Assessing Greek National Telemedicine Network

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***Abstract*—This research examines the crucial role of telemedicine in improving healthcare access in Greece, especially on isolated islands and distant mountainous regions. Telemedicine, utilizing Information and Communication Technologies, primarily through interactive videoconferencing, is a significant advancement in the digital health field. It is crucial in guaranteeing fair healthcare access for all individuals, in line with Greece's dedication to protecting the constitutional right to healthcare. This study focuses on the implementation of the Greek National Telemedicine Network (EDIT) and a qualitative assessment of the data recorded by the system. The data analysis of teleconsultation services revealed a clear preference for mental health treatments in both adults and children throughout the study period. Telepsychiatry accounted for the majority of teleconsultations, including over 50% of sessions in the first year and increasing to over 80% from 2017 to 2023. In addition, multiple consultations were conducted to diagnose and treat chronic illnesses, such as diabetes. Over the course of the first five years of operation, the EDIT system had steady annual growth, with an increasing range of examinations being added each year. This signifies the progression of the system and the growing level of approval from users.**

***Keywords*-e-health; telemedicine; Greek national telemedicine network.**

I. INTRODUCTION

In today's digital world, it is crucial to provide technologically advanced solutions that are scalable, cost-effective, and efficient in order to improve the overall health and well-being of individuals [1]. E-health, often known as electronic health, encompasses the utilisation of Information and Communication Technologies (ICT) in the context of healthcare. It includes a wide array of solutions or processes that utilise digital technology to enhance the administration and provision of healthcare. The primary objective of e-health efforts is to enhance the efficiency, cost-effectiveness, and accessibility of healthcare. One of the earliest recorded definitions of eHealth describes it as a developing field that combines medical informatics, public health, and business. It specifically refers to the delivery and improvement of health services and information using the Internet and related technologies [2] [3].

One of the most notable products of e-health could be considered to be Telemedicine. Telemedicine refers to the use of various technologies related to telecommunications and information in the field of healthcare, with interactive video being the most frequently used medium. Various programs were initially developed decades ago. However, the technology has significantly advanced in the previous ten years [4]. Telemedicine offers an appealing substitute for traditional emergency, long-term, and preventive care and can potentially enhance clinical results. Additionally, it is expected to increasingly shift healthcare provision from hospitals or clinics to people's homes in the industrialized world [5].

The technology under investigation has the capacity to enhance traditional healthcare approaches, ultimately ensuring widespread access to high-quality healthcare for individuals worldwide. It may primarily conduct this by enhancing equal access to medical knowledge and facilitating sharing throughout the whole healthcare structure [6]. In light of the statement above, recent research works express that telemedicine has been found to be effective and has beneficial outcomes. These cover the positive impacts on health, improved effectiveness in healthcare delivery, and enhanced technical usability. Other works indicated that it has promise or potential, but further research is necessary to establish definitive findings [7].

Implementing telemedicine in Greece, particularly in isolated islands and rural mountainous regions, is a necessary and practical strategy to fulfill the constitutional mandate of providing equal healthcare access to all citizens, regardless of

their location of residence. This work introduces Greece's National Telemedicine Network (EDIT) along with a qualitative research analysis based on various data exported directly from EDIT's central system. The rest of the paper is structured as follows. Section 2 portrays the main concept of the utilization of telemedicine in Greece; Section 3 presents the study's result. Section 4 provides an overview of the current and future directions of the system under consideration. Section 5 offers a discussion, while Section 6 concludes with the findings and future projections.

II. Greece's National Telemedicine Network

The use of telemedicine in Greece especially in islands and remote rural and mountainous inaccessible areas is an ongoing high-importance matter from the Greek Ministry of Health. An endeavor was initiated in 2011 to significantly address the matter, with the following considerations: a) the factors contributing to previous setbacks; b) pertinent studies conducted by the Ministry of Health regarding the advancement of telemedicine in Greece; and c) the implementation of an integrated planning strategy that encompassed not only a technological implementation or telecommunication infrastructure, but also a comprehensive functional framework delineating regulatory framework parameters, institutional coverage, and procedural aspects. In the following paragraphs, a brief description regarding the main system, the subsystems, and the Telemedicine stations is provided.

The National Telemedicine Network - EDIT now comprises the following:

There are 66 Patient Doctor Telemedicine Stations (PDTS) located in Hospitals, Health Centres, and Multipurpose Regional Clinics. These are the actual spaces where the patient is received and where the examination takes place with the attending physician present. They are situated in the country's isolated healthcare facilities, typically Health Centres, Multi-Purpose Regional Medical Centres, and smaller healthcare units.

Twenty-one Consultant Telemedicine Stations (CTS) are located in 12 hospitals of the 2nd HR and the National Emergency Centre (NEC). Additionally, one station has been constructed in Papageorgiou Hospital in Thessaloniki. The CTS functions as the recipient in a telemedicine session. The device is equipped with imaging tools to present the data, vital signs, and images of the patient to the Consultant Physician. It is set up similarly to a PDTS but lacks diagnostic tools and only includes imaging gear. The CTSs are implemented in Regional Hospitals and tertiary hospitals within the 2nd Health Region (HR).

Moreover, 170 Home Care Stations (HCS) are situated in the homes of in-patients or social care facilities inside the 2nd HR international boundaries. Home Health Care Centres are established in the residences of chosen patients to provide direct communication with the Health Unit in their area. The home care and monitoring system is equipped with characteristics that allow it to be used in patients' homes or in collaboration with local social care facilities. Figure 1 illustrates the primary structure of EDIT, while Figure 2 showcases the apparatus found in a telemedicine station.

A. Main Architecture

Telemedicine nodes communicate via broadband networks and specific communication software, exclusively utilizing the Transmission Control Protocol/Internet Protocol (TCP/IP) network protocol and the Multiprotocol Label Switching (MPLS) services of the Public Sector Telecommunications (PST) network. Three logically distinct communication channels are used between the stations for this communication.

- A single channel for transmitting high-definition images and audio for intimate communication between the patient, the patient's doctor, and the consulting doctor.

- A single channel is used to transmit data from diagnostic instruments at the Telemedicine Unit of the PDTS to the Telemedicine Unit of the CTS.

- A secondary channel for transferring additional telemedical data, whether new or old, in digital format that does not come from the PDTS Telemedicine Unit.

The telemedicine network's architecture has specific properties.It enables two forms of telemedicine connections:

(a) Point-to-point (b) Point-to-multipoint (e.g. for teleeducation)

Access to the service will be granted exclusively through the telemedicine application and restricted to authorized personnel. Moreover, authorized staff will also conclude the medical appointment via the telemedicine site. The systems will also offer real-time updates on system availability to physicians and authorized personnel.

B. Software

EDIT's software features a versatile and open framework, user-friendly interface, and straightforward functions, providing a distinctive experience for users, including doctors, nurses, other health professionals, and patients. With thorough planning for the operation of the EDIT, it is simple to guarantee access to top-tier health services. A brief overview of some of the software's included features follows:

- Direct medical consultation services are provided by qualified specialist doctors, available to patients regardless of their location or place of hospitalization.
- Reducing needless travel to urban centers to deliver quality health services to patients in rural or island regions.
- Changing the health service delivery model and using innovative methods to get secondary health care to alleviate the strain on outpatient and emergency units in major urban hospitals.
- Implementing telepsychiatry programs.
- Offering ongoing education and job training to medical nurses working in isolated health facilities in collaboration with academic and scientific organizations.
- Ensure equal access to healthcare services for all individuals in the population.

Additionally, it is worth mentioning the key functional characteristics of the software.

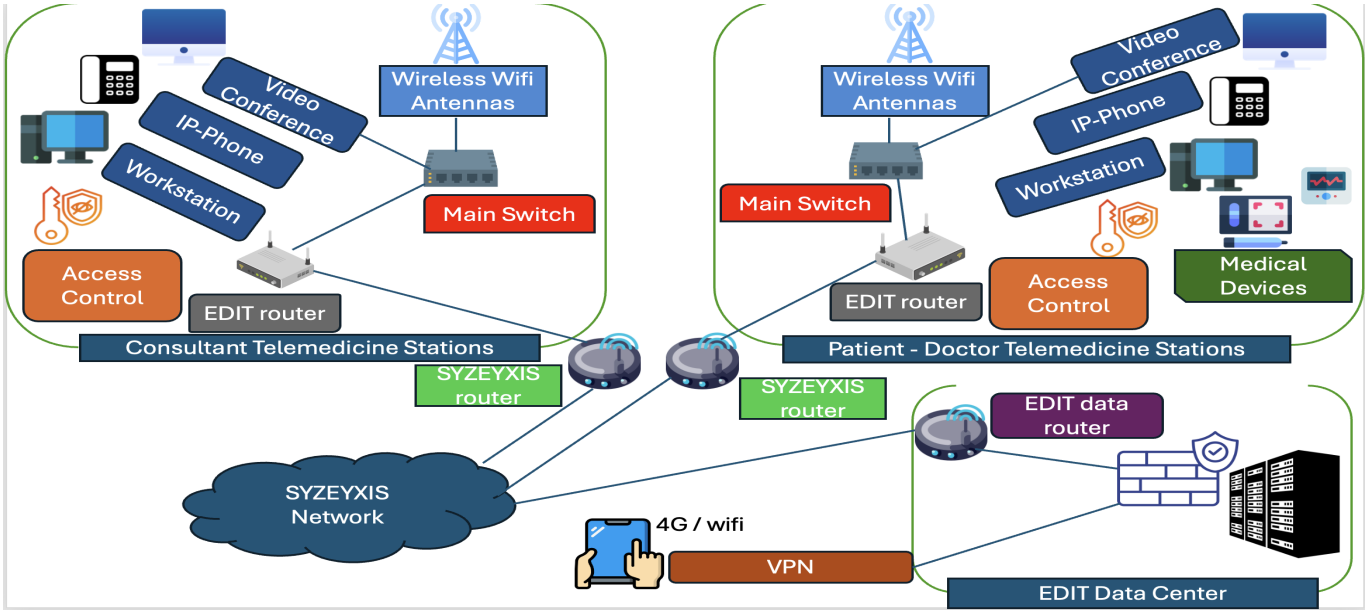

Figure 1. EDIT's Architecture.

Figure 2. A telemedicine station.

1) The application enables remote medical consultations both online and at a later time. Users of the CTS and PDTS platforms can choose to join a live tele-examination or access a patient's uploaded medical data to review later.
2) The application enables communication over the Application Programming Interface (API) and Health Level Seven (HL7). The software provides a well-documented API interface protocol that allows for integration with Electronic medical records (EMRs) and other Hospital Information Systems (HIS) through HL7 and Fast Health Interoperability Resources (FHIR).
3) The software can be configured in High Availability mode to work with an existing Electronic Health Record (EHR) infrastructure. The Carenation application in the current EHR network functions in High Availability mode and will continue to do so with the inclusion of the new EHR health units (PDTS, CTS, HCS).
4) The application combines the functionality of creating a medical tele-appointment, available both online and by scheduling. An option is to seek an immediate tele-appointment for emergencies or scheduled appointments with a certain physician or specialization.

C. Main Components - Sub-systems

1) Subsystem for managing medical devices (Component 1 - Device Gateway): This subsystem facilitates the connecting of medical devices with varying characteristics, measurements, and manufacturers. The medical instruments can be connected through the Device Gateway to transmit the patient's telemetry data, such as video or photos from endoscopes or ultrasound, directly to the medical software on a PC or mobile device and then to a remote site in real-time. A healthcare organization utilizing the EHR system can use current medical instruments for examinations instead of buying new specialized medical equipment due to the interoperability of medical devices.

2) Central Telemedicine Portal Subsystem (Component 2 - Core Care Portal): Appointment management activities are mainly carried out using Component 2 (C2). The system comprises physician and patient management, the patient examination console, auxiliary subsystems for physicians during patient examination, automated examination process flow, and the patient medical record. The system features a central administration and control system that offers enhanced options for configuring the software operation without requiring specialized technical people.

3) Subsystem for Statistics and Analysis (Component 3 - Analytics): Component 3 (C3) was created to provide a

detailed analysis of the functionality of telemedicine systems, focusing on both quantitative and qualitative aspects. This subsystem offers pre-designed analytical statistical reports and allows users to create custom reports or export data in formats such as xls, CSV, etc., with precise coding for further analysis. The recording and retrievability of all system data for historical usage are particularly important. C3 can be accessed through C2, which is the Central Telemedicine Portal Subsystem, depending on the user's roles.

4) Subsystem for managing the availability and scheduling of both regular and emergency telemedicine visits (Component 4 - Schedule): Component 4 (C4) is a crucial subsystem for the efficient daily functioning of a telemedicine system. C4 coordinates the process of verifying and certifying the presence of doctors and the availability of telemedicine stations at various appointment sites alongside the central management system.

5) Subsystem interoperability with external systems and applications (Component 5 Integration and Interoperability): Component 5 (C5) was created to enable EDIT's software to work with current or upcoming eHealth subsystems or other systems. It can work with Hospital Information Systems using the HL7 - FHIR protocol, prescription systems, and other systems with specified APIs that support open interfacing. This subsystem is responsible for implementing Single Sign-On (SSO) apps as needed and has an API for connecting with third-party systems.

6) Home care subsystem (Component 6 - Home care environment and functionality).: Component 6 (C6) carries out all functions associated with the Home Care System for Patients. This subsystem allows for the personalized distribution of instructive and educational content. The only subsystem that interacts directly with patients is the one that includes a portal for patients and their aides. An overview of C6's main functionality characteristics is provided below:

- A system designed to provide tailored instructional and advising material for patients.
- Doctors employ both synchronous and asynchronous theta examination in the telemedicine system's second subsystem to offer a uniform interface for all users.
- The system facilitates the transfer of medical examination data from home medical equipment, including oximeters, thermometers, and pressure gauges, through the first subsystem to the Carenation application and subsequently in real-time to telemedicine units as needed.
- Implemented a web-rtc-based video-conferencing system to enable direct connection through the Carenation application with all telemedicine locations.
- The apps of this subsystem have been optimized for optimal productivity and usability on mobile devices such as tablets and mobile phones. - mobile optimization features.

D. Telemedical devices

The Medical Device Management subsystem (Component 1 - Device Gateway) allows for the integration of medical instruments with diverse characteristics, measurements, and manufacturers into the telemedicine program. The examination data from the medical instruments is transmitted through this interface to a remote location, allowing a medical expert to view the examination in real-time and provide advice or opinions. The Device Gateway is a crucial component of the telemedicine program and is responsible for standardizing the telemetry data from connected medical instruments. The data from medical instruments is categorized into channels to provide an interoperability framework based on the data itself rather than on specific manufacturers or products. This approach reduces or eliminates the requirement for parameterization when integrating new medical devices into the system.

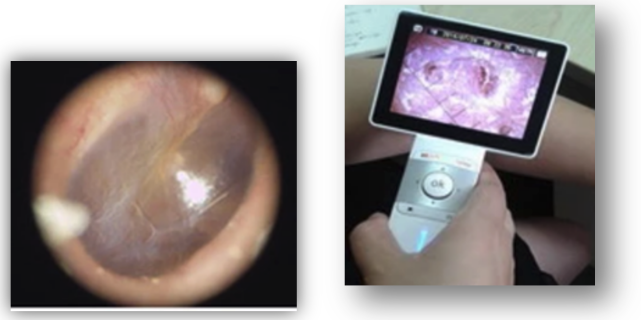

Figure 3. A telemedicine consultation involving an examination camera.

The system supports various devices, such as the following:

- Digital Stethoscope
- Examination Camera
- Dermoscope
- Otoscope
- Ophthalmoscope
- ECG
- Digital Microscope
- Ultrasound
- Medical Cameras for general examination
- Pathology Examination Systems

Figure 3 displays a telemedicine consultation involving an examination camera.

III. Case Study

In order to assess EDIT, a case study was conducted, including the number and the type of teleconsultation for the years 2016-2023. All the data were exported directly from EDIT. The telemedicine services provided by EDIT were primarily implemented in clinical diseases that followed a defined teleconsultation clinical protocol. The implementation of EDIT's telemedicine services did not entail any corresponding organizational adjustments, such as the inclusion of teleconsultation requests in the referral procedures and the introduction of payment. The safety and data privacy concerns were effectively addressed.

A total of 248 teleconsultations were conducted between February 26, 2016 and December 16, 2016. Table 1 categorizes all 248 teleconsultations by speciality.

TABLE I
OCCURRENCES OF DIFFERENT TYPES OF EXAMINATIONS FOR THE YEAR 2016

SPECIALITY	OCCURRENCES
RADIODIAGNOSTICS	1
DERMATOLOGY	2
ENDOCRINOLOGY	1
ODONTIATRICS	109
OPHTHALMOLOGY	2
PEDIATRIC SURGERY	1
TELEPSYCHIATRY WITH CHILDREN	120
SURGERY	1
TELEPSYCHIATRY WITH ADULTS	9
PSYCHOLOGY	2
TOTAL	248

As it could be easily derived from the table shown above, the majority of teleconsultations included telepsychiatry with children at 48.39% and odontiatrics at 43.95%.

The number of teleconsultations in 2017 grew to 352, representing a 41.94% rise. Furthermore, new specialisations such as Hepatology, Diabetology, Pathology, and Social Worker consultation were included for the first time. These additions accounted for 12.5% of all teleconsultations. Telepsychiatry with children accounted for the vast majority of teleconsultations, representing 63.35% of the total. Diabetology followed with a share of 8.8%.

The following year, 2018, once again a new rise in the total number of teleconsultations was observed, with a stunning 239.2%. The examination of teleconsultation services over the aforementioned study period indicates a notable demand for mental health care. Telepsychiatry emerged as the primary area of teleconsultation, with 39.94% of all sessions. Telepsychiatry for children accounted for a significant proportion of teleconsultations for children's mental health, specifically 32.66% of the total consultations. Finally, there was also a substantial portion of diabetology consultations, representing 15.66% of the overall consultations.

In 2019, there were a total of 1638 teleconsultations, representing a 37.19% increase compared to the amount recorded in 2018. 49.81% of the teleconsultations were connected to telepsychiatry, whereas 23.5% were focused on telepsychiatry with children. Moreover, the results indicate a significant 100% rise in psychology consultations and a substantial 317.65% increase in endocrinology consultations.

In 2020, the data on teleconsultations showed a 16.06% increase. Telepsychiatry is the most common form of assessment undertaken with children at 36.29%, followed by telepsychiatry with adults at 35.08%, and psychology at 19.25%. New specialised fields such as Paediatric Developmental Medicine, Urology, Vascular Surgery, Paediatric Allergy, Paediatric Endocrinology, Gynaecology, and General Medicine were introduced.

The data regarding teleconsultations for the year 2021 revealed one more rise in the total of 53.34%. Telepsychiatry with adults is the most prevalent kind of assessment at 27.75%, followed by psychology at 26.58%, and telepsychiatry with

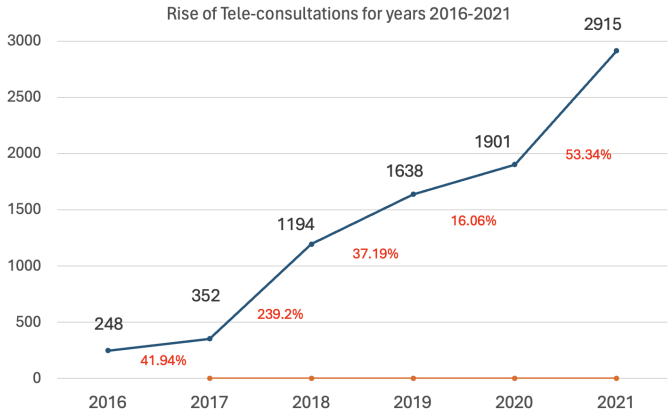

Figure 4. The growth of teleconsultations for years 2016-2021.

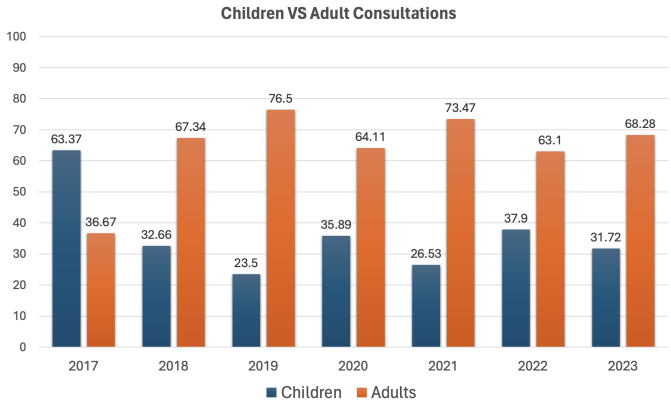

Figure 5. Teleconsultations categorized in regard to whether children or adults were involved.

children at 26.14%. Furthermore, an analysis of the initial 6 years of operation reveals a steady growth in the number of teleconsultations every year for the years 2017-2021, as shown in Table I.

In 2022, the most common forms of teleconsultations were telepsychiatry with children at 37.58%, telepsychiatry with adults at 28.73%, and psychology at 19.88%.

Finally, for 2023, the most common forms of teleconsultations were telepsychiatry with children at 31.52%, telepsychiatry with adults at 25.55%, and psychology at 22.1%.

In Figure 5, a breakdown of the teleconsultations in regard of whether they were for children or adults is provided, while Figure 6 portrays the types of consultations, whether they were Psychiatry related or not, for the years 2016-2023.

IV. DISCUSSION

The data analysis of teleconsultation services during the study period showed a notable preference for mental health services. Telepsychiatry sessions were the most common type of teleconsultation, representing more than 50% of all sessions in the first year and over 80% from 2017 to 2023. This demonstrates the increasing acceptance and dependence on

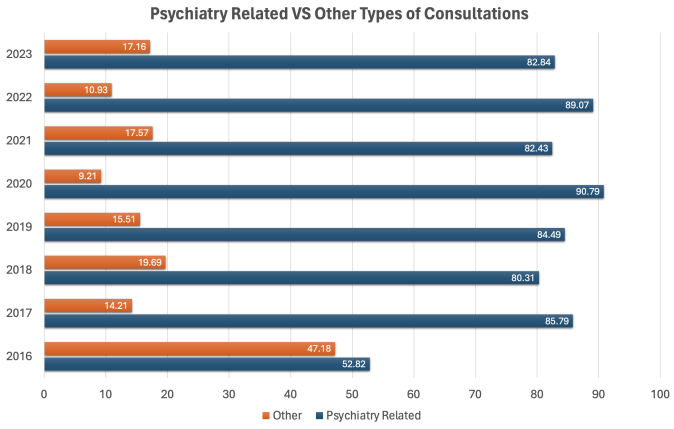

Figure 6. Psychiatry versus other types of consultations for years 2016-2023.

digital platforms for mental health help, indicating a rising awareness and normalization of mental health issues in society.

Following telepsychiatry, teleconsultations for children's mental health, notably in telepsychiatry for children, comprised a considerable portion of the services. This emphasizes the urgent requirement for easily available mental health services for younger demographics, who might be especially susceptible or incapable of accessing conventional face-to-face treatment. The flexibility of teleconsultation platforms in meeting the specific requirements of children and adolescents highlights the capacity of e-health solutions to address gaps in pediatric mental health care.

Diabetology related consultations via telemedicine platforms also represented a substantial portion. This demonstrates a dependence on teleconsultation services to manage chronic illnesses like diabetes, where constant monitoring and regular consultations are crucial. Tele-consultations for chronic disease management show how e-health can improve patient care, treatment adherence, and quality of life for individuals with chronic illnesses.

Furthermore, as derived from Figure 4, Teleconsultations showed steady annual growth from 2017 to 2021. This indicates that the adoption of new and emerging technologies in healthcare is steadily increasing. The technology being studied can improve traditional healthcare methods, ultimately guaranteeing broad access to high-quality healthcare for individuals globally. It accomplishes this by improving fair access to medical knowledge and streamlining its distribution throughout the healthcare system.

Furthermore, new specialties were introduced annually to the current types of consultations. Patients' trust in telemedicine for a variety of examinations is increasing as advancements in software and hardware lead to the development of new medical devices. This progress will make currently unavailable examinations accessible, establishing telemedicine as a primary medium for healthcare.

The distribution of teleconsultations among different specialties demonstrates the adaptability and potential of telemedicine to address various healthcare requirements. It also indicates the changing trends in healthcare delivery towards more convenient and patient-focused solutions. Telemedicine is advancing and provides a significant opportunity to increase healthcare access, particularly in underserved or rural regions, and for people who may encounter obstacles in accessing conventional health services.

V. Current and Future Developments

An ongoing National Programme is currently in place to facilitate the first significant growth of the National Telemedicine Network. The National telemedicine network will be expanded in the 1st, 3rd, 4th, 5th, 6th, and 7th HR. The initiative involves developing a new system that will directly connect with the existing one. Additionally, the existing system will be upgraded in the 2nd HR to include more regional equipment and subscription services. Some of the additions are the following:

1) Three hundred and fifty-five new Patient Doctor Telemedicine Stations - PDTS will be placed in particular Health Facilities nationwide. The PDTS stations are categorized based on space availability data and the operational readiness of each health facility.
2) Thirty-five new Telemedicine Consultant Telemedicine - CTS will be placed in designated Health Facilities. CTS stations are categorized based on space availability data and operational requirements of each Health Facility.
3) Five Telemedicine Training Stations with CTS and PDTS features will serve as training centers for new system users and will be placed in University Hospitals nationwide.
4) Home Monitoring Systems - HCS: 3,000 units with direct communication with the EDIT and related software
5) Medical diagnostic devices for sexually transmitted infections and educational facilities.
6) Three new regional Control Centres and one Command & Control Centre at the Ministry of Health.

In addition, other software changes and subsystems are being prepared for integration into the Central EDIT system. Some of these include but are not limited to, the following.

A new subsystem that focuses on enabling EDIT's healthcare professionals to utilize the globally acknowledged clinical decision support system UpToDate [8].

The nursing staff can utilize the subsystem to access up-to-date medical material for addressing clinical inquiries with dependable, scientifically grounded advice (such as publications, conference papers, best practices, etc.) to enhance patient care and quality of service. This subsystem is crucial for the project as it provides high-quality training content and clinical decision support systems for physicians working in remote NHS units, which is a key measurable goal of the project funded by the Recovery Fund operation.

The subsystem's functioning seeks to enhance the medical services supplied and ensure the availability of high-quality medical clinical information for continued education and training. Improved documentation of expert opinions can help prevent medical errors and reduce complaints about

medical practices. Users, including physicians and nursing staff, can access and search through patient records using the EDIT telemedicine program. This activity aims to decrease the time needed to switch environments (e.g., from EMR to web browser) and promote more service usage, leading to increased physician searches.

The quest for sustainable development of the EDIT consists of three main components: economic, social, and environmental issues. Attaining sustainability necessitates a cautious method in developing policies, focusing on certain goals, and rigorously tracking advancements.

To achieve the aforementioned objective, it is essential to create and incorporate a new business intelligence system into the central system. This system will monitor activities and assist in developing new policies based on the continuously observed data.

The EDIT Business Intelligence (BI) system, designed for the National Telemedicine Network, is a pioneering venture focused on utilizing data-driven insights for data processing, performance measurement, and strategy development. Functioning as a central hub, it guarantees that telemedicine operations are both efficient and transparent while also being responsive to stakeholders' needs.

The system will primarily serve the supervision of operational activities, creating usage reports, and developing policies.

The policies will be utilized by the central authority responsible for overseeing the operations and strategic planning located at the Ministry of Health. The Health Regions' administrations and other relevant agencies, such as NEC and Civil Protection will have access to the information.

VI. Conclusion

In the current digital age, it is crucial to have inventive approaches that are expandable, economically viable, and efficient to improve individuals' physical and psychological well-being. E-health refers to the utilization of ICT in the healthcare sector. Telemedicine is a prominent illustration of e-health's accomplishments. Telemedicine uses information and communication technologies to deliver healthcare services, primarily through interactive videoconferencing. Implementing telemedicine in Greece, particularly in isolated islands and remote mountainous regions, is crucial to guaranteeing every citizen's legitimate right to equitable access to medical care regardless of where they reside. The paper introduces the Greek National Telemedicine Network - EDIT and offers a qualitative study using data sourced from EDIT's central database.

Analysis of data from teleconsultation services showed an unambiguous preference for mental health treatments during the time frame under consideration. Telepsychiatry sessions were the most common type of teleconsultation, representing over 50% of all sessions in the first year and rising to over 80% between 2017 and 2023. This trend highlights an increasing trust and dependence on other forms of mental health assistance, indicating a greater acknowledgment and normalization of mental health issues in society. Child telepsychiatry was an important portion of the teleconsultations focused on children's mental health. This highlights the crucial necessity of providing easily available mental health services for young individuals, who can be especially susceptible or incapable of pursuing conventional face-to-face therapy.

A significant portion of consultations focused on diabetology via telemedicine, emphasizing the importance of such treatments for managing chronic illnesses like diabetes. Regular consultations are crucial for ongoing evaluation, and periodic appointments are necessary for optimal illness management. Utilizing teleconsultations for chronic illness management showcases how digital health could enhance medical attention, treatment adherence, and quality of life for individuals with chronic medical problems.

Regarding the EDIT system and its associated data, there was consistent annual growth over the first five years of operation, with an increase in the variety of examinations included each year. This indicates that telemedicine is progressing and offers a valuable chance to enhance healthcare accessibility, especially in underserved or isolated regions, and also for individuals facing barriers to traditional health services.

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