Analysis of the Impact of Telemedicine
on the Health System in a European Context

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Abstract

Accessibility, cost, availability and quality of medical services have always been an important topic in the European Union. The rapid development of high-tech technologies, software and hardware, have allowed the emergence of a new trend in the health system, telemedicine. The aim of this paper is to propose a detailed analysis of the openness of the European health system to innovation, in particular to the adoption of telemedicine solutions. Thus, the aim is to identify the barriers of this type of medicine by studying the literature. The application of the analysis in principal components highlights factors that influence the decision of a member state of the European Union to adopt or postpone this trend such as education, level of technology or demographic aspects. The analysis is completed by the study of telemedicine in Romania. The results of the statistical models capture the evolution of telemedicine, offering a general perspective on the spatial impact, emphasizing the specifics of the Romanian health system.

Key words: telemedicine, analysis in principal components, barriers, European Union, Romania
J.E.L. classification: I15, C38

1. Introduction

Telemedicine, a term that has become increasingly popular lately, is a solution for the dissemination of the medical service, which offers the possibility of access to health care for an increasing number of patients.

Telemedicine can be considered a remote medical practice that uses information and communication technologies and artificial intelligence. In other words, it is a different way of treating patients according to the same protocols in terms of quality and safety as in conventional procedures.

The new approach allows, on the one hand, finding solutions in the medical field in terms of population aging, and, on the other hand, in-depth monitoring of chronic diseases. At the same time, telemedicine is an important vector for improving access to healthcare, especially in disadvantaged areas. In addition to being useful in implementing national health policies, telemedicine can help communicate between national hospitals and those located in rural or least accessible areas. At the same time, depending on the available IT resources, strategies for the development of telemedicine at national level can be developed. On the other hand, an advantage of using telemedicine is training and education in health care. Indeed, it allows for better care closer to where patients live and contributes to coordinated care by health professionals and health professionals. It is also an important factor in improving the efficiency and organization of health care.

Even if telemedicine offers the possibility for medical staff to offer support to as many patients as possible, in addition to the multiple advantages offered by its adoption, there are certainly a number of impediments. If doctors want to practice in different EU countries, it is necessary to comply with the legislation in force in each country. There are certainly different policies and

regulations that may require medical licenses from doctors in each of the states in which they wish to practice or pay fees. Most likely, in this case, a possible solution would be to adopt a single medical license, at the level of the European Union, which seeks to reduce transnational barriers to the adoption of telehealth. In addition, the accreditation process requires a long period of time and a high cost of material resources.

The main objective of this analysis is to explore the various drawbacks involved in the evolution of telemedicine in the Member States of the European Union. By using the analysis in principal components s, we want a clear delimitation of the states based on factors derived from the barriers highlighted by the literature such as education, technological evolution, the state of the national health system, social and financial characteristics.

Also, the research focuses on the individual study of the dynamics of telemedicine adoption in Romania, which aims at a time evolution of the degree of acceptance and adoption of medical innovation by technology by private or public medical institutions, but especially the perspective of Romanian doctors. An objective of this analysis is to investigate in detail the vision of the health system regarding telemedicine and to determine what are the barriers that place Romania on one of the last places in terms of the use of telemedicine services.

The analysis of the concept of telemedicine and the barriers highlighted based on the literature, easily leads to the characterization of the European health system, the analysis of barriers in the adoption of telemedicine in the European Union and the evolution of this type of medicine in Romania. The last part of the paper summarizes the main conclusions of the article, offering new research topics.

2. Theoretical background

The integration of high-tech technologies in the health system was an opportunity in the evolution of telemedicine at European level. Telemedicine is defined as the way of providing medical services that aim to replace the traditional direct interaction between doctor-patient (or doctor-doctor) with a remote approach through technology. Looking from another perspective, Shaw (2009) considers that this branch of medicine is reduced to the use of telecommunications to provide a diagnosis, continuous monitoring, and for therapeutic purposes when the obstacle of geographical distance between the two actors, the patient and the doctor.

The emergence of new monitoring and diagnostic devices, as well as medical platforms has improved online communication between consumers and healthcare professionals regarding the exchange of information. These remote monitoring devices transmit real-time patient status data to physicians, patients or a third party, which is one of the reasons for the growing market demand from year to year. The development of the health system has led to the focus on the decision of public and private management to adopt telemedicine solutions amid increasing cases of chronic disease, cardiac arrest, asthma and cardio-lung problems (Market Data Forecast, 2019). Economically developed countries have adopted new technologies as well as alternative methods to provide superior medical services in order to reduce costs and improve quality. However, the expansion of telemedicine has occurred without having been planned in detail in detail based on a strategy, so developed countries have not yet managed to significantly reduce the costs of services provided or improve access to health care (Bali, 2018).

In recent years, telemedicine has become one of the most important centers of medical and scientific interest, amid the technological revolution and the opening of the medical system to innovation. Telemedicine solutions can be described as products and services developed on the basis of technology in order to improve the patient's health and reduce mortality through early detection of chronic diseases. The advantages of adopting these smart devices are represented by the increased efficiency of the services provided, the possibility to monitor patients remotely, facilitating access to electronic files, superior quality services and a balanced management of chronic diseases. According to statistics, most monitoring, prevention, analysis and diagnosis solutions have focused on cardiovascular disease, lung disease and diabetes (Almathami, 2020). Regarding the evolution of telemedicine, it is strongly correlated with the level of digitalization of a country, being determined by both the digital skills of patients and medical staff. Any teleconsultation required requires the availability of medical professionals, as well as a significant investment from the state for the

development of information systems (El-Miendany, 2017). Brodie (2020) developed a model that demonstrated that a more informed population that has access to online services such as health services, transportation, education is also correlated with economic development and the adoption of telemedicine services. Moreover, Wang (2012) studied the global health system for 50 years, concluding that both industrialized and highly developed countries will have to increase government spending on health in the context of the impact of barriers. in the long term, in order to ensure higher quality services and significantly increase life expectancy.

Also, no significant link was found between the adoption of the electronic record system and the adoption of medical solutions based on advanced technologies. However, in the case of hospitals with high technological capabilities, determined by the presence of a specialized intensive care unit, they are more likely to adopt this trend (Bali, 2018).

National legislation also plays an important role in the adoption of telemedicine, so a negative impact is brought by the decision of states that impose special licenses on cross-border providers, as opposed to the positive impact of the state's decision to ensure the same rights of access to telemedicine services as medical services that require patient-physician interaction (Becker's Health IT, 2020). Thus, as there are different regulations and laws at the level of each Member State, most of the medical devices on the European market are only certified at national or regional level. To reduce this inconvenience, in order to facilitate trade on a European scale, the EU has tried in recent years to promote uniform standards.

Another result from the literature highlights that population density is negatively correlated with the process of adopting telemedicine, and medical institutions operating in less competitive markets are twice as likely to adopt a telemedicine program.

3. Research methodology

One of the methods agreed by statisticians to reduce the dimensionality of data, increase the degree of interpretability and minimize the loss of information is the principal component analysis. This statistical method is based on a simple principle, the creation of new uncorrelated variables that maximize total variation. The new variables, the principal components s, are actually a linear combination of the initial variables. This analysis aims to obtain a graphical representation of European Union countries in a small space, through projection (Jolliffe, 2016).

The total variation explained indicates how much of the variability of the data was modeled by each barrier identified. Because the principal component analysis method is based on the correlation matrix, the variables are standardized, which means that each variable has a dispersion equal to 1, and the total variance is equal to the number of variables used in the analysis. According to Kaiser's criterion, only the eigenvalues with the property $\lambda_i \geq 1$ are retained, and according to the coverage percentage criterion we retain those components that explain the percentage variability of at least 80%. However, in practice, a value between 70% and 80% is also accepted.

The methodological framework is based on surveys, national or European databases, which are used to characterize the impact of telemedicine in the European Union. Thus, the Eurostat, World Bank, The Global Economy or OECD platforms were used as data sources. Additional sources such as surveys conducted by EU Member States' statistical institutions or data in specialist articles were also used to support the analyzes.

4. Findings. Analysis of the dynamics of the telemedicine market at European level

4.1. Health system - evolution and innovation

The European countries that recorded in 2018 the highest revenue from telemedicine solutions and services are Denmark, Sweden, Germany, the Netherlands, Austria, Finland, France and the United Kingdom. On the other hand, countries such as Malta, Cyprus, Romania and Bulgaria have the lowest incomes from this form of medicine. These data are also positively correlated with government spending on health, indicating a strong link between innovation and a state's financial power to support it.
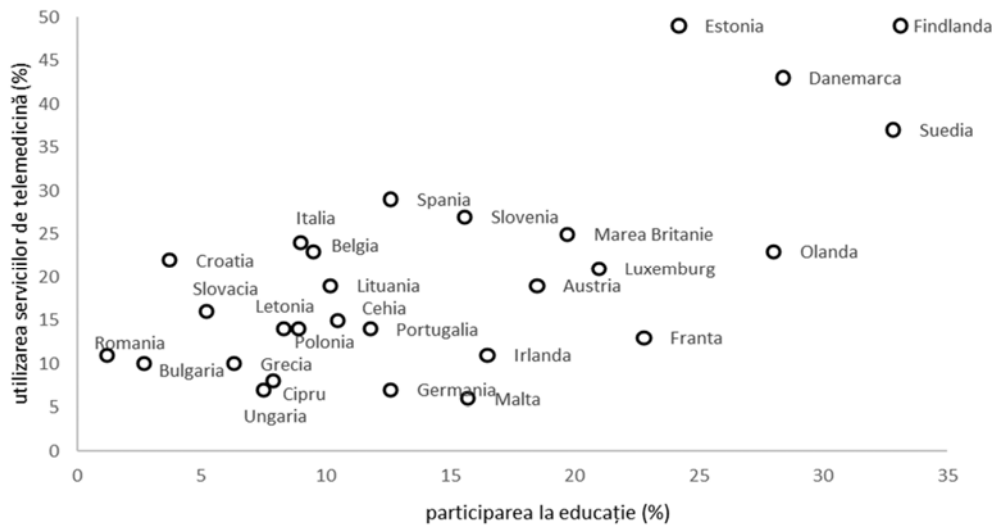
Figure no. 1. Telemedicine market demand under the existence of legislation, 2018
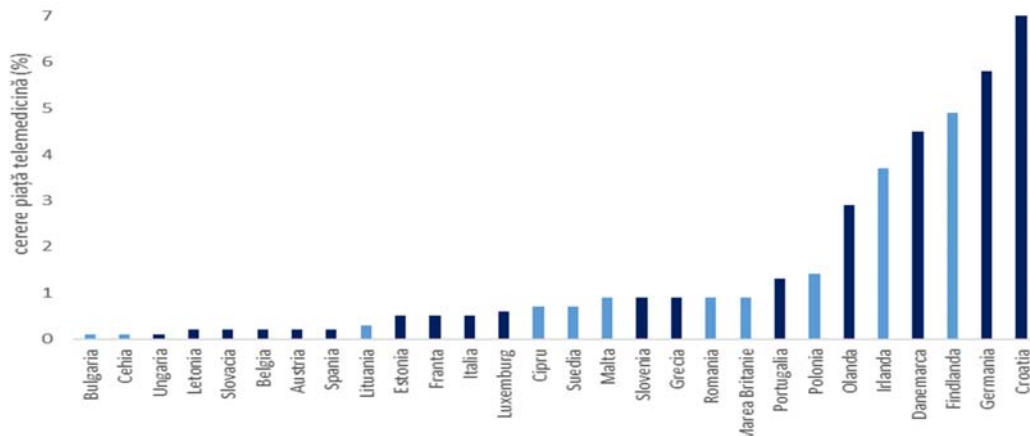
Source: Own processing based on data provided by the European Commission (pwc)

Based on data provided by the European Commission, Figure 1, the highest market demand for telemedicine services comes from economically developed countries, such as Croatia, Germany, Finland and Denmark. It should be noted that not all the great pawns of this market have developed adequate legislation for this form of distance medicine (represented by the dark color). Romania manages to rank in the first half of the member countries in the ranking of market demand, the need for innovation being strongly felt in every sector of the national economy.

Figure no. 2. Use of telemedicine services versus participation rate in education, 2018

Source: Own processing based on data provided by the European Commission (pwc) and Eurostat

A crucial factor in the evolution of telemedicine is the education system, which plays a decisive role in adopting innovation and marketing as an innovation leader. Romania and Bulgaria have the lowest participation rate in education, a value strongly correlated with the level of use of telemedicine services. Northern and Western Europe, known for the quality of the education system, mainly due to significant investments and successful results, hold most of the telemedicine market, whether it is telecardiology, teleradiology or teleophthalmology.

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"Ovidius" University Annals, Economic Sciences Series

Volume XX, Issue 2 /2020

Also, at the level of the European Union, internet access continues to increase from year to year. Internet consumption is much higher for young people, leading to an increase in demand for telemedicine in Europe.

Regarding the health status of the population, according to statistics, diseases of the cardiovascular system are the leading cause of death, with an estimated 17 million deaths annually in Europe, 85% of which are caused by heart attacks or strokes. The current technology for monitoring the patient in hospitals has a short period of autonomy, which increases the difficulty of these devices to detect an irregular heart rhythm. It should also be mentioned that in 2019, according to Eurostat, the proportion of the population over 65 years of age reached 20% of the total population of the European Union. These considerations demonstrate the rapid evolution of telemedicine in the European Union, as well as the significant differences between the stages of progress of each state.

4.2. Barriers to the implementation of telemedicine

According to the literature, the barriers that appear in the process of adopting telemedicine can be grouped into several categories, such as: industrial and technological component, socio-demographic characteristics, educational system, financial field and market situation. Also, although these bottlenecks exist at the level of each European country, the severity of the impact is different. These obstacles not only influence the evolution at national level, given a market divided by several shareholders, but also affect the players in each country differently. Thus, based on these assumptions, it is difficult to quantify the impact of these shortcomings over time for all European states (European Commission, 2018).

In order to rank the member states of the European Union according to the impact factors in the adoption of telemedicine, we chose a method to reduce the dimensionality of data, using the base year 2018.

Table no. 1 Barriers to telemedicine considered for the ACP

Telemedicine services		
util_serv_tel	use of telemedicine services	Million Euros
venit_tel_loc	revenues from telemedicine	Euro / capita
Education		
part_educ	participation in education	% population
Level of technology		
acces_int_gosp	internet access	% households
ind_inov	innovation index	%
Demographic characteristics		
pop_den	population density	%
rt_pop_65p	population aged 65 and over	%
rt_mortal	mortality rate	%
dec_sist_circ	deaths caused by diseases of the circulatory system	%
Economic characteristics		
gini	gini index	

Source: own processing

The first stage of the principal components analysis is the investigation of the correlation matrix, which is the first justification for the need to use this analysis. Correlation coefficients suggest strong correlations both positive and negative, which demonstrates the usefulness of ACP application. (Table no. 2)

Table no. 2 Correlation Matrix

	acces int_gosp	rt mortal	ind inov	rt_pop_ 65p	venit_tel _loc	pop den	gini	part educat	utilize serv_tel
acces_int_gosp	1	-0.57	0.89	0.30	0.69	0.11	-0.39	0.80	0.50
rt_mortal	-0.57	1	-0.59	-0.41	-0.54	-0.31	0.43	-0.48	-0.16
ind_inov	0.89	-0.59	1	0.21	0.76	0.16	-0.26	0.87	0.45
rt_pop_65p	0.30	-0.41	0.21	1	-0.06	0.33	-0.67	0.20	-0.05
venit_tel_loc	0.69	-0.54	0.76	-0.06	1	-0.10	-0.30	0.69	0.48
pop_den	0.11	-0.31	0.16	0.33	-0.10	1	-0.10	0.07	-0.25
gini	-0.39	0.43	-0.26	-0.67	-0.30	-0.10	1	-0.31	-0.20
part_educat	0.80	-0.48	0.87	0.20	0.69	0.07	-0.31	1	0.69
utiliz_serv_tel	0.50	-0.16	0.45	-0.05	0.48	-0.25	-0.20	0.69	1

Source: own processing (SAS)

The variables represented on the first axis, on the positive side, refer to "innovation", such as household access to the Internet, innovation index, participation in education, income from telemedicine per capita and the degree of use of these services, being negatively correlated with the rate mortality.

Table no. 3 The matrix of the principal components rotated

	C1	C2
	Innovation	**Characteristics of society**
acces_int_gosp	0.433679	0.035636
ind_inov	0.434867	0.083685
part_educat	0.428839	0.156667
venit_tel_loc	0.3819	0.24233
rt_mortal	-0.339677	0.25543
utiliz_serv_tel	0.283918	0.365425
pop_den	0.066648	-0.470064
gini	-0.2497	0.381757
rt_pop_65p	0.174014	-0.585645

Source: own processing

The second principal components refer to the "characteristics of society", the mortality rate, telemedicine services and the gini index being positive determinants, while population density and the phenomenon of demographic aging imply a negative impact.

Figure no. 3. Representation of selected variables according to the principal components s
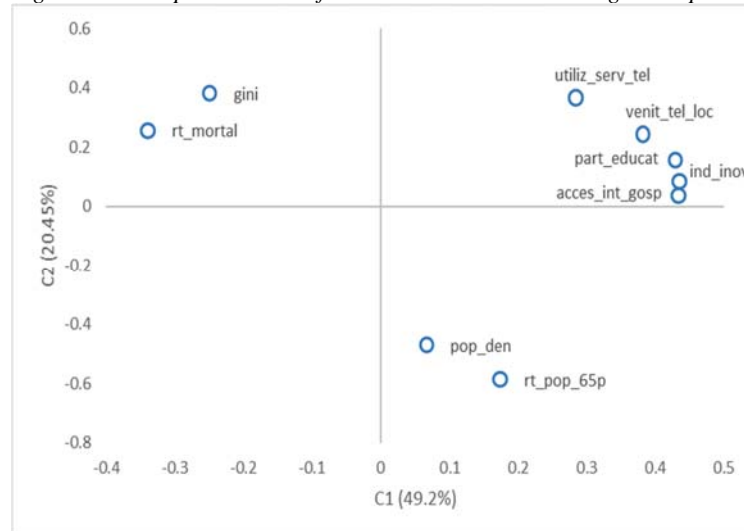
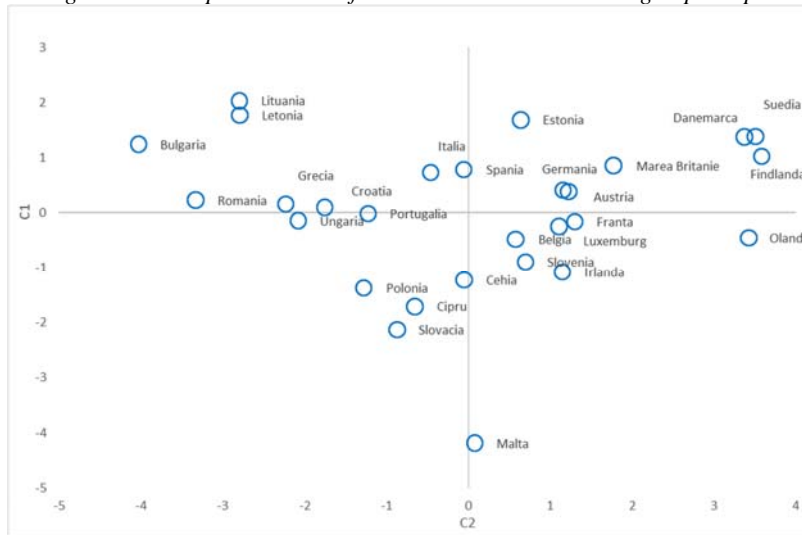*Source:* Own processing based on analysis in principal components (SAS)

The graphical representation of the selected variables according to the principal components (Figure no. 3), highlights the fact that the factors that support the development of telemedicine are represented by the educational system, internet access and the presence of innovation. The first principal components demonstrate the negative influence of the increase of the income discrepancy through the Gini index, but also of the mortality rate. Also, from a negative perspective, but on the second component, the effect of population density is explained, but also of the increase of the population proportion of 65 years and over.

It is clear that the most developed countries, in terms of marketing of telemedicine solutions and services, as well as revenues in this sector, are the countries of Northern Europe and Western Europe.

Educational and financial barriers, the level of digitalization is an advantage for them, managing to overcome them through sustained investments over time in the education and health system compared to the rest of Europe. Eastern Europe (Bulgaria, Romania, Hungary) and Southern Europe (Greece, Italy) which are characterized by high levels of mortality and income inequality. These

require a weak development of the telemedicine system, to which is added a low rate of digitization, as well as an educational system still in development.

Figure no. 3. Representation of selected countries according to principal components

Source: Own processing based on analysis in principal components (SAS)

On the other hand, Malta is a particular case, being strongly characterized by the phenomenon of demographic aging and having a high population density compared to the rest of the EU member states. However, it has the lowest revenues from telemedicine, as this service is rarely used.

4.3. Analysis of the perspective of adopting telemedicine in Romania

Romania is still a member state of the developing European Union, as are the rest of Eastern European countries. Regarding the Romanian health system, there have been significant improvements in recent years, although insufficient investment in relation to medical demand remains a problem. Also, according to data published by Eurostat for 2019, 45.9% of Romania's population is still in rural areas, of which about 30% do not have access to primary health services.

Thus, telemedicine can become a solution for Romania, especially for the population in rural areas, where the health system is quite limited. However, an important barrier is still the lack of clear legislation on the practice of any form of telemedicine, to which is added the need for financial resources from the state to be able to purchase technological solutions in medical institutions. Panait (2004) argued in his research that Romania is not yet sufficiently prepared to support this phenomenon of innovation in medicine, given the outdated telecommunications infrastructure and internet access, lack of computers or basic digital medical equipment for treating patients.

In November 2020, the emergency ordinance (OUG) no. 196/2020 (for the regulation of telemedicine), and the implementing rules will be issued within 45 days. It regulates the medical specialties and the list of services covered by telemedicine services and the medical specialties and the list of services covered by telemedicine services. At the same time, in addition to the conditions of organization and operation of telemedicine, for each type of telemedicine service, the responsibility for establishing the quality of the telemedicine service and verifying its compliance as well as the manner of providing telemedicine services will be specified.

The services that patients can have faster access to the medical act, provided by telemedicine, thus officially regulated in our country, are: teleconsultation, teleexpertise, telecare, teleradiology, telepathology and telemonitoring.

5. Conclusions

The relationship between the adoption of telemedicine solutions and the level of economic, social and cultural development has been a topic of interest, which has intensified recently amid the success of this form of medicine, which involves the lack of contract between doctor and patient. The impact of the digitalization of medical services has occurred mostly in recent years and is expected, according to the forecasts of specialists in the field of statistics and medicine, to reach a point of maximum spread and use in the near future. Based on this surprising evolution, the performance of the medical system must be taken into account, as well as the barriers imposed at the country level.

In order to investigate the obstacles faced by a medical system, the analysis was used in principal components s, which segment the variables into components that illustrate technological innovation, demographic and economic characteristics. This study shows that economically developed countries have managed to overcome many barriers at European level, through financial support of the most important systems that affect society: the health system and the education system. Romania, one of the countries affected by the low participation in education and an unstable economy, is strongly affected by these barriers, having a very low per capita income from telemedicine, on the Romanian market there are still no major manufacturing companies.

In the current context, telemedicine may be a solution that could limit the spread of the virus. Thus, in recent months there has been the development, by the most important medical service providers, of online platforms that can offer modern medical solutions that could help the health system to manage the increase in demand for minor consultations.

Summarizing the results obtained, it is clear that the description of the evolution of the telemedicine services market is incomplete if it does not integrate an analysis of companies that offer technological solutions in the field of medical services. Therefore, it is desired to continue the study of the telemedicine market to analyze the main producing and consuming countries, as well as the impact of the economic, legislative, cultural situation of the country in the process of marketing products.

6. Acknowledgments

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