



Human Resources Management in Quality 4.0 Maturity Assessment

Anastasia Vlastaridou¹
Evdokia Nikou²
Ioulia Kouroupaki³
Michail Glykas⁴

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Abstract: *The paper analyzes critical success factors and enablers for the maturity assessment of Quality 4.0 implementations. The emphasis is on how digital transformation technologies have impacted human resource processes and how technology and quality are related. This study presents a literature review on Quality 4.0 and provides an overview of the key issues and future perspectives for quality management in the digital era. The research results contribute to the digitalization and quality literature and a holistic approach that should be composed of CSFs and Enablers. No previous studies have been identified that provide a holistic analysis.*

1. INTRODUCTION

Technology has been used to create significant changes in society. The term digital era refers to the period when the changes were most significant. The recent discourses have focused on digital transformation which is defined as the changes associated with the use of technology in various aspects of human society (Veldhoven & Vanthienen, 2021). Due to the increasing use of digital tools, the human resource management (HRM) function is affected by its effects on the organization's core values. One of the advantages of digitalization is the ability to gather and analyze vast amounts of data. This process enhances the knowledge acquired in the organization and increases the analytical capabilities of the collected data, by using algorithms and an increase in information flows.

Due to the rapid emergence of DT in the workplace, HRM has become more diverse, and people-oriented. The various changes that are happening in the industry are some of the challenges that the profession faces. The rise of digital employees has required HR professionals to make operational and strategic changes in order to influence their behavior and attitudes (Fregnan et al., 2020).

The need for a relationship between technology and quality has become clear as we recognize the importance of quality in today's environment. Quality Management is a process utilized for optimizing the operations of organizations. This discipline can help improve the productivity

¹ Department of Financial and Management Engineering, School of Engineering, University of the Aegean, Kountouriotou 42, Chios, 82100, Greece

² Department of Financial and Management Engineering, School of Engineering, University of the Aegean, Kountouriotou 42, Chios, 82100, Greece

³ Department of Financial and Management Engineering, School of Engineering, University of the Aegean, Kountouriotou 42, Chios, 82100, Greece

⁴ Department of Financial and Management Engineering, School of Engineering, University of the Aegean, Kountouriotou 42, Chios, 82100, Greece

and competitiveness of businesses in times of societal change. The goal is to help companies develop their capabilities in order to capitalize on the opportunities presented by Industry 4.0 (I4.0). This includes developing their innovation management capabilities and improving their skills in this field. Models for the Quality Management System (QMS) could play a role in supporting the development of skills and competencies in I4.0. As a result, there is a term of Quality 4.0 (Q4.0) signifying an integral part and extended concept of I4.0. The core culture and managerial approaches of quality managers are considered as factors that drive the success of the Q4.0 concept. This argues that adopting a quality management system could help improve the profitability of the organization. Quality 4.0 is a shift that addresses the challenges of working with production systems that are constantly monitored and assessed in real-time.

While Quality 4.0 is mainly focused on the technical aspects of improving efficiency and effectiveness, it has a social side. This concept tackles issues such as the need for people to develop new skills and attitudes, as well as the establishment of a supportive culture. One of the key factors that the Q4.0 transition needs to be considered is the development of skills in leadership. The new era of quality management requires a leader who combines the principles of quality with the demands of I4.0. This leader should have the necessary resources and the mindset to implement Q4.0 effectively.

The transition to Q4.0 requires continuous learning and innovation. A quality-based knowledge is also necessary to support the development of effective and efficient processes and procedures, setting benchmarks for sharing digitalization-related practices. The goal of an agile approach is to enable cross-functional collaboration and the sharing of knowledge. This method facilitates the continuous improvement of processes and the dissemination of ideas and experiences, which leads to positive results.

2. HUMAN RESOURCES PRACTICES

Human Resources Management (HRM) refers to a set of practices that organizations use to ensure that their workforce is well-equipped to meet their operational needs. HRM Practices are focused on the combination of administrative personnel functions with performance, employee relations and resource planning. They help organizations maximize their return on investment and minimize financial risk. HRM practices can affect various aspects of an organization's performance such as turnover, stress, and burnout, etc., which in turn influences organization performance indicators like reputation, sales per employee, sales growth, return on investments, etc. (Alam & Mukherjee, 2014).

A particular definition of HRM is the one defined HRM as those decisions and actions which concern the management of employees at all levels in the business and which are related to the implementation of strategies directed towards creating and sustaining competitive advantage (Syed & Bayeroju, 2019). HRM practices can improve and sustain an organization's performance. These practices are based on employee selection that fits with the company's culture, behavior, attitude, and necessary technical skills required by the job, compensation contingent on performance, and employee empowerment to foster teamwork. Seven HRM practices that improve organizational performance are employment security, selective hiring of new personnel, self-managed teams and decentralization of decision-making as the basic principles of organizational design, comparatively high compensation contingent on organizational performance, extensive training, reduced status distinctions and barriers, including dress, language,

office arrangements, and wage differences across levels, extensive sharing of financial and performance information throughout the organization (Pratibha et al., 2021).

Due to digitalization, the competition between workers has changed into competition between people and machines. Employees' careers depend on their skills in digital technologies, regardless of their qualifications. People take responsibility for their qualifications and skills and may be more or less willing to learn new technologies in any environment they want and to be open to change.

Technological, cognitive, social, and emotional are skills that are in great demand. Companies need to offer continuous learning and training to their employees to acquire these skills. Education and continuous training must be based on the learning culture and HRM practices of organizations to be effective. Among the human resources practices that favor the success of training is the reward and promotion system of organizations that values continuous learning at the individual level and compensates employees accordingly for recently acquired skills. Creating a climate of continuous learning requires organizations to adopt characteristics such as openness, innovation, discipline, interactive collaboration and constructive confrontation (Zaitouni et al., 2020).

3. SOCIAL NETWORKS, HRM PRACTICES AND E-HRM IN THE TECHNOLOGY ERA

The rise of social media has completely changed the way people connect. Social networks are tools that allow people to connect and share interests and activities, by developing online communities. Social networking tools allow organizations to create and maintain their own social networks without the need for extensive training or expertise. From an organizational point of view, by adopting social networking technologies companies could communicate with stakeholders inside and outside the organizational boundaries: they could be effective in creating and directing their culture, in managing change, in stimulating collaboration, in increasing motivation, in empowering expertise and in sharing and building knowledge (Manuti & de Palma, 2018). The term collaboration is an evolving process whereby two or more social entities actively and reciprocally engage in joint activities aimed at achieving at least one shared goal (Bedwell et al., 2012). The explosion of social media has highlighted the importance of collaboration in organizations. It has also called for a redefinition of what constitutes collaboration. The emergence and evolution of technologies within an organization's context have contributed to the creation of the so-called Enterprise 2.0, featured by an extended use of technology mainly addressed to four main working processes: communication, collaboration, cooperation, and connection (Manuti & de Palma, 2018). People use various platforms to communicate with each other. These platforms allow people to interact with each other in various ways. They help people at work with their needs related to operation and sociality. These platforms allow people to communicate with others in various ways, such as text, image, voice, video, or a combination of these.

E-HRM (Electronic Human Resource Management) is the use of online technologies for HRM services and practices within an organization. It is the first field of HRM to make use of web-based technology and it embraces e-recruitment and e-learning.

From this base e-HRM has expanded to embrace the virtual delivery of all HR policies and strategies. E-HRM is a tool that allows HR professionals to perform various HR activities such as planning and conducting appraisals, training, and analyzing employee development programs, training, and evaluation labor costs. Employees can use e-HRM to plan their own development, apply for promotion, transfer, and career development plans and access a range of information

on HR policy and strategy. This system is essentially the devolution of HR functions to management and employees. They access these functions typically through web technology channels. E-HRM involves the configuration of human resources, and it is a way of implementing human resource management in an organization. This implementation can be done through the application of strategies, policies, and practices. Improvement in the HR strategic orientation, improvement in client focusses and satisfaction and decrease in costs or increase in efficiency can be achieved by following a specific e-HRM direction. Companies are aware of the fact that human resources have changed from a cost factor to a success factor. E-HRM is an automated and web-based tool that supports various HR processes. The three main tiers of e-HRM are *operational, relational, and transformational*. Operational e-HRM is concerned with administrative functions payroll and employee personal data. Relational e-HRM is concerned with supporting business processes by means of training, recruitment, performance management and so forth. Transformational e-HRM is concerned with strategic HR activities such as knowledge management, strategic re-orientation. An organization may choose to pursue e-HRM policies from any number of these tiers to achieve their HR goals (Prakash & Mores, 2019).

Hiring is the process by which employers look for candidates to fill jobs in their business. The beginning of the process is the search for recruits, and the end is the submission of applications. Through an online application, managers have more efficient and effective ways of recruiting. Electronic recruitment is the implementation of this process through network technology. The websites used to fill the posts are resume databases, marketing, search engines, or social networking platforms.

Companies hire employees through many websites. E-recruitment channels are corporate websites, online recruiting platforms such as CV online, professional social media platforms such as [linkedin.com](https://www.linkedin.com) and [xing.com](https://www.xing.com) and social media platforms such as [facebook.com](https://www.facebook.com) and [twitter.com](https://www.twitter.com). The services allow users to communicate with peers by voice using a microphone, video by using a webcam, video conferencing and instant messaging over the Internet. Skype is a computer program that can be used to make free voice calls over the Internet to anyone who is also using Skype. It is more useful for selecting the right candidate. E-recruitment offers wider access and geographical spread, a larger audience, better chances of finding the right candidate, time and cost savings, better matching of staff with vacancies, efficiency, easy access to job seekers, reduction of unqualified candidates and more opportunities for smaller companies. Apart from these advantages, it also has several disadvantages such as checking the validity of CV skills, low Internet penetration and lack of knowledge in many locations worldwide and the non-exclusive dependence of organizations on e-recruitment methods (Ltd, 2019).

Through online recruitment job, search costs are much lower, there are more opportunities for candidates to show their skills, there is no factor of geographical location, vacancies can be filled in less time, because through social media networking answers are faster, young people have more job opportunities and positions can be viewed by more candidates.

E-learning technology is the utilization of web technology to deliver learning. E-learning as an idea covers a scope of uses, learning techniques and procedures. E-learning allows the learners to watch different activities and listen to lessons repeatedly as required (Ghosh et al., 2021).

E-learning technology is in great demand worldwide. Organizations prefer e-learning because it reduces employee stress and increases collaboration and satisfaction. The growing preference

for e-learning is attributed to the motivation of the individual to interact with others, to exchange views, to receive feedback, to share knowledge, to improve communication and to facilitate the relationship that maintains learning agility.

E-learning technology can help employees maximize their performance by giving them the knowledge they need at the right time. E-learning (distance mode) technologies enable organizations to support the complete Human Value Cycle (HVC): recruit, assess, train, test, certify, and retain (Prakash & Mores, 2019). E-learning is successful when the focus on everyone working is ensured. By combining the right tools and methods of collaboration, knowledge and e-learning, employees can easily achieve higher performance. E-learning tools help identify and address a skills gap in one part of the solution while helping collaborate on one outcome that can improve the performance of the workforce.

4. THE NEED FOR NEW COMPETENCIES AND SKILLS

Companies, employees, and managers are not only confronted with completely new issues in their work and organizational processes as a result of digital transformation. To keep up with and adapt to these rapid changes, new skills and abilities are required, such as capturing and filtering information. Whereas it used to be easy to cover one's entire working life with information gained through apprenticeships or studies, this is no longer the case. The half-life of expert knowledge has drastically diminished, and the task of lifelong learning has taken on a whole new meaning. No longer is it simply needed to learn to move ahead, but it is also needed to learn to stay up with the constant changes.

Expert knowledge must be continuously expanded and partially aligned in the workplace multiple times, to the point where there will be completely distinct job profiles every 10 years in the future. Recognizing, evaluating, and using relevant data is becoming increasingly critical. As a result, Markgraf's research has identified a number of new skills that will become increasingly important in the context of the fourth industrial revolution (Brauweiler et al., 2020). The respondents were asked to rate how essential things will be short, from their perspective. The significance was graded on a scale of 1 to 7, with 7 indicating the highest level of significance. In total, more than 500 people took part in the assessment of future competency requirements.

Participants were able to make their own additions to the given competencies in addition to rating them. This option was frequently used, but there was no clear idea of what additional skills would be necessary. The data included a wide range of themes related to teamwork and communication in many cases. Only self-organization and ethical action or ethical moral responsibility can be identified as extra points.

Overall, it is clear that abilities connected to new problems, new situations, and communication and interaction are becoming increasingly important. The participants anticipate a constant metamorphosis and the opportunity to continuously train themselves.

Organizations in practically all industry categories are implementing different programs to study and utilize the benefits of emerging digital technologies, such as social networks, mobile, big data, and so on. Companies must adopt management strategies to oversee these complex transitions, which usually entail transformations of critical company operations and impacts products and processes, as well as organizational structures. As a result of the maturing

of digital technologies and their widespread penetration across all marketplaces, society as a whole is undergoing rapid and drastic transformation.

Digital technologies help companies reduce costs, improve work efficiency and productivity, improve customer satisfaction, and optimize the company's supply chain. These digital technologies have been defined as Artificial Intelligence (AI), Big Data, Cloud Computing, the Internet of Things (IoT), Virtual and Augmented Reality (VR/AR), and cyber-physical systems, social media, analytics, mobile devices, or built-in devices. Features of digital technology are re-programming, homogenization of data and self-referential character of digital technology.

A digital artefact is a digital component, multimedia content, or application that composes a portion of a new product or service and provides value or specific functionality to the end user. Examples may be different applications running smartwatches (Sukreep et al., 2019), Amazon Dash Button (Sharma, 2021), Google Pay (Poongodi et al., 2021), and Face ID. Digital objects work either as standalone software or as a hardware component in a physical gadget or as part of a wider ecosystem running on a digital platform. A digital artefact makes natural products or services support innovation. For example, companies use social networking sites to create and grow social capital and find new business opportunities (Stepantseva & Breitenecker, 2020).

Digital platform corresponds to the common sets of services and architectures used to promote product and service offerings. Examples are the Google Chrome browser which allows you to work with the Google search engine and Apple's iOS platform which allows you to run different applications on your smartphone. Digital platforms have facilitated the transformation of the industry while creating new bases of innovation and positions.

Digital infrastructure or tools are the set of digital technology systems and tools that contribute to collaboration and communication. These tools support business and innovation. Examples of digital infrastructure include Microsoft Azure, the Google Cloud Platform, or Stanford FabLearn and MIT Fab Central Labs used for digital prototypes and mock-ups.

Successful Digital Transformation necessitates the development of a diverse set of talents, the relevance of which will vary based on the business context and the specific demands of the organization. In order to be competitive, digital technology must become integral to how businesses run, and businesses must rethink and possibly re-invent their business models.

Because of their pervasiveness and economic effect, digital technologies spread quickly. They're referred to as general-purpose technology (GPTs) (Casalet & Stezano, 2020). The phrase GPTs has been thrown around a lot in recent discussions of the role of technology in economic growth, and it usually refers to changes that affect both domestic life and corporate practices. For this reason, steam, electricity, internal combustion, and information technology (IT) are frequently characterized as GPTs. This transformation comes in the shape of a once-in-a-lifetime opportunity to increase welfare and solve major social challenges ranging from health care to education, or environmental protection. GPTs have four main characteristics: pervasiveness, which means they can be used in a wide range of industries; improvement, which means they should improve over time and thus improve quality; cost-cutting, which means they should continue to reduce costs for their users; and innovation spawning, which means they should make it easier to invent and produce new products or processes.

Interinstitutional and collaborative ties were increasingly important as Industry 4.0 took shape, helping to solve the digital ecosystem's execution and implementation issues. As social networks grew in size, decision-making became more important, opening up new avenues for thinking about highly specialized environments in collaborative settings.

5. DIGITAL TECHNOLOGY TRENDS

Value networks are reshaped by developing the digitalization of products and services. Organizations must monitor technological changes to make improvements to the transformation and business. These improvements can give organizations a competitive advantage. Digitalization of products and services requires the application of new digital solutions.

Many companies monitor the trends in digitalization and its influence in the services and production sectors. The term digitalization is sometimes associated with industry 4.0. Industry 4.0 is defined as the integrated digitalization and connection of production processes, starting from the customer's order, through the creation of production processes, up to the next stage of products (Wilkesmann & Wilkesmann, 2018). In course of the digitalization concept, it is important to apply to common technology trends in Industry 4.0. As shown in figure 1, PricewaterhouseCoopers has identified the following core digital technologies for the production: Mobile devices, IoT platforms, Location detection technologies, Advanced human-machine interfaces, Authentication & fraud detection, 3D printing, Smart sensors, Big data analytics and advanced algorithms, Multilevel customer interaction and customer profiling, Augmented reality/wearables, and Cloud computing (Stepantseva & Breitenecker, 2020).

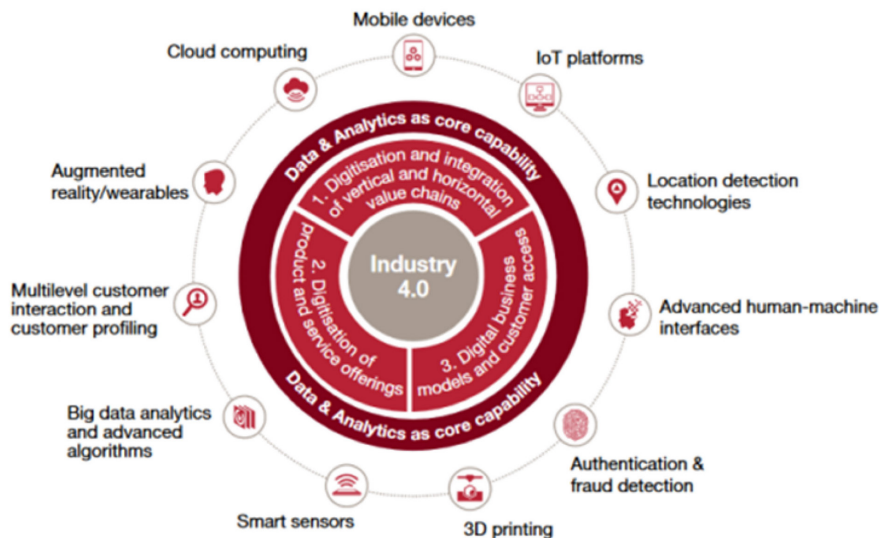


Figure 1. Key contributing digital technologies

Source: Stepantseva and Breitenecker, 2020.

Several trends in digital technology are important changes for society and business. With *analytics* organizations extract information about markets, customers, operations, and anything else related to their operations through big data. Since the amount of data is constantly increasing, companies use supporting infrastructures such as algorithms and analytics engines. The *cloud* is a tool that can differentiate a business from its competitors. It is used to expand the data center and shift the workload, while allowing access to artificial technology, digital reality, blockchain, quantum computing and for other more. The term *digital reality* refers to the way

people interact with technologies and data. These are virtual reality (VR), augmented reality (AR), mixed reality (MR), the Internet of Things (IoT) and spatial technologies. Large companies implement *blockchain* solutions to manage different databases. It is expected that business process reengineering will enable companies to realize massive transformation across various functions and locations. *Cognitive technologies* make decisions and activate business opportunities, for people. Some examples are Robotic process automation (RPA), neural networks, bots, machine learning (ML), natural language processing (NLP), and the broader domain of artificial intelligence (AI) (Stepantseva & Breitenecker, 2020).

Companies need to deal with strategic digital trends. *Automation* tools such as robots, autonomous vehicles, and drones, use artificial intelligence and perform automated functions that used to be done by humans. *Augmented Analytics* are a key feature of modern analytics, data preparation and management, data process mining, data science platforms and business process management. To create more artificial location solutions, developers can work independently using *AI-Driven Development*, and advanced models delivered as a service. A *digital twin* is a digital representation of a system. Companies carry out digital representations in order to improve their ability to collect and display data and to apply the right analytics. *Empowered Edge and IoT* are endpoint devices. Edge computing outlines a computing topology where information processing, content collection and delivery, are located closer to these endpoints. *Digital reality* includes virtual (VR), augmented (AR) and mixed (MR) reality. It helps employees to understand digital world and be able to interact with it. Respectively offers a digital experience to customers. *Blockchain* ensures trust and reduces excessive interaction between business ecosystems. It reduces costs and time and increases cash flow (Stepantseva & Breitenecker, 2020).

Artificial Intelligence (AI) is a tool that improves human well-being, increasing individual and social well-being and facilitating progress and innovation. It also contributes to achieving the goals of sustainable development by monitoring climate change, the proper utilization of natural resources, the improvement of human health and the business processes of companies.

Trust in artificial energy systems concerns the internal characteristics of technology and quality assurance of socio-technical systems that provide the use of artificial energy. Similarly, in systems related to food safety, aviation, and nuclear energy. The reliability of the system and the systemic approach must be applied to all parts and processes of the system, during its all-life cycle.

Reliability of AI applied throughout the life cycle of system should be legal, in line with human ethical values and principles, and technically and socially strong, in order not to damage the systems. These elements are necessary all together, but they are not enough alone to achieve reliability.

A reliable approach is a driver for providing responsible competitiveness by enabling the base for all players they can trust that their development, expansion, and application of AI systems are lawful, ethical, and robust. The requirements for reliable artificial intelligence are human agency and oversight, technical robustness and safety, privacy and data governance, transparency, diversity, non-discrimination and fairness, societal and environmental well-being and accountability (Stepantseva & Breitenecker, 2020).

6. DIGITAL TECHNOLOGY IN PRACTICE

Connectivity and mobility are the key features of digital technology. These features are found in modern products and services and operate regardless of geographical location. The structure of the industry and the view of the company on its customers is changing due to technology. This means that to maintain their market position, organizations must interact with change.

Business transformation of companies is necessary to be part of their strategy. Organizations are now developing new digital divisions, shaping existing ones and hiring experts in digital transformation and technology. Companies that rely on digital technology, even if they are new to the market, are gaining a competitive edge. The reason is that they have not introduced changes at all or not changed promptly enough, or because these companies have not succeeded to adapt own business models to the competitive market conditions they meet from digital giants and major digital service providers, for example, as Amazon, Google, Facebook, Apple, Alibaba, Microsoft, Snap and eBay, Airbnb, Uber, [Booking.com](https://www.booking.com) or Spotify. The music industry is one illustrative example of how rapidly change can occur. Ten years ago, Apple radically changed the industry by launching iTunes. But up to date, new streaming services (e.g., Spotify, the new Apple Music, and Deezer) are turning the successful iTunes model inefficient. Thus, Apple has moved from a pioneer in its industry to an imitator (Stepantseva & Breitenecker, 2020).

Artificial life and machine learning are new digital technologies that have been developed. For example, voice-user interfaces such as Google Assistant, Amazon Alexa, Apple Siri, Microsoft Cortana and Yandex Alice (Golenkov et al., 2020). These virtual assistants are based on voice recognition software and intelligent interfaces that enable collaboration between humans and computers. They can help you find information and follow some instructions. Recently, Amazon patented a new Alexa feature that it could understand based on speech and emotion when a user is sick and offer medication. All this enhances the customer experience and creates added value for the company's customers.

Digital technology became an important tool for organizations and new forms of work have emerged. Nevertheless, companies continue to use and enforce the old procedures and laws. An example is Uber, a company that provides digital taxi services. The government was against the company because it applied technology to open up and enhance access to taxi services for both providers and customers (Stepantseva & Breitenecker, 2020).

New digital technologies require constant updating of employees' skills. Digital skills, the use of innovation and the ability to organize and make decisions are important for employees to be able to confront new technologies. Organizations that implement digital transformation are looking for candidates with critical thinking, entrepreneurship and problem-solving while providing opportunities for learning and adaptation to new transformational work environments. The necessary skill of an employee in a business is cooperation. Cooperation includes an ability to read and react to emotions, intentions and needs.

Digital technology has affected job search in the labor market. Platforms have been created that allow finding employees, while also finding a job. Such platforms are LinkedIn and Facebook. LinkedIn and Facebook have become important tools for companies, for facilitating the recruitment processes and attracting candidates. Young people have the opportunity to connect with

potential employers or start their own businesses. For recruiters, social networking platforms have become one of the key tools in finding potential employees (Marin & Nila, 2021).

Digital technology has also become an integral part of the banking system. Digital technologies have contributed too many changes in banking processes, in terms of management, production and delivery. Digital transformation has affected banks in *new business models, operational efficiency, higher quality and faster service, personalization, transparency of operations and cybersecurity and largest investments*. Digital technologies were incorporated in the business processes of the banks and new business banking models were created, resulting in the development of digital banking. Banks improve their efficiency by transforming business models and automating business processes. In this way they save their workforce in simple functions that are not necessary and direct it to tasks related to strategic tasks. Financial technology allows improving the accessibility and speed of operational services and reduces errors and deviations in the work process. Banks offer targeted content thanks to a better understanding of lifestyle, interests, stage needs and social affiliation preferences. Financial technology helps prevent the risks associated with financial technologies. Artificial selection allows the problem to be solved. The application of digital technologies in the business processes of banks requires time and investments in research and development. The digitalization process improves the customer experience by delivering better, faster, and more personalized banking services and products. Factors that create added value to customers for banking products and services are higher personalization, increased service speed, access to the service or product anytime and anywhere, better functionality and forecasting, a better understanding of customers' needs in advance, and offering relevant products and services early.

7. INDUSTRY 4.0 AND HRM 4.0: NEW SOCIAL SUSTAINABILITY

Human Resources Management (HRM) activities are impacted by The Fourth Industrial Revolution (i.e., Industry 4.0) from three perspectives.

Firstly, Industry 4.0 puts Human Resources Management to the test by asking it to add value to the emerging smart organization, where work transcends organizational borders and successful human-machine collaboration can potentially deliver new benefits. Human Resources Management may play a new critical role as a change agent, assisting smart organizations in developing new workforce digital mindsets and competencies to communicate with machines, as well as colleagues and supervisors, in an open community setting (Imperatori & Bissola, 2018).

Second, workplace digital transformation necessitates a reform of existing HR policies, which must accommodate the evolving employee-organization relationship, in which employees can work from anywhere, have no set working hours, and collaborate with people both inside and outside the company. Hierarchical control loses its effectiveness in such circumstances, performance evaluation becomes more important, and all employees are expected to actively contribute ideas and decisions. In the same vein, smart technology allows e-HRM to expand and deliver new HRM solutions that usually provide more direct contact between workers, HR, and the organization. They also better correspond with people's routines and behaviors when it comes to connectivity, and they offer a more flexible work environment (Imperatori & Bissola, 2018).

In this context, HR systems must be compatible with the new manner of working and the new types of workers, and supervisory and worker behaviors must be aligned with the new digital

culture. Performance must be clearly defined and measured in terms of work results. Career paths must be organized consistently. Ways of interaction, as well as the time and space for collaborations, must be openly set, and organizational spaces (i.e., offices and plants) must be specifically redesigned for the new work processes, allowing workers to better manage their time and space.

Human Resources practices should also enable firms to manage a segmented and composite workforce. Diverse people practices are needed, among other things, for a diverse workforce that can balance the organization's and people's expectations sustainably and fairly. To effectively recruit, select, and engage external as well as internal stakeholders, as well as to best match the demand and supply of talents and competences across the product lifecycle, new and aligned management methods are required. Real-time employee data is becoming more common, which can provide useful insights and enable data-driven decision-making. The data necessitates firms' and HRM experts' digital and analytical capacities to be enhanced (Bissola & Imperatori, 2019).

Third and most importantly, the Human Resources department should be the organizational unit that is most committed to Industry 4.0's human-centered approach and supports its implementation in a socially sustainable manner (Schneider, 2018).

People are becoming more conscious of how their actions and lives affect others. The current economic crisis revealed some of the capitalism socio-economic system's contradictions, resulting in undesirable phenomena including unemployment, austerity, and social insecurity. Customers, communities, employees, governments, and shareholders are among the stakeholder groups putting pressure on businesses to be socially sustainable (Bissola & Imperatori, 2019). Organizations have reacted in a variety of ways to this pressure. *Society and business, social issues management, public policy and business, stakeholder management, and corporate accountability* are just a few of the phrases that have been used to characterize the phenomenon of corporate responsibility in society.

Sustainability, according to Wheeler, Colbert, and Freeman, is *an ideal toward which society and business can continually strive; the way we strive is by creating value, by creating outcomes consistent with the ideal of sustainability along social, environmental, and economic dimensions* (Bissola & Imperatori, 2019).

Human Resources Management 4.0 has the potential to play a pivotal role in the development and implementation of socially sustainable solutions. It can provide a stimulus for positive social change and the long-term adoption of new digital technologies and innovative organizational solutions, supporting the positive outcomes of Industry 4.0 while avoiding potential downsides.

Human Resources Management experts and academics must assist corporate executives and employees in adopting a 4.0 attitude, which entails using digital tools to manage, organize, lead, and work for positive social change. Human Resources Management 4.0 can help with work innovation, employee empowerment, competency development, and enabling them to actively address current labor concerns. Employees have been considered as passive performers of their assigned job activities for a long time. Several academics have recently emphasized that work design theory must take into account the effect of employees on their job design. Human Resources Management 4.0 could be the key to allowing employees to have more control over their job characteristics, resulting in increased work motivation and more sustainable social growth.

In this new world, the concept of an unnecessary trade-off between *doing well* and *doing good* must become a crucial issue, and HRM experts and practitioners share a significant social duty (Bissola & Imperatori, 2019).

This is a new world for the HRM area, which may provide HR professionals with new employment options. Furthermore, it has the potential to change the impact that scholars have on people, businesses, and society at large by promoting the positive and, more importantly, long-term aspects of ongoing work transformation and allowing for a human-centered organization (figure 2).

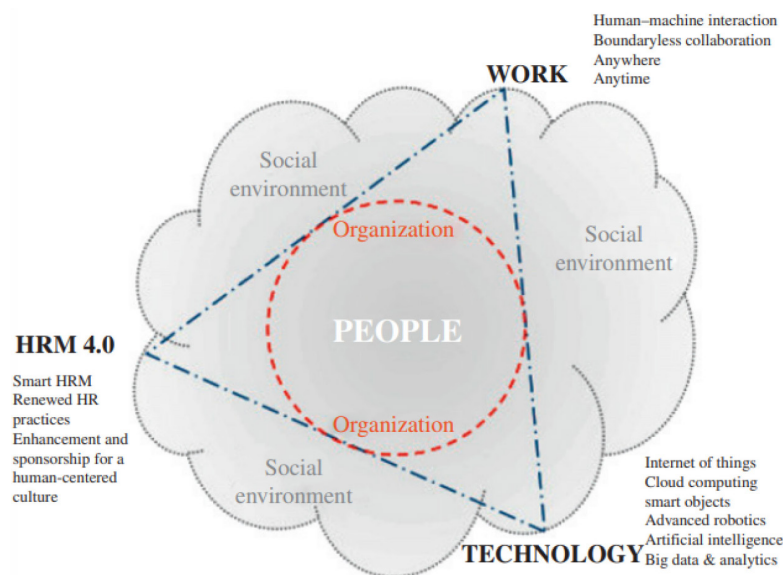


Figure 2. Ecosystems for Human-centered Approach in Industry 4.0

Source: Bissola and Imperatori, 2019.

8. CONCLUSION

Quality 4.0 framework can be developed and defined in a variety of ways. It can be based on a variety of factors, including a move from products to services, value creation in markets, and the quality of business models, among others. Zairi (2017) proposes such a response to the quality profession's crisis. He proposes that the quality profession requires a new quality DNA by changing how quality is understood as a concept and the notion of customer satisfaction, by employing disruptive thinking to keep up with business evolutions, particularly the digital revolution, for the proactive pursuit of excellence and quality leadership, and by changing the meaning of strategy in the role of quality to reflect the need for agility and flexibility and to focus on a customer-centric approach (Zonnenshain & Kenett, 2020).

For the new quality revolution, which Zairi refers to as Quality Mark II, he proposes the following framework: The discovery as the propelling force; the value creation generator which includes: personalization, perfection, partnership, prediction and delivery; the business renewal rocket which includes: experience, engagement, experimentation, enlightenment, disruption and distinction (Zonnenshain & Kenett, 2020).

The Quality 4.0 system's goal is to help companies attain maturity in their Industry 4.0 capabilities. Real-time data management, interoperability, virtualization, decentralization, agility, service orientation, and integrated business processes are all Industry 4.0 design principles

(Ranjith et al., 2021). These design concepts are relevant for developing the framework since they are organizational capabilities for both Industry 4.0 and Quality 4.0. In addition, achieving Sustainability is a vital competence for enterprises in the Industry 4.0 age. The core goal of Quality 4.0 strategy and implementation is to achieve maturity in these eight skills.

Aldag and Eker defined Quality 4.0 (or Q4.0) as the blending of traditional quality management practices and techniques with new technologies such as machine learning, cloud technologies, Big-Data, connectivity devices, Internet of Things, and Artificial Intelligence (Sader et al., 2021). Through the integration of various functions, such as supply chain and customer relationship management, the management of these activities were brought to a more collaborative environment. Jacob defined Quality 4.0 as the leverage of traditional quality management techniques which was gained by modern technologies in order to reach a new level of excellence at the functional and operational levels (Sader et al., 2021). He noted that adopting Q4.0 enabled manufacturers to improve their efficiency and effectiveness, which in turn boosted their market share and enhanced brand recognition.

In 2018, Allcock explained how Q4.0 refers to the shift from manual measurement to fully automated manufacturing. This process involves the use of sensors and software to automate the manufacturing process. Schnreiter defined Q4.0 as the process of integrating and managing data related to manufacturing activities and processes (Sader et al., 2021). Quality 4.0 required an analysis system that can monitor and control the entire value chain.

Quality 4.0 combines quality management with digitalization and technology, which provides a management and process dimension to the digital transformation technology driver (Fonseca et al., 2021). Industry 4.0 requires product and process quality, to support flexibility, productivity, planning and implementation of the new processes. Quality 4.0 can improve Industry 4.0's quality and results.

Quality management is related to the four elements of business analysis, namely the organizational structure, jobs, processes, and management systems, and the six business resources which are buildings, equipment, human resources, stocks, technologies, and capital. More specifically with quality management the organization can detect defects in products or processes, trackback its processes, identify the cause of the defect in the resources or analysis data and perform actions to correct the defects and ensure that they do not reappear. The four processes that describe quality management are *total quality management*, *quality methodologies*, *quality standards* and *excellence awards*. Total quality management focuses on human resources, and it is desirable to transfer to the employee level. Quality methodologies install the four quality elements, quality organizational structure, quality jobs, quality control procedures and quality management systems. The goal is continuous improvement with various methodologies, such as Six Sigma. There is a continuous improvement in the quality standards with the difference that it needs certification and renewal every year (e.g., ISO, IEEE, ANSI). According to excellence awards, there is a list of indicators that evaluate the organization in terms of quality management, which are divided into two categories, people enablers and people result (e.g., EFQM model).

The concept of digital transformation is often interconnected with the concept of I4.0 and Q4.0. This concept proposes that the goals of digital transformation are aligned with the goals of quality and that the use of digital tools and methods can achieve these goals. The main driver for I4.0 is a technology and Artificial Intelligence (AI) while Q4.0 focuses on a customer-centric approach. Quality 4.0 refers to the capacity of a product to meet the needs of its customers at any

stage of its life cycle. It can be seen as a way to improve the efficiency of the entire value chain. It can be used to measure and improve the quality of production through digital tools.

Quality 4.0 is often referred to as a major transformation that affects all levels of an organization. The new era of technologies can help people and businesses achieve their goals and needs. They should be used to improve processes and efficiency. The evolution of human capabilities and the fusion of various Quality Control disciplines enable organizations to achieve an agile Q4.0 transition. This can be achieved through the development of the TQM 4.0 environment consisting of the convergence of Industry 4.0, Total Quality Management (TQM), and Quality Control (QC) (Dias et al. 2021).

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