and their food intake will not be coded in certain ways which influences their desire to eat. The healthiest way is to eat at the table while enjoying the food [123].
7. In winter, stores tempt us with hundreds of sparkling and colorfully packaged products at reduced prices, but you must be careful. Check the fat, sugar and number of calories on food labels when shopping and preparing food. Imagine how hard it would be to burn calories from a dessert rich in sugar and fat! [15].

Results from a study that sought to determine whether adding a menu chart that includes both the calorie content of the item and the amount of physical activity required to burn the calories in each item will lead the shopper to purchase a meal with fewer calories from a sample menu showing a significant difference in the average number of calories ordered by menu type.

8. In general, respondents ordered the lowest-calorie meals when shown the menu with calorie information and the number of miles they would walk to burn those calories. Those who were shown the menu with information about calories and the number of minutes of walking to burn those calories also chose the lower-calorie meals, although to a lesser extent. Pairwise comparisons revealed a statistically significant difference in the total number of calories ordered from the menu with miles walked to burn those calories compared to the menu without nutritional information [124]. Therefore, choose wisely and read the labels, including when shopping for the holidays. The holiday season can be stressful because people want the house to be perfectly decorated, the food to be tasty and the gifts to please everyone. This can trigger long-term emotional problems associated with loneliness, anxiety, and depression. In stressful times such as these, the consumption of comfort foods that are rich in calories, fat and sugar is common. For example, when rats were presented with a choice of highly palatable food such as lard or sugar, stress consistently increased intake of palatable food specifically. Humans similarly turn to hyperpalatable comfort foods such as fast food, snacks, and calorie-dense foods even in the absence of hunger and lack of homeostatic need for calories [125]. Therefore, it is important to keep stress levels under control during the holidays with sports, yoga meditation, and deep breathing [126].
9. A lack of sleep leads to metabolic and hormonal imbalances such as decreased glucose tolerance, decreased insulin sensitivity, increased evening concentrations of cortisol, increased levels of ghrelin, decreased levels of leptin, and increased hunger and appetite leading to higher calorie intake. Even if the holiday season is busy, sleep as much as your body needs. In a study from 2011, it was discussed that approximately 50 epidemiological studies carried out in different geographical regions examined the association between sleep and obesity in adults and children. Most of them showed a

significant association between short sleep (generally <6 h per night) and increased risk of obesity. A meta-analysis of 18 studies of 604,509 adults demonstrated a pooled obesity odds ratio (OR) of 1.55 (1.43–1.68; $p < 0.0001$) for less than 5 h of sleep and a dose effect of sleep duration so that for each additional hour of sleep BMI decreased by 0.35 kg/m^2 [127].

10. To make everything simpler, look for a friend to team up with to be motivated and accountable over the holidays!

5. Strengths and Limitations

In this study, the authors gathered information related to the impact of food during the winter vacation on the adult population. The unique approach is a strong point of the work, considering that we did not limit ourselves only to the studies presented, but also chose to present the possible psychological or consumerist reasons behind overeating at this time of the year and also information published during the COVID19 pandemic. A note of originality is given by the Tips and Tricks section, but also by the information related to physical activity. Among the limitations of this study, we can include the fact that the search for articles was performed on a single platform and we focused on a period of only 10 years.

6. Conclusions

Sustaining long-term behavioral changes and effectively managing obesity necessitates ongoing attention and support. Even the most effective short-term interventions are likely to produce continued positive outcomes with persistent intervention and support. It is essential to acknowledge that obesity is a multifaceted condition that requires a comprehensive and multidisciplinary approach to address underlying factors and provide ongoing assistance to individuals in their weight management endeavors.

Behaviors that have been linked to long-term success in weight loss include various factors. These imply regularly monitoring and weighing oneself, reducing calorie intake, consuming smaller and more frequent meals or snacks throughout the day, increasing physical activity, more at-home meals rather than restaurant or fast-food meals, limiting screen time, and incorporating portion-controlled meals or meal substitutes into the diet. All these measures should always be respected, including during the holidays.

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Digital Technologies to Support Sustainable Consumption: An Overview of the Automotive Industry

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Abstract

Having in view the current global disruptive social and economic landscape, sustainability becomes more important than ever. As producers become more concerned about adopting more sustainable practices, customer awareness towards sustainable behavior must be the focus of all stakeholders. Within this context, the SHIFT framework (proposed in 2019) highlights the manner in which consumers' traits and attitudes influence their propensity towards sustainable consumption. It consists of five factors considered to be relevant to consumer behavior: Social influence, Habit formation, Individual self, Feelings and cognition, and Tangibility. Different from previous studies, this research focuses on applying the SHIFT framework to the automotive industry, taking into consideration the contribution of digital technologies to fostering sustainable consumer behavior throughout the entire product lifecycle. Using a qualitative research approach, the most relevant digital technologies in the automotive industry were identified and mapped in relation to the three phases of consumption (choice, usage, and disposal). The research aimed to develop and test an original conceptual framework, starting from the SHIFT. The results of the study highlight the fact that the digital technologies, in their diversity, are integrated in different ways into each of the three phases, facilitating the adoption of sustainable consumption. To achieve sustainability, the two key stakeholders, consumers and producers, should share a common ground on capitalizing the opportunities offered by digital technologies.

Keywords: sustainable consumption; SHIFT framework; digital technologies; automotive industry

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1. Introduction

Based on the Brundtland Report of 1987 [1], this study focuses on the philosophy of sustainable development. Although the original approach was ambitious, aiming to promote a new era of socially and environmentally sustainable economic growth, the reality has proven that, globally, the situation remains concerning. This is because, according to predecessors in research, the new vision of economic growth, which had the undeniable merit of raising awareness of sustainability issues, failed to provide an ethical platform to support effective environmental protection [2], fueled the growth of social inequalities [3], did not provide better living conditions for workers and consumers [4], and continued to

promote the capitalist economic growth model, which does not pay sufficient attention to issues of social justice and ecosystem health [5].

Analyzing the sustainability and desirability of economic growth, Kallis et al. (2025) [6] showed that post-growth research has identified new ecological macroeconomic models that have the potential to better address sustainability and welfare concerns, but only if national economies are linked to global climate economy models and all stakeholders are more responsibly involved. For example, amid the latest crises, the EU has proposed the "smart, sustainable and inclusive" growth model that is climate-resilient, based on a competitive digital economy, ensuring the just transition, promoting innovation and reducing the carbon footprint.

As regards the carbon footprint (directly targeting CO_2 emissions and raw material extractions), a notable study argues that specific environmental pressures need to be analyzed in direct relation to the consumption of goods and services [7]. More specifically, the authors pointed out that resource consumption is under the impact of two major factors: the behavior of end consumers and the scale of international trade. Having as general frameworks two of the conditions of sustainable economic growth (responsible involvement of all stakeholders and the behavior of end consumers), this study places the debate in the area of the automotive industry.

Within the automotive industry, a certain segment was considered—passenger car manufacturers. This is due to the fact that the literature indicates that strategies of car manufacturers differ from the strategies of producers of other means of transport. Even for the selected segment, it has been observed that some manufacturers adopt a transformative and change/innovation-oriented approach, while others adopt a conservative and sustainability-oriented approach [8]. Other authors have emphasized the dependence of the manufacturer's profit on fuel efficiency and performance in use, both in the scenario of different types of vehicles [9] and in the scenario of ignoring differences in vehicles [10]. In addition, the behavior of users varies across different modes of transport, such as cars, mopeds, and minibuses [11].

Globally, but also in the European Union (EU), there is an increase in the number of registered passenger cars. In just 6 years (2018–2023), the number of passenger cars on the road increased by 15.7 million (from 240.4 million in 2018 to 256.1 million in 2023) (Figure 1). Given the growing concerns about sustainability, debates on the environmental impact of car production and use have intensified. As road transport produced a fifth of the EU's carbon dioxide emissions, European policies focused on climate neutrality were not long in emerging. Car manufacturers, in turn, have adapted their production to meet the objective of reducing pollution. Concurrent with the concerns of increasing the share of less polluting cars in the total production volume, in the context of the unprecedented advance of digital technologies, car manufacturers have made additional investments to manage the environmental impact along the entire value chain. In this context, the integration of digital technologies has been seen both as an opportunity to better meet the expectations of digital consumers, and also as a lever to facilitate the adoption of more sustainable consumption behaviors.

With the changing economic foundations of the production, commercializing and use of cars, it is noticeable that there has been an intensification of scientific debates focused on the automotive industry.

As previously noted, scientific research analyzing data from the automotive industry has expanded and addressed new themes, directly related to sustainability issues. However, the analysis of digital technologies used in the automotive industry with a focus on their impact on sustainable consumption behaviors is in its early stage of development. Few studies have been identified that directly address these interdependencies. For example,

Zhang et al. (2023) [12] provided evidence on how digital technologies can be used to analyze user behavior patterns. The authors processed data collected by electric vehicle sensors and analyzed behavior patterns from the perspective of carbon emissions related to electric vehicles' sharing operations. Considering electric vehicles as the most advanced form of technological advancements in the automotive industry (incorporating digital technologies that enable "regenerative braking, advanced battery storage, and highly efficient electric motors"), Durmus Senyapar and Aksoz (2024) [13] showed that innovations improve not only the driving experience, but also the efficiency and performance of the vehicle and, implicitly, the environmental impact. Their study highlighted the importance of consumer education (through digital campaigns, experiential marketing and sustainability messages) to shape positive attitudes, capable of marking economic benefits, reduced emissions and technological advances.

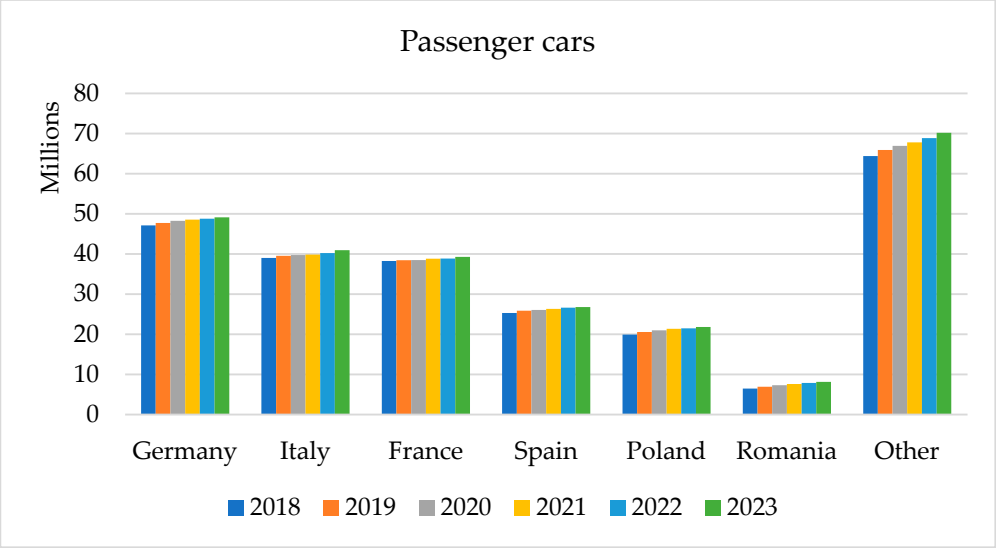

Figure 1. Passenger cars. Source. EUROSTAT: road_eqs_carpda__custom_15513805.

Focusing their research on smart sustainable mobility, Ketter et al. (2023) [14], admit that information systems have an important role in creating ecosystems that prove to be beneficial for both mobility users and providers, as well as for the environment. The authors point out that the development of information systems has triggered a profound socio-technical transformation of the mobility sector by incorporating various technologies into means of transport, such as those that ensure mobile connectivity, computing hardware and information systems management powered by artificial intelligence. Also, in the area of mobility, but with a focus on urban mobility, without directly targeting sustainable behavior, Lopez-Carreiro et al. (2020) [15] were concerned with using technological innovations (such as Mobility-as-a-Service) to provide personalized mobility solutions. Capitalizing on the literature review and the results of primary research (based on focus groups), the authors identified new services that can be offered by digital technologies, both to meet the daily needs of car users and also to assess the impact on the environment and human health.

Starting from the fragmented debates on the use of digital technologies in the automotive industry, to fill the existing literature gap, this study aims to identify answers to the following research questions:

RQ1. What is the current state of knowledge regarding various applications of digital technologies that might contribute to improving the value package of automotive operators/players?

RQ2. Can the integration of digital technologies into the various functionalities of the final product contribute to the adoption/consolidation of sustainable consumption behaviors by car users?

The answer to the first research question is summarized in the Literature Review Section. In order to answer the second research question, the following research objectives were defined:

- To identify and map various applications of digital technologies used in the automotive industry;
- To test the mapping results and provide evidence about the potential of digital technologies to foster a sustainable consumer behavior in the automotive industry.

In this study, focused on assessing the potential of digital technologies used in the automotive industry to create/strengthen sustainable consumption behavior, two reference frameworks were considered: the Triple Bottom Line (TBL) approach and the SHIFT conceptual framework. The analysis focuses on assessing the extent to which passenger car manufacturers use social leverages to more effectively fulfill the objectives of the environment.

This sequential approach to sustainability (based only on "people" and "planet"), without denying the importance of the third dimension ("profit"), was imposed because the research aimed to develop and test an original conceptual framework, starting from SHIFT. Specifically, consideration was given to assessing how consumer traits and attitudes (as a reflection of the social dimension), guided by the use of digital technologies, influence their tendency towards sustainable consumption (as a reflection of the environmental dimension).

A similar approach, starting with the TBL model, was carried out by Gmelin and Seuring (2018) [16], who analyzed the social and environmental dimensions of the organizations' activities. Using the case study as a research method and assuming that the development of new products must be aligned with the sustainability objectives, the authors found that the social aspect is rarely present in the development of new products.

Other studies have reported that (under pressure from consumers, government regulations and stakeholder requirements) automotive companies have been forced to pay more attention to social and environmental issues [17]. This is because the automotive industry outputs (represented by products that integrate associated services to provide mobility) are addressed to a very large and diverse number of users. Therefore, the supply of the automotive industry must respond to a very dynamic demand, but without losing sight of the environmental aspects.

From a more pragmatic perspective, other authors pointed out that the TBL approach forced automotive companies to make trade-offs between the three dimensions (economic, environmental and social). Even if such a decision could affect the prospects for aligning the objectives of different stakeholders, the authors argue that disruptive innovations (such as additive manufacturing) can contribute to simultaneously improving one or more dimensions without compromising the others [18].

Regarding the SHIFT conceptual framework [19], the purpose of its foundation was to provide practitioners and researchers with a tool to facilitate the analysis of the conditions under which consumers are guided to adopt sustainable consumption behavior. The research problem identified by the authors was that reducing resource consumption (as evidence of environmental concerns) can only be achieved through sustainable consumption behavior. Based on an extensive literature review (280 articles), the authors identified five channels (Social Influence, Habit Formation, Individual Self, Feelings and cognition, and Tangibility) through which consumers can be stimulated to behave in a more sustainable way.

According to the SHIFT conceptual framework, social influence is the first channel that has the power to influence sustainable consumer behaviors. In this regard, the following

tools prove their applicability: social norms, social identities and social desirability. The second channel of intervention is aimed at the formation of consumer habits. The authors point out that discontinuity in consumption and penalties can limit unhealthy habits, while repetition and recognition can strengthen positive habits. Thirdly, the authors admit that "positivity of the self-concept, self-interest, self-consistency, self-efficacy, and individual differences" can have a strong influence on consumer behaviors. Fourth, the authors take into account the concepts of feeling and cognition, which are considered the foundation of choices. Last, but not least, the authors admit that the results of environmental policies are difficult to quantify, and consumer behavior can become more sustainable if they have a clearer understanding of intangible aspects [19].

Two years after its foundation, three of the authors of the original article proposed using SHIFT to assess to what extent consumer behavior can be influenced to improve climate impact [20]. Based on a new literature review, the authors classify behavior change strategies considering the five pillars of the SHIFT conceptual framework. In addition, the authors followed the grouping of these strategies according to the consumption cycle, divided into three stages: choice, use and disposal. Finally, the authors admit that climate change is the consequence of human behavior, which justifies that "human behavior must be part of the solution".

Noting that there are only a few studies that have investigated the role of value co-creation (through technology) in stimulating sustainable behavior, Saha et al. (2023) [21] used the SHIFT and MAPED frameworks (Market acceptance; Appreciation and rewards; Positive affirmation; Empathy in communication; Dematerialization) to assess sustainable consumption in the retail sector. The authors argue that the process of co-creation of value, based on the use of the two conceptual frameworks, can be used to stimulate sustainable consumption behavior. Moreover, the authors identify specific strategies that can be used by retailers, which have the responsibility to co-participate to achieve the same goal (minimizing environmental impact).

A recent paper highlights another direction of using the SHIFT conceptual framework. Gallen et al. (2025) [22] used it to understand adolescents' perceptions of alternative foods. The authors noted that there is a "green gap" due to discrepancies between adolescents' personal desires and environmental goals. The SHIFT framework has been used to identify how the green gap (in terms of food diet) can be reduced by controlling the psychological factors it incorporates. Based on the information collected from structured interviews, the authors provide evidence that SHIFT has the ability to encourage behavior change.

Following the predecessor models and capitalizing on the results of research based on the Delphi Technique, the results of this study highlight the fact that digital technologies, incorporated into the various functionalities of passenger cars, have a significant influence on the factors considered relevant for consumer behavior. Furthermore, the study reveals that digital technologies are integrated in different ways in each of the three phases of the product life cycle (choice, usage, and disposal).

The originality of this study stems from the fact that it proposes and validates a construct that has not been the subject of previous debates, but whose utility is crucial in the context of the intensification of sustainability concerns in general, and sustainable consumption behaviors in particular. The results of this study are valuable from both a scientific and a practical point of view, providing support to players from the automotive industry in their concern to assess and improve sustainability throughout the value chain. To this end, all stakeholders (especially manufacturers and consumers) must work together to capitalize on the opportunities offered by digital technologies.

The study is organized as follows: the Section 2 presents the results of the literature review, focused on how the various digital technologies—available and used in the auto-

motive industry—can contribute to strengthening sustainable consumption behavior; the Section 3 presents the research methodology; the Section 4 presents the research results and initiates the discussions upon these; and the Section 5 highlights the conclusions of the research, specifies its limitations, and offer ideas for potential future research.

2. The Contribution of Digital Technologies to Fostering Sustainable Consumption Behavior—A Literature Review

Aminpour et al. (2020) [23] analyzed the origins of the sustainability concept and showed that, most of the time, the definition of the concept has as a benchmark the Brundtland Report: the development that "seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future" [1]. However, in order to shed more light on this concept, the authors conducted further research in the academic environment and showed that, in the relevant literature, four emerging definitions of sustainability can be identified, centered on the following key aspects: "environmentalism concerns, common understanding, neo-Malthusian environmentalism and sustainability as well-being". The final conclusion of the authors is that the multidimensional nature of sustainability has not allowed the formulation of an unanimously accepted definition, and further research is needed to explain why sustainability is understood differently.

As a practical implementation of the sustainable macroeconomic development model established in 1987 by the Brundtland Report, seven years later, the Triple Bottom Line (TBL) was proposed as a microeconomic tool to facilitate the integration of sustainability into business strategies [24]. More specifically, TBL has been imposed due to the need for an integrated approach to the social and economic dimensions in order to make real progress in environmental matters.

According to research, TBL has evolved over time, integrating new concepts such as sustainable business models (Nogueira et al., 2023) [25] and supply chain management [26]. Moreover, in order to better capture the dimensions of sustainability, other authors proposed the introduction of a new pillar—digital technology. The argument of expanding the area of representativeness was that digitalization has boosted value creation, with companies coupling the sale of products with the provision of associated services. Thus, ''digitalization has reconfigured both the operational processes and the relations between companies and their stakeholders" [27].

2.1. Sustainability in Consumption Behavior

There is a growing number of researchers providing evidence that consumers engage in purchasing sustainable products. Whelan and Kronthal-Sacco [28] reported a study of purchase increase of consumer-packaged goods (CPGs) of 50%, from 2013 to 2018, based on sustainability. Focusing on whether marketing a product as sustainable would determine an increase in sales they discovered that consumers preferred sustainable brands and that companies must adjust for this trend.

Reichheld, Peto and Ritthaler (2023) [29] revealed that, based on a survey of more than 350,000 US customers aged from 18 to 98 across 500 brands and 30 sectors, a shift in consumption patterns is imminent towards truly sustainable brands and away from those that had not invested enough in sustainability. They propose three factors that drive change and explain the shift in consumption behavior: Trust (in the company), which drives consumer behavior and thus business outcomes, sustainability, which, among younger generations, promotes trust (companies conveying positive intent and demonstrating competence), and the purchasing power in the US that will soon shift towards younger generations (Gen Z and Millennial customers).

Wang and Sherry [30] analyzed whether eco-conscious customers are willing to pay premium prices for sustainability labeled products. Their dataset analyzed the comparative sales ranking of 1350 labeled products with 16,264 comparable non-labeled products over 10 months of data collected from Amazon. Sustainability labels drive consumer demand and, even though most consumers were not actively filtering for labeled items, credibility played an important role. Consumers choose products with the label when presented with a choice between labeled and unlabeled options, especially when the sustainable messages were aligned with consumer preferences across various price ranges. The investments companies made in sustainable practices positively impacted sales.

Research in consumption behavior extended beyond consumers into employees [31], as Porsche challenged its brand identity, technology and company culture towards embracing electric vehicles. Whilst some companies appeal to reason, depicting sustainability as "leaving a better world for future generations" Porsche used message framing to avoid patronizing its employees in their decision-making process of choosing their next vehicle. The research was based on a choice between battery electric vehicles (BEHs) and plug-in hybrid electric vehicles (PHEVs) for several hundred employees eligible for a new fleet car. Responses from a control group were compared with those from several hundred anonymized and randomized employees who received three different framing messages. In-depth analysis of 147 employees who first triggered an order encouraged Porsche to extend its nudge strategy for more sustainable choices on a larger scale.

In 2017, the conscious consumer market (CCM) was estimated at USD 300 billion [32]. These conscious consumers seek to "demonstrate an awareness and desire to make, in the most part, informed and considered ethical choices]" [32] (pp. 24-25). The research compares the sustainability market entry strategies of six sustainable new ventures (SNVs) and seven multinational corporations (MNCs) on CCM. Results revealed an analytical space where the authors plotted entry strategies: value alignment and scope of the target market. The customers wanted to identify with its core values, not only to shop for a brand and its products.

Engaging in sustainability implies profound transformations for companies [33], based on strong top executive commitment, collaboration with customers, nongovernmental organizations (NGOs) and other stakeholders across the value chain and business model innovation, for a new value proposition and operating model to profitably deliver the offering. To understand consumption behavior, the companies must understand how their customers think about sustainability and whether they are willing to pay premium price for a more sustainable product or service. Collaboration beyond the boundaries of the enterprise with individuals, customers, businesses and groups is a great opportunity for the company to identify meaningful sustainable objectives aligned with customer perceptions and values.

Sustainable consumption refers to consumer behaviors that minimize environmental damage and ensure that future generations can meet their needs through reducing waste, conserving resources and making environmentally responsible purchasing decisions [34]. Kostadinova (2016) [35] defines sustainable consumer behavior as the set of choices and actions individuals take to reduce environmental and social harm while satisfying their own needs, integrating practices such as green consumption, ethical consumerism and pro-environmental behavior. A clear distinction is made by the author between "green" consumer behavior, which refers to specific product choices aimed at minimizing environmental impact and "sustainable" consumer behavior, which involves a larger transformation in consumption habits, aimed at reducing overall resource use and promoting environmental and social responsibility.

Within the domain of sustainable consumption, according to Sargin and Dursun (2023) [34], consumer behavior can be split in two main categories: natural resource use and product consumption. Natural resource use involves efforts made by consumers to reduce their environmental footprint through actions such as lowering water and energy consumption, switching to sustainable transport options like electric vehicles or public transit and reducing dependance on fossil fuels through renewable energy adoption. On the other hand, product consumption refers to choices surrounding what and how individuals consume goods. This includes preferring eco-friendly and ethically produced products and reducing consumption through minimalism and voluntary simplicity. More than this, product consumption also includes actively engaging in reuse, recycling and circular economy practices such as renting or subscribing to products instead of owning them [34]. It is important to highlight that all these behaviors are increasingly supported nowadays by digital tools such as AI, blockchain and IoT, technologies that can really improve transparency and individual awareness in sustainable decision-making.

Sargin and Dursun (2023) [34] identify three main categories of factors that influence sustainable consumer behavior: individual, social, and external. Individual factors include environmental awareness, personal values, attitudes, and traits like responsibility and openness. Social and cultural factors refer to the role of peer influence, demographics, lifestyle, and the impact of media and green marketing. External factors include government policies, corporate practices, economic constraints, and technological innovations that make sustainable options more visible and accessible. Kostadinova (2016) [35] categorizes the factors influencing sustainable consumer behavior into just two main groups: individual-related factors such as environmental awareness and personal values, and contextual or situational factors, including economic constraints, social norms and the availability of sustainable options.

2.2. Sustainable Transport

Sustainable transport has gained increasing attention, particularly from stakeholders within the automotive industry. Research in this area has evolved along distinct sustainability dimensions and can be categorized into nine major thematic streams. The first emerging theme within the sustainable transport research direction is more concentrated on researching and framing specific dimensions used for its assessment and performance [36]. According to this research stream, it is necessary to understand the concept of "sustainable transport" itself. Gudmundsson (2004) presented three main approaches to be taken into consideration in addressing this particular concept: sustainable transport as a metaphor to broaden policy agenda, from the point of view of existing limitations and through the lens of a mixed approach, which takes into account sustainable dimensions and indicators in order to advance and promote sustainable transport agenda [37]. Although it is recognized that there is a necessity to incorporate economic, social and environmental dimensions and indicators, this direction remains under-explored in terms of sustainable transport operationalization, as it depends on the specific context [38]. From this point of view, researchers were rather concentrated on exploring specific methods to define specific indicators. Various methodological approaches can be observed, such as integrating life-cycle assessment [39], multi-criteria decision methods [40] or scenario building, based on the context [41]. The second research area is mostly concentrated on policy development and its impact towards increasing sustainable transport [36]. This research stream was linked further to supply chains, policy development and stakeholders' engagement. From the perspective of policy development, an effective transition toward a sustainable behavior should be closely linked to societal values and norms such as social acceptance [42,43]. An interesting observation is that sustainable transport, from a social perspective, is influenced

both by restrictive policies and by those that encourage sustainable behavior [44]. Moreover, people's decisions and choices are dependent on the resources they possess, the opportunities they identify in terms of quality infrastructure, availability of transport choices, living or working location, and their transportation needs [36,42]. Some research directions are entirely committed to analyzing environmental metrics of sustainable transport. Considering the evolution of environmental policies within the automotive industry, it can be emphasized that there is an increasing attention toward low-emission vehicles as the main factor influencing and reducing negative environmental impact [36]. Within this research stream, the attention is rather concentrated on new technology development and usage, such as renewable energies, alternative fuels, and eco-driving [43]. From this point of view, there can be observed an increasing attention to the type of low-emission transport [45] such as sustainable buses, electrical passenger cars, and the use of bicycles [36]. Although the implementation of sustainable transport is essential in terms of promoting sustainability, it cannot be achieved without social involvement. Moreover, it requires rigorous strategic and sustainable transport planning [36,43].

2.3. Sustainable Consumption in the Automotive Industry

It is essential for the passenger car manufacturers to understand the evolving customer expectations, so that they provide the right value proposition. A key trend is the growing customer preference for sustainable mobility solutions [38–40]. This can be clustered together within the three pillars of the "triple bottom line" describing sustainability. In the environmental pillar, consumers desire transport solutions with reduced negative impact on climate change and ozone layer degradation [40]. They want vehicles that release fewer pollutants into the air and that consume fewer of the non-generative resources of the earth. In the social pillar, consumers expect products to ensure people's health, safety, comfort and mobility [40]. In the economic pillar, they want reasonable operating and maintenance costs. Consumers also expect a future resale of the product at a fair price [40].

According to Accenture (2021), 64% respondents, out of a total of 8500 from seven countries, are concerned about the environmental impact of transportation [38]. Most of them (91%) are even willing to pay higher prices for sustainable vehicles. Specifically, 30% would pay 1–5% more, 44% would pay 6–15% more, 13% would pay 16–25% more, and 4% are willing to pay above 25% more [38]. However, when researching the importance of sustainability in the purchase decision of a customer, sustainability should be considered in comparison with other factors. In a study from Wellbrock et al. (2020), the participants ranked sustainability as having the lowest importance, placing more importance on quality, design, performance, price, equipment, fuel, and brand of the car [39]. Despite this ranking, the participants still agree on mobility as an important area of life where sustainability should be considered, together with food, energy supply, habitation and apparel [39].

When examining the automobile's modules individually, consumers assess the power unit as being the most important for environmental sustainability [39]. They are shifting towards purchasing zero CO_2 emissions vehicles (ZEVs) [41]. Examples of ZEVs are Battery Electrical Vehicles (BEVs) and Fuel Cell Electrical Vehicles (FCEVs) powered by hydrogen, each type having specific advantages and disadvantages [41]. BEVs are quiet and comfortable, while having a good acceleration, but the battery is a disadvantage in terms of driving range and charging time. FCEVs have a lower refueling time, allowing for longer distances, but their price is high. Both BEVs and FCEVs have the disadvantage of a low availability of the charging infrastructure [42]. Besides the specific advantages and disadvantages of each type, there are several other financial and non-financial factors influencing the purchase decision of a customer towards a ZEV. In Slovenia, a study

identified the body shape (non-financial factor) and the total vehicle price (financial factor) as being the most significant factors, according to the participants [41].

Besides ZEVs, there are other environmentally sustainable transportation alternatives that do not require owning a car. Transportation-as-a-Service or Mobility-as-a-Service allow consumers to rent a vehicle or a ride [43], using the connectivity of the car to the internet originating in Telematics [44]. Public transportation might be the preferred choice for people, if it is available, convenient, reliable and affordable. But it may not fully satisfy the need to travel without constraints of schedule or location [45]. The bicycle is also a great alternative for short-distance commutes [36]. However, these are not in the scope of the current study, since it focuses on passenger cars.

As pointed out in the previous section, this study considered the potential of digital technologies (used in the automotive industry) to create/strengthen the sustainable consumption behavior of car end-users. The assessment was carried out from the perspective of passenger car manufacturers. For these manufacturers to achieve their environmental commitments, collaboration with end-users is essential. The aim was to provide practitioners with a tool to identify the most important levers through which consumers can be stimulated to behave in a more sustainable way.

3. Materials and Methods

The methodology of this study is focused on establishing the most relevant applications of digital technologies used in the automotive industry, which have the potential to contribute to the adoption of sustainable consumption behavior by car users. The study combines qualitative and quantitative analyses, the aim being to develop and test a theoretical–practical framework, following the SHIFT model. The methodology of the study is structured in two stages, and the methods applied in each stage are summarized in Table 1.

Table 1. Research methods and objectives.

Research Methods and Techniques	Objectives
Qualitative research	Identifying and mapping the digital technologies incorporated into the final product (a personal car) with the aim of facilitating sustainable end-user behavior. Developing an original construct (that will be referred to as "SHIFT for Automotive"), which incorporates the identified digital technologies.
The Delphi technique (quantitative and qualitative analyses)	Construct validation and identification of digital technologies that have the greatest potential to facilitate sustainable consumption behaviors.

3.1. Identifying and Mapping Digital Technologies in Accordance with the SHIFT Conceptual Framework

As presented in the Introduction Section, the SHIFT conceptual framework has been used for various purposes. For example, Saha et al. (2023) [21] used SHIFT to assess sustainable consumption in the retail sector. Gallen et al. (2025) [22] used SHIFT to explore adolescents' attitudes towards adopting a sustainable diet and to assess the costs and benefits of adopting sustainable behaviors. Habib et al. (2021) [20] used SHIFT to analyze the extent to which consumer behavior can be appropriate for improving climate impact.

Different from previous research, the present study focuses on applying the SHIFT framework to the automotive industry in order to assess the means/instruments through which manufacturers co-participate in the adoption of sustainable consumption behaviors by end-consumers. Considering the contribution of digital technologies to stimulating sustainable consumer behavior throughout the entire product life cycle, the aim was to identify and map

the most relevant digital technologies in relation to the five pillars of the SHIFT conceptual framework and the three phases of consumption (choice, use, and disposal).

To map digital technologies in accordance with the SHIFT conceptual framework, a mixed team of 4 researchers and 2 practitioners (IT experts in the automotive field) adapted the SHIFT conceptual framework, going through the following stages:

(a) The group of practitioners (representing two PhD students in the field of "Engineering and Management", but who are experts in the field of designing digital technologies for the automotive industry) developed a list of digital technologies currently used to equip cars; for each digital technology included in the list, the basic functionalities and the manner in which they contribute to the efficient/sustainable operation/operation of the car were highlighted.

(b) The group of senior researchers conducted a literature review to substantiate both sustainable behavior and the pillars of the SHIFT conceptual framework: Social influence, Habit formation, Individual self, Feelings and cognition, and Tangibility; according to the SHIFT conceptual framework, consumers are more inclined to engage in pro-environmental behaviors when the previously listed psychological factors are capitalized on.

(c) Two mixed teams assessed the extent to which each digital technology serves the particular purpose of each pillar of the SHIFT conceptual framework; the results obtained by the two mixed teams were discussed and concatenated to achieve a reasonable consensus from both the practitioners' and theorists' points of view.

(d) Within three rounds of debates (in mixed teams, with practitioners and theorists, and with the co-authors in this study), the digital technologies associated with the different pillars of the SHIFT conceptual framework were analyzed from the perspective of their use during the three stages of the car life cycle (choice, usage, and disposal).

(e) By associating digital technologies with each pillar of the SHIFT conceptual framework and with each stage of the life cycle, an original construct was obtained, which was very useful, both theoretically and practically.

The adapted SHIFT conceptual framework (hereinafter referred to as "SHIFT for automotive") included a set of 12 digital technologies—and specific applications—which, incorporated into different car functionalities, can drive end-users to adopt sustainable consumption behavior. Specifically, the technologies considered were the following: Artificial Intelligence (AI), Augmented Reality (AR), Big Data (BD), Blockchain (B), Cloud Computing (CC) and Mobile Apps (MA), Digital Twin (DT), Distributed computing (DC), In-car connectivity (IC), Internet of Things (IoT), Virtual Reality (VR), and Digital Realities (DRs). The selection of these 12 technologies was guided by their current relevance, maturity and applicability within the automotive industry, as well as their documented potential to influence sustainable consumer behavior, according to the existing literature. Table 2 presents the applications of digital technologies considered in assessing SHIFT for automotive.

Table 2. The applications of digital technologies in relation to SHIFT for the automotive industry.

Technology	Definition
Artificial Intelligence	"Systems that display intelligent behavior by analyzing their environment and taking actions—with some degree of autonomy—to achieve specific goals". Recent innovations in the field comprise of: Generative Adversarial Networks (GANs), and General Purpose Technology (GPT) [46].
Augmented Reality	Augmented Reality is a technology that overlays digital information onto the real world, enhancing user experiences across various fields. Unlike VR, which creates entirely digital environments, AR combines reality with virtual elements [47]. Currently, it is commonly used for visual (computer-generated) information, but, technically, it could be used for all five senses [48].

Table 2. *Cont.*

Technology	Definition
Big data	A field using digital technologies for collecting, storing and analyzing the data, which is produced in huge amounts nowadays. It is characterized by 5Vs: "value, velocity, volume, veracity, and volume" [49].
Blockchain	A technology implementing a digital ledger of transactions in a distributed, decentralized and immutable way. Combined with cryptographic mechanisms and other technologies, blockchain is used in cryptocurrency, with Bitcoin being the first cryptocurrency developed [50].
Cloud Computing and Mobile Apps	A model for offering "on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [51]. A subcategory of distributed computing [52].
Digital Twin	A virtual representation of a physical asset enabled through data and simulators for real-time prediction, optimization, monitoring, controlling, and improved decision-making [53]. A set of virtual information constructs that fully describes a potential or actual physical manufactured product from the micro atomic level to the macro geometrical level [54].
Distributed Computing	A technology that solves a task by using the computation power of multiple computers connected over a network, called nodes. The nodes may be assigned a different load of the computation or even specialized functions, such as graphical processing [52].
In-car connectivity	Enables the car to transmit data in a network by using "low-energy wireless communication and sensor network technologies" [55].
Internet of Things	A system of connected devices and objects, which exchange information with each other over a network [56].
Virtual Reality	A digital environment that provides an immersive and interactive human experience, by triggering the human sensory systems by means of devices and software [57,58]. VR systems aim to engage multiple senses, including vision, sound, and touch, to create immersive and interactive experiences for users through computer-simulated environments [59,60].
Digital Realities	An integration of multiple digital technologies, creating an immersive digital environment for humans [61]. Digital realities encompass a spectrum of technologies that simulate and extend our perception of reality through digital means [62]. In this study, the term "Digital Realities" integrates Augmented Reality and Virtual Reality [61].

The Results and Discussion Section details the associations between digital technologies and the five factors underlying the formation/adaptation of sustainable consumption behaviors.

3.2. The Delphi Technique—Validation of the "SHIFT for Automotive" Construct

As a method of organizing communication in groups of experts in order to answer a clearly defined research question or a complex problem, the Delphi technique is applied to seek consensus (when opinions are divergent) or to evaluate, confirm or validate a theoretical or practical construct. For example, Dağılgan and Ercan (2025) [63] used the Delphi technique to assess the materiality and validity of sustainability themes for construction companies. Pearson et al. (2025) [64] conducted a Delphi study to obtain a consensus on the essential training needs for a specific category of educators employed at the level of the formal education system. Huang et al. (2025) [65] used the Delphi technique to assess the quality of AI-generated digital educational resources for university teaching and learning. By applying this technique, the authors identified the most important aspects of AI-generated resources: content characteristics and expressive characteristics, such as authenticity, accuracy, legitimacy, relevance, etc. Véliz et al. (2025) [66] investigated the

specificities of designing and implementing circular economy strategies for construction and demolition waste management. The Delphi technique was used to identify the key factors influencing the current and future adoption of circular economy practices.

As we can see, although there are some associated limitations (such as those related to potential bias, sample size and their heterogeneity, generalizability of the results, etc.), many recent studies use the Delphi technique for various purposes. Unlike previous studies, in this study the Delphi technique was used to validate an original construct—"SHIFT for automotive". The steps followed are detailed below:

1. Defining the purpose. Evaluating the opinions of automotive industry experts on the contribution of various applications of digital technologies in shaping/shaping/stimulating the sustainable behavior of car users.
2. Developing the tool for the assessment and validation of the adapted conceptual framework. Based on the "SHIFT for automotive" construct (which integrates different applications of digital technologies with the role of engaging users in pro-environmental behaviors), a set of 58 items were formulated, structured as follows:
    - Twelve items assessed the extent to which digital technologies (such as AI, Augmented Reality, Cloud computing, and Big Data) have a direct influence on the social factors that guide the sustainable behavior of end-users. These items assessed influences at all three stages: choice (5 items), usage (5 items) and disposal (2 items).
    - Eleven items assessed the extent to which digital technologies (such as AI, Big Data, Big Data Analysis, Cloud Computing, Internet of Things, and Virtual Reality) have a direct influence on the formation of sustainable consumption habits (habit formation). These items assessed influences at two of the three stages: choice (1 item), and usage (10 items).
    - Eight items assessed the extent to which digital technologies (such as AI, Blockchain, Digital Realities, Big Data, and Cloud Computing) have a direct influence on the lifestyle and identity of end-users (individual self), leading them to adopt a sustainable behavior. These items assessed influences at all three stages: choice (3 items), usage (4 items), and disposal (1 item).
    - Twelve items assessed the extent to which digital technologies (such as AI, Cloud Computing, Digital Realities, and In-car connectivity: cellular network, Augmented Reality, Mobile Apps) shape consumers' emotions and reasoning (feelings and cognition), leading them to adopt a sustainable behavior. These items assessed influences at all three stages: choice (6 items), usage (5 items) and disposal (1 item).
    - Fifteen items assessed the extent to which digital technologies (such as Digital Twin, and In-car connectivity: Cellular network and Wi-Fi, AI, Internet of Things, Blockchain, Distributed computing, and Cloud Computing) influence users' sustainable behavior by facilitating awareness of a tangible environmental impact. These items assessed influences at all three stages: choice (4 items), usage (4 items) and disposal (7 items).

Due to the large number of items, and in order to facilitate the work of the experts, the decision was made to associate the 58 items with a five-point Likert scale: 1—Strongly Disagree, 2—Disagree, 3—Neutral; 4—Agree, 5—Strongly agree. For each set of items, also taken into account was the possibility that the experts could provide their own opinions/observations/arguments by formulating an answer to an open question. According to the opinions of previous researchers [67,68], in most cases, in the application of the Delphi Technique, (mixed) standardized Likert scales combined with open questions are used.

3. Designation of a moderator and establishment of communication methods with experts. In order to optimize the management of the flow of information between the research team and the experts, a representative was designated. Since a team of internal and external experts was envisaged, communication was carried out online, with correspondence being carried out via email and communication of opinions via the Google Forms form/application).
4. Expert recruitment. In order to have a broader perspective on the validity of the construct, 15 experts were selected. Although previous studies admit that the opinions of at least 4 experts can be considered sufficient for the application of the Delphi technique [63,69], a larger number of experts was considered, precisely to ensure the robustness of the assessment.

The criteria for selecting the experts were experience in the automotive industry and the degree of involvement in the implementation of digital technologies in the various functionalities of cars. The 15 selected experts were sent an invitation (and a request to confirm/deny their availability. The 15 experts were informed about the research objectives, the research methodology, the tools used (Google Forms), the response method, and the deadlines for each stage.

5. Questionnaire distribution (round 1). The experts' opinion assessment tool, to obtain consensus on the validity of the newly developed construct ("SHIFT for automotive"), was organized into 5 sections (corresponding to the original SHIFT conceptual framework): Social influence, Habit formation, Individual self, Feelings and cognition, and Tangibility. Experts were asked to express their opinion, voluntarily, anonymously and separately, on how each of the selected digital technologies can contribute to empowering the end-user to adopt a more sustainable consumption behavior.
6. Collection and analysis of expert responses (round 1). For each item of the evaluation instrument, the experts' responses were analyzed. Particular attention was paid to free responses, as they allowed the experts to freely express a point of view on the evaluated aspects. Based on these analyses, the items were grouped into two classes: items for which there is consensus among the experts and items for which consensus was not achieved. The items in the second category were inserted into a new evaluation instrument (having a similar structure to the first instrument).
7. Retransmission of questions to experts (round 2). In this second round, experts were informed that for some items a general/reasonable consensus had not been reached, which is why they were invited to analyze the data and formulate opinions (anonymously and separately) on how each of the selected digital technologies can contribute to empowering the end-user to adopt a sustainable consumption behavior.
8. Collection and analysis of the answers formulated by the experts in the second round. The analysis of the answers formulated by the experts (in the second round) narrowed the area of divergences of opinion and allowed the validation of the construct "SHIFT for automotive".
9. Building the "SHIFT for automotive" conceptual framework, taking into account the results obtained from the processing of the opinions expressed by the experts.
10. Discussing the results and how they can be interpreted in the light of previous studies and working hypotheses.

4. Results and Discussion

The application of the Delphi technique aimed to collect the opinions of 15 experts. Out of the total number of 15 experts, 12 experts answered. Table 3 summarizes the socio-demographic profiles of the experts.

Table 3. Demographics of the experts.

Years of Experience in the Automotive Industry	What Is Your Field of Expertise in the Automotive Industry?	What Is Your Position in the Company/Project?	Are You Currently Working in the Automotive Industry?	Your Company Is Based in
>15 years	Body Controllers	Project Manager	Yes	A non-EU state
>15 years	Digital Clusters, Head-Up Display, Infotainment	Team Leader	Yes	An EU state
10–15 years	Digital Clusters, Head-Up Display, Infotainment	Project Manager	Yes	An EU state
10–15 years	Digital Clusters, Head-Up Display, Infotainment	Team Leader	Yes	An EU state
5–9 years	Digital Clusters, Head-Up Display, Infotainment	Project Manager	Yes	An EU state
5–9 years	Braking Systems	Project Manager	Yes	An EU state
5–9 years	Autonomous Mobility	System Architect	Yes	An EU state
5–9 years	Wireless Access Systems	Technical expert	Yes	A non-EU state
5–9 years	Autonomous Mobility (Assisted Driving Functions) and Process Development	Product Owner	Yes	An EU state
2–4 years	Autonomous Mobility	Software Developer	Yes	An EU state
2–4 years	Autonomous Mobility	Software Integrator	Yes	An EU state
<2 years	Digital Clusters, Head-Up Display, Infotainment	Technical expert	No	An EU state

According to the data in Table 3, more than 33% of the experts have an experience of more than 10 years in the automotive industry. A total of 42% of the experts have an experience of between 5 and 9 years. The competencies of the experts are in diverse domains of the automotive industry: Digital Clusters, Head-Up Display, Infotainment, Body Controllers, Braking Systems, Autonomous Mobility, and Wireless Access Systems. Four experts are in a project manager role, and two experts are in a team leader role. The other experts have technical roles. A total of 11 out of the 12 experts were working in the automotive industry (during the time of this study). Among the respondents, two experts are working for a company based in a non-EU state. Due to the application of the general data protection regulation, the exact residence of the experts was not made public.

Analyzed from the perspective of experience, areas of expertise, and positions held, the socio-demographic profile of experts meets the diversification requirement. Conversely, from a geographical representation perspective, the possibilities for generalizing the results remain limited, given that most of the experts are from EU countries.

Before analyzing the results of the first round of application of the Delphi Technique, the internal consistency of the items was analyzed to assess the reliability of the construct. According to the data in Table 4, the test performed (reliability statistics) revealed that the items that formed the basis for the evaluation of the experts' opinions (regarding the role of digital technologies in the adoption of sustainable behaviors by end-users) are correlated with the overall score of the test, the Cronbach's Alpha coefficient registering a value of

0.959. The result indicates a high level of internal consistency for the items used within the specific sample. For greater accuracy, the Cronbach's Alpha coefficient was calculated for each of the five sections of the construct. As can be seen in Table 4, the reliability of the construct is also proven at the level of the pillars of the SHIFT conceptual framework that formed the basis of this research.

Table 4. Cronbach's Alpha Coefficients.

Information	Cronbach'sAlpha	Cronbach's Alpha Basedon Standardized Items	No. ofItems
All components of SHIFT	0.958	0.959	58
First pillar—Social influence	0.822	0.937	12
Second pillar—Habit formation	0.767	0.781	11
Third pillar—Individual self	0.939	0.945	8
Fourth pillar—Feelings and cognition	0.887	0.897	12
Fifth pillar—Tangibility	0.898	0.906	15

After the first round of applying the Delphi technique, and after testing the viability of the construct, the results were analyzed to check to what extent the experts agree or disagree with regards to the potential of the applications of digital technologies to positively influence sustainable behavior consumption. The results for each of the five pillars of the SHIFT conceptual framework are presented in Figure 2.

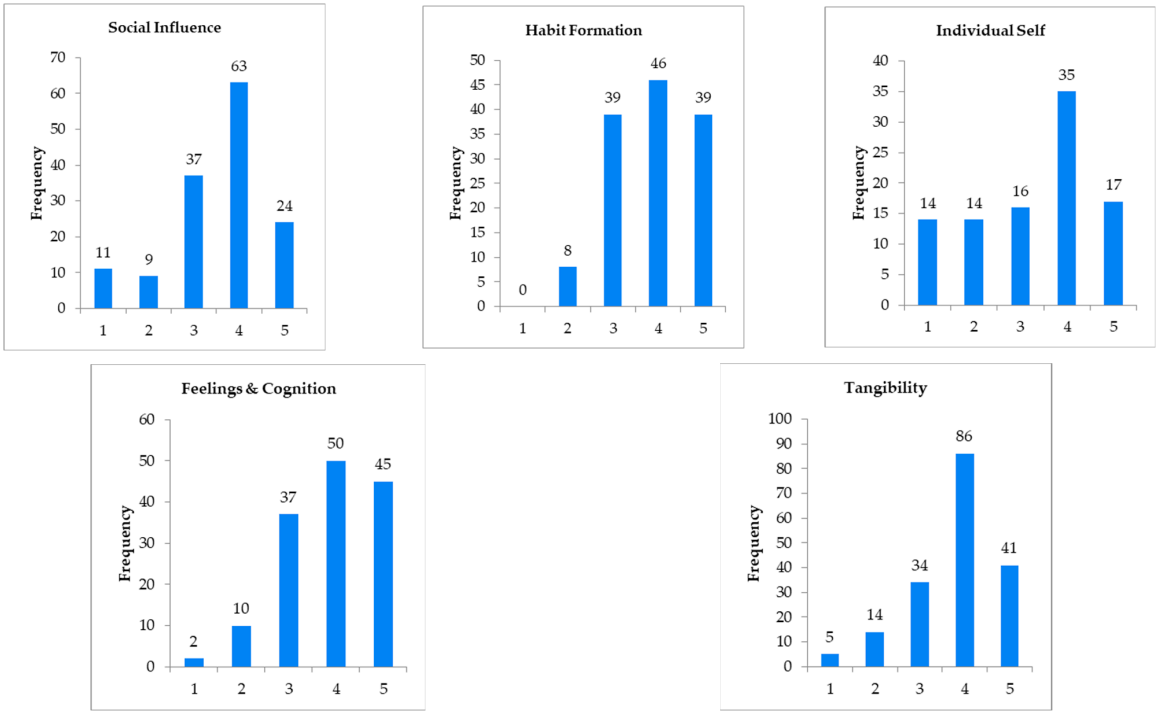

Figure 2. Results of the first round of applying the Delphi technique.

For the 12 items evaluating the extent to which the digital technologies have a direct influence on the social factors guiding sustainable consumption, 87 (out of 144) responses were in the superior part of the Likert scale, indicating that the experts "agree" or "strongly agree". A total of 37 responses were at the middle of the Likert scale ("neutral"), while

the other 20 response were in the lower part of the Liker scale ("disagree" and "strongly disagree"). This is illustrated in Figure 2—"Social Influence".

In terms of the extent in which digital technologies directly influence the "Habit Formation" of sustainable consumptions, the responses from the experts indicated a greater level of agreement: 85 (out of 132) responses were in the superior part of the Likert scale. This is illustrated in Figure 2—"Habit Formation". In the analysis of the responses regarding the extent to which the application of the digital technologies directly influences the lifestyle and the identity of the users (Figure 2—"Individual Self"), 52 (out of 96) responses confirmed the potential of the digital technologies analyzed to influence the consumers to adopt a more sustainable consumption behavior.

For the 12 items evaluating the extent to which the digital technologies shape the emotions and the reasoning of consumers (Figure 2—"Feelings and Cognition"), the responses were in the superior part of the Likert scale. This validates the idea that the digital technologies analyzed have the potential to influence consumers to adopt sustainable consumption behaviors. Regarding the extent to which the applications of digital technologies influence sustainable consumer behaviors of the users of automobiles, the results for the 15 items for the pillar "Tangibility" include 127 responses in the superior part of the Likert scale. This indicates that the experts agree on the potential of the analyzed digital technologies to facilitate user awareness of the tangible impact of their behaviors on the environment.

The analysis of the responses regarding the entire construct concept indicated the following: 18 items had 100% consensus, 2 items had 83% consensus, while the results for the remaining items did not show clear agreement/disagreement. This was a strong argument to carry out a second round of the Delphi technique. In developing the evaluation instrument for the second round, significant attention was placed on the items for which the opinions of the experts were in the lower part of the Likert scale, indicating disagreement or strong disagreement. In order to simplify the evaluation process for the experts, but also to optimize the evaluation, the second round did not include the 11 items for which the first round indicated more than two responses in the lower part of the Likert scale (1—strongly disagree, 2—disagree). Thus, in the second round, the total number of items for evaluation was 27, calculated in this way: $58-20-11 = 27$. After data collection, the analysis of the reliability of the partial construction (composed of the 27 items) was resumed. The results of this analysis indicated a Cronbach's Alfa coefficient of 0.810, which confirmed that the results can be used with confidence.

The results corresponding to the two rounds of the Delphi technique are illustrated in Tables 5–9. The first three columns of each table present the items corresponding to the five pillars of the SHIFT conceptual framework. The "Results" column presents the decision for each item, a decision which is based on the opinions of the experts. The remaining two columns present the evidence for confirmation/rejection, based on the opinions of the twelve experts (in absolute value, indicating how many out of the twelve experts agreed with that item, but also in relative value).

Table 5. Results—Social Influence.

No.	Code	Items	Results	Support	Degree of Confirmation
		Choice			
SI.C1. Artificial Intelligence					
1	SI.C1.1	AI-powered social media trends that promote sustainable vehicle choices by showing what others are purchasing	confirmed (R2)	11/12	91.67%
2	SI.C1.2	AI-driven social media campaigns that encourage sustainable vehicle choices or ridesharing platforms	confirmed (R2)	11/12	91.67%
SI.C2. Augmented Reality					

Table 5. *Cont.*

No.	Code	Items	Results	Support	Degree of Confirmation
3	SI.C2.1	AR Showrooms that showcase the environmental impact of different vehicle choices	infirmed (R1)	3/12	-
SI.C3. Virtual Reality					
4	SI.C3.1	Interactive VR training modules for sustainable choices	confirmed (R2)	10/12	83.33%
SI.C4. Cloud computing					
5	SI.C4.1	Cloud-based platforms for knowledge-sharing and best practices in sustainable automotive choices	confirmed (R2)	11/12	91.67%
		Usage			
SI.U1. Artificial Intelligence					
6	SI.U1.1	AI-driven social comparison dashboards that rank drivers based on fuel efficiency and emissions reductions	infirmed (R2)	3/12	-
7	SI.U1.2	Eco-routing (chose an eco-route because other users in the area did so)	confirmed (R1)	12/12	100%
SI.U2. Virtual Reality					
8	SI.U2.1	VR experiences that simulate sustainable driving habits (efficient acceleration, braking)	infirmed (R2)	3/12	-
SI.U3. Big Data					
9	SI.U3.1	Real-time feedback providing drivers with insights into their driving patterns and how to optimize for sustainability	confirmed (R1)	11/12	91.67%
SI.C4. Cloud computing					
10	SI.U4.1	Remote vehicle diagnostics to optimize energy efficiency and reduce unnecessary repairs	confirmed (R1)	12/12	100%
		Disposal			
SI.D1. Virtual Reality					
11	SI.D1.1	VR training modules educating consumers on responsible vehicle recycling, component reuse and disposal	confirmed (R2)	11/12	91.67%
SI.D2. Blockchain					
12	SI.D2.1	Transparent supply-chain tracking to verify the sustainability of vehicle components and materials	infirmed (R2)	3/12	-

Table 6. Results—Habit Formation.

No.	Code	Questions	Results	Support	Degree of Confirmation
		Choice			
HF.C1. Artificial Intelligence					
1	HF.C1.1	AI can recommend new vehicle choices or features based on the users' sustainable habits (based on distance, charging time, range, etc.)	confirmed (R1)	12/12	100%
		Usage			
HF.U1. Artificial Intelligence					
2	HF.U1.1	Personalized eco-driving assistants that analyze driving patterns and suggest habit changes	confirmed (12)	12/12	100%
3	HF.U1.2	AI nudges that remind drivers to switch to energy-saving driving modes, reinforcing eco-driving habit	confirmed (R2)	10/12	83.33%
HF.U2. Virtual Reality					
4	HF.U2.1	VR-based eco-driving training programs to help drivers optimize energy usage	confirmed (R2)	11/12	91.67%
HF.U3. Cloud Computing					
5	HF.U3.1	Cloud-integrated remote diagnostics that optimize energy efficiency in EVs (electrical vehicles)	confirmed (R2)	11/12	91.67%
HF.U4. Internet of Things					
6	HF.U4.1	Eco-driving	confirmed (R1)	12/12	100%
7	HF.U4.2	Eco-routing	confirmed (R1)	12/12	100%
8	HF.U4.3	Autonomous Driving Features	confirmed (R2)	12/12	100%

Table 6. *Cont.*

No.	Code	Questions	Results	Support	Degree of Confirmation
		Disposal			
HF.D1. Cloud Computing					
9	HF.D1.1	Cloud platforms that send messages to users to properly dispose of parts when the components reach end-of-life	confirmed (R2)	12/12	100%
HF.D2. Artificial Intelligence					
10	HF.D2.1	AI-driven waste reduction strategies for vehicle owners, suggesting part repairs instead of replacements	confirmed (R2)	11/12	91.67%
HF.D3. Big Data Analysis					
11	HF.D3.1	Regulations for disposal, created based on big data analysis	confirmed (R1)	12/12	100%

Table 7. Results—Individual Self.

No.	Code	Questions	Results	Support	Degree of Confirmation
		Choice			
IS.C1. Artificial Intelligence					
1	IS.C1.1	AI-powered eco-personality profiles that align green vehicle choices with a consumer's lifestyle and identity	infirmed	3/12	-
2	IS.C1.2	AI-powered analysis of needs, for purchasing smaller vehicles, with functionalities that cover the main needs	infirmed	3/12	-
IS.C2. Blockchain					
3	IS.C2.1	Decentralized vehicle history tracking, increasing trust in second-hand cars and reducing new-vehicle production demand	infirmed	5/12	-
		Usage			
IS.U1. Artificial Intelligence					
4	IS.U1.1	Personalized energy efficiency goals that users set and track, enhancing their sense of self-efficacy	confirmed (R2)	11/12	91.67%
IS.U2. Digital Realities					
5	IS.U2.1	Use of AR/VR headsets for storytelling (visualizes the direct impact of eco-friendly choices on the user's life and value)	infirmed	4/12	-
IS.U3. Big Data					
6	IS.U3.1	Personal sustainability dashboards that track fuel savings, emissions reductions, and personal impact over time	confirmed (R2)	12/12	100%
IS.U4. Cloud Computing					
7	IS.U4.1	personal carbon-footprint journals that help users track their long-term sustainability journey	confirmed (R2)	11/12	91.67%
		Disposal			
IS.D1. Blockchain					
8	IS.D1.1	Ownership and recycling certificates stored on blockchain, reinforcing responsible disposal decisions and self-commitment	infirmed	5/12	-

Table 8. Results—Feelings and Cognition.

No.	Code	Questions	Results	Support	Degree of Confirmation
		Choice			
FC.C1. Artificial Intelligence (AI)					
1	FC.C1.1	AI-powered personal assistants for cost–benefit analysis of vehicles based on powertrain: BEV, FCEV, PHEV	confirmed (R1)	12/12	100%
2	FC.C1.2	AI-powered advertising campaigns for encouraging purchase of EV	confirmed (R2)	10/12	83.33%

Table 8. *Cont.*

No.	Code	Questions	Results	Support	Degree of Confirmation
3	FC.C1.3	Online branding campaigns for increasing brand attachment	infirmed	3/12	-
FC.C2. Cloud Computing					
4	FC.C2.1	Online communities for sustainable mobility	confirmed (R2)	10/12	83.33%
5	FC.C2.2	Online customization of vehicle and comparison of pricing	infirmed	3/12	-
FC.C3. Digital Realities					
6	FC.C3.1	AR and VR product visualization	infirmed	3/12	-
		Usage			
FC.U1. In-car connectivity: cellular network (5G, LTE), Wi-Fi					
7	FC.U1.1	Over-The-Air updates: for upgrading software in vehicle	confirmed (R1)	12/12	100%
8	FC.U1.2	Car-sharing: for (un)locking the car for remote car rental	confirmed (R1)	12/12	100%
FC.U2. Augmented Reality (AR)					
9	FC.U2.1	AR-enhanced repair guide	confirmed (R1)	12/12	100%
FC.U3. Cloud Computing and Mobile Apps					
10	FC.U3.1	Car-ride (Mobility-as-a-Service)	confirmed (R1)	12/12	100%
11	FC.U3.2	Car-sharing (Mobility-as-a-Service)	confirmed (R1)	12/12	100%
		Disposal			
FC.D1. Cloud Computing and Mobile Apps					
12	FC.D1.1	Digital marketplaces for resale vehicles	confirmed (R2)	12/12	100%

Table 9. Results—Tangibility.

No.	Code	Questions	Results	Support	Degree of Confirmation
		Choice			
T.C1. Digital Twin					
1	T.C1.2	Simulations for carbon footprint of the vehicle (throughout its entire lifecycle)	confirmed (R1)	12/12	100%
T.C2. In-car connectivity: cellular network (5G, LTE), Wi-Fi					
2	T.C2.1	Subscription-based EV ownership	infirmed	5/12	-
T.C3. Artificial Intelligence (AI)					
3	T.C3.1	Digital-comparison tools for lifecycle emissions of a vehicle	confirmed (R2)	12/12	100%
4	T.C3.2	Interactive emission calculators for vehicle choices based on powertrain, driving habits and other criteria	confirmed (R2)	11/12	91.67%
		Usage			
T.U1. Internet of Things (IoT)					
5	T.U1.1	Predictive maintenance: based on sensors in the car, driver receives recommendations for vehicle maintenance, increasing vehicle lifetime	confirmed (R1)	12/12	100%
6	T.U1.2	Vehicle-to-infrastructure (V2I) communication: reducing traffic congestion, providing accurate arrival times for public transportation	confirmed (R1)	12/12	100%
7	T.U1.3	Optimization of HVAC (Heating, Ventilation and Air Conditioning)	confirmed (R2)	11/12	91.67%
T.U2. Blockchain					
8	T.U2.1	Digital-product passports providing sustainability scores	infirmed	2/12	-
		Disposal			
T.D1. Distributed computing					
9	T.D1.1	Crowdsource databases for vehicle parts	confirmed (R2)	11/12	91.67%
10	T.D1.2	Digital marketplaces for resale of vehicle parts	confirmed (R2)	12/12	100%
T.D2. Cloud Computing					
11	T.D2.1	Digital platform for upcycling recommendations for vehicle parts	confirmed (R1)	12/12	100%
12	T.D2.2	Digital education for recycling vehicle	confirmed (R1)	12/12	100%
T.D3. Artificial Intelligence (AI)					

Table 9. *Cont.*

No.	Code	Questions	Results	Support	Degree of Confirmation
13	T.D3.1	AI-powered resale valuation for vehicles and parts	confirmed (R1)	11/12	91.67%
T.D4. Blockchain					
14	T.D4.1	Blockchain-based tracking of car parts and materials	confirmed (R2)	12/12	100%
15	T.D4.2	Blockchain-based ownership history for vehicle	confirmed (R2)	12/12	100%

Table 5 contains the opinions of the experts with regard to the way in which consumer behavior can be influenced by social norms, opinions and expectations of the social groups the consumer is part of. This social influence can be amplified by integrating digital technologies into different functionalities of the vehicle. According to the results of this study, the digital technologies that have the potential to influence consumer behaviors towards more sustainable ones, at different stages of the product lifecycle (choice, usage, and disposal), for "Social Influence" are Artificial Intelligence, Virtual Reality, and Big Data.

Besides expressing their opinions using the 5-point Likert scale, the experts were able to provide a more detailed opinion in open text. Their comments highlight the concern of the representatives of the automotive industry regarding sustainable consumption behaviors. The following presents some of their expressed concerns (the number attributed to the expert corresponds to the order in which the response was received; this order is different between round 1 and round 2).

> "I think to 'sell' a concept to someone, it's useful to highlight what will bring them value, and that requires targeted discussion, not casting a broad net. While teaching consumers via training modules, knowledge sharing, etc., can be useful in educating them, sometimes sustainability will lose in favor of a smaller price if the buyer is on a budget; and showcasing the smaller environmental impact of an electric car will fail if they live in a country that lacks the infrastructure".
>
> Expert 2 (first round)
>
> "I am not certain to what degree people distinguish between hype features (e.g., a feature that displays the real time energy consumption) versus features that address real problems and needs (e.g., driving patterns, eco routing). There is also the control that the manufacturers manifest when trying to control the market (e.g., in-depth vehicle diagnosis directly available for the driver) that impact how sustainability is perceived on the driver's side, meaning that he will be influenced to still go to the dealership because they don't want to lose business by allowing customers with too many self-diagnostic data versus a visit to the dealership service, where only a specialized mechanic can provide a diagnostic".
>
> Expert 10 (first round)
>
> "Blockchain enhances transparency in electric vehicles supply chain, helping consumers make informed choices".
>
> Expert 2 (second round)
>
> "I discount learning experiences (VR or otherwise, as long as they feel like classes) here based on the thought that this is a 'show, don't tell' type of situation. Basically, you can only teach someone if they're willing to learn, but peer pressure seems like a more useful tool in this scenario".
>
> Expert 4 (second round)
>
> "Digital technologies can profoundly influence consumer behavior".
>
> Expert 5 (second round)

> "There is an impact of digital technologies that I don't know if it has been noticed: due to a lack in quality and reliability of some digital technologies, many people, especially from low–mid social class, feel that digitalization of cars has decreased the quality in comparison with classic cars (produced until 2005–2010) and are reluctant to buy a "modern" car, due to increases in complexity, lower reliability, lower repairability and lower maintainability".
>
> Expert 9 (second round)

According to the results summarized in Table 6, the following digital technologies have the potential to influence "Habit Formation" towards more sustainable consumption: Artificial Intelligence, Virtual Reality, Cloud Computing, Internet of Things, and Big Data.

Compared to the first pillar of the SHIFT conceptual framework (Social Influence), for the second pillar (Habit Formation), there was agreement among the experts. A total of 5 (out of 11) items were confirmed in the first round of applying the Delphi technique, and the remaining 6 were confirmed in the second round. As the table clearly shows, the applications of the selected digital technologies were perceived as having a strong potential to positively influence sustainable consumption behaviors. The comments provided by experts are also evidence for this:

> "I think these are all good initiatives to aid habit formation, and I would also add some form of reinforcement of positive behavior. If AI keeps throwing "please switch to energy-saving mode!" messages at me, I may learn to switch to energy-saving mode or I may learn to turn off notifications. On the other hand, if by switching to energy-saving mode I get 20 EnergySaver points, and there's a database showing I'm the 89th best EnergySaver in the country and the 2nd best out of all my friends, maybe I'm incentivized".
>
> Expert 2 (first round)
>
> "Automotive market must be considered in the context of each society, with its rules, living habits, transportation system. If automotive is analyzed in isolation (e.g., eco-run, but the town is so crowded and there are no real alternatives like public transport or infrastructure), the influence of all the above factors under analysis will be close to minimum".
>
> Expert 10 (first round)
>
> "Cloud solutions are dependent on signal availability".
>
> Expert 11 (first round)

Table 7 presents the results of the analyses for the third pillar—Individual Self; the purpose of the analysis was to assess the extent to which digital technologies (through specific applications) are aligned with the lifestyle and identity of consumers for the automotive industry.

According to the data in Table 7, collected during round 1 of the Delphi technique, there was no consensus for the selected 8 items. One of the experts explained this:

> "... The identity of the automotive industry has changed in the last years, to become basically data mining. And this is not unexpected, it is in line with today's massive information-based industry. However, most services that require user data are free because the user is not the client, they are the product (e.g.: social media—your data is sold to ad companies in exchange for the right to use a platform like Facebook or Instagram for free). But the automotive industry has taken this concept and removed the ability to actually GAIN something in exchange for your data—instead, you pay a lot of money for a car, and then you give the car maker your data for free, and sometimes you STILL have to pay more for subscription-based services. I do not

believe this is what the identity of the automotive industry was, or should be. In a society where laws kept up with technological advance, these would be considered predatory business practices and would be regulated".

Expert 2 (first round)

In the second round of the Delphi technique, for the pillar *Individual Self*, the utility of three digital technologies (and their corresponding applications) was confirmed: Artificial Intelligence, Big Data, and Cloud Computing (Table 7).

Table 8 contains the data for the fourth pillar of SHIFT conceptual framework—Feelings and cognition. Starting from a set of digital technologies selected based on the literature review and the opinions of experts in the field, the goal was to evaluate the degree in which these digital technologies (and their corresponding applications) can shape the emotions and reasoning of consumers, influencing them towards the adoption of sustainable consumer behaviors with regards to the products of the automotive industry (automobiles). The results confirm that the following digital technologies are able to influence the emotions and reasoning of users of automobiles in all of the three stages of the product lifecycle (choice, usage, and disposal): Artificial Intelligence, Cloud Computing (and Mobile Apps), Digital Realities, In-car connectivity, and Augmented Reality).

In addition to the responses using the 5-point Likert scale, some of the experts have also provided detailed comments to support their answer, as follows:

"I think most things you can throw at a consumer need to be: 1. targeted directly at that consumer's beliefs (. . .); 2. targeted at their budget (. . .); 3. targeted at their social status (. . .)".

Expert 2 (first round)

"Branding works. You're in a hypermarket; there are 50 brands of detergent around you. If you don't have budget constraints forcing you to limit your choice pool, you will most likely buy something you've heard of before. There are studies that demonstrate that brand familiarity reduces decision fatigue and increases perceived value, thereby increasing likelihood of purchase. Brand trust, loyalty and recognition all affect consumer behavior".

Expert 4 (second round)

Table 9 presents the results for the last pillar of SHIFT: Tangibility. For this pillar, experts have evaluated the extent to which digital technologies can contribute to increasing awareness about the tangible impacts of sustainable consumption on the environment.

Out of a total of 15 items for Tangibility, 13 items were confirmed by experts (with 6 of them being confirmed in the first round). Thus, it has been proven that the following digital technologies can support users of automobiles to adopt more sustainable consumption behaviors, by increasing their awareness levels regarding the tangible impacts on the environment: Digital Twin, Artificial Intelligence, Internet of Things, Blockchain, Distributed computing, and Cloud Computing.

Regarding the last pillar of SHIFT, even though there was consensus in the responses using the 5-point Likert scale, in their comments some of the experts mentioned some particular aspects:

"If the goal is indeed increasing awareness—I think educating the people helps. A marketplace for refurbished parts will help in actually decreasing the environmental impact, but will not really increase awareness IMO (in my opinion)".

Expert 2 (first round)

"If you want to increase awareness on something, bite-sized chunks of important, eye-catching info are the way to go. I think maybe sometimes it's more important

how the info is packaged, as not everyone will sit through a lecture on a subject, they lacked awareness in (and are therefore not already interested in). I believe most of these ideas would add value here".

Expert 4 (second round)

Using the results obtained by applying the Delphi technique and taking into consideration the five pillars of SHIFT, it was possible to define an adapted conceptual framework (named "SHIFT for automotive"). Table 10 presents the digital technologies that can influence sustainable consumption behaviors of the users of automobiles, and provides details about their concrete applications.

Table 10. SHIFT for automotive.

		Digital Technologies (Applications)		
		Choice	**Usage**	**Disposal**
S	Social Influence	SI.C1. Artificial Intelligence: - AI-powered social media trends that promote sustainable vehicle choices by showing what others are purchasing; - AI-driven social media campaigns that encourage sustainable vehicle choices or ridesharing platforms; SI.C3. Virtual Reality: - Interactive VR training modules for sustainable choices; SI.C4. Cloud computing: - Cloud-based platforms for knowledge-sharing and best practices in sustainable automotive choices	SI.U1. Artificial Intelligence - Eco-routing (chose an eco-route because other users in the area did so) SI.U3. Big Data - Real-time feedback providing drivers with insights into their driving patterns and how to optimize for sustainability SI.C4. Cloud computing - Remote vehicle diagnostics to optimize energy efficiency and reduce unnecessary repairs	SI.D1. Virtual Reality - VR training modules educating consumers on responsible vehicle recycling, component reuse and disposal
H	Habit Formation	HF.C1. Artificial Intelligence - AI can recommend new vehicle choices or features based on the users' sustainable habits (based on distance, charging time, range, etc.)	HF.U1. Artificial Intelligence - Personalized eco-driving assistants that analyze driving patterns and suggest habit changes; - AI nudges that remind drivers to switch to energy-saving driving modes, reinforcing eco-driving habit; HF.U2. Virtual Reality - VR-based eco-driving training programs to help drivers optimize energy usage; HF.U3. Cloud Computing - Cloud-integrated remote diagnostics that optimize energy efficiency in EVs; HF.U4. Internet of Things - Eco-driving; - Eco-routing; - Autonomous Driving Features;	HF.D1. Cloud Computing - Cloud platforms that send messages to users to properly dispose of parts when the components reach end-of-life; - AI-driven waste reduction strategies for vehicle owners, suggesting part repairs instead of replacements; HF.D3. Big Data Analysis - Regulations for disposal, created based on big data analysis
I	Individual Self	-	IS.U1. Artificial Intelligence - Personalized energy-efficiency goals that users set and track, enhancing their sense of self-efficacy; IS.U3. Big Data - Personal sustainability dashboards that track fuel savings, emissions reductions, and personal impact over time; IS.U4. Cloud Computing - Personal carbon-footprint journals that help users track their long-term sustainability journey	-
F	Feelings and Cognition	FC.C1. Artificial Intelligence (AI) - AI-powered personal assistants for cost–benefit analysis of vehicles based on powertrain: BEV, FCEV, PHEV; - AI-powered advertising campaigns for encouraging purchase of EV; FC.C2. Cloud Computing - Online communities for sustainable mobility	FC.U1. In-car connectivity: cellular network (5G, LTE), Wi-Fi - Over-The-Air updates: for upgrading software in vehicle; - Car-sharing: for (un)locking the car for remote car rental; FC.U2. Augmented Reality (AR) - AR-enhanced repair guide; FC.U3. Cloud Computing and Mobile Apps - Car-ride (Mobility-as-a-Service); - Car-sharing (Mobility-as-a-Service)	FC.D1. Cloud Computing and Mobile Apps - Digital marketplaces for resale vehicles

Table 10. *Cont.*

		Digital Technologies (Applications)		
		Choice	**Usage**	**Disposal**
T	Tangibility	T.C1. Digital Twin Simulations for carbon footprint of the vehicle (throughout its entire lifecycle); T.C3. Artificial Intelligence (AI) - Digital comparison tools for lifecycle emissions of a vehicle; - Interactive emissions calculators for vehicle choices based on powertrain, driving habits and other criteria	T.U1. Internet of Things (IoT) - Predictive maintenance: based on sensors in the car, driver receives recommendations for vehicle maintenance, increasing vehicle lifetime; - Vehicle-to-infrastructure (V2I) communication: reducing traffic congestion, providing accurate arrival times for public transportation; - Optimization of HVAC (Heating, Ventilation and Air Conditioning)	T.D1. Distributed computing - Crowdsource databases for vehicle parts; - Digital marketplaces for resale of vehicle parts; T.D2. Cloud Computing: - Digital platform for upcycling recommendations for vehicle parts; - Digital education for recycling vehicle T.D3. Artificial Intelligence - AI-powered resale valuation for vehicles and parts T.D4. Blockchain - Blockchain-based tracking of car parts and materials - Blockchain-based ownership history for vehicle

According to the above, the Delphi technique proved useful to develop and validate the "SHIFT for automotive" construct. Different from previous studies, which focused on assessing the applicability of the SHIFT conceptual framework to other research areas [20–22], the present study contributes to the advancement of knowledge, providing evidence on the potential of digital technologies to contribute to the consolidation of sustainable consumption behaviors.

5. Conclusions

Different from previous studies that used the SHIFT conceptual framework for other domains [20–22], this study takes an original approach and transposes the construct from the perspectives of automotive industry stakeholders. The main objective was to assess the extent to which the integration of different digital technologies into the various functionalities of passenger cars can contribute to strengthening the sustainable consumption behaviors of end-users.

Using the Delphi Technique, based on the evaluation of expert opinions, it was shown that the selected and evaluated digital technologies (Table 11) can represent real levers for increasing the responsibility of end-consumers regarding their sustainable behavior.

Table 11. SHIFT for automotive—technologies.

		Choice	**Usage**	**Disposal**
S	Social Influence	SI.C1. Artificial Intelligence SI.C3. Virtual Reality SI.C4. Cloud computing	SI.U1. Artificial Intelligence SI.U3. Big Data SI.C4. Cloud computing	SI.D1. Virtual Reality
H	Habit Formation	HF.C1. Artificial Intelligence	HF.U1. Artificial Intelligence HF.U2. Virtual Reality HF.U3. Cloud Computing HF.U4. Internet of Things	HF.D1. Cloud Computing HF.D3. Big Data Analysis
I	Individual Self	-	IS.U1. Artificial Intelligence IS.U3. Big Data IS.U4. Cloud Computing	-
F	Feelings and Cognition	FC.C1. Artificial Intelligence (AI) FC.C2. Cloud Computing	FC.U1. In-car connectivity: cellular network (5G, LTE), Wi-Fi FC.U2. Augmented Reality (AR) FC.U3. Cloud Computing and Mobile Apps	FC.D1. Cloud Computing and Mobile Apps
T	Tangibility	T.C1. Digital Twin T.C3. Artificial Intelligence (AI)	T.U1. Internet of Things (IoT)	T.D1. Distributed computing T.D2. Cloud Computing T.D3. Artificial Intelligence T.D4. Blockchain

The results of this study have profound theoretical, methodological and practical implications. From a theoretical point of view, the study proves its usefulness because it fills the literature gap in the field of research on the sustainability of consumer behavior. To the authors' knowledge, up to the time of writing this study, no similar studies have been identified in the relevant literature.

From a methodological point of view, the study presents in a detailed and original manner a method for evaluating expert opinions. Although the purpose of the work was not the original application of the Delphi Technique, the nature of the research, the number and amplitude of the variables taken into account, and the particularities of the different stages forced a permanent adaptation to the circumstances.

The study has practical utility, serving as a guide for both automotive industry operators and car users. As experts have noted, automotive industry operators are concerned (downstream and upstream) to ensure sustainability throughout the value chain. An important link in this chain is represented by car end-users, who need to understand the facilities offered by the various digital technologies integrated into the various car functionalities, so as to be helped/motivated to develop sustainable consumption behavior.

This study has some limitations. One limitation is that only the most representative digital technologies (and related applications) were taken into account, without a prior assessment of the end-consumer's openness to the use of these technologies. As one of the experts highlighted, these technologies may have a boomerang effect ("due to a lack in quality and reliability of some digital technologies, many people, especially from low–mid social class, feel that digitalization of cars has decreased the quality in comparison with classic cars"). To overcome this limitation, in future studies we consider evaluating the "SHIFT for automotive" conceptual framework from the perspective of end-consumers. This research direction will also consider the preliminary assessment of the nature of digital technologies and their sustainability. At the same time, the assessment of the risks associated with the digital technologies integrated into "SHIFT for automotive" will also be taken into account.

Another limitation is the poor homogeneity of the selected expert sample. Although the initial goal was to obtain the opinions of as many categories of experts as possible, it was observed that the diversity of experts may result in poor convergence of results. Future studies will consider assessing the extent to which experts' perceptions are influenced by socio-demographic variables (number of years of experience, position in the company, position held, etc.). Another limitation is related to the representativeness of the data and the possibilities of their generalization. This limitation is produced by the fact that most experts are from EU countries. Furthermore, the present study was designed to meet the requirements of qualitative research. To expand the area of applicability of the "SHIFT for automotive" construct, in future research we consider validating the construct for other geographical areas, by inviting experts from countries/continents not covered by this study.

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Acceptance of Digital Transformation: Evidence from Romania

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Abstract: The digital transformation (DT) implies designing products and services, to which digital technology is applied, that are adopted and used by customers. However, if people do not accept the new technologies embedded in the innovative products and services, DT will fail. Therefore, getting to know the determinant factors that affect acceptance is necessary, especially during economic turmoil that requires companies to become even more competitive. Moreover, Romania is lagging behind in its digital progress. The aim of this research is to draw upon a previous study on successful DT, analyze personal and social acceptance factors, and empirically verify whether they would affect DT in Romania. We identified from the literature the main factors (behavioral and innovative characteristics) affecting the DT acceptance attitude and adapted the theoretical model to the Romanian context. The study collected data from 123 persons using an online questionnaire and applied a structural equation model to test the theoretical model. The empirical results emphasize that the acceptance attitude of DT is positively associated with individuals' behavioral factors and innovative characteristics. Moreover, DT acceptance attitude positively impacts both personal and social acceptance of DT. This research provides both theoretical and empirical contributions by adapting the theoretical DT model and testing it for the Romanian context, using personal and social acceptance. These findings are important for managers and policy makers that seek to transform their organizations.

Keywords: digital transformation; acceptance attitude of DT; innovation; behavioral factors; Romania

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1. Introduction

The digital transformation (DT) implies designing products and services, to which digital technology is applied, that are adopted and used by customers. However, if people do not accept the new technologies embedded in the innovative products and services, DT will fail. Therefore, getting to know the determinant factors that affect acceptance is necessary, especially during the economic turbulence from the cumulative effects of the recent pandemic and the Ukrainian crisis, which has led to great economic instability.

Whilst performing very well on connectivity, on the proportion of female ITC specialists in employment and ITC graduates, there are several indicators Romania is lagging behind. The human capital dimension, integration of digital technology, digital public services, and level of basic digital skills are all very low compared to the EU average [1]. The context of Romania's performance is important because the European Commission allocates EUR 127 billion through national Recovery and Resilience Plans in order to support the digital transformation. The EU is monitoring member states' digital progress through the Digital Economy and Society Index (DESI) country profile structured on four key areas: human capital, connectivity, integration of digital technology, and digital public services. Therefore, it is important to explore the factors that foster the acceptance of DT for Romania, as the results of the research may be used by other member states that have an overall low DESI score or are lagging behind in any of its four key areas [1].

Recent studies on the relationship between sustainability and digitalization have investigated the use of the digital transformation for sustainability purposes. Castro et al. [2] focused their research on identifying the ways that sustainability improves through digital transformation. Berger et al. [3] underlined that, at present, digitization is the most significant driver of entrepreneurship and innovation. For companies to grow in a volatile and uncertain environment and to achieve sustainable development, it is essential to pursue digital transformation [4]. Consequently, the sustainability transition can be accelerated through digitization [5].

In the era of digitalization and globalization, to achieve sustainable performance, companies must develop sustainable strategies that will enable them to better cope with limited resources [6]. Such digital technologies must be developed and implemented to enable digital transformation.

Whilst environmental, social, and economic sustainability had been viewed as triple bottom line perspectives, the digital age blurs such boundaries and transcends these dimensions [7]. Digital technologies and the transformations required for their implementation generate, beyond their intended benefits, some unintended positive and negative second-order consequences for society, firms, and individuals ([7], p. 600).

Previous studies focused on individual behavior regarding technology acceptance [8–11] rather than on social-level change or social acceptance. However, other studies [12–15] only analyzed social change without researching the DT dimension. This research builds on a previous study [16,17] that focused on both individual and social acceptance of DT. Whilst previous studies analyzed the determinant factors of successful acceptance and use of DT [18–20], this research aims to identify and analyze the factors enabling personal and social acceptance of DT in the Romanian context and to empirically test the model using an online survey. The paper seeks to test whether the acceptance attitude of DT is positively associated with individuals' behavioral factors and innovative characteristics and if DT acceptance positively impacts both personal and social acceptance of DT in the Romanian context.

2. Literature Review and Hypothesis Development

2.1. Digital Transformation

Seeking to better understand the digital transformation, Martin [21] analyzed the literacies of the digital transformation and identified six important dimensions: computer, IT or Information and Communication Technology (ICT), which represents a continuum of knowledge and skills in order of increasing cognitive complexity [22], and technological, information, media, visual, and communication literacy.

Martin [21] highlights that change regarding the use of technology in society is complex and based on human actions and interactions with innovative technologies. Such transformations are neither sudden nor unexpected but a series of transitions on a continuum. The author states that digital transformation is achieved through individual usage of digital technology that will enable creativity and innovation and thus stimulate substantial change within a specific professional or knowledge domain ([21], p. 173).

DT was also defined as the "consumerization of IT" ([23], p. 209) through the changes and evolution required by personal and corporate IT environments to adapt for businesses to take advantage of new opportunities opened by the digital workplace. The author highlights the benefits of four technologies that would synergize through their interaction to enhance workforce productivity and profitability: mobile, big data, cloud computing, and search-based applications, inducing changes to individuals, organizations, and society, as it will impact both personal and organizational cultures ([23], p. 212).

Kane et al. [24] classifies businesses as "mature digital", which integrate mobile, social, analytics, and cloud technologies, and "less mature", which use individual digital technologies to solve discrete business problems. They define DT as the means to foster the adoption and use of technology by individuals, employees, and businesses through a change in strategy, culture, talent development, and leadership. These will drive DT

through stories, risk acceptance, and better collaboration among people and teams rather than just through technology.

Udovita [25] highlights two important dimensions of DT: "digitization", which refers to analog to digital conversion of information facilitating the use of digital formats, and "digitalization", which uses digitization to improve existing goods and services and develop new business models and incorporate IT into the business strategies to exploit new digital opportunities. Her definition of DT includes four key dimensions: go-to-market, engagement, operations, and organizations.

A literature review on DT revealed two main perspectives: organizational and social. The organizational perspective includes corporate focus [26–29], services [30–37], SMEs from both manufacturing [38–40] and services [41,42], and transformation of the organizations' business models [43–46] and social perspectives [47–50], including COVID 19 [51–53] and sustainability and CSR [54–57].

Based on the literature research, we adopted the DT definition used by Kyunghwan et al. ([16], p. 2): "activity in which an organization makes social changes through customer-centered business model improvements using new digital technologies".

2.2. Model Development

2.2.1. Theory of Diffusion of Innovation (DOI)

The Theory of Diffusion of Innovation defines diffusion as a process of communicating innovation through certain channels over time among members of a social system and innovation as an idea, practice, or object that is perceived to be new by an individual or other unit of adoption. There cannot be diffusion without communication, defined by Rogers ([58], p. 5) as a convergent or divergent two-way process in which participants both create and share information to reach mutual understanding. As diffusion means communicating the latest ideas, this implies some degree of uncertainty and a lack of predictability, as there exist several alternatives with different probabilities of occurrence.

The theory of DOI identifies the factors and their relationship that affect the adoption rate of any innovation within a social system. There are five steps an individual passes through when adopting an innovation ([58], p. 20): knowledge (required to recognize it and understand how it functions), forming an attitude (favorable or not towards it), the decision to accept or reject, implementation (when the user puts innovation to use), and confirmation (when the adopter seeks reinforcement if exposed to conflicting messages about the innovation).

Rogers [58] defines five components of an innovation: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage is a criterion that assesses the perceived degree of innovation being better or more advantageous compared with existing innovations. It can be measured in both economic and non-economic terms such as convenience, social prestige, or satisfaction. Compatibility assesses the potential adopters' perceived degree of innovation consistency with existing values, needs, and past experiences to be accepted. Complexity measures the potential adopter's perceived difficulty in understanding and using the innovation. Trialability evaluates whether the potential adopter may experiment with the innovation before adoption, on a limited basis. Observability considers the degree to which others may see the results of the innovation as the adopter is using it.

Further research on the perception of the adoption of an information technology innovation (AITI) had built upon DOI [59] and proposed a model based on eight concepts: voluntariness, relative advantage, compatibility, image, ease of use, result demonstrability, visibility, and trialability ([59], p. 216). Whilst important, the model must also consider that the adoption process is influenced by organizational context, user experience, and demographic characteristics [60]. Habit and risk are key factors that may trigger an individual's resistance to innovation adoption [61].

2.2.2. Theory of Planned Behavior

Seeking to develop a general theory that would predict, explain, and influence behavior, Ajzen and Fishbein [8] developed the Theory of Reasoned Action (TRA) based on two predictors that influence the intention to perform a behavior: attitude towards the behavior and subjective norms (as social factors that refer to the perceived social pressure of whether or not to perform that behavior). TRA distinguishes two kinds of salient beliefs that influence attitudes toward behavior: behavioral and normative [9,10]. Further research revealed that some of the goals and behaviors were not under complete volitional control, and a new construct had to be included in the theory: perceived behavioral control [11], that is, a person's perceived ease or difficulty in performing the behavior of interest. Such perceived control over behavior is influenced by both obstacles that may hinder or block access to a desired behavior as well as the facilitating factors, such as information available, skills, opportunities, and other resources that may facilitate and aid the process. This improved theory is the Theory of Planned Behavior (TPB), which facilitates the prediction and understanding of a particular behavior within specific contexts.

2.3. Research Hypotheses

Seeking to analyze the factors that enable DT in Romania, we built on previous research by Kyunghwan et al. [16] and used the same personal and social acceptance framework, to which we added two variables related to behavioral factors, specific for the Romanian context. In the theoretical framework proposed by Kyunghwan et al. [16], digital transformation acceptance attitude (DA) is a mediating factor, not an independent variable. We also assumed that behavioral factors and innovative characteristics will affect acceptance behavior (both personal and social acceptance), but their effect is mediated by DA (Figure 1).

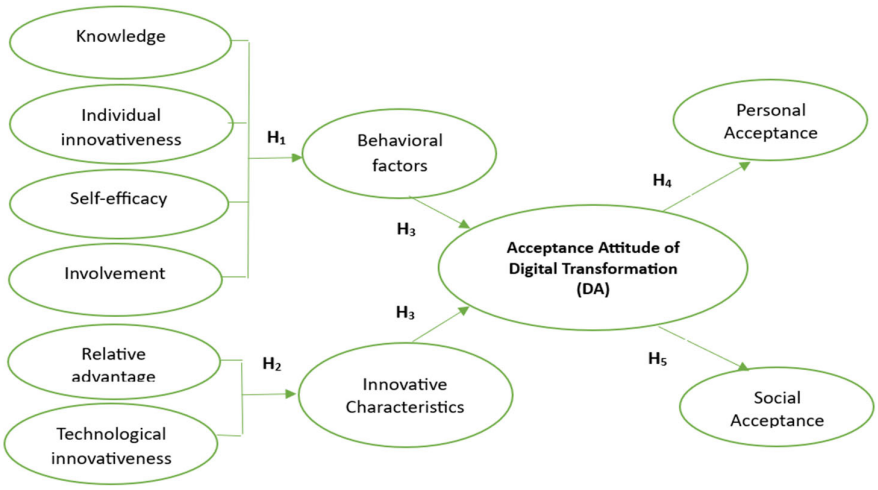

Figure 1. Theoretical model of the digital transformation.

2.3.1. Behavioral Factors

There are four constructs, each with specific items that were generated from literature research [17,58], defining the behavioral factors that affect DT: knowledge, individual innovativeness, self-efficacy, and involvement.

Knowledge represents the first of the five steps of Rogers' DOI [58]. Without a positive attitude towards innovation, even if someone has the knowledge, he will not adopt it. A communication channel is required to connect someone that has the knowledge to "transfer" it to an individual that does not yet have appropriate knowledge about that innovation. Such diffusion requires time. The concept might also incorporate familiarity, defined as the number of product-related experiences accumulated by the consumer, and expertise, which

is the ability to perform product-related tasks successfully ([62], p. 411) and is well-suited for digital technology.

Individual innovativeness describes how likely an individual is expected to belong to a category of early/late adoption of a new digital technology, compared with other members of the social system. It represents the degree to which an individual belongs to one of the five categories of early/late adopter [58], or their willingness to try out any new digital technology ([63], p. 206).

Self-efficacy is a significant direct determinant of behavior, as an individual subjectively judges whether they perceive that they have control over external and internal constraints and can perform a task [64]. It is equivalent to the "perceived ease of use" concept, defined as the belief that using digital technology would be free from physical and mental effort [59]. Self-efficacy as a concept represents the "subjective judgment of an individual who is confident that digital technology can be used easily" (as proposed by [16], p. 4).

Involvement was introduced by Muzafer Sherif in the Psychology of Social Norms [12], where it is linked to the ego as a factor in the activity motivated by basic needs.

Involvement is influenced by three major antecedent factors: characteristics of the person, stimulus, and situation [65]. As a motivational construct, it includes a person's values, needs, and interest in innovative technologies or situations. The authors simplified their initial scale retaining the interest, need, importance, and meaning of a particular object [60]. Identifying that high involvement is more of a left brain activity and low involvement is associated with right brain activity, Krugman [66] highlights the importance of comparing users according to their degree of involvement. High-involvement users find the quality of arguments presented to them to be a more important determinant of persuasion compared with low-involvement ones [67], which underlines the importance of involvement when conducting a research study.

Beyond Kyunghwan et al.'s concepts [16], our research considered relevant to introduce in the questionnaire two more variables relevant for the Romanian sample: the estimated time used by the respondent to learn about new p/s with DT and whether the respondent wants to use p/s with advanced DT. Considering that involvement with digital technology is of high interest for both people and society, all variables were set up from the perspective of high involvement.

Hypothesis 1. *Knowledge, individual innovativeness, self-efficacy, and involvement have a positive impact on the behavioral factors that affect DT.*

2.3.2. Innovative Characteristics

Relative advantage is a criterion people use to assess whether the innovation is perceived to be better than the idea it supersedes ([58], p. 15). It is a perceptual variable that was found to predict consumer adoption better compared with personal characteristics [68]. People will adopt digital technology faster if they perceive it to bring them more advantages compared to traditional technologies. That is, whether it has reduced complexity and is easier to use, whether it is compatible with their values and social norms, whether it may be experimented with on a limited basis, and whether its results are visible to others [58].

Technological innovativeness has a certain degree of benefit or advantage perceived by its adopters in DOI. Its benefits may be rooted in the reduction in uncertainty, as a potential adopter is motivated to exert effort and learn about its anticipated consequences. He or she may also seek the possible efficacy of that innovation in solving a perceived problem [58] by using the latest technology, which is new, original, creative, and different from those that already exist on the market. Ram [69] highlights the importance of perceived newness by the consumer. Regardless of the amount of "newness" introduced by the firm, if it is not perceived by the consumer, he or she will not adopt it. This may not be due to consumer resistance to technological innovation but to the failure of the communication effort to stimulate optimal newness. Digital technology incorporates a great amount of change and many technological innovations.

Hypothesis 2. *Technological innovativeness and relative advantage have a positive impact on the innovative characteristics that affect DT.*

Hypothesis 3. *Behavioral factors and innovative characteristics have a positive impact on DT.*

2.3.3. Personal and Social Acceptance

Digital transformation cannot be achieved without personal and social acceptance of innovative technologies. The three important technology adoption models are the Technology Acceptance Model (TAM) [70], the Theory of Planned Behavior (TPB) [11], and the Unified Theory of Acceptance and Use of Technology (UTAUT) [60]. Whilst all three models include constructs of both use intention and behavior as indicators of technology acceptance, all have constructs regarding both personal and social acceptance. Therefore, the questionnaire used in this research includes intention (willing and should use) and behavior (use, increase the use) for both personal and social acceptance constructs.

2.3.4. Acceptance Attitude for Digital Transformation (DT)

People's behaviors are caused by intentions and their actual control (skills/abilities and environmental factors) which are, in turn, influenced by their behavioral, normative, and control beliefs and individual, social, and informational factors ([10], p. 22). Acceptance and use of digital technology is affected by that technology's perceived usefulness, ease of use, and acceptance [70] on both personal and organizational levels. Therefore, we considered in this study the acceptance attitude of digital transformation as mediating personal or social acceptance.

Hypothesis 4. *Acceptance attitude of digital transformation has a positive impact on personal acceptance.*

Hypothesis 5. *Acceptance attitude of digital transformation has a positive impact on social acceptance.*

3. Materials and Methods

3.1. Questionnaire

The questionnaire applied for data collection was developed starting from the question list proposed by Kyunghwan et al. [16]. It was completed with two variables relevant for the Romanian context: the estimated time used by the respondent to learn about new p/s with DT and whether the respondent wanted to use p/s with advanced DT. The questionnaire was pretested to ensure that it was properly understood by the respondents.

3.2. Sample

The data were collected through an online survey during May and June 2022 from users across Romania. The questionnaire was created in Google Forms. The research focused on individuals rather than employees of a specific industrial sector or users of a specific digital technology, such as e-commerce. Reaching people from different regions of Romania was significantly difficult in applying probabilistic sampling. Therefore, a mixture of non-probabilistic convenience and snowball sampling methods was used for data collection. The link to the Google Forms questionnaire was distributed using both e-mail and social media (Facebook and WhatsApp).

Overall, 123 completed questionnaires were collected. The structure of the sample according to socio-demographic characteristics is shown in Table 1. The sample is described along a set of demographic variables, such as age, gender, and area of residence, as well as from the perspective of experience and degree of digitalization.

Table 1. Sample description (n = 123).

Socio-Demographic Characteristic	Values	Percent
Age	<25	9.8
	25–35	10.6
	36–45	27.6
	46–55	37.4
	56–65	6.5
	>65	8.1
Gender	Male	51.2
	Female	48.8
Area of residence	Urban	90.2
	Rural	9.8
Degree of digitalization	Informative org. level	2.4
	Informative Social Media	17.9
	Conceptual understanding	11.4
	Average	12.2
	Digitally mature	26.8
	Do not know	29.3

The largest share of respondents (65%) belongs to the age group of 36–55 years. From the gender perspective, the sample is well-balanced (51.2% of respondents are women, and 48.8% of respondents are men). Most of the respondents (34.1%) have between 21 and 30 years of experience. The segment of respondents that consider themselves digitally mature represents more than a quarter of the sample (26.8%). Also, more than a quarter of respondents (29.3%) are not capable of assessing their level of digitalization.

3.3. Method

To obtain a structural model that can be used to confirm the theoretical model, we applied structural equation modeling (SEM) based on partial least squares analysis (PLS) using SmartPLS software (v. 4.0.8.2) [71]. The PLS-SEM approach consists of two models based on covariance structural equation modeling; the measurement model specifies how latent variables (hypothetical constructs) are indicated by the observed variables, and the structural equation model specifies the causal relationship among constructs. The reliability and validity analyses have been applied for testing the measurement model. Moreover, the structural model validation implied the estimation of the path coefficients and their significance. The objective of the algorithm is to maximize the explained variance of the dependent latent variables in the PLS path model [72]. The PLS technique has the capability to model latent constructs under the next two conditions: non-normality and small or medium sample sizes [73].

PLS-SEM has been recently applied in empirical research on digital transformation. Zhang et al. [74] studied the improving role of digital transformation for organizational resilience, while Galindo-Martin et al. [75] analyzed the effects of digital transformation and digital dividends on entrepreneurial activity. The results of Ko et al. [76] reveal the role of business and management commitment to digital innovations and of IT departments in digital transformation. Moreover, using PLS-SEM, Singh et al. [77] highlight that digital transformation is impacted by competitive pressure, IT readiness, organizational mindfulness, and strategic alignment. Korachi and Bounabat [78] used SEM to define and identify a digital transformation strategy. El Hilali et al. [79] applied PLS-SEM and identified the main drivers of companies' digital transformation (customers, data, and innovation) and their impact on sustainability. Also, Sousa and Rocha [80] used the SEM approach to identify the importance of skills for an effective digital transformation. Nayal et al. [6] investigated, by means of SEM, the relationship between digital transformation, supply chain collaboration and coordination, sustainable development strategy, and collaborative advantages, and their influence on sustainable supply chain firm performance. Jovic et al. [81] have identi-

fied that organizational, technological, and environmental factors affect the digitalization of organizations in the maritime transport sector. By applying PLS-SEM, Capusneanu et al. [82] found a positive and significant association between the intention to use Industry 4.0 solutions and the benefits of digital transformation.

3.4. Variables

In this study, we have considered the following major constructs of digital transformation: behavioral factors (BF) and innovative characteristics (IC) that directly influence digital transformation acceptance attitude (DA), which directly influence personal acceptance (PA) and social acceptance (SA).

The measurement items (observed variables) corresponding to each construct (latent variables) are presented in Table 2, along with validity and reliability measures.

The internal consistency of the constructs was tested using Cronbach's alpha. It measures the degree to which the items quantifying the same concept are consistent [83]. We can conclude that the internal consistency is validated because all the alpha values are above 0.8.

The two-stage analytical approach for SEM consists of the following procedures: the test of the measurement model (validity and reliability of the measures), and then the examination of the structural model [73].

Table 2. Constructs and corresponding measurements items.

	Constructs **Items**	**Loadings**	**AVE**	**Cronbach's Alpha**
	Behavioral Factors (BF)		0.621	0.948
Knowledge	I am well aware of the pros and cons of products or services to which DT is applied. (BF1_K)	0.753		
	I am well aware of products or services to which digital technology is applied. (BF2_K)	0.777		
	I can explain to others about a product or service to which digital technology is applied. (BF3_K)	0.816		
	I am confident in solving problems related to products or services to which digital technology is applied. (BF4_K)	0.833		
Individual innovativeness	I usually use products with new technology before anyone else. (BF5_II)	0.882		
	I try to use products or services with advanced technology first. (BF6_II)	0.816		
	I tend to inform people around me about products with new technology. (BF7_II)	0.745		
Self-efficacy	I think I can use DT more easily than others. (BF8_SE)	0.800		
	I think I can accumulate knowledge about digital technology in a relatively short time. (BF9_SE)	0.840		
	I am confident in using DT. (BF10_SE)	0.558		
Involvement	I am interested in innovative new DT. (BF11_I)	0.727		
	Please estimate how much time/week would you use to learn about new p/s with DT? (BF12_I)	0.884		
	Do you want to use p/s with advanced DT. (BF13_I)	0.757		

Table 2. *Cont.*

	Constructs Items	Loadings	AVE	Cronbach's Alpha
	Innovative Characteristics (IC)		0.710	0.940
Relative advantage	DT is likely to be more useful than existing technology. (IC1_RA)	0.885		
	Using DT will be more convenient than using existing technology. (IC2_RA)	0.901		
	DT is more reliable compared to existing technology. (IC3_RA)	0.863		
	DT will be better compared to existing technology. (IC4_RA)	0.923		
Technological innovativeness	I think DT is made with the latest technology. (IC5_TI)	0.778		
	DT is innovative. (IC6_TI)	0.860		
	DT is original, creative, and novel. (IC7_TI)	0.844		
	DT differs greatly from existing technology. (IC8_TI)	0.659		
	Acceptance Attitude of Digital Transformation (DA)		0.894	0.941
Acceptance Attitude of DT	I think positively about using products or services with DT applied. (DA1)	0.947		
	I feel good about using products or services with DT. (DA2)	0.948		
	I am actively in of the use of products or services to which DT is applied. (DA3)	0.941		
	Personal Acceptance (PA)		0.974	0.925
Personal acceptance	I am willing to use a product or service with DT applied. (PA1)	0.960		
	If I have a chance, I will use products or services with DT applied. (PA2)	0.972		
	I will continue to use products or services with DT applied in the future. (PA3)	0.953		
	Social Acceptance (SA)		0.908	0.950
Social acceptance	DT and related products or services should be used more actively in our society. (SA1)	0.953		
	DT and related products or services should be used in more diverse areas of our society. (SA1)	0.956		
	We need to gradually increase the use of DT in our society. (SA1)	0.950		

4. Results

4.1. Measurement Model

First, the measurement model was assessed for convergent validity using the following indicators: factor loadings, composite reliability (CR), and average variance extracted (AVE). Table 2 shows that all item loadings surpass the recommended value of 0.6 [84].

Composite reliability values show to what degree the construct indicators explain the latent construct. The CR values exceed the recommended value of 0.7; therefore, the construct indicators are representative of the latent construct.

The average variance extracted reflects the total amount of variance in the indicators accounted for by the latent construct. The AVE values exceed the recommended value of 0.5; therefore, the latent constructs account for an important share of the overall variance in the indicators [73].

Table 3 presents the convergent validity and reliability indicators. For all the constructs, the CR and AVE values are appropriate.

Table 3. Validity and reliability indicators.

Construct	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Behavioral Factors (BF)	0.948	0.954	0.955	0.621
Knowledge	0.886	0.886	0.921	0.746
Individual innovativeness	0.914	0.916	0.946	0.854
Self-efficacy	0.844	0.844	0.906	0.763
Involvement	0.799	0.840	0.880	0.712
Innovative Characteristics (IC)	0.940	0.947	0.951	0.710
Relative advantage	0.952	0.953	0.965	0.874
Technological innovativeness	0.870	0.885	0.913	0.725
Digital Transformation Acceptance Attitude (DA)	0.941	0.941	0.962	0.894
Personal Acceptance (PA)	0.959	0.960	0.974	0.925
Social Acceptance (SA)	0.950	0.950	0.967	0.908

Consequently, the results on the measurement model indicate an adequate level of convergent reliability and validity.

4.2. Structural Model

The results concerning the relationship between latent variables involve the interpretation of the beta estimations, and corresponding t-values, via bootstrapping procedure.

The output of SEM-PLS shows that both BF and IC significantly influence DA ($\beta = 0.282$ and $\beta = 0.667$, respectively). Moreover, DA affects significantly both PA ($\beta = 0.929$) and SA ($\beta = 0.891$). Therefore, the research hypotheses are all supported (Table 4).

Table 4. Path coefficients and hypothesis validation.

Hypothesis	Relationship	Path Coefficient	T Statistics	*p*-Values	Decision	f^2
H1	Indiv. Innov. → BF	0.314	12.426	0.000	Supported	265.450
H1	Involv → BF	0.219	19.514	0.000	Supported	148.026
H1	Knowledge → BF	0.316	20.105	0.000	Supported	307.318
H1	Self. efic. → BF	0.258	14.311	0.000	Supported	167.346
H2	Rel adv → IC	0.594	29.983	0.000	Supported	136,947.164
H2	Tech Inov → IC	0.466	28.543	0.000	Supported	84,292.345
H3	**BF → DA**	0.282	2.879	0.004	Supported	0.154
H3	**IC → DA**	0.667	7.559	0.000	Supported	0.861
H4	**DA → PA**	0.929	42.066	0.000	Supported	6.272
H5	**DA → SA**	0.891	28.495	0.000	Supported	3.834

The structural model is assessed through quality indicators such as R^2 and the effect sizes (f^2). The R^2 values highlight a substantial model [85,86]. BF and IC explain together 83.2% of the variance in DA ($R^2 = 0.832$), while DA explains 86.2% of the variance in PA ($R^2 = 0.862$) and 79.3% of the variance in SA ($R^2 = 0.793$). The values of the effect sizes (f^2) show that the BF → DA relationship has a medium effect ($f^2 > 0.15$ for medium effects), while the other relationships have a large effect ($f^2 > 0.35$ for large effects) [85,86].

The results of the structural model are presented in the diagram shown in Figure 2.

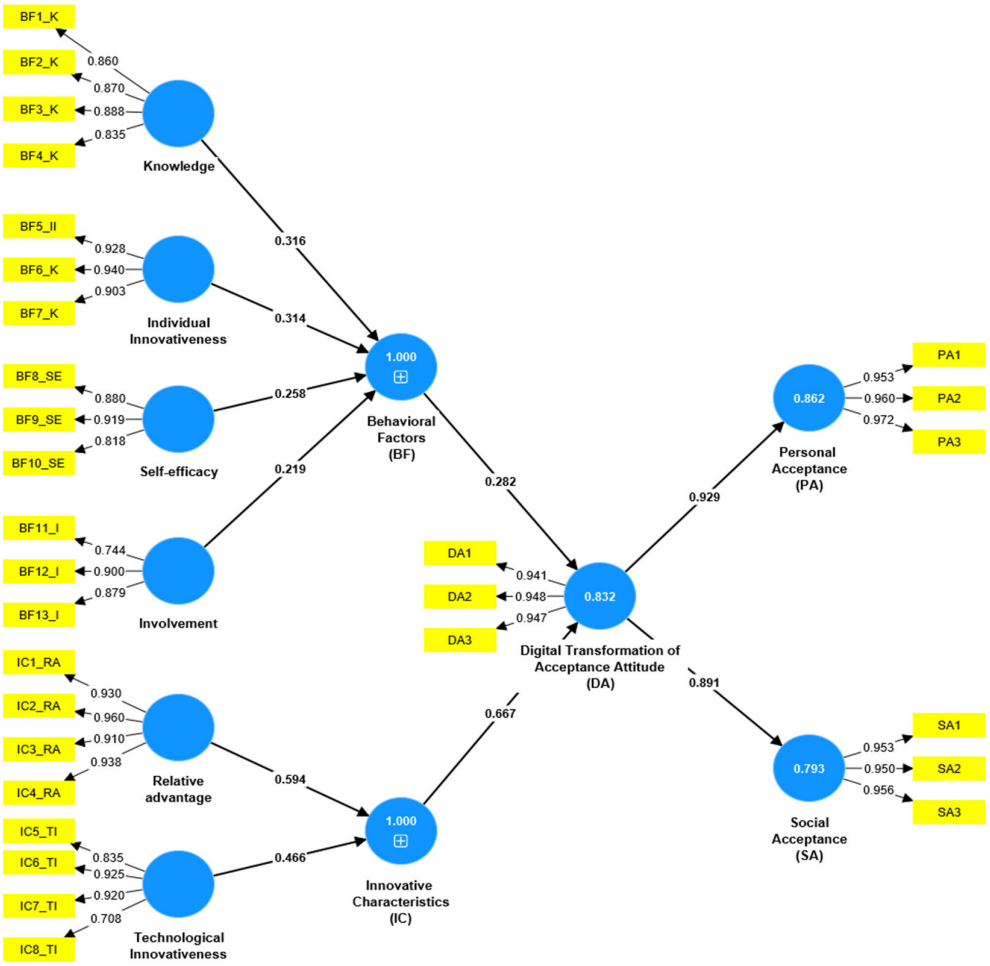

Figure 2. Structural model of digital transformation.

5. Discussions

The study aimed to explore the determinant factors affecting personal and social acceptance of DT and to verify empirically the effects of these determinants based on the data regarding Romanian practitioners collected by means of a questionnaire.

Whilst drawing on Kyunghwan et al.'s [16] study, our research adapted the model to the Romanian context, resulting a measurement model that indicates an adequate level of convergent reliability and validity. Our research has brought statistical evidence showing that the projected structural model for evaluating the impact of the determinants of digital transformation is significant for the Romanian context. It also indicated that for a successful DT, 'social change' is required by organizations and society along with the adoption of new technology, as also indicated in Kyunghwan et al.'s [16] paper.

The results indicate that all five hypotheses formulated in the study have been validated. All the indicators of the latent variables considered measure well the concepts and are representative of the nine latent constructs.

The path coefficients that explain the relationship between each of the determinants of individuals' behavioral factors are positive and statistically significant. Therefore, knowledge, individual innovativeness, self-efficacy, and involvement have a positive impact on the behavioral factors that affect DT. Thus, hypothesis H1 is validated.

Also, the path coefficients that explain the relationship between each of the determinants of individuals' innovative characteristics are positive and statistically significant. Consequently, technological innovativeness and relative advantage have a positive impact on the innovative characteristics that affect persons' acceptance attitude of DT. Hence, hypothesis H2 is validated.

The path coefficients that quantify the impact of behavioral factors and innovative characteristics are positive and significant. Also, BF and IC explain together 83.2% of the variance in the individuals' acceptance attitude of DT. Consequently, hypothesis H3 is validated.

These results are consistent with the Theory of Planned Behavior, which states that people's behavioral factors and innovative characteristics have a direct effect on their acceptance of technology.

The important levels of the variance of the latent variables explained by the considered factors highlight that the structural model is valid. Individuals' acceptance attitude of DT explains 86.2% of the variance in personal acceptance and 79.3% of the variance in social acceptance. The findings for the path coefficients show statistically significant effects of the acceptance attitude of DT both on PA and SA. Therefore, hypotheses H4 and H5 are both validated.

In addition, we have compared the level of the factors (behavioral factors and innovative characteristics), the acceptance attitude, and consequences of digital transformation (personal and social acceptance) among various groups of respondents defined according to socio-demographic characteristics.

According to age, we have identified a significant difference among the persons aged 56–64 and the other age groups in relation to the acceptance attitude of digital transformation (the probability corresponding to Fisher's test and post hoc tests is lower than the significance level of 10%). The respondents aged 56–64 have a significantly lower acceptance attitude of digital transformation compared to the respondents in the other age groups.

According to gender, we have noticed that the behavioral factors manifest with a higher intensity in the case of male respondents compared to female respondents (the probability corresponding to Student's test is smaller than the significance level of 5%).

According to the degree of digitalization, we have observed that the respondents with informative organizational level have lower scores for all the five constructs compared to the groups of respondents with other degrees of digitalization (the probability corresponding to Fisher's test and post hoc tests is lower than the significance level of 1%). Therefore, respondents with informative organizational level of digitalization show a smaller acceptance attitude of digital transformation and of personal and social acceptance than other groups of respondents.

With respect to area of residence, we have not identified any significant differences in the scores for the five constructs between urban and rural respondents.

Whilst it is very difficult to compare our results to other studies due to our framework based on personal and social acceptance derived from acceptance attitude of digital transformation (see Figure 2), we would like to establish connections with other studies on the acceptance of digital technologies.

Literature research revealed a very small number of studies with Romanian samples, all focused on companies' digital transformation, but without special focus on acceptance. Căpușneanu et al. [82] seeks to analyze the impact of distinct factors on the intention to use Industry 4.0 processes and solutions that would lead to perceived benefits of digital transformation and employed the same methodology (survey and analysis uses SmartPLS software) as in our study. Vuță et al. [87] focuses on entrepreneurs' perceptions regarding digital transformation through marketing during difficult times. Their results revealed that the limited resources available to SMEs acted as a barrier towards embracing marketing digital transformation for most of the companies from the sample, even if entrepreneurs have shown an awareness of the major impact that online presence may have on sales. By contrast, all five of our research hypotheses were validated and the results proved that behavioral factors and innovative characteristics have a direct effect on their acceptance of technology, which is consistent with the Theory of Planned Behavior.

There are also several studies [18–20,88–90] that analyzed the acceptance of digital technologies in specific samples: employees' acceptance [20,88], young people and citi-

zens [18,19], and consumer's acceptance [89,91]. Dakduk et al. [88] reported a series of divergent results contrary to other studies, where among other constructs, social influence did not significantly affect low-income consumers' intention to use digital technologies. One of the possible explanations is national culture [88]. Both Ecuador and Romania are countries that have very high scores on power distance and uncertainty avoidance [89]. The extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally represents the power distance, which means that Romanian people accept hierarchical order in which everybody has a place and which needs no further justification [89]. In an organization with strong hierarchy, subordinates are expected to do what they are told; the ideal boss is a benevolent autocrat and there exists inherent inequalities. Thus, in Romania, personal acceptance of technology may be influenced by some of the respondent's managers and supervisors. An unknown future implies the decision to try to control the future or just let it happen. This means that society deals with ambiguity of the future, representing uncertainty avoidance [89]. Romania as a country with high uncertainty avoidance has a culture where there exists an emotional need for rules (even if these never seems to work), where people have an inner urge to be busy and work hard, where innovation may be resisted, and where security is an important element of individual motivation [89]. Romania also has a moderate individualism score, being considered a collective society. Individualism is the degree of interdependence a society maintains among its members, and Romanians manifest a close long-term commitment to the member group that may include family, extended family, or extended relationships, to which they are loyal, overriding most other societal rules and regulations.

In our study, the results indicate that the path coefficients show statistically significant effects of the acceptance attitude of DT both on personal acceptance and social acceptance (SA), but the SA construct is based on different variables compared to social influence, reported in [88].

6. Conclusions

The paper seeks to investigate the determinant factors that affect the personal and social acceptance of DT, and to empirically verify those effects with a questionnaire data collected from a Romanian sample. The study conducted a theoretical literature review including acceptance, digital transformation, acceptance, Theory of Planned Behavior (TPB), Theory of Diffusion of Innovation (DOI), etc. A research model was developed based on previous research by Kyunghwan et al. [16] that used the same personal and social acceptance framework, to which we added two variables related to behavioral factors, specific for the Romanian context.

The research results contribute to both academic and practical perspectives. For the academic perspective, it adds knowledge on a theoretical model that examined the factors affecting personal and social acceptance of DT. It also applies the methodology used by Kyunghwan et al. [16] for a Romanian sample and provides similar results. The study supports TPB, in showing that the acceptance attitude of DT is positively associated with individuals' behavioral factors and innovative characteristics.

Our empirical results also showed that DT acceptance positively impacts both personal and social acceptance of DT in the Romanian context, distinguishing between individual and social acceptance, not previously explicitly distinguished, excepting [16]. From a practical perspective, this study offers a valuable perspective on the determinants of a successful DT, by suggesting the determinant factors for DT. Therefore, the research results could be applied by responsible experts in transferring an organization to innovative technology. The main outcomes boost the information on how technology is accepted and disseminated at individual and societal levels.

Our research provides a series of practical implications. On a country level, the degree of digital transformation may be assessed using DESI (Digital Economy and Society Index). As Romania is lagging behind on several indicators, the results may be useful for

other countries that have a low overall DESI score or lag behind on some of the indicators. Another practical implication is the use at the country level of the Hofstede Insights, in order to gain access to the country's position on the six cultural dimensions [89]. Such cultural and individual positioning would provide a better understanding of the mechanisms that would influence the acceptance attitude of digital transformation and subsequently personal and social acceptance.

Although this study provides a number of contributions, there are a few limitations that should be mentioned.

First, the study is based on a small sample (123 respondents) due to the focus of the paper on individuals rather than employees of a specific industrial sector or users of a specific digital technology, such as e-commerce.

The second limitation is due to the difficulties in applying probability sampling techniques, especially when trying to reach people from different regions of Romania. Consequently, a mixture of non-probabilistic convenience and snowball sampling methods was used for data collection.

Third, our survey may be subject to social desirability bias, that is, respondents may have overstated their digital transformation acceptance, either consciously or unconsciously.

Further research should consider other latent variables that have an impact on digital transformation and that may incorporate socially oriented concepts. Multigroup Analysis, which identifies differences among groups of respondents from various industries, should also be applied. Follow-up research may also be conducted with questionnaires using samples from various specific industries.

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Design Thinking Workshops: Uncovering Facilitator and Participant's Experiences

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Abstract The aim of this research is to identify and describe facilitator and participant's experiences in three Design Thinking workshops. As most of the business students lack specific skills that facilitate solving unstructured problems and foster creativity and innovations acquiring them would improve the process of identifying salient customer needs during the entrepreneurial endeavor.

The workshops are constructed on the five-phases of the Stanford's model: empathize, define, ideate, prototype, test. This exploratory research bases its data collection on self-observation, artifacts (built prototypes), participants stories, photos, filmed interviews and written feedback. Most of participants expressed personal excitement and praise towards their experience, a better understanding of individual and personalized customer needs and increased ability to overcome their limitations and fears of "not being creative", especially during the prototyping phase. The facilitator benefited from the structure and was able to increase his expertise gradually going through evermore complex and challenging workshops. Depicting and discussing such experiences provides encouragements and practical advice for those that seeks to introduce Design Thinking in their curricula.

1 Introduction

Some of the students enrolled in entrepreneurship programs lack hands-on experience required for an in depth understanding of customer problems. Whilst enthusiasts about their business idea, they focus on product or service features that they believe to be great based on their experience without designing appropriate solutions for the user and/or customer context. Therefore, business plans and subsequent products and services are bound to fail with negative consequences on both financial investment and loss of self-confidence.

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Both engineering and business students would benefit from apprehending the importance of customer needs and acquiring the appropriate skills that would enable them to identify and have an in-depth understanding of such salient features. These are part of the foundation required by those that want to promote creative thinking, solve unstructured problems and manage the innovation process for the first time (Glen et.al. 2015) and need a structured framework that would support the development of the design thinking curricula in business schools.

Designing and running a workshop provides opportunities for learning for both students and facilitator/ academic staff. The design thinking expertise of the facilitator has a significant impact on the value of the learning experienced by the participants (Mosely et.al, 2018).

The paper is an exploratory research upon the discovery processes of the experiences that occurs during the preparation and running a design thinking workshop in three different environments and cultural contexts for both facilitator and participants. It also aims to assess participant's satisfaction and feedback (Grammenos and Antona, 2018). Whilst such a workshop only provides a "taste" of the depth of knowledge that could be unveiled, it represents a valuable experience that familiarize them with essential knowledge and skills on the pathway of entrepreneurial learning through insight and prototyping based on the five phases of the Stanford's model (Henriksen et.al, 2017). We will refer at "experiences" of the facilitator and participants as the key stages of the process: preparation (for the facilitator), competing the workshop (as going through the five stages 1.Empathize, 2.Define, 3.Ideate, 4.Prototype, 5.Test) and feedback/ debrief (major take-away, key learning perceived, what were participants most surprised by, things to be improved and participants level of satisfaction).

The description of such experiences may help participants to engage in practical learning thaw will enhance self-confidence in his/ her abilities to be creative, innovative and solve unstructured problems. All these will also enable participants to identify and describe salient customer needs required to build better products and services. Academic staff that will enhance their design related competences to be used in developing new courses, provide expertise to entrepreneurs and engage in EU funded projects.

2 Literature Review

The workshop flows around five mindsets: Empathize, Define, Ideate, Prototype and Test (Hasso Plattner IDS, 2012a, pp. 1-5)

Empathize – It is a mode where the researcher seeks to understand people in their contexts where using a specific product or service that is subject to the design effort. Special attention moves from observing what the subject(s) do and say in order to understand what they think and feel facilitating the discovery process of their physical and emotional needs through engagement with the user. Whilst our minds protect us from information overload, the researcher needs to get off his/her shoes and put on the users to perceive what they see, think and feel, about their values and understand their stories. In order to empathize you must observe, engage, watch and listen.

Define – In this mode, the student (researcher) brings "clarity and focus to the design space" (p. 3) based on your deep understanding of the user in his/her context and crafts "a meaningful and actionable problem statement" (p. 3) or personal point of view - that is the researcher's understanding of the user's challenge. The goals and wishes identified during previous stage (expressed as verbs) are transformed into insights. The outcome is a reframed problem statement that researcher is striving to address. It can be used as both trigger and catalyst to unveil better answers that may be viable alternative solutions to customer's needs in the next phase.

Ideate – During this mode the researcher thinks "outside the box" aiming to generate radical design alternatives both in large quantities of ideas and in a wide

diversity among them. It is sometimes like mentally climbing up in a tree and looking down to you from above, not being restricted to the usual pathways of thought. Thus, you become aware of unexpected areas of exploration that goes beyond obvious and traditional solutions. The researcher must be aware and treat distinctly the generating and evaluating phases of the process, and only mixing them intentionally.

Prototype – Most of the time the researcher has difficulties to get ideas from the warmth of its head into the cold and rough reality of paper, post-it notes, story board, role-playing activity or anything else that could take a physical form – that is a prototype. Prototyping changes and evolves during the design process. From fail fast, often and cheaply (rough and rapid) when researcher learn quickly and investigate large number of alternatives to ever-increasing sophistication that enable users to interact with them that iterate previous stages through deeper empathy that shapes new successful solutions.

Test – In this mode the researcher refines both the prototypes and the solutions based on feedback thus continuing to learn about other users and obliging a reassessment of the problem definition and/or the personal point of view.

3 Methodology

The workshop bases on Design Resources materials (Hasso IDS, 2013), provided by Stanford dschool that make available several examples of projects. These workshops use the methodology for The Wallet Project (Hasso Plattner IDS, 2016) based on two key documents facilitating the learning experience: for the students the worksheet packet (Hasso Plattner IDS, 2012a) and the facilitator guide (Hasso Plattner IDS, 2012b). All materials required are licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License (Creative Commons, 2017).

Designed for working in pairs, the participants assume in turns the role of the "researcher" and "consumer" that have to design not an "average" wallet but the most specific and custom-made wallet for the assigned colleague. Thus, in about 120 to 150 minutes they each have to pass through all the five modes, record their information on the specially provided worksheets, fail fast and frequent in their initial designs before they manufacture the prototype and in the end record what worked, what could be improved, their questions and ideas. All three workshops were conducted by the author as facilitator, each workshop engaging 16 to 28 participants. The workshops are coded as *W1, W2* and *W3*:

- *W1 – 3rd year undergraduates from electrical/ mechanical background*. It took place in the autumn of 2017 in a university seminar classroom, all participants forming a group of about 20 Romanians (balanced in gender) and had as facilitator's assistant a female student from same year of study but other Faculty;
- *W2 – 1st year undergraduate students engaged in "retention" program aimed to reduce school dropout.* It took place in march 2018 also in a seminar classroom, all 16 participants were Romanians (mostly female) from the same faculty. The facilitator's assistant was a female student from the 3rd year of study but another Faculty;
- *W3 – part of an international conference in Namibia (Windhoek, Namibia Oct. 30th – Nov 2nd 2018) based on a heterogenous group of 28 participants.* It took place in a designated room able to accommodate all participants and included 21 Namibians (fifteen Namibian students, four members of staff from the University and two from the Namibian Business community), 2 South Africans (Senior University Management) and 5 Germans (three undergraduate students and two Senior University Management). Such a group provided significant cultural and economic differences. There was no assistant for the facilitator during the workshop.

For W1 and W2, the worksheet packet was translated in Romanian, W3 based on the English version. All forms were printed on A3 paper and distributed to participants with appropriate materials (pencils and rubbers, fabric in various sizes and colors, duct tape, cardboard, scissors, glue, staples, etc.) to enable de development of prototypes.

Whilst different, all workshops provide small cases of facilitator and participant's experiences. Gradually increasing in complexity for the facilitator, such experiences may provide insights that may help future participants to engage in practical learning and become more aware of their abilities to be creative, innovative, solve unstructured problems that will enhance their skills and aptitudes to identify salient customer needs and build better products and services.

Fig. 1 Typical exemplar of Romanian wallet as perceived by the facilitator (top) and wallets owned by students with Zippers as "safety feature" (bottom)

4 Findings

Preparation – Before running the workshops, the facilitator's perception of a typical wallet design belonged to exemplars exhibited in figure 1 (top) that could be folded 2 - 3 times, have special places for plastic (bank) cards, pocket for coins and sold in various colors. That happened because he did not pay attention to other people's wallets, maybe due to the places people expose and use them. Therefore, he missed what individuals do or say about their wallets and did not consider any relationship with what they think and feel about such intimate and private item for so many people.

Previous instances when running the workshop revealed the importance of "assistant" especially if they are dedicated students that know what has to be done and have a good knowledge of the whole workshop experience. They play multiple roles:

- Communication interface. Being students are "part of their group and culture" and therefore it is much easier to discuss with those that attend the workshop and encourage them to engage and experiment. From this special position what they say reach the "participants' ears" far easier compared with the instructor's directions.
- Support participants. Have appropriate knowledge and content of the workshop they are perceived knowledgeable and can be approached to ask for help/ assistance.
- Become a valuable "buffer" for the situations when there is an odd number of participants out of which one could not otherwise engage in the design thinking exercise. Such an "assistant" student deeply wished not only to be part of the "support" team but also engage in the workshop and have someone to empathize and engage with her for a complete design thinking experience with the wallet. She was lucky as some workshop participants arrived later due to their part-time job (W2).

Competing – going through the five stages – All three workshops began with a breaking-ice exercise where participants were asked to draw a picture of their colleague in 3 minutes. Without excellent drawing skills it is not possible to finish

to put on paper the representation that he or she has in their mind especially when taking into account their internal fight to oppose an unpleasant assignment. Therefore, the task was not aiming to test their drawing skills but to start in better knowing their colleague for which will design the wallet and even more important to engage in a mental exercise of being able to show unfinished work and begin to empathize.

W1 – Some of the needs and desires transformed into insights included:

- Global Positioning System (GPS), a small (also prestigious) logo, manufactured from a thick but soft and well finished leather, with no clip or magnet to close it, a small ballpoint in the middle, special places for Banking Cards and Identity Card
- Elegant, slim and intimate (hidden/ secret pocket for intimate goods hidden from first viewers)
- Eco wallet to keep identification documents and cards and also protect the environment (washable, recyclable materials but not cardboard)

One pair of male students identified each other's wishes of a modern wallet by incorporating Bluetooth and chipset issues to facilitate payments in clubs and spa/swimming pool parties.

Fig. 2 "Safety feature" introduced in the prototype using a zipper (left))

W2 – A similar experience was shared during the workshop by another participant which exhibited a very small (Passport size) and light wallet, especially when compared with other items used by lady students. It was made of a delicate fabric with special embroidery. She told that she also has a full-size wallet but avoid carrying it with her for most of the time, preferring the small one with the bare essentials when going to the university and usual city wondering. Some of the students came later which pushed the "assistant" to start over several times with newcomers. She was also eager to go through all the five phases of the workshop.

Participants seemed absorbed in the prototyping stage striving to make an almost perfect exemplar.

Fig. 3 Namibian experience "Safety"

W3 – Namibian participants Very challenging experience as the group included both European and Namibian students that have very different cultural experiences and expectations. It also included Namibian members of staff, scholars and people from the business community. High officials from top management of European and African Universities were also participants in the workshop. Whilst lack of an "assistant" was compensated by the exceptional quality of the materials and support of the conference organizers, the facilitator had to manage the "data collection" through pictures, short movies and feedback forms to be filled in and processed for the plenary presentation the day after the workshop. There were several solutions to the heterogeneity issue. These included pairing participants that were culturally compatible/ fit as background, social status, etc. and an extensive and detailed presentation of the five stages. Some Namibian participants where uncomfortable with the empathize and defining phases. Facilitator had to go to each table, observe and intervene through kind encouragements and final result benefits to help them continue and enjoy the process. Prototype building was by far the most exciting activity observed among the participants. Some stayed way over the end of the exercise, to finish what they proudly designed and build (see figure 3).

Feedback / debrief – Participants reported a wide array of experiences during the workshop.

W1 – One lady student revealed that she did not realized until than the complexity of feelings and requirements that her friend and cohort colleague hold about wallets. She believed that knew her friend quite well after sharing for three years the same campus room and working as a team during numerous assignments. She was amazed about the need for two wallets each designed to hold distinct sets of items to be used in distinct circumstances. Students were proud of their prototypes showed it to other colleagues and took them home.

W2 – At the end of the exercise, during debriefing the facilitator observed that students they did not complete the last page of the worksheet packed because they did not know what to write or were not in a mood to "criticize". Same thing occurred during W1 but did not realize its impact until W2.

One of things that surprised the author during informal discussions after the workshop ended was the special wallet design (see figure 1 bottom) chosen by nearly half of woman from the students participating. They all expressed the "zipper design" as a safety feature not to lose or drop any important item that they hold inside. Such care for safety and desire for privacy emerged in one of the prototypes through a real zipper found by a student among the fabrics and materials made available by the organizers (see figure 2 left). That discovery, integrated in his/her design, prompted complaints by other workshop participants that would have also liked to incorporate a zipper in their prototype wallet.

W3 – Being a heterogenous group lead to mixed experiences. Whilst some participants declared that "They learned nothing" (see Table 1), some Namibian students were really excited by the discovery of their own capabilities of doing something new, learning from customers and understanding the importance of their needs, and discovering own latent capabilities. Other participants were very proud of their sophisticated prototypes (see figure 3) and put real money in the wallet. They reported prided and personal excitement for their prototype and understanding of specific needs as human centered design (see Table 3). Participants further categorized the persons they designed the walled for as "business/ gentleman", "Neat/ organized" or "Environmentally oriented" (see Table 2) as well as acknowledging the impact of customer needs.

Conference organizers planned a follow up plenary presentation of the workshop results with personal experiences (some participants expressed their thoughts and experiences in front of the audience) supplemented by a facilitator's presentation that included photos of the participants in various stages and a summary of their feedback forms structured on major take-away, new things learned, what surprised them most during the workshop and things that would like to be done differently (see Table 4).

5 Discussions

Whilst participants and the context of attendance are very different, some of their experiences and/or "outcomes" of the workshop were very similar.

W1 – students formed a Homogenous group that showed benevolence and polite appreciation for the experience, with some of their wallets exhibiting highly sophisticated gadgets (i.e. Bluetooth and sim-cards). They valued the innovative approach in discovering customer needs. Unfortunately, at that time, the facilitator had not used specific means for systematic and reliable data collection outcomes and participant feedback on neither W1 nor W2 (Grammenos & Antona, 2018, p.20).

W2 – students also formed a homogenous group. Their interest in the walled was augmented by the wide range of fabrics available including leather and zippers. Many showed enthusiasm for their prototype and learning experience.

Students in W1 and W2 had a great time during the workshop because participation was voluntarily and only those interested showed up. Such self-filtering mechanism positively impact both the atmosphere and results of the design thinking workshop. Key outcomes included:

- That design is fun, involves a process that requires adhering to specific steps and provides great satisfaction if you put enough energy and commitment into the activity;
- Acknowledged the importance of showing unfinished work. Because it makes sense to discuss the "problem" when understanding their point of view in order to ideate. And when discussing their ideas, it is OK to be rejected as it opens up the unseen meaning (what the subject think and feel that is different from what he/she says of do about the wallet) that leads to insights;
- Everybody enjoyed the prototyping part. It was something tangible that they produced and were greatly proud of, part of the experience that that augmented self-esteem through discovery;
- Many complained that they did not have enough time to finalize the prototype. Some of the W1 and W2 students required that next time I run the workshop to provide them with thread, needles and thimbles as well as a wide variety of zippers so they would be able to produce a (near) fully featured and functional prototype;
- Due to personalization, the wallet prototypes were very different (see figure 2 and 3);
- It was overall a great experience as students discussed enthusiastically about it (facilitator was told stories from previous workshop by next year students). Some recommended discount stores for purchasing sample fabrics in wide variety of colors and textures to be used in subsequent workshops to build realistic prototypes of the wallet;

W3 – whilst the facilitator prepared primarily for an audience of Namibian students, had to adapt to accommodate and provide a great learning experience for all. In anticipation of a large heterogenous group he updated the presentation to include more details and examples for the five mindsets that participants immerse through. During the workshop he went around each pair, observing, empathizing and providing encouragements whenever it felt necessary. Without an assistant he had also to make photos and interview some students in the end. Data collection based on pictures, short films interviews and short survey/ feedback form. A summary of the experience is exhibited in appendix. It was a challenge for the facilitator due to both group heterogeneity and cultural differences.

The whole exercise opened up a pathway to explore the innovation process so important for entrepreneurship. By exploring additional information, books, research articles and experimental learning the facilitator started to improve the business plan workbook for his students by incorporating more real-life exercises where they are exposed to deep learning about the products or services that they focus in their business plan.

On postgraduate level aspiring or existing entrepreneurs will be provided with tools and techniques that will improve their survival and profitability. For example, one student that opened a very small firm providing "photo stand" to events such as weddings, birthday parties, etc. by empathizing discovered what his first customers thought and felt about the experience provided by his device. By understanding their "job to be done" he moved away from negotiating on price and provides answers to the customer's problems and fears. This new line of research enables us to engage in new EU funded opportunities such as ERASMUS+ or partnerships with private enterprises that seeks a better design based on customer focus which will improve their competitive position in the marketplace. Based on these experience new courses related to design thinking could be offered by the Faculty.

6 Conclusions

Students reported that they could discover resources that they did not know they have related to own creativity, overcome "resistance" to do something new and exhibit unfinished work to a stranger and be proud of the result they achieved by constructing something with their bare hands in such a short period of time. They also reported to understand salient customer needs from the peer they designed the wallet for.

The interest expressed informally from the senior academics from some African Universities attending the Conference was of particular importance for the facilitator as he could not explain such "spikes" of enthusiasm and positive praise. Asking for clarifications he was able to filter such feedback for politeness or just culturally specific behavior that may be uncommon to his experiences. They appreciated the transformation that occurred in students in such a short time (workshop duration).

Participants exhibited self-confidence in their abilities to be creative, innovative and solve unstructured problems and also joy and enthusiasm for their own build prototype produced with very little resources. Such experience is important as it could be built upon on to a larger scale and transform student's attitude and instill them the belief that they can do and build anything they can see in their minds. Such experiences may encourage academic staff to enhance their curricula to include design related features, tools and techniques and explore the wider design thinking scholarly research.

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Appendix

Table 1: What was your major take-away from the workshop?

Personal excitement
The excitement of doing something new in an attempt to understand the persons' needs
That to design something, you only need brain to think of anything simple and a product can be made within an hour, a great product that meets a client´s specifications.
Importance of customer Needs
Focus on the real need of the customer rather than your own idea of what the customer requires having to take the needs of a client into consideration
Learning the customers point of view to certain product they buy
Having to take the needs of a client into consideration
Personal learning
I learned to apply my basic understand at a user's needs when it comes to wallets. I can't draw but with guidance from my client I was able to draw something simple.
That I can be taught to understand my capabilities
There is communication and improvement to quality if you try again and again
I learned and improved my drawing skills, because as the story goes, "practice makes it perfect"
I can't draw but with guidance from the facilitator I was able to draw something simple
I learned nothing / to be more harmful

Table 2: What new things did you learn about the person you designed the wallet for?

Business/ gentleman
He´s a business man, who pay just with card and hate it to have something in the pocket
That he associates a wallet with a gentleman
That he only needs a wallet that caters for his phone and cards but not keep money
Neat / organized person
That he likes a cleaned-up wallet
Easy going and wants or uses the wallet to organize her documents. Wallet is important to carry money easily
Everyone needs a wallet or a place to keep the cards
Environmental orientated person
She is caring towards the environment whilst still focused on minimalism, quality and convenience
Importance of customer needs
I learned customer point of view is very important because they need products that can make them happy
The needs and the personal feeling help to improve the marketing
Impact of drawing on wallet design
I learned and improved my drawing skills, because as the story goes, "practice makes it perfect"
I can't draw but with guidance from the facilitator I was able to draw something simple

Table 3: What surprised you most during the workshop?

Pride and personal excitement
Designing for real needs can be both fun and focused. Focusing on the real needs of the consumer allow you to connect at an emotional level and establishes trust and credibility.
I thought I was just going to be observing but to my surprise I had to participate and enjoy the journey, which I did
What surprised me most is that I am able to do something like this
Human centered design
Everyone has different why´s to why do they need a specific wallet
He´s really not about the product but about the idea that they have about a product but by all means they only buy the product because they have no choice
Having to integrate the client on her specific needs
The stages of creating a product from drawing an almost perfect prototype. "let's
The production of a wallet

Table 4: If you would do it again, what would you do differently?

Personal related changes
Pay less attention to myself and focus more deeply on the customer. Connect emotionally and check and re-check for understanding.
I would apply my mind more to be open to learning new skills and new knowledge. Thank you
I will take time to understand more about the needs of the person

I understand the practice pretty late so the next time I could work more efficiently from the beginning I will change the design of my customer
Workshop related changes
I would spend more time prototyping Plan and do accurate measurements Make clothes Hold on the time schedule Give more information's in the beginning
NO changes
I wouldn't change anything otherwise would deprive me of the chance of learning new things

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