

## LOOKING TO THE FUTURE: DIGITAL TRANSFORMATION OF QUALITY MANAGEMENT

*Cristina RALEA<sup>a\*</sup>, Octavian-Cosmin DOBRIN<sup>a</sup>, Corina BARBU<sup>a</sup>, Cristian TĂNASE<sup>a</sup>*

*<sup>a</sup> The Bucharest University of Economic Studies, Romania*

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### ABSTRACT

*Today, the world has changed. Digital has changed it. Organizations need to adapt to the market requests in order to survive and expand. Quality has become a key decision factor, that enables relevant evaluation, competitive advantage and capacity to understand what success means in the context of digital era. This article aims to study and analyze the stage of knowledge on Quality Management and concepts such as Industry 4.0, Quality 4.0 together with their impact into Romanian and other European enterprises. Moreover, there will be identified the advantages of implementing a Digital Quality Management System, compared to the alternative of maintaining a traditional Quality Management System. The last part of the paper presents some relevant studies that highlight the progress of those fields in our country, followed by concluding remarks.*

**KEYWORDS:** *Digital, Management, Quality, Transformation.*

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### 1. INTRODUCTION

Over time, it has begun to realize that the economic success of a country significantly depends on the capacity of his organizations to adapt to the internal and external markets, providing quality products and services with competitiveness, taking advantages of all the opportunities occurred via the internal and external environment.

Analyzing the most competitive business of this century, you can notice that innovation is the main success factor. Implementing new technologies in enterprises has become a 'must', since it provides high-value and competitive advantage. But what is this phenomenon that we confront?

We face Industry 4.0 or the fourth industrial revolution, exposed by technologies as Internet of Things (IoT), cloud and robotics, treated as the next action to be taken by companies.

While the industry sector is involved into a digitally transformation of his functions such as development, research, maintenance and production, it lags significantly to the digitalization of the quality management process. Most of the companies are still using an old approach of quality control, tracking and managing quality manually or through separate platforms/applications. This is the reason why they confront frequent errors, cost overruns, diminished product quality. In order to avoid investing money and time in rework and repair, and a negative impact in productivity, is necessary to connect production with quality departments.

Automation of end-to-end quality management processes will enable easy monitoring of quality across the production cycle, visibility into operations by identifying issues proactively, analyze the causes and optimize product performance.

Integrated quality management systems, thanks to automation, may establish machine-to-machine interaction, enabling access to the needed information. This type of integrated ecosystem may drive proactive quality management across the board, via process standardization, process enforcement and relevant skill qualifications.

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\* Corresponding author. E-mail address: [cristinaralea1@gmail.com](mailto:cristinaralea1@gmail.com)

The first step in digitalization process is the digitization of plant floor. It is necessary to have a plan for this alignment in order to choose from endless possibilities in terms of digital technologies and analytics solutions that can be deployed to upgrade the quality management ecosystem.

What does the top Romanian management say about digitalization? Companies in Romania seem to take action on delegating the responsibility to a top management leader to digitalize the quality of the business. Compared to 2017, when 28% of companies said they gave this responsibility to a top manager, the percentage increased to 36% in 2018.

For top management of Romanian companies, digitization quality is becoming increasingly concrete. Business leaders have begun to take action and connect quality management digitization to business development. The process of setting up directions for digital transformation will strengthen the expertise and increase the acceptance of this process inside the company, generating expectations of profitability. The success is for leaders who can change the traditional quality management system into a digital quality model.

## **2. STAGE OF KNOWLEDGE ON QUALITY MANAGEMENT**

Several theories on Quality Management have been developed since the The Middles Ages. Work made by journeymen and apprentices were evaluated and inspected by other experts to ensure that the quality standards were achieved according to guidelines and standards related to the end product, ensuring satisfaction of the customer. Even if the history of Quality Management has met several changes, the end goal is the same – to deliver quality product.

Over the years, quality management systems (QMS) began to surface. The focus of QMS was on the end product, the major standards were applied to product quality control. Inspections were the way that the product quality was determined, by measuring, examining and testing products, services and processes in order to ensure compliance to standards and guidelines.

Businesses began to experience difficulties as soon as they have started to grow and expand, due to the increase of products manufactured throughout the day. It was clear that it was a lack of control together with a great need of change and development. Being the key driver of any organization, the notion of quality management raised the need of industry leaders and experts such as W.E. Deming, J.M. Juran, H.F. Dodge and H.G. Romig (1940). They started to lay the foundation of Total Quality Management as we know it today.

The year 1946 brought three major organizations: American Society for Quality (American Society for Quality Control), International Organization for Standardization and the Japanese Union for Scientist and Engineering. American Society for Quality (ASQ) was founded in the end of the Second World War when US specialist were searching new ways to continue improving quality (ASQ, 2013). International Organization for Standardization (ISO, founded in London, when 25 countries members gathered at the Institute of Civil Engineers in London and decided to create a new organization 'to facilitate the international coordination and unification of industrial standards' (ISO, 2013b). Union of Japanese Scientists and Engineers was founded to promote systematic research needed in order to achieve compliance in the context of science and technology, contributing to the development of culture and industry (JUSE, 2013).

The progress is highlighted by new ways to prevent quality management. Production personnel started to be in charge with inspections during production cycles. In this manner, the focus have been moved from the end product to the effective prevention of problems through early detection on the production line.

During the 1940's Japan made several changes in businesses quality theories. After the great success of West countries, Japan, known as low quality provider, employed the assistance of quality management specialists like Juran and Deming, soon being able to set new standards of Total Quality Management. Feigenbaum was the first specialist using the phrase of 'Total Quality

Management' (TQM) during the first international quality management conference (1969). Even so, Feigenbaum did not manage to make himself as well understood as Ishikawa did. Ishikawa affirmed that TQM have to be applied to all employees, starting with workers up to top management.

In 1980's U.S. Government started to set clear standards and guidelines according to the concept of Total Quality Management, developing awards such as Malcolm Baldrige Award, meant to encourage the companies that exhibited Quality Management excellence.

Between 1987-1994 International Organization for Standardization established and updated ISO 9000:1994 (ISO .2013a) standard that was focused solely on quality.

Quality Management principles according to ISO can be used as a foundation to guide a company's performance improvement.

The seven principles of Quality Management are:

1. Customer Focus – capacity of achieving customer requirements
2. Leadership – mission to create a common purpose of employee's engagement
3. Engagement of people – excellence in the context of competency, engagement and empowerment
4. Process approach – activities managed as interrelated processes composing a coherent system
5. Improvement – ongoing focus on improvement
6. Evidence-based decision-making – understanding of cause-and-effect principle and potential consequences.
7. Relationship management – with all of its interested parties

### **3. STAGE OF KNOWLEDGE ON INDUSTRY 4.0 AND QUALITY 4.0**

We all heard about of Industry 4.0 concepts – known as the fourth industrial revolution. This phenomenon has revealed a true paradigm in manufacturing and delivering of products and services, d by technological progress in fields such as data, analytics, collaboration and connectivity. Internet of Things, Big data, Machine learning, Artificial Intelligence, Cloud computing, Augmented and Virtual reality, which represented an opportunity for the companies, have become a necessity in order to adapt to a new industrial market requirements.

All of the above will result in a seismic transformation of the way that many companies are doing their daily-basis activities. In order to adapt to those several changes will be required a cultural change of the organization that will affect workforce and management, increasing the importance on product innovation, supply chain performance, manufacturing efficiency, compliance and, of course, quality. This is the moment when Quality 4.0 comes in. Quality 4.0 strategies provide the capacity to align the practice of quality management while emerging capabilities of Industry 4.0, helping companies to achieve operational excellence.

The term of Quality 4.0 is an extended concept of Industry 4.0, originally addressed at the Hannover Fair (Germany, 2011). The topics debated in that meeting were the ways of increasing intelligence and interconnectedness in the context of smart factories, as an effect of the newest technological innovations.

What is changing? The dynamic expansion of the internet accelerated innovation in production and availability of information due to increasing of data produced by people and devices, connectivity, intelligent processing as an effect of affordable computing capabilities, new models of interaction such as Augmented Reality and Virtual Reality and new models of production like 3D printing and block chain.

Why is Quality 4.0 so important? The Fourth Industrial Revolution is happening now and it extends the digital impact manifested through the Third Industrial Revolution. It impacts everything we do by connecting people, machines and data in new manners, democratizes technologies to be more accessible. For the quality perspective, all of those have a direct impact to culture, collaboration,

leadership and compliance. Quality 4.0 is more than technology, is the way of maximizing value via interaction of users and processes.

It would be a misunderstanding if the range of the new technology that compose Industry 4.0 were anything less than a natural transformation of the world that we live in. Quality 4.0 represents the way that those technologies are realigning quality functions into a broader organizational strategy.

Quality 4.0 is meant to alter the perception regarding the quality functions in companies as being more than a 'quality policy'.

A strategy based on Quality 4.0 principles may enable companies to address long-standing quality issues, to review the causes of current barriers due to lack of communication, communication, traditional non-integrated quality systems, and engage in a strategic plan to explore how you can take advantage from using new technologies.

Thus, what is Digital Quality Management? It represents a digital capability used to maintain the quality throughout the lifecycle of a product/service composed by activities meant to develop the ways that organizations are offering it to customers. The focus of Digital Quality Management is not only the final product of digital capability, but also all the elements and activities needed in order to produce it. It includes quality assurance activities meant to prevent and to correct deficiencies. In addition to traditional quality management, Digital QM includes the capability to measure the quality of digital customer experiences.

Should a Digital Quality Management strategy be considered compliant with ISO Standards? Don't forget that the implementation of ISO 9000 standards requests improvement in order to obtain competitiveness, receptiveness to market demands, strong communication with the external environment.

#### **4. WHY QUALITY 4.0 IS A BETTER CHOICE?**

Albers et al (2016) summarized the influence of Industry 4.0 in a quality perspective, reporting a productivity increase of 50% and 80% increase of efficiency for the companies that adopted usage of Industry 4.0 technologies.

Traditional quality management defines quality standards and determines if the processes and the final product are acceptable. Quality 4.0 offers to companies the ability to determine a product's quality in a much more efficient way, supported by the new technologies.

An enterprise can change its standards, restructure its processes or train employees, but if those are not in line with the requirements of the new digital market, be sure that the buyer will choose another competitive provider that can offer a better customer experience.

A traditional quality management system can front delay in the process of analysis, data collection, and decision-making. Those are key elements that can describe the actual dynamic market. Technological improvements may help the organization to achieve visibility in real time, effective collation of data from various sources, ensuring an agile decision-making.

Traditional quality metrics provide relevant information on what happened, why, using predictive methods to say what can happen next. Industry 4.0 technologies allow a new type of information to the framework: prescriptive. Prescriptive analytics can predict failure together with the solution.

Quality 4.0 can set higher standards in terms of connectivity that the traditional quality management system can't, emerging business information technology and operational technology. In that manner, enterprise quality management systems and enterprise resource planning can be linked to technology used for manufacturing and laboratory. This type of connectivity can allow the collection of data in real-time.

Enterprise quality management system software provides help to organizations regarding streamlining and synthetization of quality activities for a better compliance and efficiency. Quality 4.0 leverage EQMS with practices and new tools in order to achieve a better customer experience and a greater visibility.

Additionally, Quality 4.0 brings a new type of connection with internal and external environment helped by technologies as augmented reality or virtual reality, applications, that ensure a vital data and feedback from employees and stakeholders.

One of the main problems reported by organizations about quality objectives is that it cannot be achieved properly due to fragmented data sources and systems. This lack of scalability can be healed by Industry 4.0 technologies enabling a full reconciliation of the processes, competencies and practices.

Applications development are the mechanisms that allows companies to collect data, visualize analytics and establish collaboration. The traditional quality apps are usually web-based, optimized for mobile even if it requires a large mobile device. Industry 4.0 technologies provide powerful software that can simplify the experience of an application through multiple interfaces divided by role allowing mobility in usage of smartphones and other mobile devices. Mobility and interactive applications are the fuel of quality management.

Regarding compliance, Quality 4.0 provides tools and techniques that can be used to automate activities and collect data. Data analytics can prevent compliance breaches, identifying opportunities for improvement.

Via the connection of data, analytics and processes, improving visibility, collaboration and insights, Quality 4.0, comparing to traditional quality management system, is described as a true organizational-wide culture of quality.

**Table 1. Traditional Quality Management System transformation to Quality 4.0**

<b>Traditional Quality System</b>		<b>Quality 4.0</b>
Planning		Data
Coordination		Analytics
Organization	→	Connectivity
Control		Collaboration
Quality Assurance		App Development
		Scalability
		Management Systems
		Compliance
		Culture
		Leadership
		Competency

*Source: authors' ownership*

Traditional quality management system began to be depreciated due to markets requirements. Competency definition is now represented by the capacity of improvement.

Despite multiple benefits, implementing Quality 4.0 principles is a long process. According to a study made by LNS Research, digital quality transformation has been adopted only by 65% of leading manufacturing worldwide. Due to lack of involvement of quality leaders in Industry 4.0 strategy development, many of them think that this initiative is not related to their scope. Another effect resulted is that Quality 4.0 is led by IT professionals, operation teams, marketing and Research & Development. But achieving the true benefits of Quality 4.0, quality leaders must be engaged in digital quality transformation. Many European Union Members States sponsor Industry 4.0 related initiatives, including Germany, Italy, France and United Kingdom. In 2010 German Government made the first contribution to the Industry 4.0 initiative to support the development of

smart factories. This initiative brought together academies, the private and the public sector to build a 10-15 years plan for implementing on high-quality standards digital technologies in the industrial sector. Italy has also several projects which are meant to support research initiatives in areas such as reconfigurable factories, quality in the context of digitalization, sustainability and high performance. The usage of Industry 4.0 technologies in control systems, smart factories and quality control, Italian enterprises increased quality, flexibility and customized manufacture. United Kingdom elaborated a set of standards in order to make manufacturing more responsive, sustainable and open to new markets. UK invested in high-value manufacturing centers which have the role to help companies to access expertise and research in areas such as process innovation, quality management involvement in digitalization and advanced manufacturing. Additionally, in 2012, the Government provided funds for the project called Manufacturing Advisory Service Supply Chain Initiative Fund. In France was adopted a strategic plan for the Factory of the future to create demonstration centers with new products and services. Several programs gave loans to enterprises to aid areas such as robotics, digitalization or energy-efficiency projects. In Romania, the digitalization of quality management is increasing, even though in 59% of organizations the top management does not have enough expertise for a smooth transition to Quality 4.0 concept, according to 'Digitalization Barometer 2018'. Even so, only 42% of companies have a website, 33% of total workers per country have computer-usage knowledge and only 7% of companies practice e-commerce. Only 46% of companies with revenues between 10 and 50 million euro have a leadership specialized in digital quality strategies, followed by 41% of companies with revenues between 1-10 million euro and 38% with revenues greater than 100 million euro. The main reasons why Romanian companies are not taking advantage of Quality 4.0 concept are regarding the lack of digital customers, the security and rigidity in front of development. According to 'Digitalization Barometer 2018' only the big companies are truly interested in implementing Quality 4.0 in order to consolidate their market share. Romania, despite the fact that during the previous years has met an increase of digitalization in terms of quality management, remains on the last place in European Union, according to Digital Economy and Society Index (DESI) Report posted by European Commission.

**Table 2. Digital Economy and Society Index Evolution for Romania**

Indicators	Score DESI		
	2019	2018	2017
Connectivity	53.5	52.50	45.20
Human Capital	31.1	31.50	30.20
Use of Internet	31.9	28.50	23.80
Integration of Digital Technology	20.5	20.10	20.30
Digital public services	43.2	40.40	36.50

*Source:* adapted from DESI (2017-2019)

The main questions are: What can be done? It is clear that our position on the external markets is affected by Romanian companies capabilities to ensure quality of the product/service and processes in a competitive way. How will look the progress for Romanian companies in 2020-2025? How this evolution could be impacted in a positive way? Should other third parties be involved in the process or it is related only to the companies in cause? How can the Government have a positive impact on the way that Romanian enterprises develop their quality of processes, products/services in a digital manner? Specific regulations, infrastructure development and electronic governance represent the answer to this question. The main role of the government is to generate trust regarding the trend of

quality management digitalization. To achieve this, we need specific regulations that could help enterprises to identify how to simplify standard processes like issuing electronic invoices, digital signatures and sensitive data collection. The government should think about changing some rigid regulations, which affect innovative companies with great impact to social environment – Taxi, Accommodation. The Government should elaborate a specific plan composed by strategic directions to digitalize the country, and, as France, Germany, Italy and UK did – to fund Romanian enterprises in their initiative to innovate.

Considering the fact that 10% of Romanian population does not have access to internet connections, the Government should find a way to provide an infrastructure that facilitates it, in order to achieve a larger market for digital services.

E-governance is also a good way for Government to support enterprises in the digitalization of quality management, reducing the number of papers and forms to be completed, time spent to public administrations that can be invested in innovation and increasing the productivity of employees.

Citizens are also a third party that can accelerate the progress into digitalization of quality management in enterprises. Education is one of the main keys into that process. Considering the fact that 30% of Romanian population have over 50 years, we should assume that plenty of them are not flexible in front of the digital era. How we can help them? Anyone of us can learn parents or grandparents to use Internet, computers, smart-phones, with all their advantages and risks. In this way we offer to digital Romanian enterprises the chance to have a larger customer portfolio.

Based on DESI Report related to 2015-2019, you may find below a representation of DESI scores for Romania, together with other EU country members:

**Table 3. DESI Scores (2015-2019)**

Indicators	Score					Variation			
	2019	2018	2017	2016	2015	2019 vs 2018	2018 vs 2017	2017 vs 2016	2016 vs 2015
Finland	69.9	66.3	63.7	67	66	5.43%	4.08%	-4.93%	1.52%
Sweden	69.5	66.9	63.2	67	68	3.89%	5.85%	-5.67%	-1.47%
The Netherlands	68.9	66.8	63.5	67	65	3.14%	5.20%	-5.22%	3.08%
Denmark	66.8	66.1	65.6	68	68	1.06%	0.76%	-3.53%	0.00%
United Kingdom	61.9	58.8	55.6	61	59	5.27%	5.76%	-8.85%	3.39%
Germany	54.4	51.8	49.4	57	54	5.02%	4.86%	-13.33%	5.56%
France	51	47.7	45.6	51	51	6.92%	4.61%	-10.59%	0.00%
Italy	43.9	38.9	36.5	40	38	12.85%	6.58%	-8.75%	5.26%
Romania	36.5	35.4	32	35	32	3.11%	10.63%	-8.57%	9.38%
Bulgaria	36.2	35.5	32.4	37	36	1.97%	9.57%	-12.43%	2.78%

*Source:* adapted from DESI (2015-2019)

Romania has met an increase of 10.63% in 2018 comparing with 2017 in terms of Connectivity, Human Capital, Internet Usage, Integration of Digital Technology and Digital Public Services according to Digital Economy and Society Index. Even so, Romania had the lowest score in UE (2018).



**Figure 1. DESI Total Score dynamic 2017-2019**

*Source: adapted from DESI (2017-2019)*

According to DESI Scores achieved by Romania, you may find below a forecast for 2020-2025 based on the assumption that our evolution will be linear and equal with the average ratio calculated for 2017-2019 dynamic.

**Table 4. Forecast 2020-2025 According to DESI Scores (2017-2019)**

Indicators	Score DESI					
	2019	2018	2017	2019 /2018	2018 /2017	Annual average %
Connectivity	53.5	52.50	45.20	1.9%	16.2%	9.0%
Human Capital	31.1	31.50	30.20	-1.3%	4.3%	1.5%
Use of Internet	31.9	28.50	23.80	11.9%	19.7%	15.8%
Integration of Digital Technology	20.5	20.10	20.30	2.0%	-1.0%	0.5%
Digital public services	43.2	40.40	36.50	6.9%	10.7%	8.8%
Indicators	Forecast 2020-2025					
	2020	2021	2022	2023	2024	2025
Connectivity	58.33	63.60	69.34	75.60	82.42	89.86
Human Capital	31.57	32.05	32.54	33.03	33.53	34.04
Use of Internet	36.95	42.81	49.59	57.44	66.54	77.08
Integration of Digital Technology	20.60	20.71	20.81	20.92	21.02	21.13
Digital public services	47.00	51.15	55.65	60.55	65.88	71.69

*Source: adapted from DESI (2017-2019)*



If Romania would be able to maintain this growth during the following 5 years, we will have a chance to gain competitive advantage on the external markets. Being on the last places in EU represents a big concern for Romanian enterprises and for the Government, highlighted as a barrier in achieving high profits and a healthy economic growth.

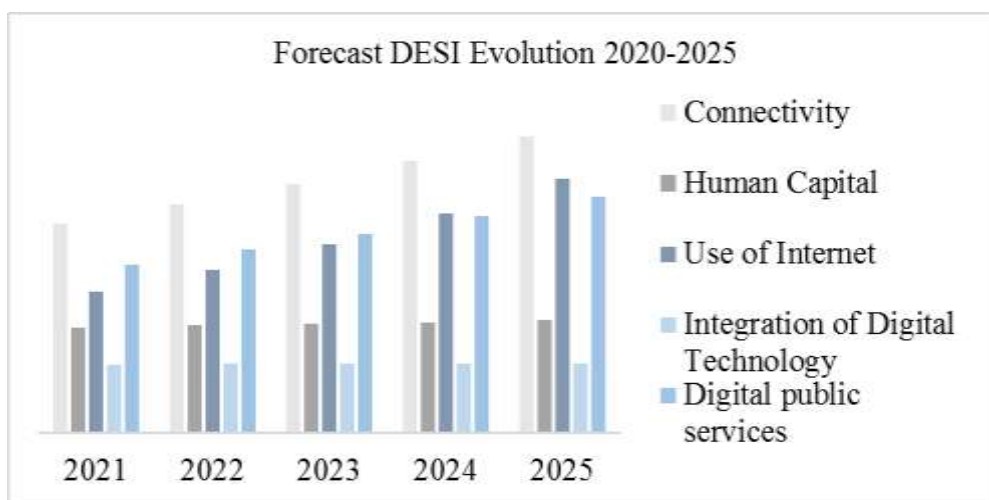
However, how will look this progress comparing first rank country, based on the assumption that the evolution is linear?

The most digitalized country as per DESI ranking (2019) is Finland, with a total score of 69.9 pct., compared with 36.5 pct.– score gained by Romania.

**Table 5. Forecast 2020-2025 Total score Finland vs. Romania**

Country	2019	2018	2017	2019/ 2018	2018 /2017	Annual average %
Finland	69.9	66.3	63.7	5.4%	4.1%	4.8%
Romania	36.5	35.4	32	3.1%	10.6%	6.9%
<b>Forecast</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>
Finland	73.22	76.71	80.35	84.18	88.18	92.37
Romania	39.01	41.68	44.55	47.61	50.87	54.37

Source: adapted from DESI (2017-2019)

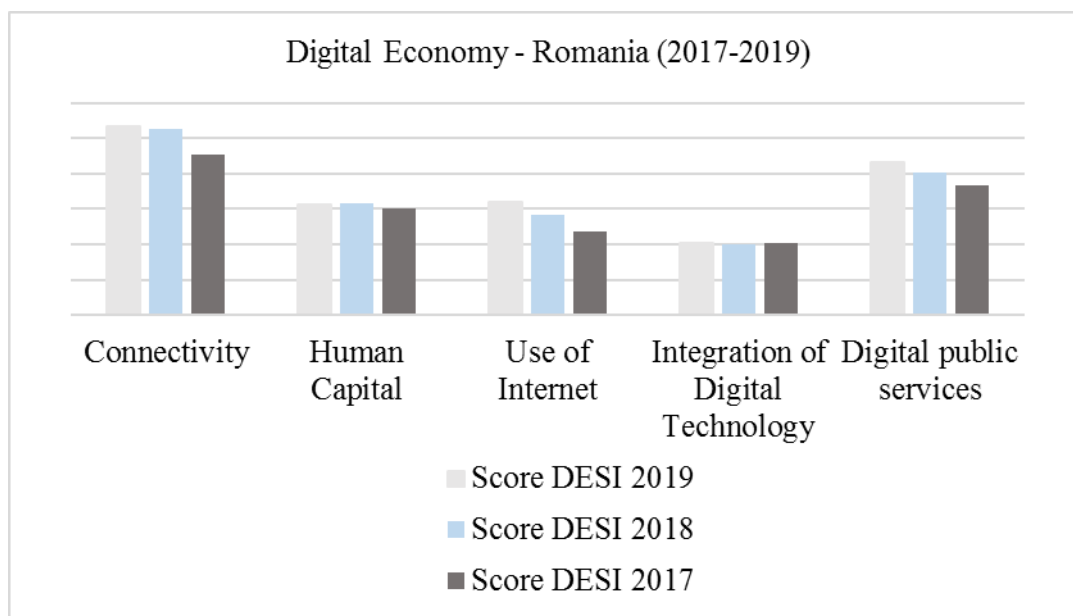


**Figure 2. DESI Indicators 2017-2019**

Source: adapted from DESI (2017-2019)

According to this forecast, Romania could achieve in 2025 a score that represents 57.68% of Finland total score.

Which are the main problems regarding the implementation of Quality 4.0 strategies in Romanian enterprises according to DESI report for 2019? As you can find in the figure below, the lowest score is related to Digital Public Services – described as the lowest progress in UE countries, followed by Human Capital.



**Figure 3. DESI Indicators 2017-2019**  
 Source: adapted from DESI (2017-2019)

Romania has the best performance in Connectivity dimension because of the availability offered by fast networks. Even so, Romanian enterprises are not taking advantage of this strength that could help them to achieve a successful implementation of Industry 4.0 and Quality 4.0 concepts.

## 6. CONCLUSIONS

In short, The Fourth Industrial Revolution has forever changed the perspective of quality. Today, the quality has the opportunity to influence product design, customer satisfaction, operational performance and many more.

Therefore, it can be concluded that organizations need to understand very well the impact of adopting Quality 4.0 strategies to areas such as product innovation, supply chain performance, manufacturing efficiency, compliance and quality in the context of cultural, workforce and management changes.

From a theoretical point of view, it may be observed that the quality in the context of the digital era has become one of the biggest problems of enterprises development and of technological progress, being in fact the key of a healthy economic growth. Moreover, many of the organizations are implementing quality as an objective for the IT, Marketing, R&D or Operations Departments, and not as a main objective for the Quality Department. As an effect to this action, most of quality leaders do not understand clearly Industry 4.0 technologies, their application and their importance.

Quality 4.0 isn't a story about technology, it's about improving culture, competency, collaboration, leadership by digital transformation of quality management and compliance. Thus, Quality 4.0 can be understood as a story about tomorrow even if it's happening now. Those who lead the Quality 4.0 transformation in the context of implementing new technologies causing the greatest effects will be the leaders of tomorrow.

Companies are generally delaying adopting digital quality management because it is challenging to adopt technology that automates fragmented processes. But don't forget: consistency is critical in order to add high-value to your product/service.

European enterprises are doing visible progress implementing Quality 4.0, even so many of them have the support of the Government. While they're growing and expand, Romania continues to be

on the last place in European Union as per the Digital Economy and Society INDEX. What can happen if we won't change that? Our profitable relationship with external markets will decrease while we will continuously buy from external markets. Our economic system will face a decrease due to the lack of digital perspectives in innovation and improvements. This should be highlighted as a question mark for the Government and also for citizens. This real challenge can be achieved by realigning people and processes that underlie quality management systems. But make no mistake: Quality can no longer afford to be just a checkbox in your organization!

The days of Quality sitting in the back seat of digital transformation are over. It's time to move on the front seat next to IT in order to achieve success together.

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