



Policy Factors Affecting the Technological Catch-up of Electronic Health Services in Iran through Blockchain Technology

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Abstract

Blockchain technology is one of the revolutionary technologies in service-based industries. E-health services are considered as a major economic and social activity in the world in which patients, the medical community and service providers such as insurance organizations play a key role. In Iran, e-health services have been introduced for more than a decade, but it is seriously lagging behind the leading countries. According to the Blockchain Opportunity window, a technological and economic catch-up is possible in e-health services in the country. Decentralization, data transparency, security and privacy are the key features of Blockchain technology. Therefore, in this research, through case study strategy and using documents, scientific articles, evidence, statistics and events and opinions of experts, policy factors were presented to catch-up through the Blockchain technology opportunity window. The dimensions of the proposed policy framework were presented in 4 categories: macro policies, market, financing, and technology learning and development. This study presents technological catch-up policy framework by Blockchain technology to policymakers for using in e-health services.

Keywords: Blockchain; Catch-up; E-health services.



Introduction

The development of e-health services, including health records and electronic health supply and distribution chains, has been one of the most important concerns of the country in recent years, which, despite numerous laws, has had a low success rate. Perhaps one of the most important projects in the field of health in the country can be considered electronic health record, which has been delayed due to issues such as lack of development of technological infrastructure. As a result, the country suffers from a technological and industrial backwardness in the field of e-health compared to other countries, even neighboring countries.

Technological catch-up is one of the policy models to compensate for this gap that is considered in this research. According to Bell and Figueredo (2012), catch-up means reducing the distance between a latecomer firm, organization, or country in technological capability compare to a leading institution. Lee (2005) denies the existence of a single pattern in different countries. E-health services in a developing country such as Iran also need their own policies for technological catch-up. One of the technological opportunity windows in this field that has been considered in the world is Blockchain(Hosseini Bamakan et al., 2021), which eliminates the need for huge infrastructure and high investments.

One of the ways to compensate for the lag in providing e-health services is to use new technologies. According to technological and economic catch-up policies, the Blockchain is a window of opportunity to make up for these lags. Blockchain technology is an emerging technology and has unique features in the exchange of information. These features, like data security (Shahnaz et al., 2019), can help the country make up for the shortfall in e-health services. Another important feature of the Blockchain is its decentralization.

This means that there is no central server and it is divided into three forms: Permissioned, Permission-less and Consortium, which allow public and managed access according to its type (Feng et al., 2019; Zheng et al., 2017).

Such features lead to network stability and lower costs compared to centralized approaches. Catch-up policies, by understanding the characteristics and risks of emerging technologies, seek to accelerate the process of compensating for backwardness by these technologies (Naghizadeh, 2021).

Compensating for the country's backwardness in developing the technological infrastructure of e-health services requires policies based on new technologies such as Blockchain. In this regard, the policy framework of technological catch-up can help the country's policy makers to compensate for the technological backwardness in the field of e-health services.

In this research, the main question is what are the key policy factors for technological catch-up through the Blockchain in the field of e-health services in Iran? In this research, we have tried to identify and analyze these factors. The next section provides an overview of previous studies in this area. The third part deals with the research methodology. The fourth section outlines the results of the case study strategy. Finally, a summary is provided.

Literature Review

Catch-up means the technological or economic development of the latecomer institution to compensate for the technological distance from the leading institution (Bell and Figuieredo, 2012). Technological catch-up is not a predetermined pattern and can be different according to the characteristics of each country or region (Naghizadeh et al., 2021). Studies have shown that catch-up occurs on a smaller scale and then the successful experiences created are spread to the whole industry and that field and the catch-up process is accelerated in the country (Souzanchi et al., 2019; Laal, 1987, 1992). The policies that lead to the emergence of catch-up at the technological and economic level in the main organizations of a country are of great importance due to the spread to other organizations and the creation of new windows of opportunity (Souzanchi et al., 2019; Szirmai, 2008).

According to Kim (1997), the technological catch-up in latecomer organizations is realized in three stages of repetitive imitation, creative imitation and innovation. Lee (2005) and Hobday (1994) divide the technology evolution of latecomer organizations into three stages: OEM, ODM, and OBM. In their study, Lee and Lim (2001) present three technological paradigms as follows: first stage: following the path followed by leading countries and enterprises, second stage: leaping from some stages of technology development path of leading countries and enterprises and the third stage: creating a new path of technology development. Of course, these three stages do not negate each other. The capabilities acquired in these stages can be summarized as operational skills, process technology, current product design technology and new product design technology (Lee, 2005). Numerous studies have also shown that the evolution of latecomer organizations in short-cycle technologies and emerging technologies has been done better (Souzanchi et al., 2019; Lee, 2013).

Technology is one of the opportunity windows in the reaching of catch-up. The technology opportunity window, for example, allowed South Korea to make technological advances in the electronics industry by making good use of chipset technology. One of the windows of opportunity in the field of e-health services industry is the window of opportunity arising from the advent of Blockchain technology.

Blockchain is a chain of blocks that are connected together and continuously growing by storing transactions on the blocks. Blockchain uses a decentralized approach that allows the information to be distributed. The key advantages of a Blockchain are security, anonymity, and integrity of data with no third-party intervention. These benefits make it an option for e-health services such as store patient's medical records or drug supply chain (Shahnaz et al., 2019). A number of researchers have also identified that using Blockchain technology in healthcare would be applicable (Gordon et al., 2018)

Shahnaz et al. (2019) examines Blockchain technology in electronic health records and examines three main challenges. Gordon and Catalini (2018), conducted a study that focused on the methods by which Blockchain technology would facilitate the healthcare sector (Shahnaz et al., 2019). Shayganfard et al. (2019) review implementation strategies for electronic health records through Blockchain. Mohammadi et al. (2021) investigates the authentication distributed through Blockchain in the electronic health network. Farahzadi et al. (2021) study this technology in supply chain and Sharif Khatibi et al. (2020) also focuses on exploiting Blockchain in information storage. Zararavasan et al. (2021) investigated the challenges of creating business value in Health Information Systems.

Researches in the field of Blockchain and e-health services have focused on the technical areas of this technology and has not mentioned the policy aspects of using technology in providing e-health services and compensating for the country's backwardness. The study focuses on technological catch-up policies in e-health services through Blockchain technology to fill the policy dimensions of using this technology in e-health services in Iran.

Methodology

In this study, considering that the behavior of the event is not controllable and deals with how and why, the case study method was used (Yin, 2003). Because the research seeks to identify policy factors related to technological catch-up in e-health services through Blockchain technology, the case study method was used. One-sample case studies on macro-policies mainly consist of several levels or components, and in the case, researcher tries to study and analyze the case from different dimensions (Yin, 2003, 2012). Based on the case study model of Yin (2003), the research steps are designed according to Figure 1.

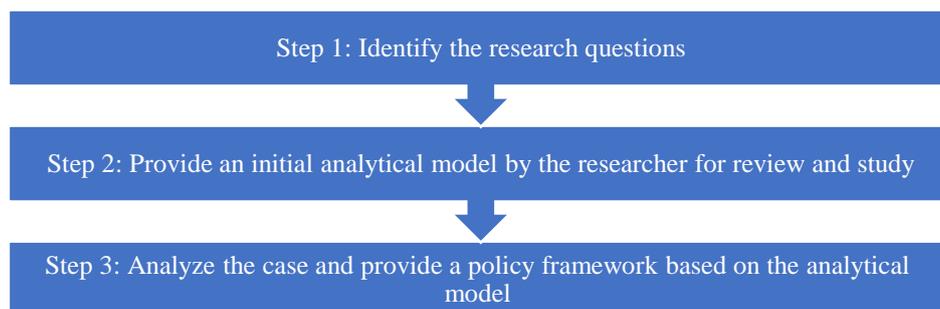


Figure 1. Case Study Steps (Yin, 2003)

According to Yin (2012), the four characteristics proposed to evaluate the quality of the case study must be met. Structural validity means choosing the right operational scales (measurements) for the concept under study and it must be shown that the selected factors really reflect the concept (Yin, 2012). To ensure the accuracy of the framework of all three strategies, including the collection of evidence from various sources, a chain of evidence and the use of key informants to study and critique the report was done carefully. Internal validity in case studies indicates the reliability and validity of research findings and results (Yin, 2003). In order to create appropriate internal validity for the explanations, evidence was used from multiple sources. The results of the expert narrations were matched with data from other sources such as previous research, series of evidence, events and statistics and other sources to verify the accuracy of the cases.

According to Eisenhardt (1989), the triangulation (which in this study was conducted through interviews and narrations, documents, series of evidence and events and questionnaires) also increases internal and external validity (Naghizadeh et al., 2016). Reliability has been considered in this research by preparing an interview protocol and creating a database for the research. All measures leading to research validity are based on the approach of Yin (2012). In the research, the opinions of 12 experts in catch-up policies and Blockchain technology were used based on case study strategy. Table 1 presents the characteristics of experts.

Table 1. The characteristics of experts

Main Expertise	Blockchain/e-health	Policy making
	6	6

Results

As mentioned in the previous section, presenting specific questions for research is the first step in the case study method. In this study, the main question is what are the main policy factors affecting the technological catch-up of e-health services in Iran through the Blockchain technology?.

Then, in order to obtain a policy framework to respond to the challenges, an analytical model is needed based on which policy solutions are presented (Figure 2). Based on the study of documents, an analytical model was predicted in two levels of macro policies of e-health services and policies of Blockchain technology.

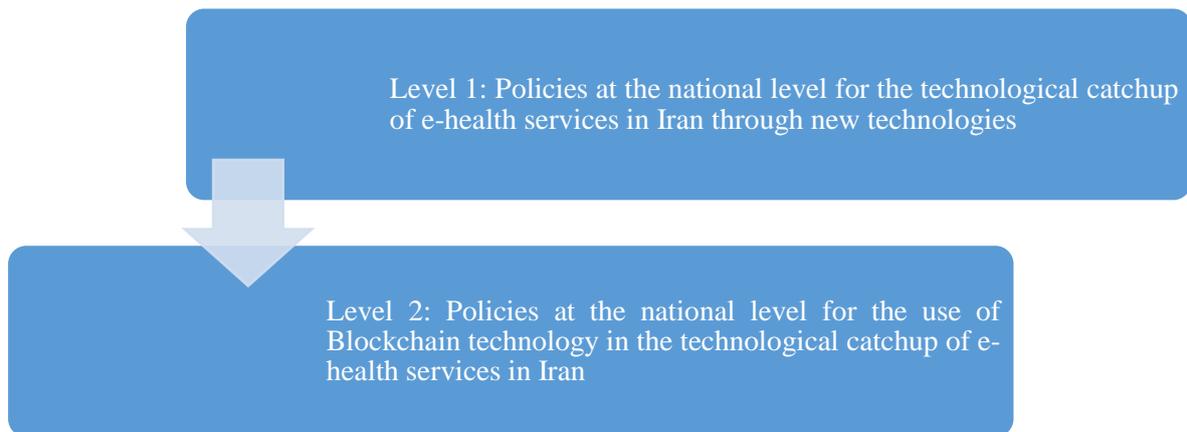


Figure 2. Analytical model to provide a policy framework

In the presented analytical model, the first level is related to national level policies (Wong et al., 1999; Souzanchi et al., 2019; Naghizadeh et al., 2021) for catch-up, especially with the use of new technologies. The role of national policies in the catch-up is recognized as one of the most key policies. At the second level, effective policies at the technical level of the Blockchain are emphasized (Naghizadeh et al., 2016; Crescenzi et al., 2016).

The purpose of the study, is to gain insight and deep understanding of the selected case and to provide a policy framework. In this research, policies are examined in two levels of e-health services and Blockchain technology. The first level is policy analysis at the national policy level in e-health services.

One expert narrates this: "There are several important policies that we need to address at the policy level and we need to address these challenges. First, the structure of the Ministry of Health and the medical community does not agree much with the e-health and increasing transparency and may be seen by some as limiting their interests. At least in practice there is not much follow-up and agreement. Second, insurance organizations may seemingly say we agree, but they are also hesitant about whether it benefits them to be electronic. Third, e-government is not pursued by the government with the necessary pressure and seriousness, and e-health is an example of e-government. With the advent of the Blockchain, the complexities become more. Among patients, the share of middle-aged and elderly people is high and it is difficult for them to use these services, and this also hinders the rapid development of the issue to some extent"(INT11).

The importance of government commitment as a senior policy maker on e-government is very important and this commitment leads to attention to new technologies in the field of e-health services.

¹ It means the first narration of experts which proposed in the paper.

“Governments in Iran have so far not really paid attention to e-government. The Ministry of Health is in a worse situation and there is a conflict of interest, and this makes the transparency approach achieved through e-government even more difficult. If you really want to solve the problem of family doctor, health record, insurance costs and the problem of drug allocation, you should pay attention to e-government. That means you should identify a time for implementing e-health” (INT2). Currently, the country has a serious backwardness in e-health and basic infrastructure (such as electronic records) from developed countries and even countries in the region, and compensating for this backwardness requires a technological roadmap.

One of the experts narrates: “Information storage and processing has played a key role in medical sciences. A lot of information is generated every day, the security and availability of which is very important for qualified people. Whether the traditional centric approach is better or decentralized approaches such as the Blockchain requires a macro-policy that measures the costs and benefits of each approach and makes the optimal decision” (INT3).

Three key needs in e-health services in Iran are illustrated. A: Electronic health records, B: Drug supply chain and fraud prevention and C: Consumption management and fraud in health insurance (Shahnaz et al., 2019) are the three main axes in the use of new technologies in the country's health system. One expert narrates: “We know that technology and the development of products based on it are costly. So first we need to see how much we save on electronic cost services in the health, pharmaceutical and insurance systems. We must first inform the policymaker of this. Now, with the mistakes made in the health transformation plan, costs have skyrocketed and become unprofitable. What should we do now? The best thing to do is to let the policymaker know that if you spend that much, you will save 100 times as much. That is, first we want an economic plan for the policymaker to motivate change. In my opinion, this will not start from the Ministry of Health. The parliament and the government must take the first step”(INT4).

At the level of government policy, the use of Blockchain technology requires attention to three main factors. The key challenges in the development of Blockchain technology in the field of e-health can be: a: storage capacity and scalability, b: lack of social skills to use technology and c: lack of comprehensive standards. Of course, in addition to these challenges, there are three unique features of Blockchain technology in the field of e-health, including: a) decentralization, b) data transparency, and c) security and privacy (Shayganfard et al., 2019). The most important policy for the development of Blockchain technology in the field of e-health is to establish comprehensive standards in this field. For this, regulatory level policies as well as technical studies should be seriously pursued and evaluated on a smaller scale. A narrator states: “We have to start with a small pilot. This technology drastically reduces costs. But there are ambiguities in how technology is used. For example, how to manage permission and access level? My suggestion is to start a national project on a small scale but with real data. If we conclude, we will implement it on a larger scale” (INT5).

One of the experts considers the main issue in the application of technology to be the acceptance of the medical community and at the same time the admission of patients, and narrates this: “Even today, the medical community has not mastered the old technologies. These are new technologies that have their own problems. The support of the medical community must first be established” (INT6).

One of the things that experts agree on is how to develop knowledge-based and technology companies to achieve this goal. Market development and financing can be considered as the most important policy aspects in the development of knowledge-based companies in this sector.

“If the Ministry of Health wants to succeed, it must provide a portion of the market to knowledge-based companies. These companies should also be supported through financial instruments such as purchase guarantees and facilities. From the very beginning, the subscribers of these systems cannot be asked for money” (INT7). Table 2 summarizes the opinions of experts at both levels.

Table 2. some key points from experts

Levels	Key points
Level 1: Policies at the national level for the technological catch-up of e-health in Iran through new technologies	<ul style="list-style-type: none"> - Government commitment to e-government in the field of health and creating a legal obligation - Requiring the Ministry of Health to make information transparent and accessible with considering to confidentiality - Creating technological opportunity windows of supportive policies and directing financial resources in the field of e-health services
Level 2: Policies at the national level for the use of Blockchain technology in the technological catch-up of e-health in Iran	<ul style="list-style-type: none"> - Development of Blockchain technology standard in the field of electronic health - Experimental implementation of e-health through Blockchain technology - Market development of knowledge-based companies providing e-health services on the Blockchain platform - Cooperation of knowledge-based companies with international technology companies at the initial product development level - Cooperation of financial funds such as the Innovation and Prosperity Fund in low-cost financing of Blockchain projects in the field of e-health services - Develop a model for the distribution of financial resources among different actors - Develop cooperation between knowledge-based companies and universities to solve the challenges in the Blockchain and provide a local model for accessibility and protection of confidentiality - Promoting the application of Blockchain and its products in e-health services

All the key points were coded until the realization of theoretical saturation. Theoretical saturation occurs when no more data is collected from the narratives and interviews of experts. Their key sentences were also identified, some of which have been mentioned. Based on the interviews, studies of previous documents and evidence and events and statistics, the policy framework focuses on 4 types of policies including 1) macro policy, 2) market, 3) financing and 4) learning and technology development. Figure 3 shows the technological catch-up policy framework in e-health services based on Blockchain technology. In this framework, it outlines 4 types of policies along with key policies in each species.

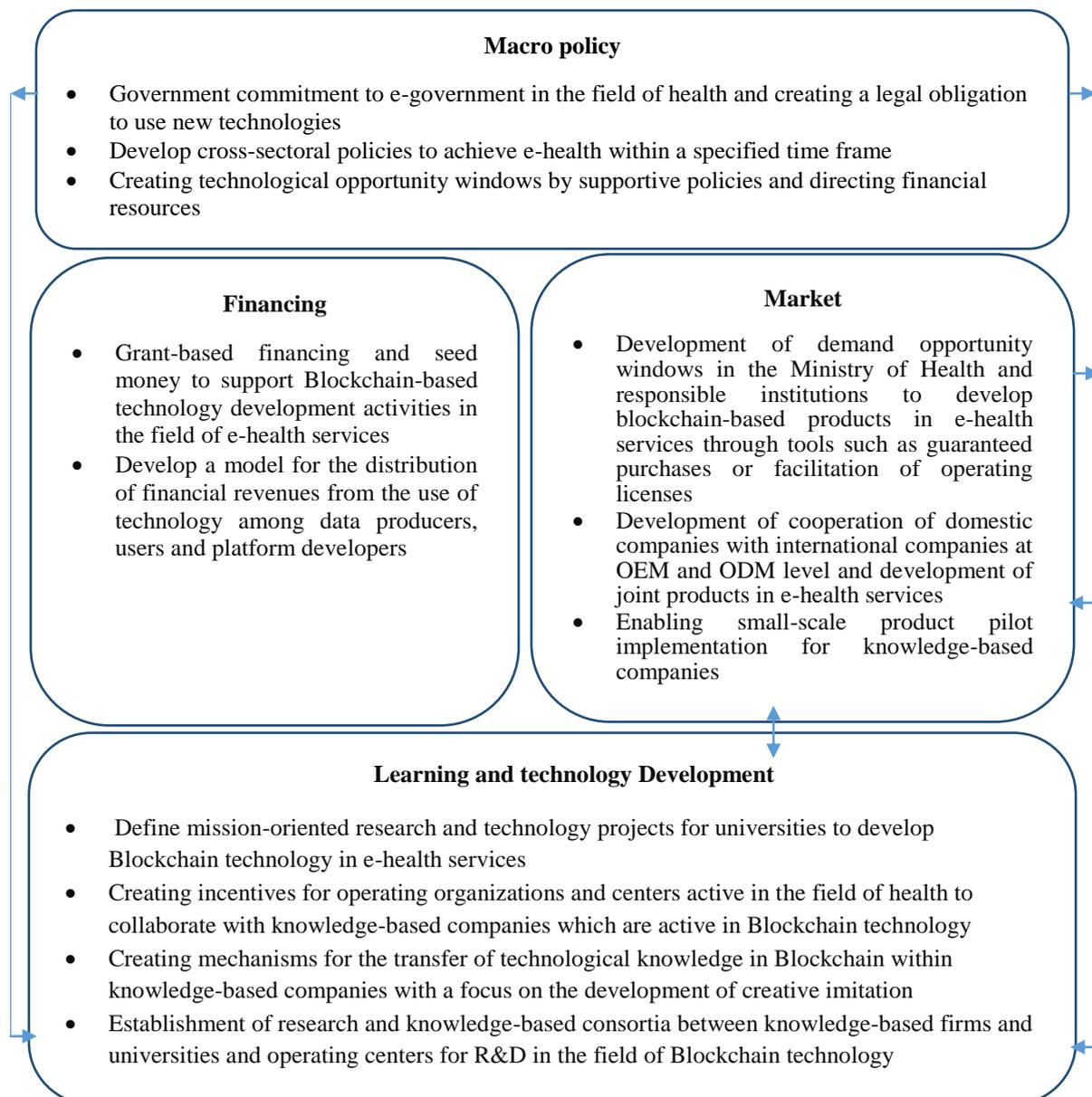


Figure 3. Technology catchup Policy Framework in e-Health Services through Blockchain technology

Conclusion

Initially, a preliminary analytical model was developed to analyze and identify technological catch-up policies in the field of e-health services based on Blockchain technology. Then, based on the presented analytical model, a case study was conducted and 4 types of policies along with 12 of the most key policies in each policy aspect were presented. Of course, these policies can be refined according to the circumstances, and even policies in the four policy types can be refined according to the existing contexts. In fact, in the form of these four types of policies, key technological catch-up policies have been proposed to respond to the Blockchain technology opportunity window. Macro policy refers to the commitment and purposeful approach of the government in the regulation of e-health services and the role of governmental system for reaching catch-up is important (Lee, 2001). The market policy type focuses on solving market-related challenges, which are mainly due to the small size of the market in advanced technologies, and its instability, and the way out of this challenge is to develop and exploit demand opportunity windows (Naghizadeh et al., 2021; Souzanchi et al., 2019; Lee, 2001; Wong, 1999). The type of financing policy emphasizes support mechanisms to be able to benefit more from nationally distributed financial resources. Creating a supportive financial system is one of the most important tools for technology development such as in e-health services based on Blockchain technology (Naghizadeh et al., 2021; Ranga, 2018; Lee, 2005). The type of learning and technology development policy also has a major emphasis on solving the challenges of absorption and learning ability at the level of enterprises. Therefore, strengthening the knowledge and management capabilities in this type of policy along with shaping the ecosystem in research and technology activities to solve challenges is importance. Also It is suggested that future research address the R&D policies of Blockchain technology for use in e-health services.

Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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References

- Bell, M., & Figuieredo, P. N. (2012). Building innovative capabilities in latecomer firms: some key issues. In Amann, E., & Cantwell, J. (Eds.). *Innovative Firms in Emerging Market Countries*. OUP Oxford.
- Crescenzi, R., Luca, D., and Milio, S. (2016). The geography of the economic crisis in Europe: national macroeconomic conditions, regional structural factors and short-term economic performance. *Cambridge Journal of Regions, Economy and Society*, 9, 13–32; doi:10.1093/cjres/rsv031
- Eisenhardt, K. (1989). Building theories from case study research. *The Academy of Management Review*, 14, 532-550.
- Farahzadi, A., & Naser, M. (2021). The role of BlockChain Technology in Addressing Supply Chain Challenges: Requirements and Policies. *Roshd-E-Fanavari*, 17(66), 11-20.
- Feng, Q., He, D., Zeadally, S., Khurram Khan, M., Kumar, N. (2019). A survey on privacy protection in blockchain system. *Journal of Network and Computer Applications*, vol. 126, pp. 45-58.
- Gordon, w. and Catalini, c. (2018). Blockchain technology for healthcare: Facilitating the transition to patient-driven interoperability. *Comput. Struct. Biotechnol. J.*, vol. 16, pp. 224_230.
- Hobday, M. 1994. Export-led Technology Development in the Four Dragons: The Case of Electronics. *Development and Change*, 25(2).
- Hosseini Bamakan, S.M., Faregh, N., ZareRavasan, A. (2021). Di-ANFIS: an integrated blockchain–IoT–big data-enabled framework for evaluating service supply chain performance. *Journal of Computational Design and Engineering*, Volume 8, Issue 2, pp 676–690, <https://doi.org/10.1093/jcde/qwab007>
- Lall, S. (1987). Learning to industrialize: the acquisition of technological capability by India. Springer.
- Lall, S. (1992). Technological Capabilities and Industrialization. *World Development*, 20(2), 165-86.
- Lee, K. (2005). Making a Technological Catch-up: Barriers and Opportunities. *Asian Journal of Technology Innovation*, 13(2), 97-131.
- Lee, K., & Lim, C. (2001). Technological regimes, catching-up and leapfrogging: findings from the Korean industries. *Research Policy*, 30(3), 459-483.
- Lee, K. (2013). Schumpeterian analysis of economic catch-up: Knowledge, path-creation, and the middle-income trap. Cambridge University Press.
- Mohammadi S, Ghanbari N. (2021). A Distributed Authentication Model for an E-Health Network Using Blockchain. *Journal of Health and Biomedical Informatics*. 7 (4) :413-424
- Naghizadeh, R. (2021). The policy framework of Technological catch-up of industrial firms in less developed regions. *Journal of Technology Development Management*.
- Naghizadeh, R., Elahi, S., Manteghi, M. (2016). The framework of technological innovation development in the regions of Iran; the case study of Bio, Nano, Aero and Information & communication technology. *Journal of Science and Technology Policy*, 8, 43-59.
- Naghizadeh, R., Allahy, S., & Ranga, M. (2021). A model for NTBF creation in less developed regions based on the Smart Specialisation concept: the case of regions in Iran, *Regional Studies*, 55(3), 441-452, DOI: 10.1080/00343404.2020.1736539
- Ranga, M. (2018). Smart Specialization as a strategy to develop early-stage regional innovation systems. *European Planning Studies*, 26 (11), 2125–2146. <https://doi.org/10.1080/09654313.2018.1530149>

- Shahnaz, A., Qamar, U. and Khalid, A. (2019). Using Blockchain for Electronic Health Records. in *IEEE Access*, vol. 7, pp. 147782-147795, doi: 10.1109/ACCESS.2019.2946373.
- Sharif Khatibi, Z., & Izadi, S. (2020). Blockchain and its usage in storing information as a secure distributed database. *Information and Communication Technology in Policing*, 1(2), 85-106. <https://www.sid.ir/en/journal/ViewPaper.aspx?id=807660>
- Shayegan Fard, M., Barati, M., Shamsi, K. (2019). Blockchain Solutions for Implementing Electronic Health Record. JCWR conference.
- Souzanchi Kashani, E., Safdari Ranjbar, M. (2019). The Role of Technology and Innovation Policy in Boosting Technological Catch-up. *Journal of Science and Technology Policy*, 12(2), pp. 455-467.
- Szirmai, A. (2008). Explaining success and failure in development (UNU-MERIT Working Papers; No.013). Maastricht: UNU-MERIT, Maastricht Economic and Social Research and Training Centre on Innovation and Technology.
- Wong, P. (1999). National innovation systems for rapid technological catch-up: an analytical framework and a comparative analysis of Korea, Taiwan and Singapore. In DRUID Summer Conference.
- Yin, R.K. (2003). Case Study Research, Design and Methods. Sage Publications.
- Yin, R.K. (2012). Applications of Case Study Research. Sage Publications.
- Zareravasan, A & ,Alizadeh, R. (2021). Challenges in Creating Business Value from Health Information Systems (HIS): A Hybrid Fuzzy Approach *Journal of Information Technology Management* .13(2), 51-74
- Zheng, Z., Xie, S., Dai, H., Chen, X., Wang, H. (2017). An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends. IEEE 6th International. Congress on Big Data, pp. 557–564.

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