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**"Digitalization, sustainability and social innovation: an exploration"**

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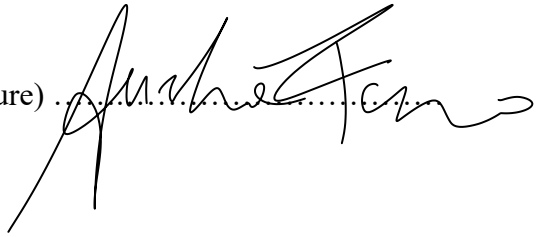

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# Abstract

The aim of this thesis is to explore the relationship between Industry 4.0 and sustainability.

Industry 4.0 is a new paradigm in manufacturing and production that relies heavily on automation, data-driven decision-making, and digital technologies. This transformation has the potential to revolutionize the way businesses operate, but it is important to understand its impact on sustainability. This thesis examines the core principles and features of Industry 4.0 and how it affects sustainable practices.

In addition to environmental concerns, this research also focuses on the social dimension of sustainability. It emphasizes that sustainability encompasses not only environmental conservation but also social well-being. It investigates how digitalization can promote social innovation, creating new solutions to social and environmental challenges that align with sustainable development goals. The research also discusses the role of Corporate Social Responsibility (CSR) in promoting sustainable practices, emphasizing how businesses can positively impact society and the environment.

The research then shifts its focus to a practical application of digital technology within the sustainability framework: product traceability. It explores how digitization can be used to track products at every stage of the supply chain, enhancing transparency and accountability, critical aspects of sustainable business practices.

To illustrate the theoretical concepts discussed throughout the thesis, it provides in-depth case studies on two well-known companies: Unilever and Patagonia. These case studies offer real-world examples of how digitalization has been effectively utilized to improve product traceability and enhance sustainability efforts. By examining these specific cases, the research demonstrates the practical implementation of sustainable practices in a corporate setting.

In conclusion, this comprehensive thesis offers an in-depth exploration of the intersection between Industry 4.0 and sustainability. It examines the impact on sustainability at both environmental and social levels, discusses the role of social innovation and CSR, and provides concrete examples of how digital tools can be applied for product traceability. The case studies of Unilever and Patagonia exemplify the successful integration of digital technology into sustainable business practices.

# 1. Industry 4.0

The inaugural chapter of this thesis aims to acquaint readers with the fundamental concepts and principles of Industry 4.0, a crucial driver of digital transformation. Technological advancements have caused significant changes in recent years, affecting various aspects of our lives, including work, social interactions, and economic dynamics. This chapter endeavors to provide a robust understanding of Industry 4.0, which distinguishes itself from historical industrial revolutions due to its rapid global impact.

The text delves into the ascent of digital assets, highlighting their value as commodities and the significance of comprehending individual preferences. It also explores the key principles of Industry 4.0, including interconnectedness, virtualization, decentralization, remote interaction, and real-time processing. These principles offer a roadmap for organizations seeking to capitalize on the potential of Industry 4.0, resulting in increased profitability and productivity.

Furthermore, the chapter investigates the enabling technologies that fuel Industry 4.0, such as Big Data and Analytics, Autonomous Robots, Simulation, Integration of Information Systems, the Industrial Internet of Things, Additive Manufacturing, Augmented Reality, and Cloud Computing. These technologies transform business operations, optimize resource utilization, enable mass customization, and provide real-time insights into consumer preferences.

However, Industry 4.0 also presents challenges, particularly in the realm of cybersecurity. As systems become increasingly interconnected, there is a growing need to safeguard sensitive data and protect against cyber threats.

In conclusion, this chapter presents a comprehensive introduction to Industry 4.0, laying a solid foundation for comprehending the transformative potential of digital innovation and the technologies and principles that drive this Fourth Industrial Revolution, reshaping the global business landscape. The inaugural chapter of this thesis aims to acquaint readers with the fundamental concepts and principles of Industry 4.0, a crucial driver of digital transformation. Technological advancements have caused significant changes in recent years, affecting various aspects of our lives, including work, social interactions, and economic dynamics. This chapter endeavors to provide a robust understanding of Industry 4.0, which distinguishes itself from historical industrial revolutions due to its rapid global impact.

## 1.1 Introduction to digital transformation

Technological advancements and digital transformations have had a significant and profound impact on the world in recent years. These changes have brought about alterations in human behavior, interpersonal relationships, and most importantly, how work is carried out. This transformation has resulted in far-reaching consequences across economic, social, and cultural landscapes. However, it is still challenging to gauge the precise long-term impact of these changes.

The current era of rapid change can be compared to the historical phases known as industrial revolutions. This period is now referred to as the Fourth Industrial Revolution and, like its predecessors, is mainly driven by technological innovations integrated into production processes. Human adaptability is essential in harnessing these innovations to enhance production activities.

The Fourth Industrial Revolution (*Figure 1*) builds upon the successes of its precursors, but it stands out due to its rapid establishment and broader geographical reach. These aspects are partly due to a shifting social context characterized by continuous global competitive challenges driven by globalization.

A notable development in this era is the rise of digital assets. Traditional physical products are no longer the primary focus; data, knowledge, and behaviors have become commodities of immense value. Digital users are actively engaged in the consumption and exchange of these digital assets. In this context, a profound understanding of individuals, encompassing their thought processes, actions, and movements, serves as a guiding principle for digital marketing and behavior modification strategies. Thus, the knowledge society relies on data and delves into the intricacies of individual preferences.

The term "Industry 4.0" originated in Germany in 2011 during the Hannover Messe, where the "Zukunftsprojekt Industrie 4.0"[1] project was introduced. The primary objective of this project was to comprehensively revamp the German manufacturing sector, positioning Germany as a global leader in manufacturing. While the term aligns with the fourth industrial revolution concept, scholars often distinguish it from the third revolution. This distinction is because while the third revolution,

[1] Anderl, R. (2014). Industrie 4.0 – *Advanced Engineering of Smart Products and Smart Production* - Technische Universität Darmstadt, Chair for Computer Integrated Design, Fachgebiet Datenverarbeitung in der Konstruktion (DiK), Faculty Mechanical Engineering Microsoft Word - Industrie 4.0 - Smart Product Engineering 14_Aug_2014_Version 1_0.doc (researchgate.net)

commonly known as the digital revolution, can be seen as an evolutionary step, Industry 4.0 represents a more profound transformation. Instead of merely automating machines and processes, Industry 4.0 aims to digitize all aspects of human surroundings. This concept includes machinery in factories and everyday objects, merging the physical and virtual realms and shaping an entirely digital ecosystem.

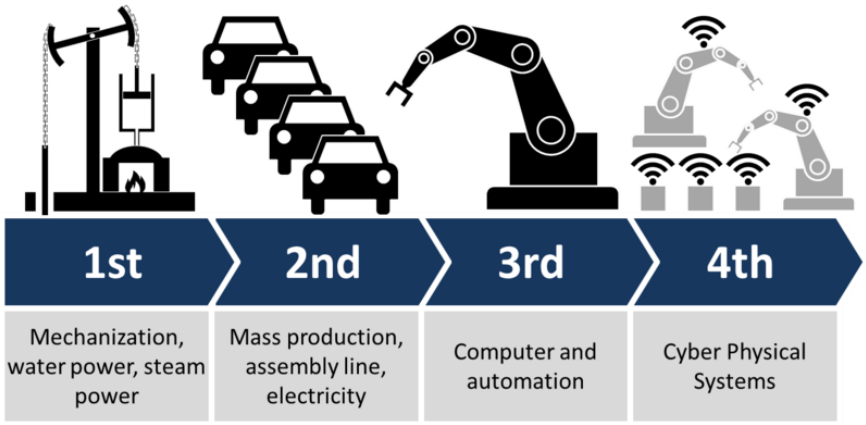


*Figure 1 - The 4 Industrial Revolutions (by Christoph Roser at AllAboutLean.com)*

The implementation of technological innovations has led to the creation of boundaryless intelligence environments. These environments allow for the more efficient harnessing of data and information, transcending traditional constraints by reducing transmission time and cost. This is made possible by the deeper integration and connection between individuals, machinery, and devices. This transformation not only affects the production phase but also the organizational and strategic aspects, providing companies with the ability to become more effective, efficient, and adaptable to different market configurations. By stepping out of their comfort zone and adapting to the market's new needs, companies can develop new business models and thrive in the changing landscape.

## 1.2 Industry 4.0 principles

Digital transformation is based on a set of fundamental principles that serve as a blueprint for businesses and organizations operating under Industry 4.0. These principles are essential drivers that can significantly impact the organization when applied effectively in business operations. They can help businesses achieve higher profitability compared to traditional counterparts-

The principles of digital transformation include:

- **Interconnectedness**

The concept of interconnectedness refers to the ability of the various assets and resources within a supply chain (such as machinery, personnel, and processes) to interact and share information with both internal and external systems through a data exchange network. This level of collaboration and ongoing connection transcends the limitations of individualism and the lack of collaboration, leading to improved system functionality and enabling real-time problem-solving across all affected areas.

- **Virtualization:**

  Virtualization involves creating a virtual replica of the company achieved through the deployment of sensors onto physical process components. These sensors facilitate the creation of a "digital twin" of the enterprise, which, when combined with physical assets, gives rise to the cyber-physical system that serves as the cornerstone of the Industry 4.0 concept. Technological advancements have bridged the divide between the physical and virtual realms, thereby enabling the exploration of augmented reality. This permits a deeper understanding of products and processes, enabling testing of alterations to reality without necessitating direct interaction with physical products. This is achieved through simulations that faithfully replicate reality. Virtualization equips organizations to navigate rapid shifts in market conditions with agility.

- **Decentralization:**

  Decentralization alludes to the capability of intelligent systems, empowered by technology, to autonomously make decisions and take action without human intervention. These systems can recognize anomalies in processes and independently adjust their behavior. This is exemplified by mechanisms featuring artificial intelligence, such as robots, which, through decentralization, can perceive their surroundings and respond accordingly without external direction.

- **Remote Interaction:**

  This function empowers stakeholders to engage with the system remotely, whether it's for monitoring processes or intervention.

- **Real-time Processing**:

  Achieving enhanced productivity and effectiveness, as well as swiftly resolving issues, necessitates the availability of functions that facilitate the rapid acquisition of information.

This information is then swiftly transformed into valuable insights, enabling immediate action. Consequently, every facet of the production process can promptly respond to demands. This fosters seamless integration between production and maintenance, involving autonomous operators capable of conducting preventive maintenance activities, thereby minimizing breakdowns and machine downtime.

The elements described above represent pivotal aspects for a comprehensive understanding of the concept of Industry 4.0. It is imperative not to overlook that the essence of Innovation 4.0 presupposes that, through heightened interconnectivity among individuals, machinery, and devices, all technological innovations must be unified to seamlessly integrate the entire production chain. Underestimating this critical aspect would risk simplifying digital transformation to the mere adoption of new technologies.

Moreover, such a transformation at the production level necessitates an evolution in the overarching strategic vision of the organization. This evolution encompasses a holistic reconfiguration, not only of the workforce, which must acquire the necessary skills for this purpose but also of the organization's readiness to adapt to an increasingly dynamic landscape. This adaptability should be geared towards a medium- to long-term vision.

This revolution encompasses all facets of business operations, sparing none. The methods of conducting business cannot undergo immediate or facile transformation. Therefore, the presence of an individual capable of navigating this process of change, and surmounting numerous obstacles, becomes highly relevant. Thus, it is of paramount importance that CEOs maintain a clear and consistent vision, both in technological and strategic terms, as well as in terms of organizational culture[2]. This steadfast leadership is vital in guiding the organization through the intricacies of Industry 4.0 and ensuring its long-term success.

The manager tasked with overseeing digital transformation bears the responsibility of instigating a shift in the mindset of every member of the organization. Their role extends to cultivating an environment wherein the experiences accumulated on a day-to-day basis take center stage in every process. Simultaneously, they must ensure that workflows remain as dynamic and flexible as possible, all while steadfastly preserving the core mission of the company.

[2] The European House-Ambrosetti, I ceo italiani di fronte alla rivoluzione 4.0, Marzo 201

## 1.3 Enabling Technologies

The fusion of digital and Internet technologies with the physical world, resulting in the emergence of intelligent and fully interconnected realities, constitutes the driving force behind the fourth industrial revolution, fundamentally transforming the entire industry.

Innovative technologies, often referred to as technology trends, which have evolved over the past decade, play a pivotal role in materializing a digital realm wherein every entity, animate or inanimate, becomes intricately interconnected. These technologies serve as the foundational pillars upon which the fourth revolution is built, offering insights into the essence and significance of Industry 4.0.

Through sustained research efforts, we aim to enhance the operational efficiency and dynamism of the supply chain by harnessing these enabling technologies to devise technological innovations and refinements that form the bedrock of employment growth and development.

The European Commission defines enabling technologies as "highly knowledge-intensive and associated with high R&D intensity, rapid innovation cycles, substantial investment expenditures, and highly skilled jobs."[3] Furthermore, they play a fundamental role within the entire system by enhancing the quality of the production chain and driving innovation not only in processes but also in the final products and services.

The trajectory towards digitizing the industrial landscape has long been established within the business realm. However, it's important to note that "*currently their application is still limited and sporadic.*"[4] Nevertheless, it is imperative to refrain from interpreting this solely in terms of productivity and efficiency gains in production processes. Instead, it is essential to focus on the myriad of benefits that these technologies bring to the forefront.

[3] Andreoli, V., Borgato, R., & Cristiani, P. (2018). *L'ABC del 4.0*.

[4] Agenzia delle entrate, CIRCOLARE N.4 del 30/03/2017

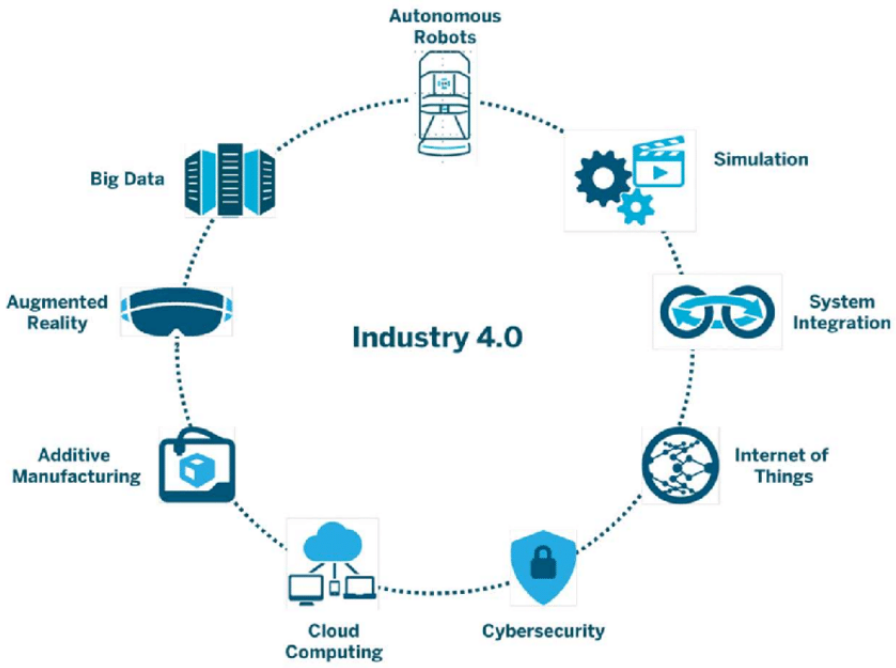


*Figure 2 - Industry 4.0 and enabling technologies (Source: www.aethon.com)*

By seamlessly integrating these technologies (*Figure 2)* within the enterprise and fostering interconnectivity, a myriad of benefits can be realized. These advantages encompass optimizing resource utilization, facilitating the emergence of novel business models, enhancing product lifecycle management, reducing time-to-market, enabling mass customization, and the ability to glean real-time insights into consumer preferences.

While many companies turn to digital solutions solely to bolster efficiency and reduce operational costs, the true market leaders will be those adepts at realizing the full potential of integrating products and services. Conversely, the drawbacks faced by companies that fail to embrace enabling technologies are evident. Remaining tethered to a system reliant solely on internal resources places them at a disadvantage. This can manifest as products lacking innovation, poor adaptability to customer demands, reduced production capacity, and a missed opportunity to leverage new channels for order management, such as on-demand ordering.

Furthermore, a lack of effective communication with customers hampers the ability to customize and tailor the final product to individual needs due to a failure to collect pertinent data. Hence, the role of actors within the digital ecosystem is and will continue to be, pivotal for companies seeking to innovate and align with these technologies to gather valuable feedback and tailor products to consumer requirements.

### 1.3.1 Big Data and Analytics

What sets apart the Fourth Revolution is its foundation on data and information of all types, collected from diverse sources and at any given time. The acquisition and utilization of these data represent the primary challenges for analysts and managers who are tasked with supporting not only long-term decisions but also those of an immediate nature, thanks to their continuous availability.

The term "Big Data" is aptly coined due to the vast quantity and diversity of data available. These data originate not only from traditional sources managed by a company's internal databases but also from emerging sources. This amalgamation creates a pivotal asset capable of enhancing various facets of business operations, ranging from optimizing the value chain to improving services offered to end consumers.

This necessitates a judicious and innovative selection of technologies capable of facilitating data collection and management. The solutions currently in use will be harnessed and fine-tuned for Industry 4.0 to enable the collection and analysis of an immense volume of data from diverse resources. Consequently, a standardized procedure for real-time decision-making processes will be established.

The provisioning of adept technologies and skilled personnel for managing Big Data will facilitate the development of a model to adapt production and design, with process optimization standing as the primary objective.

### 1.3.2 Autonomous Robots

While many companies across various industries have already integrated robots into their operations — a commendable and often indispensable investment, particularly in domains where operational speed and precision are paramount—the utilization of robotics in the production chain is gaining significant attention.

In recent years, substantial innovations in robotics have been witnessed, encompassing enhancements in autonomy, flexibility, and cooperativeness. These developments are likely to foster increased collaboration between humans and robots. Such integration is expected to yield two main outcomes:

a reduction in the cost of accessing this new generation of robots and an augmentation of their capabilities compared to their current counterparts employed in manufacturing.

### 1.3.3 Simulation

Simulation in Industry 4.0 entails the utilization of advanced 3D virtual tools capable of creating a virtual reality that closely mimics the physical world, be it a product, a material, or a production process. This digital representation is referred to as a "digital twin" as it comprehensively mirrors the physical product in all its functional and design attributes.

The primary objective is to test the product and optimize its manufacturing process, ensuring that any necessary adjustments are made prior to the physical production and market launch. This proactive approach significantly mitigates the risk of errors and failures, leading to improved product quality and a reduction in time to market. The absence of a need for extensive redesigns expedites the product's time to market release.

Presently, 3D product simulations find application predominantly in product design. However, in the future, they may see expanded use in plant operations as well. These simulations will harness real-time data to replicate the physical world in a virtual model, encompassing machinery, products, and personnel. This allows operators to test and optimize machine settings for the subsequent product within the virtual realm before executing the physical changeover, thereby reducing setup time and elevating product quality.

### 1.3.4 Horizontal and Vertical Integration of Information Systems

One of the primary objectives of the fourth industrial revolution is to establish a tightly interconnected relationship among every phase of the production cycle, from research and development to post-sales customer support, with the aim of designing vertically integrated systems.

However, this integration also extends to horizontal systems, referring to the distribution chain (supply chain). It involves activities such as synchronization and coordination with other entities, such as customers and suppliers, to enhance efficiency and collaboration.

The integration of data and systems along the value chain transforms all company departments and functions into components of a unified integrated system.

Nevertheless, to achieve complete integration for the success of businesses, it is essential to align information technologies with operational technologies, even though the latter may appear distinct from the former. The distinction lies in the fact that information technologies aim to unify different units within the enterprise for optimal efficiency and coordination, whereas operational technologies are employed by the workforce and pertain to manufacturing processes. Only through the convergence of these technologies can the desired efficiency and cost reduction be attained, leading to enhanced competitiveness and positive outcomes compared to industry peers[5].

Functions within the company, from the corporate level to the shop floor, are not yet fully integrated, and engineering itself, spanning products, facilities, and automation, lacks complete integration. However, with Industry 4.0, companies, departments, functions, and capabilities can become much more cohesive, evolving universal and intercompany data integration networks.

### 1.3.5 The Industrial Internet of Things

The Industrial Internet of Things (IoT) can be considered one of the primary drivers of Industry 4.0. It signifies the utilization of the Internet to connect various devices and create a fully integrated system of standardized technologies. However, this connectivity extends beyond devices to encompass individuals and machines, allowing for continuous monitoring and control of machine operation and product transportation.

In today's industrial landscape, the Internet of Things plays a central role due to the increasing complexity of industrial systems. If tethered to traditional systems, these industrial systems cannot achieve the desired goals of enhanced efficiency and coordination. They also lack the necessary tools to monitor and support machine operations—a role fulfilled by new digital devices. These devices facilitate the correlation between a traditional physical system, which need not be replaced, and a new virtual world to ensure coordination among various devices.

The Internet of Things brings about several economic advantages as it enhances operational efficiency, subsequently improving production. This results in cost and time savings, with more efficient and faster coordination, where activity analysis and decision-making processes are

[5] Gilchrist A., Industry 4.0: The industrial Internet of things, Apress, 2016

decentralized. IoT introduces a more efficient mode of operation that integrates all previously discussed technologies.

The interconnection employed by the Internet of Things among various technologies and devices enables timely and rapid solutions when faced with changes within operational processes.

Furthermore, it should be noted that the technologies encompassed by the Internet of Things not only reduce time and costs but also offer new production and quality advantages. This is due to the increased availability of these technologies to businesses, driven by reduced costs and the ease with which expert engineers can develop them.

In the industrial field, IoT has had a significant impact on the value creation of companies. It enables businesses to influence the creation or modification of entire business models through the utilization of the previously analyzed technologies. This transformation enhances the fundamental functions of a product by adding digital IT services, thereby revolutionizing the product and the entire business approach of the company.

### 1.3.6 Additive Manufacturing

Additive manufacturing, also known as 3D printing, encompasses processes that, starting from a digital project file, produce three-dimensional objects through the successive addition of material layers.

While 3D printing has been used in previous years, its technological development and improvement have led to significant reductions in material waste, inventory levels, production costs, and time-to-market, enabling the production of various types of products. This innovative technology allows for the modification of a physical object from its digital representation on a computer without the need to reconfigure machines and production lines.

This technology empowers businesses to achieve mass customization, effortlessly creating pieces of diverse and complex shapes. What distinguishes this innovation, characteristic of the fourth industrial revolution, is the ability to customize products according to customer preferences, setting it apart from the mass production of the second industrial revolution.

However, product customization does pose some challenges, particularly related to the high costs incurred by the company for accommodating specific customer requirements. For this reason, this type of manufacturing is not considered the most suitable for supporting mass production.

Nevertheless, thanks to the flexibility of 3D printing, it is possible to directly produce the complete product without the need to assemble individual components, positively impacting costs and, most importantly, time. This approach allows for the production of a greater number of personalized products, addressing the issue of scalability for mass production. Pieces created with 3D devices offer higher quality and precision compared to mass-produced or handcrafted items.

Before adopting a 3D printer within the company, a preliminary phase is required. This phase involves a meticulous reengineering of objects by competent authorities to determine which objects can indeed be produced using additive manufacturing. It is accompanied by a comprehensive economic analysis. Given the high cost and the often-challenging nature of this technology, it may be more cost-effective to seek assistance from companies whose core business is third-party production.

### 1.3.7 Augmented Reality

Augmented reality (AR) enriches human sensory perception by delivering information that is manipulated and conveyed in the form of imperceptible electrical output.

The ongoing research into AR, integrated with the ongoing digital transformation, has yielded promising results for the industrial sector, making it one of the key drivers of Industry 4.0.

Technically, augmented reality utilizes a 3D CAD diagram and employs sensors to transmit input to various devices containing the CAD, such as smartphones, tablets, or through cloud-based systems in the case of goggles and visors. This technology creates an image capable of providing a wholly different perception of reality by adding multimedia elements.

AR can be applied across a wide range of sectors and activities. For instance, in the construction industry, digital devices capable of augmenting reality enable the visualization of a building's image even before its construction is completed, thereby minimizing errors. AR can also be applied in emergency situations, where real-time sensor data is transmitted to the displays or visors of firefighters, enabling them to monitor a fire and assess the vital conditions of individuals. The healthcare sector has significantly leveraged the combination of the virtual and real worlds, offering

enhanced case study opportunities and more effective problem-solving. Another application of this technology is virtual training, which improves the training of technicians by integrating theoretical study with immediate practical application. This involves the observation of, for example, machinery components to understand their functionality and how to act correctly in a real-world scenario.

While this technology is not yet widely adopted in the corporate world, it is expected to be utilized in various sectors in the coming years to enhance and support a wide range of production activities.

### 1.3.8 Cloud Computing

Following the analysis of the technologies discussed in the previous sections, the emergence of cloud computing as a centralized data storage approach within companies becomes evident.

As internet connectivity evolved and the ability to collect vast amounts of data rapidly emerged, a revolution in data storage became necessary. While data was initially stored on local physical servers, the need for real-time access to information from any location led to the development of a new system called cloud computing. This system encompasses a range of on-demand services provided by a supplier to a customer over the internet.

Cloud computing is characterized by the outsourcing of crucial computing operations to third-party providers, who offer their services based on the users' needs, under conditions specified by the users themselves. It is a highly flexible technology, allowing users to modify contractual conditions with the provider in real-time to meet their specific requirements.

The primary concern associated with adopting a cloud infrastructure is data security. This includes the risk of losing control over data and resources and the potential for a data oligopoly, where data is no longer stored on individual hard disks but is increasingly centralized elsewhere. It is the responsibility of individual users to use cloud services judiciously by assessing the risks and benefits of the services offered, verifying the reliability of the provider and the service, and implementing the necessary precautions to protect the confidentiality of the data they choose to store in the cloud.

In today's business landscape, enterprise operations involve numerous activities that require vast amounts of information and computational capabilities. Possessing such capacity often requires tying up financial resources, leading to potential inefficiencies in information sharing and reduced productivity due to suboptimal utilization of production resources.

Cloud computing presents a potential solution to these problems. Key roles within the cloud computing system include:

- The service provider: Offers one or more services for data storage and transmission over the network. Providers usually operate on a pay-per-use model, enabling customers to pay only for the actual usage of the system.
- The administrator: Acts on behalf of the customer and is responsible for seamlessly integrating the service in use with existing company systems. This role coordinates with internal personnel.
- The customer: The end-user who utilizes services provided by the provider with the assistance of the administrator.

The Cloud computing structure[6] is divided into two distinct segments, Front-End and Back-End, interconnected through the internet.

The front-end architecture interfaces with the client and comprises the key elements that influence the user's experience. Included in the front-end architecture is the software, which generally takes the form of a client-side browser or application, enabling the use of the application by the client. The user interface allows interaction between the cloud and the user, often being incorporated within the software itself. Finally, the hardware refers to the client's devices used to access the service. This hardware does not require high computing power as most heavy processing operations are performed by the cloud.

The back-end architecture consists of all elements that ensure the proper and uninterrupted provision of the service. The application, the first component of the back-end, refers to the interface offered to the user, managing any critical aspects and coordinating client requests to the back-end. The service represents what is offered to the customer and may encompass various tasks, including storage, the availability of a development environment for web applications and services, and data management. Among the most commonly used services is storage, used to collect all the data necessary for the correct functioning of the cloud software, with various architectural logics depending on the type of services offered. The management software is responsible for allocating resources based on the activities required. The primary drawback of cloud systems is the relatively low availability of

[6] A. V. K, What is cloud computing architecture: Front-end back-end explained, 2019;

resources compared to physical servers. For this reason, inefficient management could lead to issues in service delivery.

Companies are already using cloud-based software for various business and analytical applications. However, with Industry 4.0, a greater number of production-related activities will require increased data sharing across sites and corporate boundaries. Simultaneously, cloud technology performance will improve, achieving response times of just a few milliseconds. Consequently, machine data and functionalities will be increasingly distributed in the cloud, enabling more data-based services for production systems.

### 1.3.9 Cybersecurity

The increased connectivity between devices also brings about a greater need to protect production systems and computer networks from potential threats, consequently raising the risk of cyberattacks for Industry 4.0. To address this possibility, there is a need to adopt reliable communication channels and sophisticated access systems.

Cybersecurity encompasses all technologies that help protect the information system from attacks that can lead to the loss or compromise of sensitive data. The frequency of such attacks is continually on the rise, as attackers prefer targeting attacks that can compromise the privacy and security of information that not only pertains to businesses but also holds national significance. Professional hackers can easily enter networks and manipulate them using any device, creating disorder and financial losses for companies in terms of customers and profits.

According to Cisco's 2020 Annual Cybersecurity Report, business executives continue to consider security a top priority, along with other indicators such as role definition and clear metrics, as well as evaluating cyber risk.
The study shows greater difficulty in managing and securing multi-vendor environments, cloud infrastructures, and mobile devices. Furthermore, according to 86% of security professionals, the use of cloud security solutions has increased visibility in their networks[7].

[7] Martino, S. (2022). A 20/20 vision for cybersecurity. Cisco Blogs. https://blogs.cisco.com/security/a-20-20-vision-for-cybersecurity

This increasingly complex and problematic system seriously jeopardizes cybersecurity, as digital transformation also leads to changes in infrastructure. The problems extend to security professionals who must continually face new challenges, such as the need to counter increasingly sophisticated hacker threats.

However, digital transformation also represents an opportunity for security professionals and the IT sector because they can leverage its use to become more competitive.

To counter this complexity, companies are increasingly investing in automation technologies to assist security professionals in making response times faster and more reactive when countering attacks. Leveraging the cloud enhances visibility within their systems and allows for more effective coordination among the groups responsible for various security, networking, and communication systems.

## 2. Sustainability

In Chapter 2, the idea of sustainability is explored in detail, with a focus on its historical and etymological origins. Sustainability is portrayed as a complex and multifaceted term with nuanced meanings that encompass a wide range of environmental, social, economic, and cultural aspects.

The chapter begins by revisiting the definition of "sustainable development" put forward by the Brundtland Commission in 1987. This definition highlights the importance of finding a delicate balance between ecology, equity, and economy, emphasizing the need to meet present needs without jeopardizing the ability of future generations to meet their own[8].

The discussion further moves on to the 2015 United Nations Global Agenda for Sustainable Development, which comprises 17 Sustainable Development Goals (SDGs). These SDGs are designed to address global challenges and are organized into five distinct categories: People, Prosperity, Peace, Partnership, and Planet. They emphasize the need for adaptation to diverse local contexts and represent a shift from global to local focus.

The chapter also introduces the "Russian doll model," which emphasizes the hierarchical relationship between ecological, social, and economic dimensions. This model emphasizes that environmental

[8] Chenavaz, Régis, et al. "Corporate Social Responsibility and Entrepreneurial Ventures: A Conceptual Framework and Research Agenda." Sustainability, vol. 15, no. 11, 2023, p. 8849.

sustainability is fundamental to society and the economy. The concept of "Strong Sustainability" is introduced, which advocates for the interdependence of all three dimensions and the harmonious balance required to ensure sustainable development. The narrative underscores the moral obligation to protect the planet's ecological systems while fulfilling the basic needs of current and future generations.

In summary, the chapter presents sustainability as a dynamic and evolving concept that reflects changing societal values. It emphasizes the need for an all-encompassing approach that aligns environmental and social concerns with economic prosperity. The multifaceted nature of sustainability necessitates a holistic perspective that acknowledges the interconnectedness of ecological, social, and economic aspects.

## 2.1 Sustainability: history and etymology

Understanding, defining, and explaining sustainability has always been a complex task. When examining the sources in the literature, it becomes apparent that the term is often laden with undefined and sometimes overused meanings. While the term “sustainability” immediately evokes environmental themes and the potential for an ecosystem to endure over time without significant change, it also encompasses many aspects related to social, economic, ecological, and cultural matters.

In 1987, through the Brundtland Commission’s report, the first definition of “sustainable development” was established, now synonymous with the term “sustainability.” It stated, “*Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*”[9] This initial definition presupposes a balance of three essential dimensions: ecology, equity, and economy. It emphasizes the concept of “carrying capacity,” which is the maximum population density beyond which ecosystems are no longer capable of reproduction. This underscores the necessity of maintaining a balance between the use of available resources and the needs of current generations without hindering the ability to use them in the future.

Subsequently, the term was expanded, and a more comprehensive definition was adopted, incorporating economic development and social progress. This expansion occurred through the Rio

[9] Development, W. C. O. E. A. (1987). *Our common future*. Oxford ; New York : Oxford University Press.

Declaration, which lists 27 principles that lay the foundations for this new conception of sustainability.

This definition is quite general and links the concept of sustainability to a fundamental principle: intergenerational equity. The objective of this type of development is not only the growth and satisfaction of present needs but also the condition that these needs are acquired without harming the capacity of future generations to meet their own needs. Adopting a sustainable approach can be seen as a triumph of collectivism and solidarity over individualism and selfishness. It represents a forward-looking orientation aimed at promoting growth that ensures future generations enjoy a quality of life no less than that of previous generations.

It is essential to highlight, particularly in the context of increasing environmental challenges, that when we speak of future generations, we refer to the immediate future. Failure to act promptly and decisively risks irreversibly compromising their future.

### 2.1.1 Global Agenda for Sustainable Development

Attention to sustainability is gradually growing and attracting the interest of most countries through global initiatives aimed at promoting its dissemination. In this regard, on September 25, 2015, the United Nations' 193 member countries approved the Global Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs)[10], comprising 169 targets and 240 indicators to be achieved by 2030.

The Agenda 2030 is the action plan UN member states subscribed to in September 2015. It encompasses the 17 Sustainable Development Goals (SDGs) (*Figure 3*) and their respective 169 targets or sub-goals. The sustainable development envisioned by Agenda 2030 is described with five adjectives: inclusive, universal, integrated, locally focused, and technology-driven. This suggests a shift from the global to the local, reflecting the need to adapt the internationally defined SDGs to national and, subsequently, individual urban contexts due to the diversity and multiplicity of local realities.

[10] THE 17 GOALS | Sustainable Development. (n.d.). https://sdgs.un.org/goals


*Figure 3 - The 17 Sustainable Development Goals (Source:https://news.un.org/en/story/2016/03/524202-un-statistical-body-agrees-global-indicators-measure-sustainable-development)*

In this sense, Agenda 2030 undoubtedly highlights the necessity to generate urban planning solutions that consider these new perspectives. The 17 Sustainable Development Goals are summarized in the five "Ps":

- **People**: Eradicate hunger and poverty, ensuring dignity and equality.
- **Prosperity**: Ensure prosperous and fulfilling lives in harmony with nature.
- **Peace**: Promote peaceful, just, and inclusive societies.
- **Partnership**: Implement the Agenda through solid partnerships.
- **Planet**: Protect the planet's natural resources and climate for future generations.

The concept of partnership naturally aligns with the slogan of Agenda 2030: "No one left behind," which underscores the interdependence of states, citizens, and the planet.

These are universal goals concern all participating countries, particularly the impoverished populations in the global South. The approval of the Agenda was met with great enthusiasm as it represents a significant step forward in addressing sustainable development and promoting a sense of global responsibility in its implementation. It reflects a clear judgment regarding the unsustainability of the current model and the serious risks it poses for the present and, most importantly, the future.

The Agenda represents a resolute response to the need for integrated action to address the challenge of sustainability in its three dimensions: economic, social, and ecological. However, it is acknowledged that achieving the SDGs will be a challenging task, requiring the involvement of all sectors of society, including businesses, institutions, universities, and, above all, individual citizens.

## 2.2 The three pillars of sustainability: ecological, social and economic

Starting from the widely accepted definition of sustainable development, which originated from the work of the World Commission on Environment and Development in 1987 (the Brundtland Report[11]), in which sustainable development is described as "*development that meets the needs of the present without compromising the ability of future generations to meet their own need*," it is evident that there are other components beyond the environmental one that should not be overlooked.

Considering the environment as a precondition for satisfying any other need (it is from the Earth, understood as a community of life, that we derive the fundamental elements for our subsistence and the satisfaction of "physiological needs"), we must not forget that the fulfilment of any "higher" need depends on both human/social capital and the "built" economic capital.

From this perspective, two additional dimensions of sustainability emerge a social dimension, constituted by individuals who, by forming relationships among themselves, create communities and even states, and an economic dimension "built" by individuals through their labor and knowledge (constructions, infrastructure, information). It is the "human system" (human/social capital + economic capital) that has caused imbalances in the natural environment through its activities.

[11] Mrcgp, B. R. K. B. M. (1988). The Brundtland report: 'Our common future.' Medicine and War, 4(1), 17–25. https://doi.org/10.1080/07488008808408783

However, it is also the primary field of intervention through which sustainable development can be ensured at all three levels.

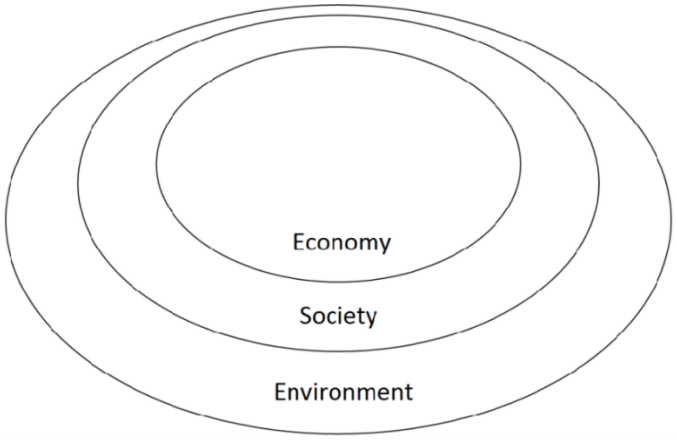


*Figure 4 - "Russian doll" model for sustainable development (e.g. O'Riordan et al. 2001)*

Another model that synthesizes this three-dimensionality and, more importantly, the order of priority among the dimensions of sustainability is the so-called "Russian doll model."[12] (*Figure 4)*. It was proposed by Roger Levett in 1998 in response to the more "conventional" "Three-ring circus model" theorized by scholars Custance and Hillier[13].

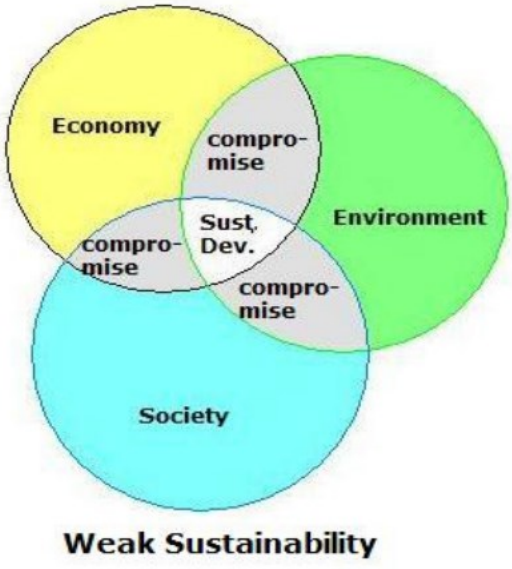


*Figure 5 - "Three-ring circus" model of sustainability (e.g. Custance e Hiller, 1998)*

[12] Hosseinian-Far, A., Pimenidis, E., Jahankhani, H., & Wijeyesekera, D. C. (2010). A review on sustainability models. In Springer eBooks (pp. 216–222). https://doi.org/10.1007/978-3-642-15717-2_23

[13] Sustainability Indicators--Integrating Quality of Life and Environmental Protection on JSTOR. (n.d.). https://www.jstor.org/stable/2983203

The “Russian doll model” clarifies the hierarchy of the dimensions. It highlights that the economy depends on society, and both are part of the broader environmental system. In this model, sustainability is achieved when it guarantees a good quality of life and stays within environmental limits. None of these constants is optional; they must be pursued in parallel. This perspective underscores that sustainable development cannot be achieved by prioritizing one dimension over the others. Instead, all three dimensions—economic, social, and environmental—need to be considered and addressed simultaneously to ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs.

Precisely because of its “rejection” of the ideas of balance or compromise between dimensions, the “Russian dolls model” has been characterized as “Strong Sustainability,” in contrast to the “Weak model” by Custance and Hillier. The “Strong Sustainability” model, in the author’s view, appears conceptually more coherent.

First and foremost, the environment is undeniably a foundational condition for the other two dimensions. As Levett asserts, “Without the planet’s basic environmental life-support systems, there can be no economy or society.” This perspective emphasizes that environmental sustainability is non-negotiable and must be preserved to ensure the viability of both the economy and society. Economic and social considerations should be integrated into an overarching framework that respects the fundamental limits and capacities of the natural world. This model underscores the interconnectedness and interdependence of the three dimensions and the need for a harmonious balance that does not compromise the planet’s ecological systems.

Secondly, the economy is not an autonomous and self-regulating entity but a social construct. Its functioning follows the rules, expectations, and directives conferred upon it by society within a specific time and place, making it dependent on society.

The awareness that society is jeopardizing the future of its children, the most significant obligation of every generation, as emphasized by Brundtland in her report, has heightened sensitivity toward the concepts of sustainability and sustainable development, creating a genuine moral issue at the international level. In this perspective, the concept of sustainable development should not be neglected, nor should it be accused of being a mere justification for the excessive use of natural

resources, as some scholars have done. It is an essential contemporary concept that expresses two needs highlighted in the Our Common Future report:

1. The need for human progress is realized through meeting the basic needs of all people (intra-generational equity) by fighting poverty and eliminating deprivations.

2. The need for this progress to stay within ecological limits, i.e., not relying on a decrease in non-renewable resources that could compromise future opportunities (inter-generational equity).

The term "sustainable development" perfectly reflects the ongoing "dialogue of values" on this issue and highlights the dynamic learning process to reconcile the three dimensions. "Development" implies a set of desirable goals for a society, signifying improvement, progress, and change leading to a preferable situation compared to the present one. The significant debate on this topic makes it clear that the goals of today's society no longer revolve solely around economic growth but also encompass an increased focus on the quality of life, resource availability, and equitable wealth distribution in different parts of the world.

As suggested by the history of advanced countries, per capita income is not the only measure that enhances citizens' well-being and satisfaction, as they seem to be associated with other factors, such as the quality of the environment in which they live. For this reason, the Brundtland report prioritizes the fight against poverty as an intervention necessity. It should be considered that "the poor are often more affected by unhealthy environments than the wealthy."

In summary, in the author's view, sustainability and sustainable development can harmoniously coexist and contribute to charting a new growth path. This path urges institutions and businesses to prioritize attention to environmental and social concerns in their activities, as these concerns significantly impact economic prosperity.

# 3. Social Sustainability

Chapter 3 delves into the various aspects of social sustainability, offering several definitions to capture its essence. Initially, it is defined as the capacity to ensure equitable distribution of human well-being across classes and genders while striving to minimize deterioration. It recognizes that

well-being, particularly in a welfare state context, extends beyond basic needs and should encompass freedom and the moral ability to engage in significant societal issues.

A more comprehensive definition posits that social sustainability involves the ongoing fulfillment of basic human needs such as food, water, shelter, and higher-level needs including security, freedom, employment, and leisure. The concept embraces intergenerational and intragenerational equity and touches upon vital facets such as education, equity, employment, human rights, social justice, and contemporary issues such as demographic changes, identity, culture, and health.

Several scholars have contributed to this definition. Khan (1995) broadens social sustainability to encompass equity, empowerment, accessibility, participation, cultural identity, and institutional stability. McKenzie (2004) offers an operational definition emphasizing life-enhancing conditions and mechanisms within communities that facilitate the achievement of these conditions.

While measuring the social dimension is challenging due to its subjective nature, it is suggested that a comprehensive view includes both objective indicators and subjective perspectives.

The chapter highlights the United Nations Declaration on the Right to Development, underscoring the central role of human beings and their universal rights in development. It aims to rectify obstacles to development, respecting civil, political, economic, social, and cultural rights. This declaration calls for international efforts to create a new economic order based on equality, interdependence, common interest, and cooperation.

Moreover, the chapter introduces the concept of "emploi durable" or "sustainable employment" in France, which involves long-term, multi-faceted employment that contributes to poverty prevention and social inclusion. This perspective emphasizes the need for public policies, business involvement, and the promotion of social rights through Corporate Social Responsibility.

In conclusion, the chapter argues that sustainability, if acknowledged as a recognized legal principle, has the potential to reshape the entire legal framework beyond environmental laws, extending to broader societal and global economic contexts. Social sustainability is not limited to individual needs but encompasses a broader spectrum of human rights and well-being, transcending traditional welfare state perspectives.

## 3.1 Definitions of Social Sustainability

*Social sustainability* can be defined as the ability to ensure human well-being (security, health, education) distributed equitably across classes and genders so that it can grow but never deteriorate (or, at most, temporarily worsen). The well-being category is certainly central in the perspective of a welfare state. However, as Amartya Sen[14] has argued:

"*Considering humans only regarding their respective needs leads to a rather meagre view of humanity. Hence, one can ask whether environmental priorities should be conceived only as an instrumental element to meet our needs rather than as a support to our freedom as responsible citizens endowed with the moral power to reflect on issues that go well beyond mere individual selfishness*."

Consequently, a more appropriate definition of social sustainability is "*the ongoing satisfaction of basic human needs (food, water, shelter) and higher-level social and cultural needs like security, freedom, employment, and leisure.*" This concept must also be characterized by intergenerational and intragenerational equity, including fundamental aspects such as education, equity, employment, human rights, and social justice, as well as contemporary issues like demographic changes (increasing life expectancy, international migration), identity, culture, health, safety, well-being, quality of life, and social cohesion.

Furthermore, according to Khan (1995), social sustainability encompasses equity, empowerment, accessibility, participation, cultural identity, and institutional stability. An operational definition of social sustainability is provided by McKenzie (2004), who states that "*social sustainability is a life-enhancing condition within communities and a process within communities that can achieve that condition*."[15] According to the author, this condition is characterized by specific elements/mechanisms that can be considered as indicators, allowing for measurement. These elements/mechanisms include:

[14] Sen, A. (2021). Amartya Sen · Why We Should Preserve the Spotted Owl: Sustainability · LRB 5 February 2004. London Review of Books. https://www.lrb.co.uk/the-paper/v26/n03/amartya-sen/why-we-should-preserve-the-spotted-owl

[15] Das, S., & Hazarika, O. B. (2023). The social, political, and institutional context of sustainability. In Elsevier eBooks (pp. 439–453). https://doi.org/10.1016/b978-0-323-90500-8.00005-1

- Equity of access to key services (e.g., healthcare, education, transportation, housing, and leisure).
- Equity between generations.
- A system of cultural relationships that values and preserves the positive aspects of diverse cultures while supporting cultural integration.
- Widespread political participation of citizens (elections and political activities, especially at the local level).
- A system for transmitting awareness of social sustainability across generations.
- A sense of community responsibility for maintaining this transmission system.
- Mechanisms that allow a community to collectively identify its capacities and needs.
- Mechanisms that enable a community to meet its own needs, where possible, through collective action.
- Political defense mechanisms to address needs that cannot be met through community action.

In the writer's opinion, this dimension is not easily measurable, as judgments regarding the various factors tend to be predominantly subjective. In order to provide a more comprehensive overview of the social pillar, objective indicators should be complemented by subjective perspectives.

A significant contribution that emphasized the importance of the social dimension of development was the Declaration on the Right to Development, adopted on December 4, 1986, by the United Nations General Assembly at its 97th plenary session[16]. This declaration highlights that the purpose of development is to "continuously improve the well-being of the entire population and all individuals, based on their active, free, and meaningful participation in development and the fair distribution of benefits resulting from that place." Thus, it places human beings, with their universal rights and fundamental freedoms (indivisible and interdependent), at the center of development, which should respect these rights "without distinction of any kind" through agreements, conventions, resolutions, and all relevant instruments of the United Nations and its specialized agencies (ILO). Consequently, it considers severe obstacles to development situations that still exist today that deny civil, political, economic, social, and cultural rights. International efforts should be directed towards rectifying these circumstances and "establishing a new international economic order" based on sovereign equality, interdependence, common interest, and cooperation among all states.

[16] UN. General Assembly (41st sess. : 1986-1987). (1987, February 23). Declaration on the Right to Development :: resolution /: adopted by the General Assembly. United Nations Digital Library System. https://digitallibrary.un.org/record/126476?ln=en

The right to development is also considered an inalienable right, subject to appropriate national policies to create favorable conditions for its full realization. A noteworthy perspective recently emerged in France, a country with a long history of sensitivity to sustainability, is the concept of "emploi durable" or "sustainable employment."

The concept of emploi durable refers to "*employment that provides individuals with the capacity to develop their workforce over time, engaging in one or more employments and in one or more enterprises during their working lives.*" Such employment requires careful foresight on the part of central authorities. It can be seen as an advancement of the notion of decent work, coined by the ILO in 1999, and an extension of the Lisbon Strategy[17], which aims to make the European Union "*the world's most competitive and dynamic knowledge-based economy capable of sustainable economic growth with new and better jobs and greater social cohesion*." Promoting emploi durable thus lays the groundwork for poverty prevention and combating social exclusion. As the current crisis demonstrates, poverty is increasingly a consequence of unemployment and job insecurity. By providing local wealth redistribution, emploi durable undoubtedly has a long-term impact on wealth production and therefore requires not only public policies at various levels (compensatory measures, restructuring, or preventive measures for future problems) but also direct involvement from businesses.

Corporate Social Responsibility is a crucial tool for promoting social rights in the global economic context, which is why it will be the focus of the next chapter. Therefore, the concept of emploi durable is subordinate to and connected with the presence of a solid social pillar, that is, "an economy that is more solidary, guided by ethical concerns, and respectful of fundamental social rights, which places humans at the center of business and the social system."

In conclusion, if accepted as a recognized legal principle, sustainability reformulates the entire legal framework, not only environmental or national-level laws.

# 4. Corporate Social Responsibility (CSR)

Chapter 4 explores the concept of Corporate Social Responsibility (CSR), which refers to a company's proactive commitment to ethical and fair operations. It takes into consideration the broader societal, economic, and environmental implications of its activities. The concept was first introduced by the

[17] https://www.europarl.europa.eu/meetdocs/2009_2014/documents/empl/dv/lisbonstrategybn_/lisbonstrategybn_en.pdf

American economist Howard Bowen in 1953. He stressed that companies should strive to create value for society beyond mere profit generation.

In Europe, CSR voluntarily integrates social and environmental concerns into a company's business operations. Additionally, the ISO 26000 norm provides an alternative definition. It highlights an organization's responsibility regarding its impact on society and the environment. The European Union emphasizes the impact that businesses have on society.

To be considered a responsible company, several actions can be taken. These include improving employee well-being, generating a positive social impact within the community, and enhancing environmental sustainability.

CSR encompasses two dimensions: an internal one and an external one. The internal dimension focuses on the management of human resources, environmental impact, occupational health and safety, and organizational structure. The external dimension deals with relationships with local communities, economic partners, suppliers, customers, consumers, and concerns about human rights and global environmental issues. For a company to be genuinely responsible, it must go beyond mere legal compliance. It should invest in human capital, environmental sustainability, and constructive relationships with stakeholders.

The chapter also introduces Carroll's Pyramid of Corporate Social Responsibility. It categorizes responsibilities into four levels: economic, legal, ethical, and philanthropic. A genuinely responsible company fulfills these responsibilities across all levels.

Porter and Kramer's concept of Creating Shared Value (CSV) challenges traditional CSR. It emphasizes that economic and societal value can be intertwined. CSV encourages companies to address social issues while creating economic value, promoting innovation, and ensuring economic sustainability.

The Triple Bottom Line model, introduced by John Elkington (*Figure 6)*, advocates that businesses should measure their impact based on three dimensions: people (social), planet (environmental), and profit (economic). This model encourages a holistic approach to business that considers social and environmental factors alongside financial performance.

Non-financial reporting has become essential for evaluating a company's holistic impact. Sustainability is increasingly integral to business success, emphasizing the interconnectedness of financial, social, and environmental performance.

Overall, the chapter highlights that CSR goes beyond legal compliance or public relations. It is about responsible corporate conduct that contributes to societal well-being and environmental sustainability. Companies that embrace this approach are better positioned for long-term success and positive societal impact.

## 4.1 The Concept of Corporate Social Responsibility

Corporate Social Responsibility (CSR) denotes the proactive commitment of an enterprise to conduct its affairs with fairness and ethical rectitude, taking into meticulous consideration the far-reaching economic, social, and environmental consequences emanating from its operations. This pivotal paradigm of Corporate Social Responsibility was inaugurated in business scholarship in 1953 by the distinguished American economist Howard Bowen. Bowen's seminal premise posits that an enterprise is not merely obligated to attend to its narrow economic pursuits and provision of services but ought to engender substantive value for its populace. A corporate entity must deliberate over decisions poised to translate into societal prosperity subsequently.

Presently, the quintessential definition of CSR that stands as the benchmark within the European context emanates from the Green Paper published by the European Commission in 2001[18], which was subsequently expounded upon in the "*Communication from the Commission on Corporate Social Responsibility: A Contribution to Sustainable Development" issued in July 2002. In this distinguished document, Corporate Social Responsibility is articulated as "the voluntary integration of social and environmental concerns into commercial undertakings and dealings with pertinent stakeholders by corporate entities*.[19]"

[18] Moon, J. (2007). The contribution of corporate social responsibility to sustainable development. Sustainable Development, 15(5), 296–306. https://doi.org/10.1002/sd.346

[19] COM(2001) 366 final Green Paper Promoting a European framework for Corporate Social Responsibility. (n.d.). European Environment Agency. https://www.eea.europa.eu/policy-documents/com-2001-366-final-green

Furthermore, the ISO 26000 norm[20] furnishes an alternative definition of social responsibility: "*the responsibility of an organization concerning the ramifications of its determinations and activities on both society and the environment. This responsibility is manifested through ethical and transparent comportment that effectively contributes to sustainable development, encompassing public health and societal well-being. It judiciously factors in the expectations and interests of stakeholders, aligns with the dictates of applicable law and adheres to international standards of ethical conduct. This commitment is harmoniously embedded throughout the organizational fabric and manifests itself in the practical interrelations."*

Conclusively, in 2011, the European Union augmented these antecedent definitions by stipulating that "*Corporate Social Responsibility is inexorably tied to the impact enterprises exert upon society*."[21]

## 4.2 The fundamental actions undertaken by a Responsible Company

Following an initial exploration of the Corporate Social Responsibility concept, it is pertinent to delve into how a company can genuinely exhibit responsibility through tangible actions aimed at:

- **Enhancing the Quality of Life for its Employees**: Initiatives may include establishing a daycare facility for employees' children, offering socially impactful volunteer activities, or providing benefits for families, such as assistance in acquiring essential goods.
- **Creating a Positive Social Impact in its Operational Territory**: A company can financially support projects proposed by the Third Sector, thereby giving back to its local community regarding human resources and raw materials.
- **Ensuring and Improving its Environmental Protection and Sustainability**: implementing measures to render the production process more sustainable and fostering a transparent relationship with all stakeholders engaging with the company. This serves to enhance the corporate image and establish a new brand reputation founded on ethical values. In this manner, the company becomes recognized in the

[20] ISO - ISO 26000 — Social responsibility. (2021, October 15). ISO. https://www.iso.org/iso-26000-social-responsibility.html

[21] Luke, T. W. (2013). Corporate social Responsibility: an uneasy merger of sustainability and development. Sustainable Development, 21(2), 83–91. https://doi.org/10.1002/sd.1558

market not only for its products but also as a beacon of social change and a force for positive impact within the system.

## 4.3 The dimensions of CSR

Corporate Social Responsibility (CSR) comprises two dimensions: an internal one and an external one *(Figure 6)*. The internal dimension encompasses the management of human resources, occupational health and safety, organizational structure, the utilization of natural resources, and the effects on the environment. The external dimension, on the other hand, includes local communities, economic partners, suppliers, customers, consumers, the observance of human rights, and global environmental concerns.

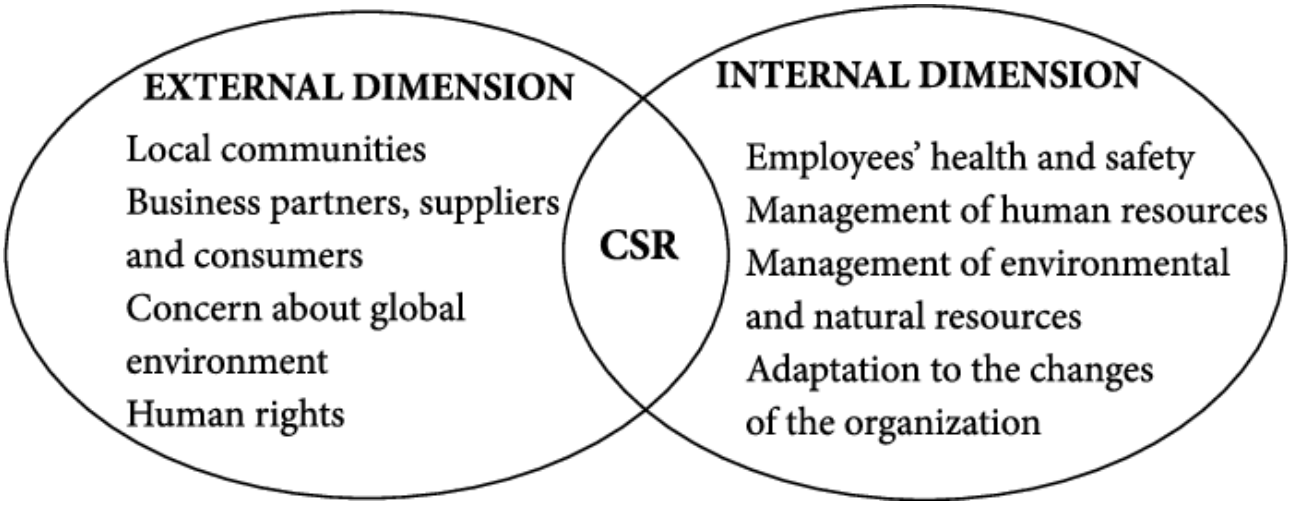


*Figure 6 - Dimensions of CSR (adapted by Ruzevicius, Serafimas 2007)*

For a company, CSR is not merely a communication tool or a financial strategy but rather a comprehensive strategy to be applied whenever the company faces a decision. To be socially responsible, companies must surpass legal compliance. It must invest more in human capital, the environment, and relationships with the organization's key stakeholders, as these can significantly impact a company's survival.

Suppose a company can establish a relationship with citizens and the community based on trust and credibility. In that case, it will reap economic benefits and be regarded as reliable in business relationships. Embracing socially responsible behavior, therefore, means more than just adhering to laws or implementing standard sustainability practices dictated by the market. It entails a commitment to producing long-term benefits for the community without resorting to opportunistic means. A genuinely responsible company adopts production processes that minimize the environmental impact

on its surroundings, strives to meet the economic, environmental, and social expectations of its target audience, and initiates projects aimed at promoting socially virtuous behavior.

Every company must be aware that each of its decisions and activities will impact society and the environment in which it operates.

## 4.4 The Pyramid of Corporate Social Responsibility

The Pyramid of Corporate Social Responsibility was conceived in 1991 by A. Carroll, an Emeritus Professor at the University of Georgia, USA, after analyzing and categorizing the relationships that can exist between a company and society. Carroll's pyramid is structured into four levels of increasing importance. Starting from the base, we find:

- **Economic Responsibilities** (upon which all others are built): The company commits to being profitable and ensuring adequate remuneration for its primary stakeholders, without whom the enterprise would cease to exist while securing its long-term survival.

- **Legal Responsibilities**: The company pledges to fully comply with the laws and regulations of the countries in which it operates[22]

- **Ethical Responsibilities**: The company undertakes to act ethically and morally and take into account the emerging needs of society.

- **Philanthropic Responsibilities**: The company can choose to act as a "good citizen" and take on responsibilities toward society that go beyond economic matters, involving investments aimed at improving the well-being of the community.[23].

According to Carroll, true Corporate Social Responsibility can be said to exist when a company tangibly fulfils these responsibilities at various levels. Carroll's model is straightforward to comprehend and highlights the various facets of CSR while emphasizing the importance of the economic aspect. However, some scholars have deemed it overly simplistic and unrealistic, as many

[22] Jørgensen, Michael Søgaard, et al. "Analysis of Cheminova CSR Practice." 2008, https://core.ac.uk/download/13709848.pdf.

[23] . "Report of the Fifth Meeting of the Forum of the Countries of Latin America and the Caribbean on Sustainable Development ." 2022, https://core.ac.uk/download/528359634.pdf.

companies do not effectively implement what they proclaim when they pursue social responsibility policies.

## 4.5 Creating Shared Value (CSV)

In 2011, economists Michael E. Porter and Mark R. Kramer developed the concept of "Shared Value"[24] exploring the connection between the economic system and society. Starting from the premise that no company exists in isolation and its success is greatly influenced by its relationship with the community, Porter and Kramer seek to go beyond traditional CSR. They encourage businesses to adopt a value-creation model that integrates social and environmental impact into their business activities. In the authors' words: "CSR programs primarily focus on reputation and have a limited link to the business, making it difficult to justify and sustain them in the long term. In contrast, Creating Shared Value (CSV) serves the profitability and competitive position of the company. It leverages the specific resources and expertise of the company to create economic value through social value."

Indeed, Creating Shared Value means generating economic value in ways that simultaneously benefit the company and society, addressing both business and social needs. However, companies often do not approach social issues from a value perspective, considering value solely in financial profits.

Companies can create shared value in three distinct and mutually reinforcing ways:

- **Reimagining Products and Markets:** Through continuous exploration of social needs, companies can discover new opportunities for differentiation and repositioning in traditional and potential markets.

- **Redefining Productivity in the Value Chain:** Social issues can lead to economic costs within a company's value chain. However, companies should address these issues from a shared value perspective, fully leveraging the benefits, especially in hygiene, safety, and environmental protection. Improved resource utilization can yield significant cost savings.

- **Enabling Local Community Development by Creating Industrial Support Clusters**: Strengthening clusters supports local purchases and allows companies to address social issues

[24] Michael E. Porter, Mark R. Kramer, Harvard Business Review, 2011

collaboratively. Creating shared value necessitates new and more intensive forms of collaboration.

The CSV concept introduced by Porter and Kramer represents a shift in perspective, emphasizing that business success and societal advancement can be intrinsically linked, offering a more sustainable approach to corporate responsibility.

## 4.6 Triple Bottom Line

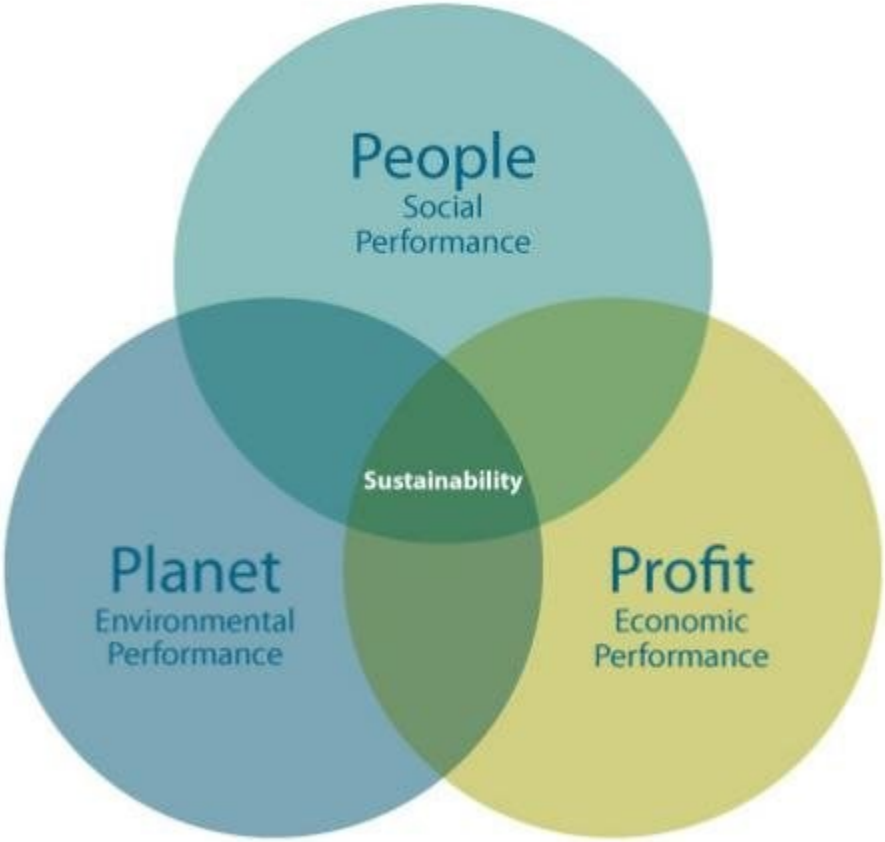


*Figure 7 - John Elkington's Triple Bottom Line Model*

The term "Triple Bottom Line"[25] *(Figure 7)* was coined in 1994 by entrepreneur John Elkington to encourage companies to include social, environmental, and economic performance within the broader framework of their profits, measuring the impact generated over a specific time frame. Every company can generate money, but only a few can create value. According to this theory, businesses should always make decisions while simultaneously pursuing three objectives:

[25] Elkington, J. (1998). Partnerships fromcannibals with forks: The triple bottom line of 21st-century business. Environmental Quality Management, 8(1), 37–51. https://doi.org/10.1002/tqem.3310080106

- **People**: The "people" dimension includes employees, stakeholders, and the entire community. The company should assess whether its operations have benefited society and to what extent. A socially responsible enterprise cannot expect without giving back but must always anticipate a "social return" to the people who sustain it.

- **Planet**: In this case, the company must measure its environmental responsibility, continually striving to improve its performance by reducing emissions, pollution and keeping all factors contributing to global warming in check. Another way to contribute to the planet's preservation could be through investments in renewable energy, improved resource management, and responsible waste disposal.

- **Profit**: This encompasses the traditional measurement of profits and losses from business activities. This dimension is the easiest to estimate because, unlike the other two, it is based on objectively measurable quantitative data. Measuring the social and environmental aspects is more complex than profit, as it involves a predominantly subjective assessment, subject to variables and arbitrary parameters established by the companies.

The primary goal of this model is not to position itself as an objective evaluation tool but to propose a new idea of capitalism, stimulating critical thinking about the role of companies in their communities. Sustainability is the actual future of business. In this way, the company's vision is no longer solely focused on pursuing the best financial results but also places particular emphasis on improving the living conditions of people and the planet.

Until a few years ago, accounting was considered a separate part of a company, but now, a business's impact is evaluated based on its interconnectedness with the environment and society. If a company concentrates on financial aspects, it can only develop a comprehensive corporate framework in some of its dimensions. Non-financial reporting provides concrete information and facts about impact in the most transparent manner possible. A sustainable approach is the only one capable of delivering tangible results over time for the company, the community, and the environment: three dimensions that are now inseparable.

"*Today, companies must demonstrate their value not only from a financial standpoint but also in terms of their ability to provide greater commercial value to their customers, investors, employees, society at large, and the environment."*[26]

# 5. Social sustainability in the ages of digitalization

## 5.1 Introduction

The profound Impact of Industry 4.0, the fourth industrial revolution, is felt across every facet of society. In today's world, technology has seamlessly woven into the fabric of our daily lives, often so subtly that we may not even be consciously aware of it. The result is a world where simplicity and speed have become the norm.[27]

In this chapter, our goal is to conduct a comprehensive examination of the transformative force that is Industry 4.0 and its sweeping consequences on society. We aim to explore the extensive body of literature that attempts to describe and dissect this phenomenon, shedding light on its positive and negative aspects. However, this literature presents a complex and often fragmented picture. There is no straightforward interpretation, and the academic community is divided, reflecting the multifaceted nature of the societal impacts of Industry 4.0.

One of the critical paradoxes surrounding Industry 4.0 is the simultaneous reduction in human labor in many sectors and job categories, coupled with the creation of new job opportunities and enhancements in working conditions[28]. While some scholars underscore the undeniable improvements in work conditions, there are legitimate concerns stemming from the technology-centric approach of Industry 4.0[29]. This approach has raised questions regarding its implications for the workforce, job security, and the potential for wage disparities[30].

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[26] Flavio Attramini, Head of Business Sales Epson Italia, 2017

[27] Ross, P. E., & Maynard, K. (2021). Towards a 4th industrial revolution. Intelligent Buildings International, 13(3), 159–161. https://doi.org/10.1080/17508975.2021.1873625

[28] Neumann, P., Winkelhaus, S., Grosse, E. H., & Glock, C. H. (2021). Industry 4.0 and the human factor – A systems framework and analysis methodology for successful development. International Journal of Production Economics, 233, 107992. https://doi.org/10.1016/j.ijpe.2020.107992

[29] Grybauskas, A., Stefanini, A., & Ghobakhloo, M. (2022). Social sustainability in the age of digitalization: A systematic literature Review on the social implications of industry 4.0. Technology in Society, 70, 101997. https://doi.org/10.1016/j.techsoc.2022.101997

[30] Postelnicu, C., & Calea, S. (2019). The Fourth Industrial Revolution. Global risks, local challenges for employment. Montenegrin Journal of Economics, 15(2), 195–206. https://ideas.repec.org/a/mje/mjejnl/v15y2019i2195-206.html

In addition, the debate surrounding Industry 4.0 extends to its relationship with social sustainability. The current body of research in this area is sprawling, with findings that resist a unilateral interpretation. The complex interaction between Industry 4.0 and social sustainability raises questions about its long-term societal implications. The industry's rush toward automation, fueled by the allure of technology-driven efficiency, might have unintended social consequences.

Furthermore, it is essential to acknowledge the central tenet of Industry 4.0: profit. The overarching objective of this industrial revolution is to leverage advanced technologies to optimize the efficiency, productivity, and profitability of businesses. While this pursuit of profit is a driving force behind economic growth and innovation, it sometimes appears at odds with a more human-centric approach that places people and their well-being at the forefront of industrial progress.

The European Commission has been vocal in challenging the efficacy of the technology-centric approach, arguing that it may need to be better suited for achieving the broader goals of the European industrial landscape. This raises fundamental questions about the balance between profit and social responsibility in the age of Industry 4.0.

In summary, Industry 4.0 is ushering in a profound transformation that touches every corner of society. Its impact is multifaceted, from the changing nature of work to its relationship with social sustainability and the tension between profit-centric and human-centric approaches. This complex landscape demands a nuanced and holistic understanding as we navigate the path forward in this era of unprecedented technological advancement.

## 5.2 A glance at the literature

According to a previous analysis (Grybauskas et al., 2022)[31] on the literature concerning the correlation between Industry 4.0 and social sustainability, a selected sample of 256 articles revealed that a third of them, 173 articles to be precise, had a predominantly conceptual nature and lacked empirical evidence. This suggests that a significant portion of the discussion on the subject has taken place at a theoretical level rather than being supported by concrete empirical data.

[31] Grybauskas, A., Stefanini, A., & Ghobakhloo, M. (2022). Social sustainability in the age of digitalization: A systematic literature Review on the social implications of industry 4.0. Technology in Society, 70, 101997. https://doi.org/10.1016/j.techsoc.2022.101997

The articles that did include empirical evidence employed various research methods, including questionnaires, surveys, interviews with experts, and econometric research methods. This diversity of methodological approaches indicates a growing interest in empirically assessing the Impact of Industry 4.0 on social sustainability. The use of questionnaires, surveys, and interviews suggests that scholars are striving to gather data directly from businesses, industry experts, and other stakeholders involved in implementing Industry 4.0 to gain a more comprehensive understanding of the effects of this industrial transformation.

Another noteworthy point that emerged from the analysis pertains to the tone of the discussion in the papers. Most articles (187 out of 256) discuss or evaluate the specific potential of Industry 4.0 concerning social sustainability. A greater number of writings focused on the negative impacts of Industry 4.0 on social sustainability. This might indicate a growing concern regarding the unintended consequences or risks associated with the widespread adoption of advanced technologies within the industry.

Industry 4.0 is a paradigm that signifies the digitalization of value addition and delivery processes. What sets it apart is that this transformation is not confined to a singular scale, but rather, it radiates its influence across various levels. These levels encompass the micro-scale, involving individual entities and their inter-organizational interactions, and the macro scale, encompassing entire industries and regions. The authors conducting this study emphasize the paramount importance of appraising the Impact of Industry 4.0 at these varying scales.[32]

### 5.2.1 Impact of digitization on the workforce and employment

The digitalization of the economy is expected to have a profound effect on various economic aspects, particularly in terms of employment and the skill sets required for different jobs.

According to previous analysis (Benjamin et al., 2019)[33] findings indicate a strong relationship between a company's investment in digital technologies and changes in employment within that company. This relationship considers variations in skill levels and the types of digital technologies being adopted.

[32] Ghobakhloo, M., Fathi, M., Iranmanesh, M., Maroufkhani, P., & Morales, M. (2021). Industry 4.0 ten years on: A bibliometric and systematic review of concepts, sustainability value drivers, and success determinants. Journal of Cleaner Production, 302, 127052. https://doi.org/10.1016/j.jclepro.2021.127052

[33] Balsmeier, B., & Woerter, M. (2019). Is this time different? How digitalization influences job creation and destruction. Research Policy, 48(8), 103765. https://doi.org/10.1016/j.respol.2019.03.010

Specifically, the research conducted by Betsmaier et al. reveals that investments in digital technologies are positively correlated with the employment of highly skilled workers. Conversely, there is a negative correlation with the employment of low-skilled workers. However, the overall impact on employment is positive. These effects are primarily driven by machine-based digital technologies, such as robots, 3D printing, and the Internet of Things, which drive the industrial revolution.
On the other hand, there is no significant impact on employment when only firms adopting non-machine-based digital technologies like ERP, e-commerce, or cooperation support systems are considered.

In combination with a decrease in jobs for low-skilled workers, this trend will likely lead to increased inequality within the population. From an economic perspective, it is essential to develop and implement strategies that minimize potential negative impacts while nurturing positive effects. Training and professional development programs can play a vital role as long as medium- and low-skilled workers can acquire new skills to take on tasks created during the digitalization process.

For segments of society that may struggle to adapt to the digital age, solutions are needed. Collaborative artificial bits of intelligence, as mentioned earlier, could offer a means to empower medium and low-skilled workers by allowing them to focus on tasks where they excel compared to machines, such as work that involves personal emotional interaction. In turn, machines can handle tasks where they surpass human capabilities, such as price prediction and pattern recognition. This could increase the productivity of medium and low-skilled workers and lead to the creation of new job opportunities.

If such efforts fail, inequality among workers is likely to rise, presenting a significant challenge for public institutions and policymakers.

Policymakers may pursue three primary objectives to address these challenges:

1. Efficiently allocate skilled labor to growing, productive sectors by promoting flexible labor markets and competitive product markets that incentivize innovation and the adoption of new technologies. For small countries, ensuring worldwide free movement of talent and streamlining the hiring process with low administrative costs is particularly important.

2. Invest in training and ongoing professional development to improve the match between skills and job requirements. This includes not only technical skills but also soft skills and emotional intelligence to manage the digital transition of labor markets. Governments should make tertiary education more attractive, as higher educational attainment is positively correlated with the ability to learn and retrain skills.

3. Address the potential inability or unwillingness of some segments of society to manage the transition to the digital age. This can be achieved through the development of collaborative artificial bits of intelligence or innovative social measures, such as an unconditional basic income.

# 6. Social Innovation

Chapter 6 explores the realm of social innovation and provides an overview of the main goals and insights of the chapter. It defines the concept of social innovation, its historical origins, and evolving definitions, with the primary objective of providing a comprehensive understanding of what social innovation entails, its significance, and its underlying principles.

The chapter begins by tracing the roots of social innovation, going back to the works of Max Weber, who associated social change with unconventional behaviors. It highlights how this term has gained scholarly attention in the 21st century.

The definition of social innovation is expounded, focusing mainly on the characterization provided by Murray, Coulier-Grice, and Mulgan in 2010. Social innovation is defined as "new ideas (products, services, and models) that meet social needs while fostering new social relationships and collaborations." This definition underscores the importance of innovations that benefit society and enhance its ability to take action.

European institutions have also provided their perspective, encapsulated in EU Regulation No. 1296/2013, which categorizes social innovations as those with social purposes and means, addressing social needs, nurturing new social relationships, and empowering society.

A recurring theme in these definitions is the ability of social innovations to respond to collective needs and improve overall well-being, highlighting their potential for significant societal impact.

Furthermore, the chapter introduces the role of cooperation and networking as fundamental to social innovation. It aligns with the concept that innovations should be socially accepted, widely diffused, adaptable, and institutionalized as new social practices. Information and Communications Technology (ICT) is noted as a facilitating factor for the rapid dissemination of social innovations.

The chapter also emphasizes the importance of coalitions and networks in fostering social innovation, distinguishing it from corporate-level innovations. Social innovations often require a broader network, bringing together diverse actors from the public sector, public enterprise providers, social movements, entrepreneurs, and financiers.

The discussion then transitions to the process of social innovation. While the literature typically focuses on isolated case studies or the initial and diffusion stages of social innovations, this chapter highlights a more holistic approach. It introduces a comprehensive model of the innovation process featuring six distinct phases:

- Exploration: Identifying unmet needs and opportunities.
- Idea Generation: Conceiving practical solutions and social business models.
- Prototyping: Developing and testing innovative ideas.
- Piloting: Implementing solutions on a small scale.
- Diffusion: Scaling up innovations to reach a broader audience.
- Systemic Change: Achieving transformative impact at the societal level.

The model acknowledges the iterative nature of social innovation, recognizing that many phases may overlap or occur in different sequences. It also accounts for the diversity in the development paths of social innovations, allowing for flexibility based on unique project requirements.

In summary, Chapter 6 provides a comprehensive framework to guide the understanding and implementation of innovative ideas aimed at addressing societal needs and fostering collaboration. It unfolds the complexities and nuances of social innovation, defining its significance and underlying principles.

## 6.1 Definitions of Social Innovation

The term "social innovation," although relatively new, has roots in history. The earliest references in academic literature regarding social innovation can be traced back to Max Weber[34]. The German scholar defined the relationship between social order and innovation as the impact of abnormal behaviours on social change. While the concept of social innovation is not new, and most of what is considered progress today is a concrete example of this phenomenon, it is only in the 21st century that scholars have developed precise definitions of social innovation.

Murray, Caulier-Grice, and Mulgan (2010 define social innovations as "*new ideas (products, services, and models) that meet social needs and, at the same time, create new social relationships and collaborations. In other words, innovations that are both good for society and enhance society's capacity to act*."

European institutions have also provided their definition of social innovation. EU Regulation No. 1296/2013[35] groups under the term social innovations "innovations that have both social purposes and means, in particular those that refer to the development and implementation of new ideas (concerning products, services, and models) that respond to social needs and, at the same time, create new social relationships or collaborations, providing a benefit to society and promoting its capacity to act."

It can be noted that in all these definitions, albeit with different nuances, the focus is on the ability of innovations to respond to a collective demand for new or previously unmet needs and to enhance the well-being of people. The prevailing opinion is that innovation can be considered social only if it can create a significant impact on society and has the potential to improve the collective quality of life, offering preferable solutions to those adopted in the past.

Among the distinctive characteristics of social innovation is the ability to spread significantly among people. In this regard, the definition proposed by Howaldt and Schwarz (2010)[36] is in line with the idea that "*an innovation can be called social to the extent that the market or the non-profit sector*

[34] Ionescu, C. (2015). About the conceptualization of social innovation. DOAJ (DOAJ: Directory of Open Access Journals). https://doaj.org/article/5ec4adba5be94b25b20a14240cc0eeb6

[35] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0238:0252:EN:PDF#:~:text=1.-,This%20Regulation%20establishes%20a%20European%20Union%20Programme%20for%20Employment%20and,the%20Union's%20objectives%20in%20terms

[36] Howaldt, J. and Schwarz, M. (2010) Social Innovation Concepts, Research Fields and International Trends IMA/ ZLW. - References - Scientific Research Publishing. (n.d.). https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=1767100

*carries it, is socially accepted, and widely diffused in society or some of its sub-areas, adapts to circumstances, and is institutionalized as a new social practice*."

However, these conditions have often represented an obstacle to the widespread adoption of local initiatives that appear excellent. Many social operators, after developing brilliant projects, still need to expand the adoption of these models to new contexts different from the original one, leading to the failure of their innovations.

How innovations come to light is another determining factor for them to be considered social. There are numerous opinions that social innovation is inevitably a model of innovation based on cooperation and networking. In this sense, it is clear how the conditions listed by Howaldt and Schwarz can be achieved more quickly through new ways of operating, different from existing ones and achievable through the development of technologies that facilitate the creation of new economic models. For example, thanks to the use of Information and Communications Technology (ICT) tools, it is now possible to expand the scope of participants in the innovation process. The boundaries of communities are no longer solely geographical. Still, they are often determined by mechanisms of value membership rather than cultural or in accordance with specific interests (such as identifying with the cause of certain social issues).

This logic follows the principle of disembedding (Giddens, 1994)[37], namely the ability people have today to interact without face-to-face encounters. It is no coincidence that most modern socialization processes have arisen on the internet, following the mechanisms of disembedding mainly due to the immateriality of the internet. In this view, the successful implementation of social innovation strongly depends on the ability to bring together a plurality of actors, even if they are distant from each other, and to assign an active role to each participant in the innovation process. Coalitions and networks become increasingly crucial for successfully implementing change, unlike what often happens at the corporate level. While business innovations are primarily focused on the company, social innovation often requires a broader network that enables rapid sharing and brings together different actors, such as those responsible for the public sector, public enterprise providers, lawyers working in social movements, entrepreneurs, and financiers.

[37] Haunschild, A. (2004). Contingent Work: The problem of disembeddedness and economic reembeddedness. Management-Revue, 15(1), 74–88. https://doi.org/10.5771/0935-9915-2004-1-74

## 6.2 Process of Social Innovation

Compared to business technologies, there needs to be more detailed and systematic analysis in the literature on how social innovations are designed, disseminated, and supported. Most analyses focus on single case studies, often examples of success, rather than developing representative models of the various phases of social innovation.

Additionally, the primary focus is often on the initial stages of ideation and creativity or the later stages of innovation diffusion and expansion. While these stages are crucial for social innovation, they often overlook the implementation phase that makes new ideas worthwhile. Similarly, a focus on diffusion can risk ignoring the phase of project generation, without which the entire process would not take place.

In one of the few comprehensive approaches oriented towards the processes of social innovation, Sandra M. Bates (2011)[38] proposes a three-phase model for social innovation, consisting of:

1. Exploration: Involves defining unmet needs and exploring opportunities to meet them.
2. Innovation: Involves conceiving a practical solution and an effective social business model.
3. Implementation: Involves ensuring that the solution creates shared value among all stakeholders and employs techniques to prevent ideas from becoming orphaned innovations.

While this is a valid starting point, it would be helpful to propose a more detailed framework in which prototyping, large-scale expansion, and systemic change represent distinct parts of the overall process.

The comprehensive model of the innovation process (*Figure 8*) proposed by Murray, Caulier-Grice, and Mulgan (2010) addresses this need. According to this framework, the social innovation cycle consists of six different phases, ordered as follows:

[38] Bates, S. M. (2011). The Social Innovation Imperative: Create Winning Products, Services, and Programs that Solve Society's Most Pressing Challenges. http://ci.nii.ac.jp/ncid/BB19325646

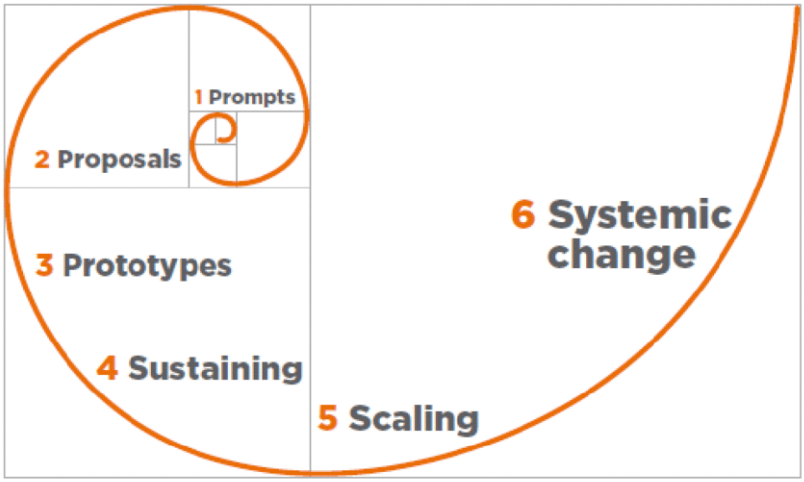


*Figure 8 - The process of social innovation (Murray et al., 2010)*

Naturally, in practice, many of these phases overlap and can occur in a different order. Some operators, for example, start with practical experience or a prototype and fully meet real needs much later. Implementation and action often stimulate innovative ideas, leading to further improvements and innovations. Feedback loops exist between each stage, making the process iterative rather than linear, so it is visually represented as a spiral rather than a linear diagram.

Additionally, social innovations only sometimes go through all six phases. Sometimes, they remain small-scale or local, bypassing growth and expansion and thus not reaching the systemic change phase. In other cases, especially with the aid of networks, social innovations can skip some steps altogether, quickly moving from prototyping to global diffusion.

However, even though this six-phase process does not capture the often-messy nature of social innovation development and growth, it provides a more detailed and precise analytical framework for organizing the various activities to be carried out and the resources required for each project's realization.

# 7.0 Exploring Product Traceability through Digitalization: A Focus on Innovative Case Studies

The closing chapter of this paper will discuss the importance of product traceability through digitization, and it will present two case studies that demonstrate the benefits of this approach.

## 7.1 Empowering Supply Chains: The Digital Transformation of Product Traceability

Digitization is a critical aspect of modern business operations aimed at enhancing product traceability throughout the supply chain[39]. In a marketplace that is increasingly globalized and complex, tracking and tracing products from their origin to their final destination is essential for a variety of reasons, including regulatory compliance, quality control, consumer safety, and environmental sustainability.

Digitalization in this context involves integrating digital technologies and data-driven solutions into supply chain management to achieve greater visibility, transparency, and efficiency.[40] This process requires the utilization of technologies such as the Internet of Things (IoT), blockchain, RFID (Radio-Frequency Identification), and data analytics to capture, record, and analyze information about products at different stages of the supply chain.

One of the primary benefits of digitalization for product traceability is enhanced transparency[41]. IoT devices and sensors enable companies to collect real-time data on the location, temperature, humidity, and other relevant variables that affect product quality. This information is then stored and transmitted digitally, providing stakeholders with an accurate and up-to-date view of the product's journey from manufacturer to consumer.

Blockchain technology is also gaining popularity in supply chain management because of its ability to create an immutable and transparent ledger of transactions. Every step in the supply chain can be recorded on a blockchain[42], ensuring that data remains tamper-proof. This helps to prevent fraud and also to track the origin of products, which is crucial for issues like food safety or verifying the authenticity of luxury goods.

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[39] Rogetzer, P., Nowak, T., Jammernegg, W., & Wakolbinger, T. (n.d.). Impact of Digitalization on Sustainable Supply Chains. Springer eBooks. https://doi.org/10.1007/978-3-658-22438-7_8

[40] Ivanov, D., Dolgui, A., Das, A., & Sokolov, B. (2019). Digital Supply Chain Twins: Managing the ripple effect, resilience, and disruption risks by Data-Driven Optimization, Simulation, and Visibility. In International series in management science/operations research (pp. 309–332). https://doi.org/10.1007/978-3-030-14302-2_15

[41] Centobelli, P., Cerchione, R., Del Vecchio, P., Oropallo, E., & Secundo, G. (2022). Blockchain technology for bridging trust, traceability and transparency in circular supply chain. Information & Management, 59(7), 103508. https://doi.org/10.1016/j.im.2021.103508

[42] What are some interesting blockchain use cases that are not financial? – ZeroGov. https://zerogov.net/?p=25

RFID technology further aids in product traceability by attaching unique identifiers to products, which can be scanned at different checkpoints along the supply chain[43]. This facilitates the quick and accurate tracking of products, reducing the risk of errors and enabling a rapid response in case of recalls.

Digitalization also supports regulatory compliance, given that many industries are subject to stringent regulations and quality standards. By having a digital record of each product's journey, companies can easily demonstrate compliance with these regulations, reducing the risk of fines and penalties.[44]

Moreover, the ability to trace products accurately is essential in recall management. In case of product defects, contamination, or safety concerns, a quick and precise recall is vital to protect consumer safety and a company's reputation. Digitalization ensures that the affected products can be identified and removed from the supply chain swiftly, minimizing potential harm and financial losses.

In addition, product traceability contributes to sustainability efforts. It enables companies to analyze their supply chain for inefficiencies and areas where environmental impact can be reduced. This can lead to better resource allocation, reduced waste, and a smaller carbon footprint, aligning with the growing demand for eco-friendly and socially responsible business practices.

In conclusion, digitizing supply chains to enhance product traceability is a transformative process that provides numerous benefits. It improves transparency, ensures regulatory compliance, aids in recall management, and supports sustainability initiatives. By leveraging digital technologies and data-driven solutions, companies can optimize their supply chain operations, enhance consumer safety, and build trust in their products and brands. As industries evolve and adapt to the demands of the modern marketplace, digitalization will remain a key driver of efficiency, accountability, and competitiveness in the supply chain.

[43] Centobelli, P., Cerchione, R., Del Vecchio, P., Oropallo, E., & Secundo, G. (2022b). Blockchain technology for bridging trust, traceability and transparency in circular supply chain. Information & Management, 59(7), 103508. https://doi.org/10.1016/j.im.2021.103508

[44] Cheng, Congbin, et al. "Impact of Green Process Innovation and Productivity on Sustainability: The Moderating Role of Environmental Awareness." Sustainability, vol. 15, no. 17, 2023, p. 12945.

## 7.2 Unilever and Digitalization for Enhanced Product Traceability: A Sustainable Revolution

Unilever[45], a renowned global consumer goods company, has made sustainability a crucial aspect of its operations *(Figure 10)*. The company is committed to transparency and traceability along the entire supply chain to ensure sustainable and ethical production of their products.[46] Unilever has concentrated its efforts on enhancing transparency and traceability across its extensive supply chain. They aim to ensure that their products are produced sustainably and meet ethical standards at every stage of production.


*Figure 10 – Unilever Sustainable Living Plan*

The company has made significant strides by leveraging advanced data collection and analysis systems, including technologies such as the Internet of Things and big data analytics, to gather detailed data from every point of the supply chain. By using this wealth of information, Unilever has identified and addressed sustainability-related challenges.

For example, the company has worked to improve working conditions in its suppliers' factories and has ensured that human and labour rights standards are met. Digitalization has made it possible for Unilever to continuously monitor these standards, allowing them to react promptly to any violations.

[45] Plc, U. (2023, October 26). Unilever Global: Making sustainable living commonplace. Unilever. https://www.unilever.com/

[46] Plc, U. (2023, September 7). Planet & Society. Unilever. https://www.unilever.com/planet-and-society/

Unilever has also harnessed digitalization to optimize manufacturing processes, reduce waste and enhance energy efficiency in production. By using sensors and connected devices, they have optimized manufacturing processes, reducing resource usage and environmental impact. In addition to its focus on sustainability, Unilever has used digital platforms to communicate transparently with consumers, investors, NGOs, and other stakeholders. This has helped build trust in the brand and raised awareness of Unilever's sustainability initiatives.

A concrete example of their commitment is the "Sustainable Palm Oil Traceability"[47] project, where Unilever used blockchain technology to track the origin of palm oil in their products. This allowed them to ensure that the palm oil was sustainably sourced, reducing deforestation and unethical practices. Furthermore, Unilever has worked to reduce the environmental impact of its products by developing more sustainable packaging and promoting plastic use reduction.

Digitalization has played a crucial role in managing product lifecycle information and tracking carbon emissions. Unilever's commitment to sustainability goes beyond its operations. The company has collaborated with other businesses and organizations to promote sustainable innovation and address global challenges such as climate change and poverty. Digitalization has facilitated collaboration and the exchange of information among partners.

In summary, Unilever, a global consumer goods giant, has made sustainability a central theme of its operations, focusing on transparency and traceability along the supply chain. By employing advanced technologies to collect data, enhance transparency, and optimize operations, the company has made significant strides in improving working conditions, reducing waste, and promoting sustainable production. Digitalization has played a pivotal role in helping Unilever achieve its social and environmental sustainability objectives, highlighting the positive role of digital technologies in the business sector.

Unilever's commitment to sustainability is deeply embedded in its corporate culture. Their Sustainable Living Plan[48], launched in 2010, reflects this dedication to addressing pressing social and environmental issues. The plan outlines three main goals:

[47] Johnston, L. (2022, March 30). How Unilever's blockchain pilot will scale palm oil traceability. Consumer Goods Technology. https://consumergoods.com/how-unilevers-blockchain-pilot-will-scale-palm-oil-traceability

[48] https://www.unilever.com/files/92ui5egz/production/16cb778e4d31b81509dc5937001559f1f5c863ab.pdf

1. **Improving Health and Well-being**: Unilever aims to help more than a billion people take action to improve their health and well-being by 2020. This includes promoting proper hygiene and nutrition through products like Lifebuoy soap and Knorr food brands.

2. **Reducing Environmental Impact**: Unilever is working to reduce its environmental impact by halving the environmental footprint of its products, from sourcing raw materials to consumer use and disposal, by 2030. This includes reducing water usage, carbon emissions, and waste generation throughout their value chain.

3. **Enhancing Livelihoods:** Unilever is committed to enhancing the livelihoods of millions of people by 2020. This involves initiatives such as supporting smallholder farmers, promoting fair wages and working conditions, and empowering women in the company's value chain.

To achieve these goals, Unilever has leveraged digitalization in several ways:

- **Supply Chain Transparency:** Unilever has used digital tools to create a transparent and traceable supply chain. They employ technologies like blockchain and IoT sensors to track the sourcing and production of their raw materials. This ensures that materials are sourced ethically and sustainably, contributing to improving social conditions in the communities where they operate.

- **Sustainable sourcing:** The company uses digital platforms to engage with suppliers and promote sustainable sourcing practices. They have launched initiatives like the "Sustainable Agriculture Code," which sets standards for sustainable farming practices and works with suppliers to meet these criteria.

- **Waste Reduction**: Unilever has harnessed digitalization to reduce waste in its manufacturing processes. This involves optimizing production processes, reducing packaging waste, and minimizing energy and resource usage. These efforts align with their goal to halve the environmental footprint of their products.

- **Consumer Engagement**: Digital technologies are crucial in communicating Unilever's sustainability efforts to consumers. They have launched digital campaigns, websites, and

social media initiatives to educate and engage customers on recycling, sustainable living, and responsible consumption.

- **Data-Driven Decision Making**: Unilever uses big data analytics to make informed decisions about sustainability. They collect and analyze data on their product's environmental impact and social performance, which informs their strategies for continuous improvement.

Unilever has made remarkable progress in advancing social sustainability through these digital initiatives. For instance, their Sustainable Agriculture Code[49] has helped thousands of farmers adopt more sustainable practices, increasing incomes and improving livelihoods. Moreover, their waste reduction efforts have led to significant reductions in greenhouse gas emissions and waste generation. They have consistently demonstrated that digitalization can be a powerful enabler of sustainability initiatives.

Unilever's commitment to sustainability goes beyond its operations and extends to broader industry transformation. They actively participate in industry collaborations and partnerships aimed at driving systemic change. For example, they are part of the Consumer Goods Forum [50](CGF), a global network of consumer goods companies working together to drive positive change across the industry. Within CGF, Unilever contributes to initiatives such as reducing food waste, promoting responsible sourcing, and advancing consumer trust.

In conclusion, Unilever's dedication to sustainability is deeply ingrained in its corporate identity, and the company has harnessed digitalization to advance its social sustainability goals. Their efforts encompass transparency, sustainable sourcing, waste reduction, consumer engagement, and data-driven decision-making. Through these initiatives, they have made tangible progress in improving social conditions and reducing environmental impact. Furthermore, their involvement in industry collaborations underscores their commitment to broader industry transformation and a more sustainable future.

[49] https://www.unilever.com/files/a3f52ce3-22f7-4048-9c5b-55fa3a7895c4/ul-sac-v1-march-2010-spread.pdf

[50] Who are the Members of The Consumer Goods Forum? (n.d.). The Consumer Goods Forum. https://www.theconsumergoodsforum.com/who-we-are/our-members/

## 7.3 Patagonia's Journey to Sustainable Product Traceability through Digitalization

The esteemed outdoor apparel brand Patagonia has launched a remarkable campaign to advocate sustainability in the fashion sector.[51] The goal is to employ digitalization to improve product traceability, explicitly focusing on their recycled clothing range. By utilizing cutting-edge technologies and upholding transparency, Patagonia is a frontrunner in revolutionizing the process of tracing clothing, from materials to end-users. [52]This is a clear indication of the company's unwavering dedication to ethical principles and eco-consciousness.

The fashion industry faces a significant sustainability challenge. Fast fashion, overproduction, and textile waste are contributing to environmental degradation. Patagonia recognized these issues and sought to create a more sustainable and traceable supply chain for its clothing, especially its recycled materials line.

The American brand approach to sustainable product traceability centres around several key elements:

- **Recycled Materials**[53]: Patagonia is firmly committed to using recycled materials in its products. This includes recycled polyester from plastic bottles and recycled down from old products. The first step in traceability is tracking the sourcing of these materials.

- **RFID Technology**[54]: The company utilizes Radio-Frequency Identification (RFID) technology to tag and trace each garment made from recycled materials. RFID tags contain unique identifiers and information about the garment's composition.

- **Blockchain for Transparency**: Patagonia stores data from RFID tags in a blockchain, a secure, tamper-proof digital ledger. This ensures the transparency of the information recorded and allows stakeholders, including consumers, to access this data.

[51] https://www.cascade.app/studies/patagonia-strategy-study

[52] Material Traceability - Patagonia. (n.d.). https://www.patagonia.com/our-footprint/material-traceability.html

[53] Rattalino, F. (2017). Circular advantage anyone? Sustainability-driven innovation and circularity at Patagonia, Inc. Thunderbird International Business Review, 60(5), 747–755. https://doi.org/10.1002/tie.21917

[54] Rhodes, M. (2016, November 28). Patagonia's new Super-Recycled collection is super impressive. WIRED. https://www.wired.com/2016/11/patagonia-recycled/

Patagonia has successfully implemented a cutting-edge digital traceability system to promote sustainable product traceability. This has brought numerous benefits, including heightened transparency and trust with consumers who are increasingly interested in the ethical and sustainable practices of the brands they support. By utilizing advanced RFID technology, the company can ensure the ethical sourcing of materials and maintain quality control by closely monitoring each garment's journey and storage conditions throughout the supply chain. This guarantees top-notch product quality. Additionally, in the unlikely event of a product recall, the system enables quick and precise identification of affected products, significantly reducing risks and ensuring consumer safety. Through detailed tracking of clothing's journey, Patagonia can also pinpoint areas where environmental impact can be minimized, contributing to a more sustainable future.

The fashion brand is committed to sustainability not only through digital traceability but also through various initiatives. One of these is the Worn Wear[55] program which encourages customers to buy and sell used Patagonia clothing. This program promotes the idea of a circular economy and reduces textile waste. Another initiative is Patagonia's use of recycled materials. The company continuously explores innovative ways to reduce its environmental footprint. In addition to this, Patagonia actively shares its supply chain information, sustainability reports, and environmental impact assessments with the public. Through digital platforms and campaigns, Patagonia also educates consumers about the environmental impact of the fashion industry and how their choices can make a difference.

Patagonia has taken a significant step towards transparency with their digital traceability system, but there are several challenges and opportunities on the horizon. Ensuring data privacy and personal data security are crucial concerns for both the traceability system itself and its users. Additionally, scaling the model and encouraging other fashion brands to adopt similar traceability systems are important for creating an industry-wide impact. Patagonia is also focused on educating consumers on how to use the system effectively and make sustainable choices. Lastly, the company is dedicated to staying at the forefront of technological advancements to continually improve their traceability system.

In conclusion, Patagonia has made remarkable strides in promoting transparency, ethical practices, and environmental sustainability in the fashion industry through its adoption of digitalization for sustainable product traceability. By leveraging RFID technology and blockchain, the company has established an unparalleled level of transparency, empowering consumers to track their clothing from

[55] Patagonia - Worn wear. (n.d.). https://eu.patagonia.com/it/it/wornwear/

recycled materials to the finished product. This dedication to ethical and sustainable practices not only instils consumer confidence but also sets a positive example for the entire fashion industry. Patagonia's ongoing efforts to refine and expand its traceability initiatives exemplify the hallmarks of a modern, responsible, and sustainable corporation.

# Conclusion

As the world evolves at a rapid pace, Industry 4.0 technology is significantly impacting sustainability practices. It is crucial to recognize that sustainability encompasses not only environmental concerns but also social responsibility as a key component. This thesis delves into the correlation between technology, sustainability, and social responsibility, with specific emphasis on how businesses can leverage technology to enhance social sustainability.

- **Leveraging Technology for Social Sustainability**

Industry 4.0, or the Fourth Industrial Revolution, is characterized by the use of technology to not only boost efficiency but also drive social progress. This era has empowered businesses to innovate and embrace sustainable practices by integrating economic, environmental, and social considerations. With the help of technology, companies can make significant strides towards sustainability, whether by implementing smart manufacturing techniques that conserve resources or leveraging data analytics to optimize their supply chain.

- **CSR and Social Innovation**

It is essential for companies to prioritize Corporate Social Responsibility (CSR) and social innovation in their core strategies in order to achieve social sustainability. CSR involves the integration of social and environmental considerations into business operations, resulting in benefits for both the company and society at large. Meanwhile, social innovation promotes the development of pioneering approaches and solutions to tackle social issues. The combination of these two concepts offers a comprehensive framework for businesses to generate positive social impact.

- **Case Studies: Unilever and Patagonia**

In order to demonstrate how technology can be used for social sustainability, we have analyzed two well-known case studies - Unilever and Patagonia. Both these companies are committed to integrating social sustainability into their business models.

Unilever's Sustainable Living Plan is an excellent example of how technology can be employed to address social challenges. The company's focus on traceability and transparency in its supply chain not only promotes responsible sourcing but also provides consumers with information about the products they use. This approach, powered by technology, enhances the lives of individuals in the supply chain while also meeting the demands of an increasingly aware consumer base.

Patagonia, famous for its dedication to environmental and social responsibility, has implemented innovative technology-driven solutions. By embracing traceability in their supply chain, they ensure that the production of their products aligns with ethical and sustainable principles. This commitment positively impacts the workers and communities involved and resonates with consumers who appreciate their transparency and ethical practices.

- **A Path Forward**

Moving forward, it is critical for more companies to adopt innovative and technology-driven approaches to social sustainability. The examples of Unilever and Patagonia illustrate that it is feasible to create a positive impact on society while running a successful business. The success of these companies indicates a growing trend of integrating technology and sustainabilty into corporate strategies.

In conclusion, this thesis has highlighted the potential for technology, within the context of Industry 4.0, to act as a catalyst for positive social sustainability outcomes. By adopting technology businesses

can operate ethically and responsibly while contributing to the improvement of society as a whole. As we tackle the complicated challenges of the 21st century, it is imperative for businesses to recognize the profound impact they can have on social sustainability through the judicious use of technology and innovative strategies.

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