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THE ROLE OF TECHNOLOGICAL CHANGES IN LABOR MARKETS TRANSITION: FROM HISTORICAL TO MODERN PERSPECTIVE

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ABSTRACT

Computing capability continues to expand at a breakneck pace. New technologies are permeating the economy at an increasing rate. Machines are becoming capable of performing jobs previously solely performed by people due to digitization and automation. Manufacturing processes and organizations are evolving, and new goods, services, and business strategies are emerging. These developments have significant ramifications for labour markets. The changing nature of work in the twenty-first century, the growing gap between skill supply and demand sparked a lively discussion regarding the role of technology in influencing future labour markets and general economic well-being. From historical to current perspectives, this working paper gives data on the effects of technology changes on labour markets. More particular, it seeks to address how technology advancements will transform the current labour market structure. The study uses the descriptive data analysis approach, based on academic literature and quantitative assessments of available data, in order to forecast the impact variables that may influence future labour market results. One of the paper's significant findings is that the main problem will not be the statistics. It refers to the employment structure and the resulting requirement for supply-side modifications to satisfy the shift in demand between occupations and sectors. Finally, this article discusses the policy consequences of systemic changes that first represent the functioning of education and training facilities, their linkages with labour market restrictions, and corporate methods to teach individuals with new skills.

Key words: Technology, Technological Change, Labour Markets, Skill-Biases, Innovation, Technology Diffusion, Future Work..

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1. Introduction

As new technologies change the “division of labour” between people and robots, labour markets are continually shifting (Goos *et al.*, 2019). A discussion over technology and the future of work has captivated media and academic interest in recent years: What is the impact of fast technological development on the quantity and quality of employment, the type of employment, and the structure of labour markets? Scientists, technologists, and policymakers hold radically disparate views, not just in terms of diagnoses and policy conclusions but also, more fundamentally, in terms of emphasis and timeline. This schism has resulted in some controversy and uncertainty (Arntz, Gregory and Zierahn, 2020).

Technological development influences the demand for and supply of labour, with significant implications for individuals and enterprises, employment, pay, and working environment. The ongoing COVID19 epidemic has caused tremendous disruption in the worksite, underlining the necessity of physical closeness at the workplace and sparking changes in company structures and consumer behaviour, many of which are likely to last (Lund *et al.*, 2021). While rapid digital transformation has not resulted in job losses, the question of whether this holds for the impact of future technological breakthroughs remains unanswered. It is unclear whether the upcoming digitization and automation will result in fewer or more jobs (Arntz, Gregory and Zierahn, 2020). These circumstances need the expansion of labour market institutions and policies suited to the needs of the labour market. Acknowledging the developments of the labour market considering the global digital revolution is critical for businesses and governments, given the advent and recent improvements in digital technology.

Human talents and capacities may be developed and improved via education, learning, and meaningful employment, which are essential drivers of economic success, individual well-being, and social cohesiveness. The foreseeable future will need intentional leadership to see a vision of the labour market that meets human potential and creates broadly assigned prosperity (Schwab and Zahidi, 2020). The future of work will need two sorts of changes in the workforce: upskilling, in which employees learn new skills to aid them in their existing tasks, and reskilling, in which employees must learn new skills to take on different or altogether new roles (Kweilin Ellingrud, Gupta and Salguero, 2020).

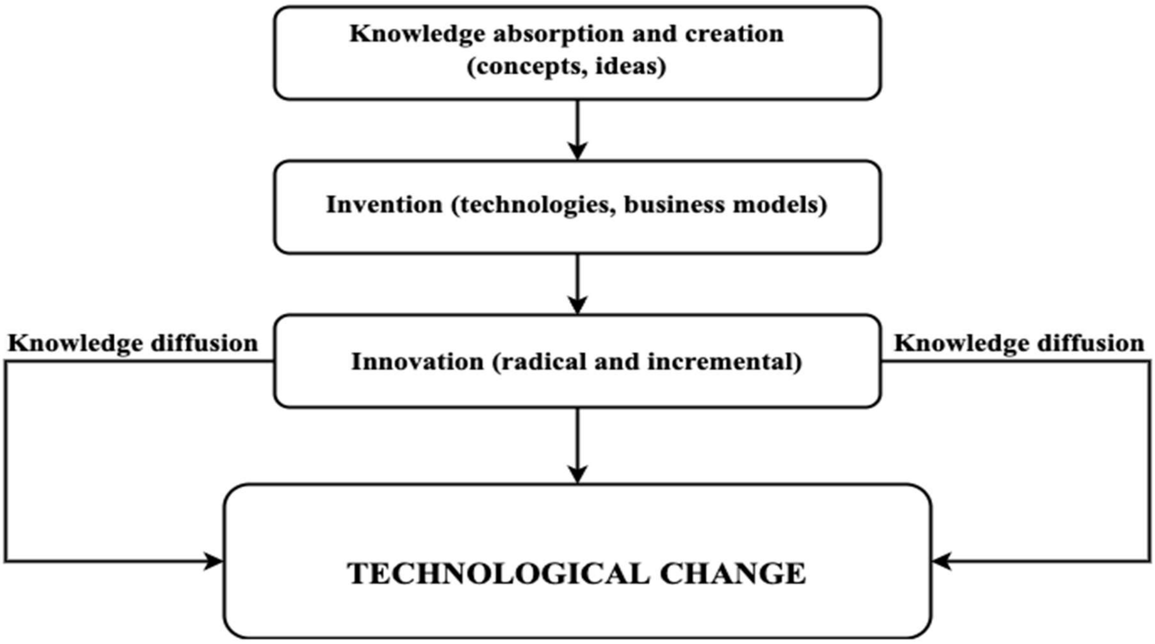
This paper aims to contextualise the various arguments and clarify the differences and consensus conclusions. From a historical to a present viewpoint, the first portion of the study will explain the prominent hypotheses addressing the influence of technological progress and its impact on labour markets. The focus then shifts to the future consequences, looking at new problems that arise as academics forecast the influence of technology on tomorrow's work and employees.

There are five sections to the study. Following the introduction section Chapters 1 and 2 present the theoretical underpinning of the technology and technological change. The emphasis is on defining terms and explaining the significance of the technological change. The third part offers several hypotheses that attempt to explain technological progress. The fourth section examines the dynamics that characterise technological evolution and diffusion processes. Section five discusses the long-term consequences of technological development, with an emphasis on labour markets. It explains the patterns of impact variables and what technological development may entail for future employment. The article concludes with policy implications for long-term labour market development as well as the summary of main findings.

2. Conceptual Framework of Technological Change

To begin with, the conventional definition of technology is the study of arts and crafts. The knowledge of adeptness and talents became increasingly standardised around the turn of the 19th century. Another major factor in development was the establishment of engineering schools in the 18th and 19th centuries. During this time, the definition of "technology" expanded from the study of arts and crafts to encompass and stress purposeful invention and, by extension, the strategic deployment (Goggin, 1959; Rip and Kemp, 1997). According to recent literature (Runiewicz-Wardyn, 2013), technology is the sum of all existing inventions and developments. The most significant product of scientific knowledge, on the other hand, is the invention, which comprises the discovery of new concepts, techniques, or items that may be patented. The transmission of technological knowledge is the adaptation and use of technical information as documented in scientific papers or patents (Crane, 1972). Conversely, technical change is the process of creation, innovation, and dissemination of technological knowledge (Figure **1**).

Figure 1: Knowledge as a Driver of Technological Change and Regional Growth



Source: Runiewicz-Wardyn (2013).

Likewise, Jaffe, Newell and Stavins (2002) trace the process of technological change based on Josef Schumpeter (1942)'s economic theory, which identified three stages in the process by which a new, improved technology pervades the marketplace. The first development of a scientifically or technically innovative product or method is referred to as an invention. Inventions can be patented, although most of them never become innovations. If a company discovers a previously existing technological concept and brings a product or method based on that idea to market, it can innovate without ever creating. The phases of invention and innovation are carried out in private enterprises through a process known as research and development (R&D). Finally, via the adoption of enterprises or people, a successful innovation progressively becomes widely available for use in relevant applications, a process is known as diffusion.

Adoption and dissemination of technology reduce ambiguity about its genuine capabilities, performances, and interdependencies - both technical and social. Indeed, to develop a durable technology, some irreversibility must be built-in, in the sense that the artefact or system cannot be disassembled after it has been assembled. Technology implementation, acceptance, use, and domestication generate and sustain social and technological ties that are difficult to break (Rip and Kemp, 1997). Technology developments become a potent engine for economic expansion and global competitiveness. Traditional production variables, like capital and labour, are no longer adequate for effective competitiveness in the face of fast technological advancement and globalisation (Runiewicz-Wardyn, 2013).

Lessons from previous technological advances support the technology deployment in the marketplace and make a critical component in accelerating technological progress. The perspective of technology as working configurations tends to focus on the artefact. The technologist who brings innovative technology identifies the technology as a novelty or new combinations. Emphasizing the item and the technologist, on the other hand, risks undervaluing the social context into which the innovation is being delivered. However, the social context has its dynamics, formed prospects, and thoughts about the new arrangement. The “progress ratio”, defined as the cost decrease after doubling cumulative installed technology, is one statistic for such transformation. This ratio has remained reasonably consistent throughout time for a specific technology, despite significant variation between technologies. The fact that the progress ratio is typically constant suggests that while technologies are new, they learn quicker from market experiences than when they are mature (Schumpeter and Elliott, 1934; Rip and Kemp, 1997; OECD, 2003).

3. Theories Explaining Technological Change

To comprehend and explain the technological change, a mix of economic and social concepts is essential. This study examines a few theories that may aid in understanding the dynamics of technological evolution.

Starting with mainstream economics, which treats technology as an exogenous variable, argues that it does not need to be studied. In other words, if other economic variables cannot explain economic development, it is the product of technological change (Rip and Kemp, 1997). Kamien and Schwartz (1968) consider the notion of induced innovation within mainstream economics. The authors expand on Shove and Hicks (1933)’s initial remark, stating that the idea of induced technological change has been extended and developed in various ways. The introduction of “biased” technical change may be produced not only by a shift in relative factor prices but also by the price of one component being “high” in comparison to the value of the other factor. This idea, which combines changes in the factor price ratio with the value of the factor price ratio as an incentive for “biased” technical progress, has been integrated into the majority of subsequent assessments (Bloom, 1946; Kamien and Schwartz, 1968).

After Kamien and Schwartz (1968), Binswanger (1974) developed the theory of induced innovation by "reformulation innovation possibilities based on research processes". It is also advantageous, to begin with, practical research procedures. Innovation may be viewed as an investment process in which the research investment portfolio is chosen based on factor costs, research productivities, and research expenses. The outcome of the selection process influences both the direction and the rate of technological change. No business would ever be seen on a technological frontier in such a model.

Binswanger (1974) describes the variables that determine biases and rates of technological development in this model:

- The relative productivity of various research paths. It includes the size and biases of innovation possibilities, as well as the exogenous changes. If capital-saving research outcomes are easier to get than labour-saving outcomes, then technological change will tend to be capital-saving.
- Similarly, an increase in the cost of capital-saving research will tend to skew technical progress in labour-saving. The following variables influence both biases and rates of technological change.

Nelson and Winter (1982) offer an evolutionary theory of technological changes based on the diffusion of new technologies and considerable study on the difficulties of technology transfer. An evolutionary theory of growth provides a framework that is substantially more capable of combining micro and macro elements of technological advancement than the neoclassical model modified by the addition of variables that reflect technological developments.

Technological progress as a driving force has been considered behind various economic phenomena, including productivity growth, firm competitiveness in industries such as electronics and pharmaceuticals, patterns of international commerce in manufactured products, and many more. Empirical investigations conducted in the 1950s revealed that increases in complementary inputs per worker could not account for the historical expansion of GNP per worker in the United States since there was a substantial unexplained surplus. When models that "anticipated" the emergence of such a residual as a result of something termed "technical progress" arose, they retained most other elements of conventional static theory. They specifically maintained the fundamental assumptions that companies in the economy maximise profit flawlessly and that the system is in (moving) alignment. When technological advancement in an industry is quick, nations that are more effective in attaining technological advancement have a competitive advantage, even though their factor costs are high. As the rate of technological progress slows, technology prowess becomes less vital, and rising factor costs impose a higher penalty (Nelson and Winter, 1982).

Sociological explanations arise after Nelson and Winter (1982), while Van den Belt and Rip (1987) propose quasi-evolutionary ideas. The authors give sociological content elaboration and expansion. These emphases and extensions are concerned with the dynamics of technological progress as defined by “technological paradigms” and “technological trajectories”.

The set of accessible procedures might regard the “genetic” make-up of an organisation in the quasi-evolutionary approach. Government policies and other institutional structures are incorporated in the selection environment to determine whether routines are feasible enough to be adopted by companies. The mechanism does not work only based on company growth differentials. Innovation is the process for economic and technological progress that is comparable to a genetic mutation. Because creative actions may adhere to search heuristics, they may be patterned. It does not, however, mean that the outcomes of innovation are predictable. As a result, firms may have unique routines, possibly change existing practices, or begin entirely new ones. Although the evolutionary theory appears to be comprehensive, it sees technological growth as more structured than heuristics suggest. In such circumstances, a technological regime generates technological trajectories to exist (Van den Belt and Rip, 1987).

The trend of aircraft design does not necessarily represent technological advancement. Heuristic search processes may follow a considerably less directed pattern; they may be primarily driven by “obstacles” in a network of related processes when and where they occur. There are also strong heuristic principles that are not specific to a single regime but are followed in a wide range of technologies, resulting in what are known as generic trajectories: mechanization and the gradual exploitation of latent economies of scale are two examples. Thus, technological advancements occurring inside a technological regime or paradigm confront a unique scenario (Rosenberg, 1976; Van den Belt and Rip, 1987).

Continuing sociological explanations, sociotechnical theories are developed to explain the connection between sociology and technology. Hughes (1983) has shown how network architects integrate sociological and technological aspects to make the environment part of the system.

Long has social science study on technology concentrated on the creation, dissemination, and the implications of certain isolated technologies or technological artefacts: the steam engine, vehicle, telephone, computer, and so on. It has been acknowledged that the existence of sophisticated and massive technical systems - geographically extended and functionally integrated sociotechnical networks such as electrical power, train, and telephone systems - is an essential feature of contemporary technology. These systems have played a vital part in industrialization and economic growth, which have led to a substantial shift in lifestyle (Mayntz and Hughes, 1988).

When Hughes (1983) released Networks of Power, social scientists interested in technology responded with bated breath. As a result of the creation and operation of massive technical systems, a new field of study formed where historians and social scientists collaborate. As an outcome of their collaboration, Mayntz and Hughes (1988) employed a socio-technical approach to addressing challenges in massive technical systems. Hughes (1983) frequent warned to regard corporations, utilities, professional groups, finance, and regulatory agencies as significant components of electric power networks is curiously incorrect in the context of sociological studies of technology. The reason for this is because, with a few exceptions, physically embedded technology has not been acknowledged as a legitimate subject matter of technology sociology. When it comes to technology, the conceptual technique for making it susceptible to social scientific study is analogous to those other social phenomena.

4. Dynamics of Technological Change

4.1 Innovation

Technical change occurs outside of the company and is influenced by the dangers and opportunities in its environment. The study of innovations is only one point of entry into the processes of technological development. Coevolution is the general trend of technological change. When the focus is on companies, the coevolution is that of supply and demand. When technology is in the spotlight, coevolution becomes a more complicated phenomenon (Utterback, 1994; Rip and Kemp, 1997). Expanding technological change and advancing up the technology hierarchy, from low to high value-added industries, is required for economic competitiveness to be maintained. These industries generate decent jobs, boost production and commerce, and promote ongoing innovation (Runiewicz-Wardyn, 2013).

Innovation has three overlapping phases or subprocesses: (1) idea development, (2) issue resolution, (3) execution, perhaps followed by dissemination. The idea generation step culminates in the designing concept or technical proposal through the synthesis of various existing pieces of information. The problem-solving phase yields an original technological solution, sometimes known as an innovation. The implementation phase culminates with the market introduction of the original resolution, so transforming it into an invention. Diffusion is the process of communication and expanding use by which invention gains a substantial economic influence. It is not precisely a part of the specified innovation process because it occurs outside of the firm (Utterback, 1971).

According to Ertürk (2009), technological innovation is the most crucial aspect influencing a firm's competitiveness. With the emergence of information economies and globalisation, organisational innovation has gained a vital role in improving business economic performance (Annavarjula and Mohan, 2009). Technological innovation is defined as considerably better technological novelty/change that provides economic benefits to enterprises. Established, high-volume items such as incandescent light bulbs, paper, steel, standard chemicals, and internal combustion engines, for example, demonstrate technological innovation. In this setting, incremental improvements are widespread, with a slow, emulative influence on production (Abernathy and Utterback, 1978). While though, technological innovation encompasses both technological invention and success in the economy (Ertürk, 2009).

The literature on innovation also emphasises that the effect of accumulated knowledge and research discoveries on technological change is determined by the type of innovation implemented: radical or gradual. Radical innovation entails significant technical improvements, which often need substantial sums of money spent on R&D for relatively unpredictable returns on investment. On the other hand, incremental innovations refine or harness the potential of already established industrial processes or products (Runiewicz-Wardyn, 2013). According to Rip and Kemp (1997), every act of technology adoption (from implementation to local acceptability) entails specific changes and is thus an act of innovation in and of itself. Two trends have been identified in the transfer of technology to other businesses and organisations:

- **Disembodied** diffusion, which stems from factors, define the innovation process and research spill overs as a business of creating a new concept or procedure unable to appropriate the benefits of its invention

- **Embodied** diffusion, equipment-embodied diffusion (acquisition of machinery, components, and other equipment), and knowledge and skill dissemination are all examples of embodied diffusion.

Complex technological breakthroughs necessitate a process of invention that integrates information from several scientific areas, also the interaction between numerous individuals. Another economic difficulty arising from technological development stems from the nature of knowledge as a non-consumable, and hence public, good (where consumption by one does not preclude consumption by someone else). It opens the door to spill overs: knowledge provides more advantages than the producer can collect. Human beings' ability to learn and innovate has become a feature of productivity. Electro technics and telecommunication systems have had and will continue to have a ubiquitous influence on local, regional, and national economics (Rip and Kemp, 1997; Runiewicz-Wardyn, 2013).

The activities and strategies of the people, businesses, and technological organisations directly engaged are crucial for the dynamics of technical development. Actors' tactics are based on their concerns about what factors contribute to success and their assessment of the environment. Innovation studies have addressed these problems to discover success criteria. The other central focus of innovation research has been to identify perceived trends on how businesses should become more agile (Rip and Kemp, 1997).

4.2 Technology Fusion and Networks

Production technologies are complex systems with interdependent elements. Changing one of these parts necessitates costly system modifications, referred to as interconnectedness costs. This idea may apply to technical systems, with several consequences. The more interconnected a current technological system is, the less probable it is that a subsequent invention will be compatible with it unless it is specifically built for this system. In other words, the direction of incremental and process innovations varies during the evolution of system technologies, such as in the car industry (Abernathy, 1978; Metcalfe, 1990; Rip and Kemp, 1997).

Some companies are skilled at combining several technologies to develop new goods that revolutionise markets. A corporation can either spend in R&D to replace an earlier generation of technology (the "breakthrough" strategy) or focus on integrating current technologies into hybrid technologies (the "technology fusion" approach). The fusion of technologies is nonlinear, complementary, and cooperative, which may be fostered by industrial strategy. It integrates incremental technical improvements from previously different domains of technology to create market-changing goods. Fusion-type innovation contributes to the slow expansion of all enterprises in the relevant industries rather than the rapid growth of a certain (Kodama, 1986, 1993).

Based on Japanese businesses, Kodama (1993) cites three fundamental characteristics critical to technological fusion: First, rather than the other way around, the market drives the R&D agenda. Second, organisations require intelligence-gathering skills to stay up with technological changes both within and outside the sector. Third, technology fusion emerges from long-term R&D collaborations with a wide range of enterprises from many industries.

The institutional factors that affect the speed of diffusion were described in Rosenberg (1982)'s book while highlighting the importance of things like decreased transaction costs in creating the climate for innovation. Rosenberg relies on Saxonhouse (2010)'s example of the reduced prices of obtaining required knowledge about new technology, which appears to have played a role in the timing of innovation spread. Because of the low cost of receiving knowledge by textile enterprises, the Japanese textile sector has a "superfast" cover of best-practice procedures. These economic prices are attributed to the efforts of a company trade organisation, the usage of a unified capital goods supplier with an active sales engineering team, and a high level of technical collaboration among enterprises (Davis and North, 1971; Rosenberg, 1982). Powell (1990) presents a conceptually equivalent study using a similar strategy. According to the author, firms pursue cooperative agreements to gain rapid access to new technologies or new markets for various purposes. The main goal is to share the risks associated with activities and benefit from scale economy, know-how, etc. There is no apparent link between the legal structure of cooperative partnerships and the goals they attempt to achieve. However, they strive to explore innovations through cooperation without exposing the collaborating partners' identities and personalities.

Individual units exist in network types of resource allocation not for themselves but the sake of others. As networks evolve, it becomes more cost-effective to use voice rather than exit. Benefits and burdens are shared. Furthermore, networks can be complex: they do not entail either the clear market criteria or the typical paternalism of the hierarchy. The fundamental premise of network interactions is that one party is reliant on resources held by another (Powell, 1990).

Network organisational structures are well-suited to a highly trained labour force. As a result, networks are more likely to form and spread in sectors where information and skills do not lend themselves to monopolistic control or usurpation by the highest bidder. Sociotechnical connections indicate that the regional level is essential as geography of externalities. Network effects may not result in superior technology and efficiency over time: there will be bind (path dependencies) and perhaps substandard technology. Because of the feedback and feed-forward relationships in the dynamics, technical change is inescapable. Vertical integration[2] was a highly effective method when the speed of technological development was relatively gradual, manufacturing processes were well known and standardised, and production runs turned out with many comparable items. However, as the speed of technological development accelerates, product life cycles shorten, and markets grow more specialised, the drawbacks of large-scale vertical integration can become significant (Powell, 1990; Rip and Kemp, 1997).

4.3 Coevolution and the Malleability of Technology

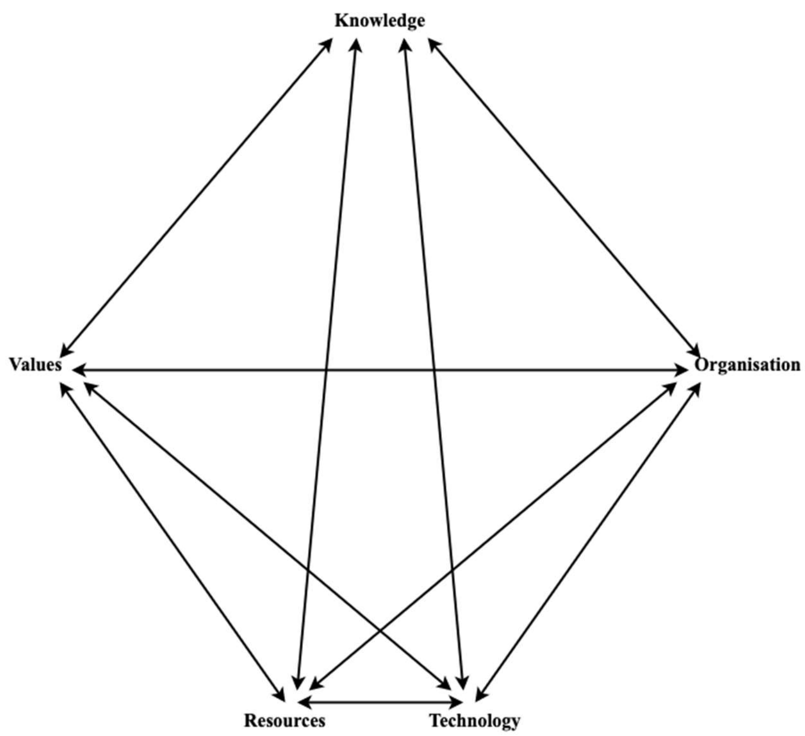
Sophisticated empirical scientists of technological progress have long recognised that the institutional structures that support it impact the rate and type of technological advancement. However, there has been minimal interaction between evolutionary economists writing on technical change and economists emphasising the significance of institutions in economic growth. The basic idea that technological progress follows an evolutionary process has been established separately by researchers of technological progress working in a range of areas. A comprehensive and explicit investigation of all sorting processes, that is, all viable causes for economic survival, not simply production efficiency, should be part of an evolutionary approach to economic transformation (Nelson, 2013).

According to Norgaard (1988), belief in technological advancement also serves as an attraction to spread values, knowledge, and modern systems of social structure to other cultures (Figure 2). The public consensus driving the transformation in both the developed and developing worlds has relied heavily on the widespread belief in technological development. People understand that every new technology, even ones invented to solve issues caused by previous technologies, has unintended consequences. The appeal for sustainable development, broadly considered, resonates with the emergence of new understandings of environmental systems, technology, social structure, knowledge, values, and interplay between them. Different new insights challenge the idea that these domains can be comprehended individually

[2] Vertical integration is a business approach that enables a corporation to simplify its operations by assuming direct ownership of various stages of its manufacturing process rather than depending on external contractors or suppliers (*Vertical Integration Definition | Investopedia*, 2021)

and do not interact. The potential for transformation is great if the concept of sustainability replaces the notion of development. Knowledge, values, social organisation, technology, and resource systems are symmetrical in their interweaving; no system dominates the others; thus, each is considered in the context of the others.

Figure 2: A Coevolutionary View of Development



Source: "Sustainable Development: A Co-Evolutionary View" (Norgaard, 1988)

For several factors such as the existence and relevance of technical linkages, complementarities, tacit knowledge, and learning, there may be a technological supply and demand imbalance. The nature and pace of technical change are connected to constraints. It is not to argue that the technological push paradigm should be revived. Studies and experience have demonstrated the relevance of the demand side, but not always a demand-pull. The overall point regarding technological change is that users and consumers must constantly learn to utilise a (new) technology while not forgetting express demand (Rip and Kemp, 1997).

While underlining the factors of uncertainty in technological advancement, it is crucial to emphasise the heavy systematic selection that many market systems provide. In most cases, there is a substantial body of technology understanding that guides what types of projects are likely to be technologically successful and which ones are not, as well as an understanding of user needs, which provides strong guidance on what advances would be valuable. As a result, the technology "mutations" available to the market-selection environment are far from random. It guides technical advancements together with selection (Dugger and England, 1995).

Technology has a certain non-malleability, not because actors lack the power or resources to acquire what they desire, but because technical innovations have laws of their own: from heuristics in search processes to the typical methods of doing things in a technological regime. These laws result in the specific shape that irreversibility adopts of technological evolution in communities. Technology impacts human agency by encouraging distinct themes of activity rather than enforcing a singular and mechanistic utility (Rip and Kemp, 1997). The unique method in which each technology frames its reference area and organises its operations curves routes of action. The variety of jobs that may be completed utilising a given technology is undoubtedly an essential component. However, the degree to which people use smaller or larger enclosures of the range of capabilities embedded in a particular technology is not evidence of the malleability and interpretation of the technology (Orlikowski, 2000; Kallinikos, 2002). Cumulativeness is one of the features of technology's non-malleability that is connected to supply-side dynamics. In this regard, the OECD (1992) acknowledges three fundamental aspects:

- **Technical knowledge accumulation** - Because technological advancements are usually conducted locally, they cannot be transported without effort. There are two types of learning processes: learning by doing and learning by using. As a result, businesses, institutions, or nations that have developed skills are better positioned to respond to new technology opportunities.
- **Paradigms and trajectories** - A technical paradigm encapsulates the relevant problem and offers future research possibilities. The patterns direct and channel engineers' and the organization's efforts and technological creativity.
- **Increasing return on adoption** - Contrary to popular belief, technology is often selected not because it is efficient but because it has been preferred. One argument for rising adoption is that when a technology spreads, more are known about how to use it, it improves, and it is more likely to be accepted by subsequent users.

5. The Long-Term Effects of Technological Change

According to Schumpeter and Elliott (1934), there is always the chance that some fundamentally new technology may emerge, resulting in fast economic development and improving living standards, even in the absence of a significant population increase. The environmental impact of radical new technologies is also unclear because no one can foresee the effects of technologies that have yet to be created. In this regard, Rip and Kemp (1997) cite three long-term patterns as essential to comprehend the growth of technology and society, as well as the existing situation (Giedion, 1948; Foucault, 1977; Beniger, 1986; Rip and Kemp, 1997):

- Early forms of automation, such as mechanical calculators and punch-card machines, were examples of mechanisation. Frequently, it is misunderstood as a separate force. Nonetheless, the trend looks to be in control, at least for the time being.
- Technology development for regulation and management of manufacturing processes, organisations, and society in general. New information and communication technologies should be viewed as a reaction to the control issue that arose after the middle of the nineteenth century after the fast expanding of industrial production, transportation, and mass consumption.
- The growing importance of software in hardware management. The obvious example is software creation and usage in computer technology, with the introduction of programming languages in the late 1950s serving as a pivotal point. The introduction of operations research and traffic engineering in telephone networks is part of a broad definition of software. Software is also used to create and discipline activities and organisations based on blueprints. In general, software, like computer software, counts as technology. The larger concept of the software is linked to historians' and sociologists' analyses of how technology is used to monitor and punish individuals, organisations, and society.

5.1 Impact of Technological Change on Labour Markets

Technological progress is the main factor of economic growth and living standards. It enhances productivity, raises income and consumption, influences the variety and quality of work and the structure of societies (Geels, 2005). Technological advancements and globalisation cause changes in labour markets. New technologies displace people in regular jobs, eliminating some and altering the extent of others. Global competition causes manufacturing to migrate, eradicating employment in one location while generating new ones in another. These developments have an impact on new types of jobs and skills (Czaja and Urbaniec, 2019).

5.1.1 Historical Overview

Work has always been a fundamental element of daily life, from the Palaeolithic hunter/gatherer and Neolithic farmer to the mediaeval craftsmen. In 1995 Rifkin (1995) predicted that in less than a century, "mass" labour in the market sector is expected to be phased out in nearly all the world's industrialised nations. A new generation of sophisticated information and communication technology is pushing into a wide range of work environments. Sophisticated technologies are replacing people in various occupations, forcing millions of blue-collar and white-collar workers out of work or, worse, into poverty.

Discussing the early form of technology intervention on labour markets, worth noticing industrial revolutions, technological changes which established innovative ways of working and subsisting and radically changed civilisation began in Great Britain in the 18th century[3]. As Phyllis Deane describes in his book First Industrial Revolution (Deane, 1979), *"to achieve the shifts in the structure and rate of growth of national output of which an industrial revolution is composed, there must be profound changes in both the quantity and the quality of the labour force"*. One of the characteristics of the first industrial revolution which contributed to the growth in labour input into the manufacturing process was the increase in the average number of hours worked per worker per day was. Alongside, the Second Industrial Revolution which began in the middle of the 19th century was a further huge step forward in technology and society[4]. Another characteristic of the second Industrial Revolution worth emphasising, according to Mokyr and Strotz (1998), is the changing form of industrial organisation. As a result, *"if ever there was a labour-saving invention, this was it"*.

After the Third Industrial Revolution, when technological capabilities were refined and strengthened, the first tracks of skill-biased labour-market impact arose[5]. In his book - "The

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[3] In modern history, the Industrial Revolution was from an agricultural and handicraft economy to one dominated by industry and machine production (*Industrial Revolution | Britannica*, 2021)

[4] The Second Industrial Revolution began in the middle of the nineteenth century (1850-1970). It was an era of expansion for current businesses as well as growth for new ones, such as the steel, oil, and power sectors (Vale, 2016)

[5] The Third Industrial Revolution, often known as the Digital Revolution, began in the late 1900s and was marked by the development of automation and digitization via electronics and computers, the advent of the Internet. This

Third Industrial Revolution: Technology, Productivity, and Income Inequality" - Jeremy Greenwood described this phenomenon: *"the advance in technology will be associated with an increase in the demand for the skill needed to implement it. Hence, the wages of skilled labour relative to unskilled labour, or the skill premium, will rise, and income inequality will widen. In the early phases, the new technologies may not be operated efficiently because of inexperience"* (Greenwood, 1997).

As it promises substantial changes in the labour market, the Fourth Industrial Revolution certainly demonstrates a skills-biased influence on the labour market. Since 2011, advanced manufacturing has been experiencing a paradigm change known as the Fourth Industrial Revolution, often addressed as Industry 4.0. The characteristics of the Fourth Industrial Revolution are destined to have a wide range of consequences on occupations, which will no longer be restricted to a single industry but will influence all industries (Flynn, Dance and Schaefer, 2017). *"New technology revolution will provoke more upheaval than the previous industrial revolutions",* warns Klaus Schwab in his book "The Fourth Industrial Revolution". Thus, continuous: *"In light of these driving factors, there is one certainty: new technologies will dramatically change the nature of work across all industries and occupations. The fundamental uncertainty has to do with the extent to which automation will substitute for labour"* (Schwab, 2016). In Industry 4.0, diverse talents will appear for manufacturing and service. New employment will have to be created, which will need the development of new job concepts that did not previously exist if robots take over many of the duties that humans now undertake (Bulte, 2018).

Industrial technologies removed the physical force of human work, swapping machines for muscle and brawn; modern computer-based technologies assure to replace the human intellect itself, substituting thinking robots for humans throughout the whole spectrum of economic activity (Rifkin, 1995). According to Dachs (2017), the development of the European labour markets proves the skill-biased nature of technology. In terms of workplace arrangement and structure of work, experts assume more self-employment, project structures and an extension in the share of tasks contracted and performed over platforms outside the company.

period is the era of the transition from computers to new technologies that enable the automation of industrial operations (*Timeline of Revolutions | MDS Events Newsroom*, 2021)

5.1.2 Skill-Biased Technological Change

The employment of new technology in production, the launch of new goods, or organisational changes may also alter firm skill needs and, as a result, the skill structure of the labour force. It might have a significant impact on the employment market and necessitates a shift in skill supply (European Commission, 2016). Technology can be biased in favour of certain groups of workers depending on their skills or tasks, they complete. Technology is skill-biased while tends to skilled workers, increasing their productivity when using technology at work and consequently, increasing the demand for their labour services, with little or no direct effect on unskilled workers. Common examples of skill-biased technical change (SBTC) are information technologies, which are used more intensively by skilled workers than by unskilled workers[6].

However, innovation and new goods and processes modify the sorts of skills that businesses require. There is a trend that technological change supports high-skilled, non-routine or low routine occupations and reduces employment possibilities in low-skilled and routine works. Many of these jobs may be displaced by technologies, in particular Information and Communications Technologies (ICT). Enterprises based on ICT imply a distinct set of skills than firms based on mechanical technology (Dachs, 2017).

Technology is a skill-nonneutral; it tends to favour specific abilities while devaluing and making others obsolete. This trend, dubbed “skill-biased technological change” in the literature, has been frequently observed and carefully investigated by Acemoglu and Autor (2011). The relative need for skills is related to technology, specifically the skill bias of technological progress. This viewpoint stresses that the return to skills is controlled by a race between the rise in the labour-market supply of skills and technological development, which is thought to be skill biased, in the sense that technological advancements naturally boost demand for more “skilled” employees.

Despite evidence of simultaneous increases in the supply of and demand for skills on several occasions, distinguishing between exogenous and endogenous technological change is challenging. According to the exogenous technical change theory, technological change is frequently skill biased. Endogenous technical change theory proposes that as the supply of skills rises, emerging technologies should be skill biased. Because the quantity of skills has generally grown, the consequences of the two models are relatively similar. The analysis

[6] The impact of new technologies on the labour market and the social economy, (WTO, 2017)

handled and reviewed the indications of the supply and demand of skills as exogenous. The number of talents will respond to economic incentives as well. When skill premia are high, more employees are likely to gain skills. If the long-run demand curve for skills in this circumstance is upward climbing, a steady-state path will exist in which the comparative quantity of skills and the skill premium rise with time (Acemoglu, 1998, 2000).

Exogenous Skill-Biased Technological Change

According to Acemoglu and Autor (2011), the typical model considers technology exogenous and often believes that technological change is skill biased. However, data shows that the degree of skill bias in technical progress has changed over time and among nations. Under very general settings, theories of endogenous (directed) technological evolution predict that as the supply of highly skilled employees rises, technology should become more skill biased (and conversely, less skill biased following increases in the endow of low skill workers).

The first set of technological explanations attributes the acceleration in skill bias to exogenous technology advancements, arguing that a "technological revolution" began in the 1970s or 1980s, resulting in more rapid skill-biased technological change. Many proponents of this view contend that the acceleration of skill bias is, at least in part, due to advances in information technology and computers (Acemoglu, 2000). In the United States, between 1984 and 1989, the percentage of workers who reported using a computer at work climbed by more than 50 per cent, rising from 24.6 per cent to 37.4 per cent of the labour force (Krueger, 1993). In the 1980s, computers had a significant influence on the workplace. The percentage of investment committed to computers tripled between 1977 and 1987, rising from 2.8% to 7.5%. The effect of computerization on skill demand is determined by whether this type of capital supplements or replaces skills (Berman, Bound and Griliches, 1994).

Beginning in the 1970s, skill-biased technical and organisational developments associated with the computer revolution appear to have contributed to a quicker rise in relative skill demand within specialised sectors. The found substantial conditional correlations of computer metrics and the increase in the comparative utilisation of highly educated employees may not simply represent causal links. It appears clear that whatever has been driving the rapid rate of within industry skill upgrading over the decades is concentrated in the most computer-intensive sectors of the US economy (Autor, Katz and Krueger, 1998).

Between 1979 and 1992, the average unemployment rate in European OECD nations rose from 5.4 per cent to 9.9 per cent and has remained high, with most unemployed individuals being unskilled. Several theories have been advanced in the literature to explain the fall in demand for unskilled labour. While there is little agreement, labour economists usually feel that skill-biased technology progress is to blame. This idea follows the set of four findings: (1) Job changes to skill-intensive industries appear too minimal to be explained by adjustments in product need. (2) Despite the rising cost of skilled labour, most US industries have increased their skilled labour ratios to unskilled. (3) There arise to be solid, within-sector connections between factors of technological change and elevated demand for skills; and (4) the nature of innovations frequently recognises innovations that reduced or are likely to reduce production labour requirements (Berman, Bound and Machin, 1998).

Theories that explain the rise in inequality because of fast technological advancement have several appealing characteristics. First, many economists and analysts see improvements in computer and information technology as a departure from previous technologies that are open to the possibility of being during a technological revolution. Second, various data suggests that competent employees have a competitive advantage in dealing with fast technological change (Acemoglu, 2000). Bartel and Lichtenberg (1987) support this idea by describing the link between education and the introduction of new technology or technological development in their work. These differences entail two distinctions, according to the authors. One between the acceptance and implementation of new technology, and the other between the short-run and long-run influence of technical change on skill or educational needs. There is a body of proof from studies of both consumer and producer (entrepreneur) behaviour indicating more educated people embrace innovations faster than less educated people. They separate their theory by what is known as the biased technical change hypothesis. If technological change is biased, the shift from old to new technology will result in permanent changes in equilibrium factor shares while retaining production and relative factor prices constant. While though Bartel and Lichtenberg (1987) do not comment on whether, in the long run, new technologies are more educated-labour-using than the technologies that they replace. However, they imply that sectors or businesses with substantial rates of innovation and, as a result, a continual implementation of new technology are likely to generate the most chances for highly educated individuals.

Foster and Rosenzweig (1996) provide more evidence of the consequences of exogenous technical change on the returns to schooling based on panel and time-series data from India’s green revolution period. Technological change has a direct impact on the returns to education. Individuals who are more educated are either have better equipment to manage new technologies or become aware of profitable breakthroughs at an earlier stage of development than their less-educated competitors. Furthermore, technological development is likely to have a higher impact on profitability in an educated society than in an illiterate population. As a result, it matters for the ensuing rates of economic development spurred by technological progress, as well as the consequent income distribution. Based on the research on the returns to education, technological development leads to increased private investment in education. The returns to technical change are broader in places with higher levels of education. As a result, the authors contend that returns on investment in technological change will be significant in general when primary schooling is available and returns on investment in education will be higher when technical change is faster.

Endogenous Skill-Biased Technical Change

Thus far end, the theories mentioned assume that technological change is skill-biased by nature. A different point of view is to relate the types of technologies created and used to financial incentives or demand-pull. Historically, profit incentives and possibilities are vital for the development and implementation of new technologies. It is also the method adopted by endogenous growth theory, which uses profit incentives to determine the overall pace of technological development but not the degree of skill bias (Acemoglu, 2000).

Romer (1990) has also produced conceptually comparable work. The author makes three claims in support of the role of technological change in increasing productivity per worker. The first idea is that technical advancement - specifically, improvements in the instructions for combining basic materials - is at the heart of economic prosperity. Technical development encourages continuing capital accumulation, and capital accumulation and technological change account for a large portion of the growth in production per hour worked. The second premise is that technological development is the purposeful activities performed by people in response to market incentives. As a result, the concept is one of endogenous technological development rather than an exogenous technical change. The idea here is that market incentives play a vital part in translating new knowledge into items with actual use. The third and most important premise is that instructions for dealing with raw materials are fundamentally different from instructions for working with other commercial products. Creating new and improved instructions is the same as incurring a fixed cost. This attribute regards the distinguishing feature of technology.

According to the hypothesis of endogenous skill bias, profit opportunities influence the extent of technological breakthroughs. The usage of microprocessors to create improved scanners, increasing the productivity of unskilled labour. Advanced computer-assisted machinery, on the other hand, would be employed by skilled personnel to replace unskilled ones. Computers become more lucrative to produce than scanners as there are more college graduates, which explains the acceleration of skill bias. Firms' endogenous response to increased supply will enhance demand for skills. According to this argument, higher supply may be the cause of increased skill premia. The market for skill-complementary technology expands as there are more skilled people. Thus, the investor may earn increased revenues and give more effort to the skill-complementary technologies. As a result, two conflicting forces govern the effect of increased skill supply on the skill premium: the first is the traditional substitution effect, which causes the economy to move along a downward sloping relative demand curve. The directed technology effect, which modifies the relative demand curve for skills, is the second. (Acemoglu, 1998, 2000).

Likewise, Kiley (1999) addressed the problem of enhanced skilled labour supply, which might alter technological bias through endogenous technology choices. The author emphasizes that the attractiveness of investing in skill-biased technology is determined by the availability of the component that complements that technology; specifically, a greater quantity of skilled people increases the incentives to invest in technology that skilled labour employs. These considerations suggest that a higher proportion of skilled labour increases the degree of skill-biased technology relative to unskilled-biased technology. In the labour economics literature, a rise in the supply of skilled labour leads to an increase in the demand for skilled labour via increased technical advances suitable for skilled labour. This impact creates higher relative salaries for skilled labour (in the long run) in response to an increase in skilled labour's percentage of the workforce.

According to the hypothesis explaining the acceleration of skill bias, the fast expansion in the supply of college-educated employees throughout the 1970s caused a more dramatic shift towards skill-biased technology, boosted demand for skills, and elevated the college premium. As the economy moves along a constant technology, a quick rise in the supply of skills would initially diminish the skill premium. After a period, technology would react, and the economy would revert to an upwards sloping relative demand curve, with a significant increase in the college premium. This argument explains both the drop in college premiums during the 1970s and the subsequent big spike, and both are related to the substantial growth in the supply of skilled employees (Acemoglu, 2000). Goldin and Katz (1995) present examples of historical periods in which a significant increase in the availability of talents appears to have influenced the direction of technological advancement. In the 1910s, high school enrolment and graduation rates doubled, although the skill premium declined dramatically. Despite rapid growth in the supply of high school talents throughout the 1920s, the skill premium levelled off and began to rise somewhat. The authors acknowledge complementary explanations for the significant decline in the wages for high-school educated employees. Technological advancements in the workplace permitted the replacement of machines and skilled labour for the exceptional worker. The quality of high school graduates may have deteriorated as high schools grew and became more accessible to the public. And as they grew, they may have taught fewer demanding courses.

5.1.3 A Glimpse into Labour Markets

In addition to being the primary source of economic development, technological development has implications for distribution. It is frequently skewed towards specific elements of production and certain sorts of employees. There is evidence that job division and structural change, both of which have significant ramifications for the labour market, come from unequal technological growth[7]. Technology is altering the way people work, but questions about which jobs are lost and which are gained - and who those changes affect - are essential in determining whether people will be able to transition from working in occupations of yesterday to the employment of future[8].

Common concerns that emerging technology would render labour obsolete in an increasing number of industries have lately been fuelled by research claiming that up to half of all employment in the United States will be automatable over the next two decades (Goos *et al.*, 2019). One key point to comprehend about the discussion over technology and inequality is that practically all of it tries to explain the current situation, but not necessarily tomorrow. Extrapolating beyond existing, backwards-looking data is required to understand how technological progress will affect employment in the coming decades. The Open Society Foundation[9] has identified four significant lines of discussion about the future influence of technology on the job market:

[7] Understanding the bias in technological change and its impact on the labour market (Barany and Siegel, 2018)
[8] How is technological advancement changing the labour market? (Brown and Loprest, 2018)
[9] Technology and the Future of Work: The State of the Debate (Open Society Foundation, 2015)

(1) Some studies are devoted to how rapidly technology will continue to advance and how much this will impact the economy. While some thinkers expect a technological transition comparable to the Industrial Revolution, others claim that innovation is declining. (2) Scholars who follow the skill-biased technological change tradition focus on breaking down the specific capabilities of technology to examine what functions and jobs are likely to be automated and what effect this will have on the distribution of employees across the labour market. (3) Institutionalists are worried that considering technology development as a past or future source of inequality would divert attention away from a more crucial focus on policy. (4) Academics are less concerned with the skill breakdown of new technologies that are replacing employees. Their fundamental focus is the systemic ways in which technological progress may continue to disrupt the basic architecture of the economy and so, naturally, influence all components of it.

In this regard, Goos *et al.* (2019) acknowledge a new paradigm for thinking about the influence of continued technological innovation on labour markets. Rather than if technological breakthroughs increase the productivity of all employees, this approach tackles the prospect that digital innovation may directly remove individuals from their activities, reducing the need for their labour. This approach addresses four crucial mechanisms which increase the demand for labour force in most cases:

- **Productivity effect:** the substitution of cheaper equipment for labour decreases manufacturing costs, resulting in lower prices and increased demand and production. Furthermore, new technologies may improve product quality or enable new products and services, increasing demand and production if customers appreciate the improved quality of the innovative products and services.
- **Capital accumulation effect:** as new technologies are adopted, there is an increase in the need for new machines and intangible capital, which raises demand for knowledge-based jobs and labour tasks that include creating, implementing, maintaining, and upgrading the innovative technologies in use.
- **The reinstatement effect** occurs when new technology provides new responsibilities for employees for two reasons: First, displacement of employees from old jobs means that more people are available to take up new, more productive jobs. Second, new machines and an increase in knowledge-based capital may need new activities or enable new tasks.

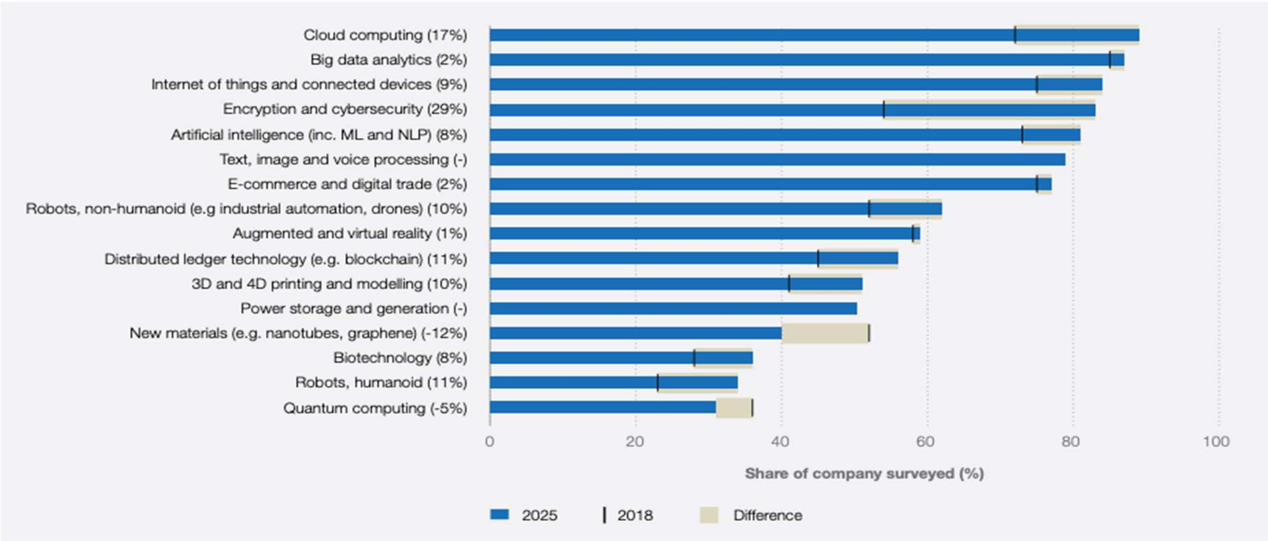
- **Displacement effect:** when robots grow more capable of performing activities that humans could previously only accomplish, corporations will progressively use such technologies to replace the human resource. As a result, there is less need for labour.

World Economic Forum[10] offers forecasts about the future of work, taking into consideration the rapid growth of technology and the automation revolution, both of which will have a substantial influence on employment (Kweillin Ellingrud, Gupta and Salguero, 2020). According to the report (Schwab and Zahidi, 2020), by 2025, the capabilities of machines and algorithms will be widely used, and the work hours completed by the equipment will match the time spent working by humans. Approximately 15% of a company's workforce are at risk of being affected. Among them, around 6% of workers are likely of being completely displaced. Furthermore, firms are striving to give reskilling and upskilling chances to most of their employees (73%), recognising that 44 per cent of the abilities that employees will need to execute their tasks successfully will change by 2025.

Almost all occupations nowadays entail technological and digital solutions. This overall progress has been swift, and the demand for technical and digital expertise has grown (Lindberg, 2021). The World Economic Forum (2020) presents an engaging trend of new technology adoption categorised by enterprises' likely to embrace them by 2025. A significant rise is expected in Encryption and cybersecurity by 29% of the increase of adoption (Figure 3). Cloud computing and Big data analytics remain leading priorities, continuing a previous year's pattern. However, the demand for Big data analytics to be adopted over the corporations is likely to increase by 2%. There is a higher probability that more companies will be willing to employ the Internet of things and connected devices, 3D and 4D printing and modelling, Artificial intelligence, Robots and non-humanoids, Distributed ledger technology and Biotechnology as their increase rate ranges between 8 to 11 per cent. However, the digital era predicts a considerable decline in the use of New materials (e.g. nanotubes, graphene) and Quantum computing with a reduction of 12 and 5%, respectively.

[10] Future of Jobs Survey 2020, (Schwab and Zahidi, 2020)

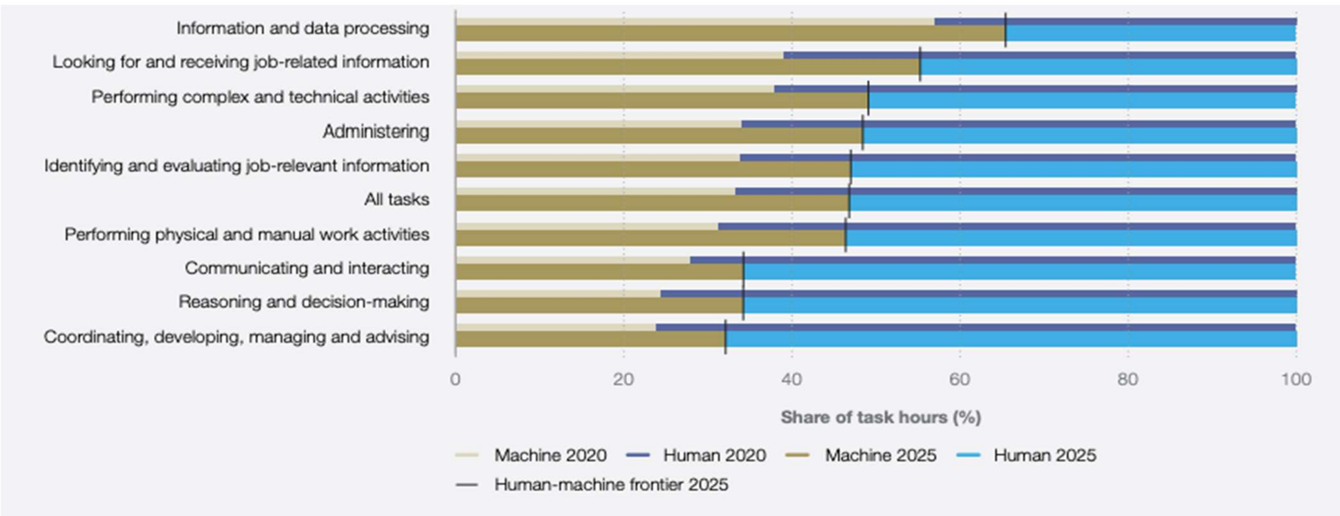
Figure 3: Technologies Likely to Be Adopted by 2025



Source: Future of Jobs Survey 2020, (Schwab and Zahidi, 2020)

Another figure by World Economic Forum, which compares the tasks performed by humans versus machines, 2020 and 2025, indicates the growing influence of technology on the labour market composition. According to Figure 4, on average, all the tasks studied within the survey have an almost 50% probability of being automated. In this regard, the most susceptible work roles focus on information and data processing, administrative chores, and conventional physical work. Managing, counselling, decision-making, thinking, communicating, and engaging are examples of jobs where technology intervention is less likely; thus, they will remain in high need of humans.

Figure 4: Share of Tasks Performed by Humans VS Machines, 2020 and 2025



Source: Future of Jobs Survey 2020, (Schwab and Zahidi, 2020)

Figure 5: Top 20 Job Roles in Increasing and Decreasing Demand Across Industries

	Increasing demand		Decreasing demand
1	Data Analysts and Scientists	1	Data Entry Clerks
2	AI and Machine Learning Specialists	2	Administrative and Executive Secretaries
3	Big Data Specialists	3	Accounting, Bookkeeping and Payroll Clerks
4	Digital Marketing and Strategy Specialists	4	Accountants and Auditors
5	Process Automation Specialists	5	Assembly and Factory Workers
6	Business Development Professionals	6	Business Services and Administration Managers
7	Digital Transformation Specialists	7	Client Information and Customer Service Workers
8	Information Security Analysts	8	General and Operations Managers
9	Software and Applications Developers	9	Mechanics and Machinery Repairers
10	Internet of Things Specialists	10	Material-Recording and Stock-Keeping Clerks
11	Project Managers	11	Financial Analysts
12	Business Services and Administration Managers	12	Postal Service Clerks
13	Database and Network Professionals	13	Sales Rep., Wholesale and Manuf., Tech. and Sci.Products
14	Robotics Engineers	14	Relationship Managers
15	Strategic Advisors	15	Bank Tellers and Related Clerks
16	Management and Organization Analysts	16	Door-To-Door Sales, News and Street Vendors
17	FinTech Engineers	17	Electronics and Telecoms Installers and Repairers
18	Mechanics and Machinery Repairers	18	Human Resources Specialists
19	Organizational Development Specialists	19	Training and Development Specialists
20	Risk Management Specialists	20	Construction Laborers

Source: Future of Jobs Survey 2020, (Schwab and Zahidi, 2020)

Figure 5 summarises the World Economic Forum's estimates for the future of work by 2025. The graph depicts the top 20 expected employment positions in rising and decreasing demand across 15 industries and 26 economies (covered by the report). It appears that computers will eventually accomplish almost any jobs for which logical principles or a statistical model outline a path to a solution, such as complex tasks that have been reduced by imposing structure. However, there will continue to be a great need for people who can solve complicated duties that involve the creative synthesis of a large amount of bright knowledge. Furthermore, labour-saving technology improvement will displace people doing specific jobs; however, in the long term, if it produces new goods and services, that will enhance revenue, eventually increase overall labour demand.

Digital technology in the 21st century is considerably different from earlier technologies that have had a broad influence on the labour market. Because of the one-of-a-kind character of digital commodities, determining the exact effect of these breakthroughs and advances appear challenging[11]. Monitor Deloitte[12] creates a scenario for what digital transformation may look like in the European Union in 2035. According to the paper, by 2035, digital transformation will not only have irreversibly altered the nature of the EU. Digital transition will have

[11] Technology and the Future of Work: The State of the Debate (Open Society Foundation, 2015)
[12] Digital transformation in the EU 2035 a glimpse into the future (Monitor Deloitte, 2019)

addressed political, economic, and social difficulties in the EU. However, it is uncertain how, to what extent, and how quickly these trends will transform European labour markets. Though, describing how some of these tendencies can manifest themselves along many dimensions might assist policymakers in allocating resources now. Creating alternative future scenarios is a strategy often employed in foresight or future studies to assist decision-makers in planning for various outcomes while keeping information limits in mind (Benton and Patuzzi, 2018).

The four possibilities depicted in Table 1 may reveal changes in the European society labour market by 2028.

Table 1: Four Possible Scenarios for European Societies in 2028

	Technological Change	**Labour Markets and Welfare**
Scenario 1 Digitisation causes extreme job polarisation and rising inequalities	Hollowing out of low-and middle-skilled sectors leads to more competition for low-skilled jobs and the rise of flexible gig work.	Rising unemployment and atypical employment relationships lead to a loss of tax revenue and, as a result, to reductions in welfare and pension budgets.
Scenario 2 Slow transformation as automation and digitisation creates a smaller than anticipated impact	New technologies do not have the anticipated effects; digital-platform jobs reach a natural ceiling and employer-employee relationships persist. Governments "luck out" despite limited planning.	Governments work with social partners to extend labour regulations and social protection to new and more flexible forms of work, including self-employment and on-demand work.
Scenario 3 A government-driven digital utopia	New technologies eliminate some jobs but create others. Governments work with the private sector, non-profit, and research partners to harness digitisation in education, social policy, and infrastructure creating a race to the top in digital technologies.	Technology boosts competitiveness and productivity, and employment rates surge. Extra tax revenue is funnelled into education systems and used to fund a minimum basic income to cushion those unable to find work; these measures encourage risk-taking and entrepreneurship.
Scenario 4 Community-led entrepreneurialism	Many jobs are replaced by machines or moved to other countries where labour costs and protections are lower. The threat of unemployment encourages large swathes of the population to set up businesses, ushering in an age of entrepreneurial and freelance activity.	Public budgets suffer a loss of tax revenue. Public spending decreases across multiple areas, from welfare to public libraries. Some of these gaps are plugged by social enterprises. To encourage economic activity, governments drastically cut red tape for entrepreneurship.

Source: How Will Changing Labour Markets Affect Immigrant Integration in Europe? (Benton and Patuzzi, 2018)

According to these scenarios, the future of European labour markets is unpredictable and, as they demonstrate, varied across a variety of circumstances and outcomes. While global integration policies and employment activities are essential, this table focuses on emerging technologies that tackle challenges at the junction of the future of work. The scenarios also indicate critical actions and important decisions that must be performed for this future to become a reality.

Recommended Policies for the Future Work

After an exhaustive analysis of theoretical aspects related to technology, its dynamics, and characteristics; also, historical, and long-term effects on labour markets, this paper provides recommended policy implications for future sustainable economic development. In this regard, there is an urgent need for structural changes that first reflect the operation of education and training institutions, their interactions with labour market regulations, and corporate approaches to educating people with new skills. Also, rules that guarantee people may save money while working; and legislation that prohibits prejudice in recruitment, resignation, and salary setting.

Based on the above assessment, the study developed concrete policy proposals in favour of equitable development of the labour market in the face of rapid technological progress:

- ***Improved social protection and balanced resource distribution***

While some social security programmes are corrective or brief, not all assistance may be transitory. Social protection must reduce harmful incentives and guarantee that emergent risks are addressed effectively and equitably. When it comes to long-term unemployment, sick leave, or disability, social protection provides a critical cornerstone of continued assistance for its residents. It necessitates income and employment help for relocated employees or those facing unemployment and occasional earnings patterns in general.

- ***Developing and promoting new types of work***

If automation and digitization result in larger-scale labour-market transformations, not everyone will be able to engage the labour force. However, disadvantaged groups of employees may be deprived of a vital form of social connection without work. Thus, labour market legislation must be revised as needed to accommodate new types of employment and is required, use new techniques. Distinct forms of work should be treated equally in terms of legislation, taxes, and benefits. Volunteering is an option for some since it provides an opportunity to gain a presence in the labour market. It commits to protecting disadvantaged groups from social isolation and provides a chance for new members to engage in society.

- ***Guiding workers in their adaptation to change***

Considering the future labour market trends will demand employees to have exceptional analytical thinking skills, sophisticated problem-solving abilities, and self-motivation to study, it is crucial to develop these core talents. Continuous learning possibilities must be encouraged, particularly for low-skilled employees, and possible impediments must be removed. The way of completion goes through improving career advising, evaluating individual skill gaps, expanding distant learning possibilities, simplifying skill assessment processes, and boosting and optimizing financial benefits and support for long-term learning projects. It will imply that digital skills will be more crucial than ever, with assimilation instructional materials and learning possibilities becoming more widely available online. Governments might collaborate with the socially responsible teams of employment networks to establish more effective recruiting and training methods that enhance the career trajectories and better integration results of a diverse variety of employees.

- ***Preparing the workers and jobseekers for matching new jobs***

Some jobs will be lost because of digital transformation, while new ones will appear. Not necessarily jobseekers inhabit areas where employees are available; hence, a territorial distance can occur as a reason for hesitation to apply for work in distant regions, a lack of information about opportunities in other locations, and so on. Supporting internal movement can encourage people living in low-wage areas to relocate to areas with better economic prospects. In combination with the evolution of labour markets, it is critical to enable effective and equitable transitions from declining to growing job possibilities.

One solution to this strategy is to relocate employment closer to where individuals are. A remote workplace may provide extra options for people who live outside of business centres. Another approach would be to increase the accuracy of matching job seekers to the exiting jobs. Employers can see potential employees' talents more quickly if they use online technology. It is possible to create a "Skills Hub" or digital portal for job seekers and offer training courses, tutoring and social connections through collaboration between the government, business sector, and educational institutions. However, these technologies are only appropriate for specific business sectors and for certain individuals.

- ***Investing in training and equipping people with a diverse set of skills***

To thrive in the digital world of work, people must have strong cognitive skills, including digital abilities, social and interpersonal skills, job-specific skills, and, most crucially, the capacity and willingness to deal with change and continue to learn both in and out of the employment. The difficulty of skills identification procedures has become considerably more well recognised in recent years. Job seekers may not have documentation of their qualifications or have been pushed out of school early, but they have some work-related skills or knowledge. These difficulties exacerbate existing issues with credential validation.

To directly address these obstacles, an existing strategy for skill development is required. Governments may actively influence the environment for efficient labour market changes and worker productivity by increasing the relationship between skills, payment, and work opportunities. Primary education should provide youth with the information, skills, and attitudes required for new developing possibilities in society and employment. Simultaneously, the elderly will have the potential to play a significant role in assisting people currently on the labour market in acquiring the skills required in digitally connected businesses. Funding programmes for worker reskilling and upskilling are universal methods to achieve the goal. First should benefit the employees during their careers and may require extra abilities to obtain employment in the future.

Conclusion

The question related to the impacts of technology on the labour market isn't a new appearance. The most important question for governments, industries and consumers is not how much automation or digitalization of human labour will affect the immediate employment rate. The main issue is how to shift the entire labour market toward a new settlement in the divisions of work between the labour force and technology and under these new conditions.

This article provided an in-depth examination of the nature of technology and its implications for the labour market. As a result, the range of activities that machines can undertake has steadily grown. With the recent digital revolution and technological breakthroughs, public anxieties have arisen that computer would render human labour redundant, resulting in massive unemployment. This study has proven that technology played a meaningful role in altering the interaction between workers and employers. Given the precarious condition of labour, this is likely to persist. Thus, to combat the threat of expanding imbalance and income inequality, authorities must provide tools and policy measures to secure vulnerable groups of workers.

This report has illustrated the predictions as the labour market estimations for the next decade. Based on this, the study developed policy recommendations. According to the implications, the extent to which the potential advantages of forthcoming technological development balance the hazards is critically dependent on appropriate governmental actions. The research recognised five key policy concerns at risk. Though, all of them are broad in scope and continually shifting. The policy solutions discussed in this article centre on initiatives in addressing some of the most pressing emergent concerns.

The key findings of this analysis are summarised and given in this part as proposed policies. First, fears about the long-term impact on labour-force participation, the efficiency of present instruments, and the government's capacity to administer these public services with acceptable efficiency at scale are driving the expansion of social protection. Second, policies that govern new technology investments and encourage new forms of employment should favour technologies that reduce the immediate danger of automation to employees while not forgetting the positive opposing impacts that enhance labour demand. Third, refers to policies aimed at assisting employees in adjusting to changes. Furthermore, growing non-standard work arrangements among low-wage employees necessitates an augmentation of social insurance to include these quasi-work arrangements. Fourth, actual labour market policies are required to address the mismatch between worker capabilities and changing skill demands caused by technological advancement. Both public and private authorities can assist in lowering the costs of labour adjustment for employees and businesses. Through improved information and matching algorithms, new technology can assist employment agencies in minimizing these expenses. Fifth, education and training policies must guarantee that employees obtain adequate training and the necessary skills for future labour markets.

Various conceptual investigations led to the conclusion that the advent of a new form of technology creates a separate set of issues, distinct from and perhaps add to the challenges currently faced by prospective automation and digitalization. Thus, there is a need to address various policy areas to reap the advantages of these new technical developments and shape the influence of the digital revolution on labour markets, employees, and the future of work. Alongside technological progress, tools and policies should regularly renew to secure future development and economic prosperity in a rapidly changing environment. The prevailing juncture provides an opportunity for business executives and government to collaborate on enhancing access to and distribution of reskilling and upskilling, empowering realignment, and reemployment, and indicating the market value of studying at spectrum through education technology.

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