

CHAPTER 14

The Use of Technology in Health Research

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Introduction

Healthcare services are a multidisciplinary set of processes that aim to maintain a person's quality of life at the highest level through disease prevention, treatment, care during illness, ensuring continuity of care, and regular monitoring. The impact of developments in science and technology on the delivery of health services is inevitable. Technology has made significant contributions, such as the creation of home monitoring and tracking systems, during the pandemic process. Treatment and care practices and research that involve innovation and the use of technology in healthcare will pave the way for quality service delivery and improved patient outcomes. The aim of this section is to highlight the current trends in health research, research examples, and the development of innovative products and useful models.

The Aim of Using Technology in Health Research

"Technology" refers to the knowledge encompassing production methods, tools, equipment, and materials used in a particular industry. It is also a term that includes all the information for the production of useful products and the design of new ones. The existence of technology can be seen in the form of new products, machines, vehicles, materials, and services. The use of technology allows science to meet the practical needs of daily life. It facilitates applications for shaping and controlling the environment. Technology helps to provide higher standards of living through increased productivity and a wider range of products. Scientific research aimed at developing new technology and the transformation of research into new products are intertwined and successive processes (Emiroglu, 2018).

Health technology is the collection of innovations and technologies that include versatile systems, philosophies, methods, applications, and other techniques used for preventive and curative healthcare services. These technologies are not only limited to the use of advanced technologies but also encompass drug and medical technologies. It is stated that both categories are affected by developments in science and technology (Sargutan 2005).

Health services are integrated with technology. Wearable technologies, especially

those used for fitness and heart rate monitoring, are actively used in the monitoring of chronic diseases. The development of artificial intelligence has accelerated the use of health technologies. "Virtual reality" and "augmented reality" are being implemented in many areas of healthcare, from surgery to diagnosis. Through the anatomy and physiological appearance of the patient, a safe and high-quality operating system can be established in the operating room (Zbrog, 2023).

Wearable technology is rapidly advancing. Wearable technology or wearable devices can be defined as electronic devices and computers that can be easily worn on the body and integrated with clothing and jewelry (Dursun & Yilmaz 2021). There are many devices that can measure vital signs and parameters for health and diseases, and promise to improve consumers' quality of life. Healthcare should be provided through health care professionals to ensure service continuity and to increase efficiency in patient care. In the healthcare sector, maintaining a balance between the quality and cost of the most appropriate service is important and can be achieved through the use of appropriate technology. Medicine, technology applications, and healthcare services can improve the quality of life and change rapidly. Therefore, any technology that can improve the quality of life without harming human life is considered invaluable. Wearable technology is evolving by playing an effective role in individual measurements. Thanks to devices that are getting smaller and easier to carry, they are becoming tools that can measure not only clinical findings but also quality of life, fitness, and overall health. While individual measurement applications are used for data recording and monitoring, methods such as interesting visuals, warning messages, and game scores can also be used to encourage positive behavior (Aydan & Aydan 2016).

Reliable seizure detection devices can help epilepsy patients in many ways, such as minimizing premature deaths (Meritam et al., 2018). Continuous monitoring provided by many wearable technologies can make individuals more proactive about their health and have the potential to prevent future health problems. According to the data obtained from this monitoring, it helps with diagnosis instead of relying on patients' memory and clinical tests as a whole. Smartphones and other smart devices can be used to keep records to track a healthy lifestyle. These technologies support applications that can identify many chronic diseases such as Parkinson's, diabetes and heart disease. Physical activities can be recorded and reliable and accurate data can be transmitted through smartphones and other wearable devices. Research shows that data obtained from smart devices is reliable. Large amounts of data can be stored in databases to establish and analyze the link between lifestyle and disease (Aydan & Aydan 2016; Demirci 2019).

The use of artificial intelligence has become increasingly important in reducing and solving the problems that arise in the delivery and management of healthcare services. Telemedicine technologies are widely used in many areas, such as elderly care, pregnancy monitoring, home care services, and remote patient monitoring. Machine learning and artificial intelligence-based big data platforms have been developed for rapid diagnosis and treatment of diseases. The development of treatment and diagnostic protocols, drug development, personalized medicine, patient monitoring, and care can be achieved through artificial intelligence. Studies are underway on the interpretation of lung X-rays. The new technology Internet of Medical Things (IoMT) facilitates the connection and communication of all devices with each other. In the healthcare field, this technology has been successful in many areas, such as shortening emergency room waiting times for patients and monitoring medical device malfunctions (Arel, 2023).

When artificial intelligence is used for management purposes, benefits can be achieved in areas such as general health management, certification management, cost and quality management, rational use of healthcare institution capacity, addressing problems in healthcare services and management, and remote provision of complementary and preventive healthcare services. In general health service management, applications such as central physician appointment systems and eNabız data can be used to predict hospital admissions, reduce wait times in emergency departments, and standardize ambulance response times based on data collected (Akalin & Veranyurt 2020). Knowing the increasing density in healthcare institutions with the growing population makes it easier to provide correct and effective service. Every passing second, health-related data can be generated electronically on devices that people wear or use applications from anywhere in the world. Looking at the application areas of artificial intelligence for clinical purposes, it can be used in many areas such as educating the community about diseases, performing and evaluating screening tests on a large number of target groups. In summary, the use of artificial intelligence can be exemplified in many areas such as emergency intervention and early diagnosis, evaluation of radiological images, querying and monitoring test results, treatment, AI (artificial intelligence) - supported surgeries, evaluation of pathological results, medication therapy follow-up, drug development, personalized treatment, post-treatment clinical support, and home care support for patients (Akalin & Veranyurt, 2021; Cirban Ekrem & Dasikan).

“IoMT technology provides unlimited benefits that can be used in every activity in human life, independent of time and location. IoMT enables the collection and processing of data from connected devices, such as sensors, machines, and smart devices, resulting in the automatic execution of certain business plans based on the processed data. The first examples of the Internet of Things used in the healthcare sector are applications such as smart sensors, remote monitoring, and medical device integration (Sezer et al., 2018). The main idea of IoMT applications in healthcare services is the perception, processing, and remote communication of patient data without any restrictions through smart devices. Smart technologies enable individuals to achieve better health self-management and personalize the content of medical services. Thanks to wireless technologies, physiological data can be collected from sensors attached or implanted on patients at home care or away from hospitals without causing pain or disrupting their daily lives (Bicakci, 2019).

The distributed ledger technology, where blocks are linked in a chain and each block contains the hash value of the previous block, is a system in which transaction data can be encrypted with hash method and shared among members of the network. Blockchain technology ensures security through encryption, as it requires continuous verification of transactions by members and the distributed nature of transaction information prevents fraud. Therefore, the benefits of blockchain technology include transparency, trust, traceability, security, control, auditability, anonymity, scalability, and cost reduction (Ozyurek, 2021).

Technology has provided many conveniences in healthcare education. Through education, patients are equipped with the ability to manage their diseases and care correctly. Patient-specific applications designed specifically for hospitals and healthcare institutions are being used. AI algorithms, technological tools such as voice assistants and chatbots, can free up the time of professionals and increase the efficiency of healthcare services through patient education. Video-based learning, diagrams, videos, and animations can

be used through tablets and mobile applications to increase individuals' understanding of their diseases, and learning can be done in the most appropriate way and at the pace that suits them best (Arkenea, 2023). Health technologies such as telemedicine, new drug development methods, data-driven healthcare services, nanomedicine, 5G-enabled devices, tricorders, smart heart pacemakers, blockchain, etc. are advanced and continue to develop (Zbrog, 2023).

Technology Use in Health Research / Innovation Project Examples

The paragraph means "health technologies refer to a field that includes all devices, drugs, vaccines, procedures, and systems designed to reduce costs and improve the quality of care in the delivery of healthcare services" (Mace, 2023). Health research also supports the development of health technology for this purpose. Research in the health field is very rich in terms of innovation (Avci, 2017).

The concept of innovation expresses both a process (renewal/rejuvenation process) and a result (innovation, new product). When we combine the definitions of innovation, it encompasses all initiatives that contribute to technology with new ideas and arrangements that result in profit. Innovation starts with new ideas and ends with commercial implementation, finally bringing innovations to the service sector. Innovation requires cost-effectiveness, higher profit, and competition both in the process and in the result (Kılıç, 2021). Innovation in healthcare has the power to respond to the needs of the system. Healthcare service innovation aims to diversify services in the treatment stages with new ideas that have outputs such as quality, safety, information protection, and cost regulation. The field that innovation covers in healthcare is very wide. The innovation process in healthcare can be carried out with comprehensive steps that include information, persuasion, decision, implementation, and approval (Avci, 2017).

Technology and innovation research provide ease in diagnosis. For example, Muhammed et al. (2020) have developed a wearable pressure sensor to measure the palm grasp reflex of newborns. The device is compatible with traditional diagnostic protocols and contributes to the working principles of pediatricians. The device has a sensitivity of 0.13 kPa-1 in a pressure range of up to 530 kPa. The grip strength of newborns has been successfully studied and examined, and the study has determined that grip behavior is associated with gender. In addition, it has been found that the palm grasp behavior changes gradually with an increase in grip strength during the first three days of life. The results showed that there is a relationship between weight loss and palm grip strength. It was concluded that the amount of weight loss during the first three days was directly proportional to palm grip strength, while weight gain was inversely proportional. As a result, it can guide the diagnosis and treatment of nervous system anomalies. In another study, an EEG device was used to measure the degree of pain, and it was found that a simple EEG device could be used to measure the degree of pain instead of traditional pain scales. In the analysis of the basic components of the device, painless data are clustered as green dots, period data as yellow dots, and migraine data as red dots. It seems possible to diagnose pain and migraine in a short time (Kagita & Mitsukura 2018). Another study, "A Wrist-worn Respiration Monitoring Device using Bio-Impedance," is designed to monitor respiration for early diagnosis of individuals with sleep apnea. Non-invasive bio-impedance (Bio-Z) is a design made of detection and ultra-thin gold e-tattoos. It is especially important for sleep apnea diagnosis due to its easy-to-wear wristband design and ability to monitor continuous respiration and

blood flow. Sleep apnea is a problem that can result in morbidity and mortality, and this technology can provide a positive development in patient diagnosis and outcomes. The device continuously records accelerations on the diaphragm using an accelerometer sensor placed on the diaphragm. It effectively measures blood pressure and heart rate. When apnea is detected by the accelerometer-based system, a signal is sent. Since this system processes respiratory changes, it can be developed for respiratory pattern analysis to detect possible hyperpnea and hypopnea with apnea (Sel et al., 2020). In another study, remote monitoring of heart failure as a diagnostic method can be achieved through device-based multiple sensors. By measuring heart rate and respiratory rate through sensors, real heart failure conditions can be predicted. Thanks to remote monitoring, electronic devices have become a standard process in the management of cardiac arrhythmias in patients. The study involved 40 patients, all of whom had implanted devices with HeartLogic feature. HeartLogic-enabled devices start monitoring automatically after implantation and report to the heart pacemaker clinic when HeartLogic scores exceed a threshold of 14 (Chang ve ark., 2020). In the study titled "Bed-Based Health Monitoring Using Pressure Sensitive Technology: A Review", it has been stated that tracking parameters such as the patient's heart rate through special sensors placed on the bed can contribute to diagnosis and treatment. It has been emphasized that there is a need for increasing remote monitoring technologies like this to reduce the pressure on the healthcare system in Canada after COVID-19 (Cohen-McFarlane ve ark., 2021). The traditional ECG Holter is a bulky device that includes multiple electrodes attached to the chest. Therefore, ECG monitoring usually requires the patient to stay in the hospital for a long time. It has been advantageous to transform the devices created in current studies into ergonomic, portable, and easy-to-use equipment. This will make the provision of healthcare much easier. The study presents research on Android mobile applications using a small EKG Holter device developed for real-time arrhythmia detection. EKG signals are obtained directly through the three-electrode sensor of the EKG Holter device and then transmitted to an android smartphone via a Bluetooth module. The android mobile application is capable of analyzing and classifying the patient's EKG data to detect abnormal signs (Mahdy et al., 2018).

There are many studies that involve technology development and innovation to facilitate patient treatment and care in clinics. One of these is the development of self-injecting certolizumab pegol (CZP) for treatment. This has given patients the opportunity to experience a new electromechanical injection device, and it has been observed that patient satisfaction in this area has increased (Pouls et al., 2019). Transferring patients between bed and stretcher is a common need in patient care. Facilitating this process plays an effective role in ensuring the safety of healthcare workers and the patient. Patients in the care process face the risk of injury and falls during transport and lifting processes. Similarly, healthcare workers are also at risk of spinal and neck problems due to the risk of mechanical breakdown in their body mechanics (Hill & Schwarz, 2004). The aim of the developed device is to eliminate the extra power expended during the patient transfer process. Looking at the features of the device, it has been shown that it improves the posture of caregivers through the use of a scoop stretcher and mechanical transfer, and prevents patient injuries. The device has been designed to be ergonomic for clinical use; its embedded feet take up less space, make it easy to move around, and allow for easy installation in other clinics (Salmani Nodooshan et al., 2017). That sentence means "Monitoring physiological parameters with monitors in intensive care units and operating rooms is very important in the treatment and care process" (Kipnis et al., 2012). The need for separate invasive procedures for any type of monitoring can

lead to the development of complications. Arterial pressure monitoring with an intra-arterial catheter is a standard method for patients with poor general condition and high risk. However, it can cause complications such as bleeding, infection, nerve damage, pseudoaneurysm formation, and arterial occlusion-related blood flow disorders. In this study, a compact, wireless, single-sensor technology using photoplethysmography with an improved calculation algorithm was developed to continuously monitor four physiological parameters (blood pressure, pulse rate) and provide continuous monitoring support for this issue (Tomita et al., 2018).

Continuous monitoring of patients has an important role in diagnosis and treatment. Recording and accumulating correct and regular data is crucial for planning proper treatment. While the healthcare industry is in a constant state of change, wearable technologies have increased recording capabilities in healthcare services. The developed technological device contains a glucose sensor that is implanted under the skin, allowing for continuous glucose monitoring (Thulasi ve ark., 2017). After discharge, patients are left alone to manage their treatment and care, and errors can be made during this stage. In particular, errors in self-medication by patients can lead to negative consequences of weak treatment adherence. These include an increase in readmissions to the hospital and higher treatment costs. Therefore, home monitoring of patients is important. Errors in the use of devices such as inhalers or insulin pens are common. A contactless and inconspicuous artificial intelligence study has been conducted that can detect and monitor self-medication errors by analyzing wireless signals without the need for physical contact. The sensor installed in the patient's home enables signal transmission in the Wi-Fi frequency range using frequency-modulated continuous wave (FMCW) technique. The system can analyze the data transmitted from the sensor using artificial intelligence. The embedded system in the sensor can monitor certain movements associated with self-medication and analyze radio reflections from the surroundings to determine when a patient has applied their medication using an inhaler or insulin pen. Additionally, by examining the patient's wireless reflections, an alert is generated if the patient cannot follow the appropriate technique (e.g., forgetting to fill the insulin pen or shake the inhaler). This AI-based solution works in a contactless and passive manner, reducing the burden on patients or healthcare professionals (Zhao et al., 2021).

Technology and innovation studies are also needed in elderly care. Pressure ulcers are a significant problem in the elderly. The presence of pressure ulcers reduces the quality of life of the patient. Positioning is recommended as an important preventive measure for pressure ulcers both in clinical care and home care. An automatic lateral turning device is designed as a turning platform the size of a mattress. Using the inflatable air cells inside the platform, it gently and consistently tilts patients from left to right, automatically turning them at user-defined intervals during both day and night. The system is designed to be compatible with most care bed frames and can be placed under any existing mattress (excluding pocket springs). The device's control unit can adjust time intervals and other settings to control and adapt the lateral turning positions according to the patient's needs. At the end of this study, the device's psychometric results were also examined and found to be positive (Lahmann, 2021). The need for an autonomous device that can assist caregivers in monitoring Alzheimer's patients is emphasized. Alzheimer's patients tend to have orientation disorders, confusion, and a tendency to wander off. The device is emphasized to reduce the need for assistance from caregivers for patients (Hegde et al., 2019).

These studies can help reduce healthcare costs, use reliable methods in diagnosis, diagnosis, and treatment, and save time. Emerging health technologies provide a basis for new ideas. It has been demonstrated through studies that new ideas, discoveries, and technological developments must exist in all fields, be in the discovery phase, and be applicable to the industry. Multidisciplinary studies by experts from medicine, engineering, software, and other fields are important for strengthening in this area (Kayakoku, 2022).

Intellectual Property Rights, Utility Model and Innovative Product, Patent Process

It can be observed that technology and innovation studies have diversified into idea generation, useful model, and innovative product development.

Intellectual Property Rights (IPR); The legal rights that protect products with the ability to develop society, which are the result of individuals' mental activities, including agriculture, trade, industry, service sectors, scientific fields, literature and other arts; are trademarks, patents, designs, utility models, and geographical indications. These rights are defined as "signs that ensure the distinction of the producer or seller of goods produced and sold in the trade area on behalf of the first implementers of inventions, innovations, new designs, and original works, and thus enable these individuals to have the right to produce and sell the product for a certain period of time." These signs allow the producers of inventions and innovations to distinguish themselves on the products they produce and sell in the trade area, and by registering them, they provide the right to produce and sell the product for a certain period of time (Geven, 2016). In general, it is divided into two; moral rights and economic rights. It means the protection of a person's dignity in all aspects of work. Economic rights, on the other hand, are the rights that provide the provision and follow-up of technology along with skills and resources. Additionally, it provides a competitive advantage and income to the individual (Parlakaylıdız, 2011; Guvel, 2015).

IPR applies to inventions or innovative product patent applications that have not yet been published in any written or oral form worldwide. The patent or utility model holder is granted exclusive rights for a limited time and place, preventing third parties from producing, selling, using or importing the invention without permission. These rights prevent others from using and selling the invention without the creator's permission (Emiroglu, 2018).

Invention; An invention forms the basis of the patent concept. An invention is the explanation of a problem with a new method or new technology. It is a collection of innovations that provide a technical solution to a problem. These innovations can be in the form of a new machine, product, chemical compound, method, or they can also be improvements made to something that is already known. Before applying for a patent, preliminary research should be conducted. It should be determined whether the work actually contains a subject that is eligible for a patent. All current sources should be reviewed in research. In addition, scientific sources, publications such as articles and conferences, should be scanned, and most importantly, patent databases should be consulted (Kayakoku, 2022). There are free internet sites that you can use to find out if your invention is new;

- European Patent Office database (<http://tr.espacenet.com> , <http://worldwide.espacenet.com>)
- World Intellectual Property Organization database (<https://www.wipo.int/portal/en/index.html>)
- United States Patent and Trademark Office database (<https://www.uspto.gov/>)
- Google Patents database (<https://patents.google.com/>)
- Turkish Patent and Trademark Office database (<https://portal.turkpatent.gov.tr/>)

Patent; In English, the paragraph would be: "Patents are documents that provide inventors with the right to "produce, use, sell or import" the technologies they have developed and created for a certain period of time. With this document, all kinds of protection rights are provided for original designs and ideas. Patents are the most important output of Research and Development (R&D) activity (Altuntas & Yilmaz, 2017). Patents are granted to inventions in various fields of technology under certain conditions. Conditions such as the novelty, industrial applicability, and originality of a new invention play an important role in granting patent rights. The patent holder has the right to prevent others from commercially using, producing, selling, importing, or exporting the patented invention without permission (Turk Patent, 2023). Patent rights apply to inventions, provided that the patentability criteria are met. This situation, which is applied similarly all over the world, is expressed in Article 82 of the Industrial Property Law (Sınai Mülkiyet Kanunu) No. 6769 in Turkey, which describes patent rights as follows: "Patents are granted for inventions in all fields of technology, provided that they are new, involve an inventive step, and are capable of industrial application" (Sınai Mülkiyet Kanunu, 2017). Although they may be considered inventions, the following subjects have been excluded from patentability in the Industrial Property Law:

- Inventions contrary to public order or morality,
- Biological processes primarily related to the production of plants or animals, except microbiological processes and products obtained through these processes,
- Diagnostic methods for the application to the human or animal body and surgical methods, as well as all therapeutic methods,
- The mere discovery of the formation and development of any element of the human body at any stage of its formation or development, including a sequence or partial sequence of a gene,
- Human cloning processes, changing the genetic identity of the germ line of human beings, using human embryos for industrial or commercial purposes,
- Genetic identity-changing procedures that inflict suffering on animals, as well as animals obtained from such procedures, without providing significant medical benefits to humans or animals. (Ozsahin, 2017)

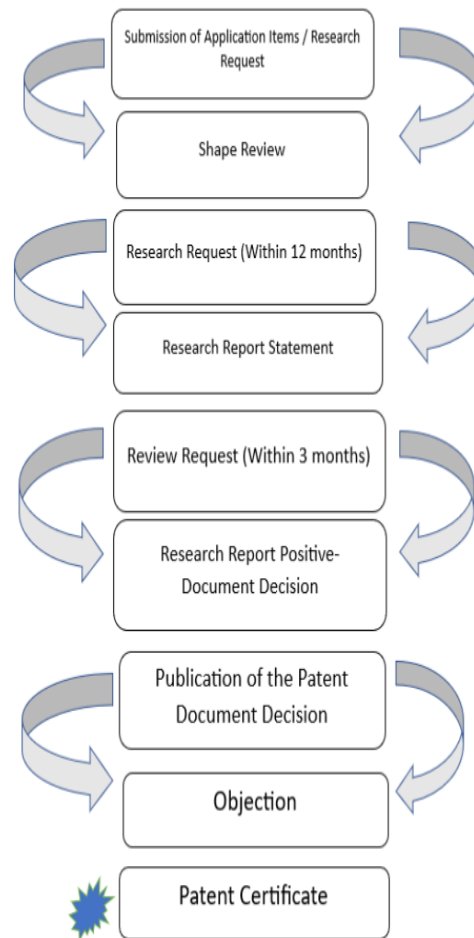
Patent Process

The importance of the invention in a patent application notwithstanding, the application process is based on the characteristics that can be described in the patent. Patent applications should contain the most detailed, clear, and specific information that makes up the technical framework of the planned subject/developed product. After it is determined that the application is of sufficient importance, all technical and written details must be written with visuals and descriptions. The application is first submitted to the Turkish Patent and Trademark Office and then examined for its form, and adjustments are made. When the legal process is complete, the application document is officially published. At the end of the process, the registration of the invention that has been definitively granted a patent is announced (Kayakoku, 2022). The "Turkish Patent and Trademark Office" has prepared the "Patent / Utility Model Application Guide" to guide applications in Turkey. "The following guide explains in detail with examples how the application should be prepared and what elements it consists of. Applications must be made only online via the Electronic Application System, using e-Government password, electronic signature, mobile signature or internet banking, through the address "<https://epats.turkpatent.gov.tr/run/TP/EDEVLET/giris>" after logging in." (Turk Patent, 2023). The patent certificate provides exclusive rights to an individual. There is an opportunity to prevent others from using the invention for a certain period of time. The patent only grants ownership for the country in which it was obtained; separate applications are required for other countries (Emiroglu, 2018). Granting a patent;

- The process of granting a patent consists of several stages, including:
- Examination of the application for compliance with formal requirements
- Request for search, preparation and publication of a search report
- Publication of the application and its effects
- Request for examination, preparation of examination report, and granting of the patent. (Sinai Mulkiyet Kanunu, 2017).
- The patent application process is summarized in Figure 1 (Turk Patent, 2023).

The utility model process is similar to the patent process. Like a patent, an industrial applicability and novelty publication are required for a utility model document. Novelty means that it must not have been disclosed or used in any form, neither in writing nor otherwise, and must be accessible to everyone in the world. It must be applicable and practical for the industry. (Emiroglu, 2018). Both patents and utility models can differ in terms of "patentability criteria, types of inventions that can be protected, registration process, and protection process". In inventions protected by patents, all three criteria of novelty, inventive step, and industrial applicability must be met, while for inventions protected by utility models, it is sufficient to meet the criteria of novelty and industrial applicability (Kayakoku, 2022).

Figure 1
Patent Process



There are many differences between the registration processes for patent applications and utility model applications. One of the most important differences is that both the research and examination stages are required for patent applications, while only the research process is conducted for utility model applications. There is no examination stage for utility models. In terms of protection, according to Article 101 of the Industrial Property Law, "the protection period is 20 years from the application date for patents, and 10 years for utility models, and these periods cannot be extended" (Kayakoku, 2022). The third paragraph roughly translates to: According to Article 3 of Article 142 of the Industrial Property Law, useful models are not preferred for biological and chemical substances or products obtained by methods, products related to pharmacy, and biotechnological inventions. Patent protection is more appropriate for these products, and they cannot be protected by a useful model document. The patent right ends when the protection period expires, the patent owner abandons the patent right, or both the annual fees and additional fees are not paid within the specified periods due to various reasons (Turk Patent, 2023).

In summary, this section covers the broad foundations of innovation, technology,

and patent processes. In health research, the aim is to improve the quality of healthcare service delivery, protect service providers, increase the number of people benefiting from care and treatment services, and also reduce the cost. Innovation efforts and technology development will contribute to achieving these goals.

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