Critical Factors Influencing Electronic Health RecordAdoption in U.S. Hospitals: An Empirical Analysis Using the Technology-Organization-Environment Framework

Abstract

There is a growing agreement that electronic health record (EHR) can play a key role in improving healthcare quality and efficiency. Despite thebenefits associated with the use of EHR, the adoption of EHR is low in the United States. The main aim of this study is to identify the critical factors affecting the hospitals' adoption of EHR. This study identifies seven critical factors that are key to the adoption of EHR by using the technology, organization, and environment (TOE) framework. Moreover, we propose a research framework that provides future research opportunities that can offer further insights into the study of adoption of EHR.

Keywords: Electronic Health Record (EHR), Health Quality, Technology, Organization, Environment, TOE framework

Introduction

Even though the United States (US) healthcare industry is one of the largest industries in the entire world, it is the most inefficient industry across the globe [11]. Several studies suggest that patient safety is often compromised due to a lack of proper medical management. The report "To Err is Human," published by the Institute of Medicine of the US estimated that between 44000 and 98000 lives are lost annually in the United States due to medical error [16]. Other research has also shown that there is a substantial financial loss and increase in mortality rate due to medical errors such as adverse drug events [33]. The result of these studies has emphasized the importance for better medical management by both policymakers and health organizations.

With the advent of Information technology (IT) it was anticipated that IT would transform the quality and efficiency of health care by reducing medical errors and costs [21]. Electronic health records (EHR), one of the critical components of health information technology, was anticipated to play a pivotal role in improving healthcare quality and efficiency [24]. Electronic health records are the real-time health records of patients. Healthcare Information and Management Systems Society (HIMSS) defines EHR as a "longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting" (HIMSS). Further U.S. Department of Health & Human Services (HHS) defines EHR as "An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization" (NLM). A lot of initiatives were taken by the US government to promote the EHR with the hope that EHR will transform health care by providing better health care, improved efficiency, lowered health costs, and better clinical decisions. In 2004, the President of the US signed an executive order to have interoperable electronic health records for most of Americans by 2014 [8]. The main thrust came from the Health Information Technology for Economics and Clinical Health (HITECH) Act of 2009 to promote the adoption and meaningful use of EHR. This act allocated around $19.2 billion in incentives for healthcare organizations and healthcare professionals to adopt HER [14].

Recently Blumenthal studied the importance of IT in healthcare and emphasized that IT is the lifeline of the healthcare system and it is impossible for any healthcare organization and physicians to deliver high-quality care without information technology [6]. Further, a number of studies have shown the benefits of EHR on outcomes such as quality, efficiency, and cost [13][38]. Despite the availability of the technology for more than 30 years and the benefits

associated with the use of EHR, the adoption of EHR is low in the United States [20]. In important research, analyzed earlier studies done on EHR adoption and found that 23.9 % percent of physicians use EHR and only 5% of hospitals use basic HER [39]. Furthermore, in another study, found that only 1.5% of US hospitals have comprehensive EHR systems and 7.6% of US hospitals have basic EHR systems [26].

Moreover, analysis of studies related to EHR suggests that there is indeed a gap in the adoption of EHR and attempts should be made to understand the reasons behind these gaps [19]. In the past, there have been limited studies that have focused on understanding the factors affecting EHR adoption among hospitals. A few notable studies include Kazley and Ozcan (2007) who studied the organizational and environmental factors affecting the EHR adoption and Angst et al. (2010) who studied the EMR adoption using the social contagion and diffusion theory. However, none of these theories are comprehensive in nature. For example, Kazley and Ozcan (2007) did not include the technological context in their study. Angst et al.(2010) used EMR and EHR interchangeably in their study limiting the generality of the study as EMR and EHR are two distinct things. Prior research suggests that no significant work has examined the influence of Technological, Organizational, and Environmental factors on EHR adoption in US hospitals simultaneously [10]. Considering the above facts, the main aim of this study is to fill this gap by using standard EHR definition and investigate the adoption of EHR in hospitals with the following research questions:

1. What are hospitals' technological, organizational, and environmental context factors that Influence the adoption of EHR?

2. How do hospitals' technological factors, organizational factors, and environmental factors influence EHR adoption?

Theoretical background

Innovations are adopted by organizations to sustain or enhance their performance to stay ahead ofthe competition [3]. In the literature of innovation, numerousdefinitions have been provided to conceptualize innovation [22].Damanpour and Evan(1984) defined innovation as the introduction of a new product, newservice, or change in the process of production or service operation of the firm. EHR is also anew system that will bring change in the way services are provided by the hospitals to thepatients. Based on above argument, the adoption of an EHR system by hospitals will beconsidered as innovation in this paper. Researchers have studied the contextual factors that can influence the adoption ofinnovation by the organization [32].Damanpour (1987) suggested that adoption of innovation is strongly influenced by thecharacteristics of individuals, organization and the environment. Tornatzky and Fleischer(1990) developed a framework to study the influence of technological context,organizational context, and environmental context on the adoption of innovation.The focus of this paper is to study the contextual factors that in turn influence theadoption of EHR systems in hospitals. Technology, organization and environmentframework is appropriate and are used for this study.

Technological, Organizational, and Environment Context

Technology-Organization-Environment (TOE) framework has three dimensions withinthe context of the organization. These three dimensions explain the adoption andimplementation of innovation in the organization. The three dimensions of the TOEframework are technological context, organizational context, and environmental context.Technological context refers to technologies that are relevant to the organizations[29]. It also includes the availability of technologies andtechnology characteristics. There are a number of factors identified by the

researchers thatinfluence the adoption of technology by the organizations [40].The majority of the studies have suggested that characteristics of technology such as“compatibility” have significant impact on the adoption of technology in theorganization. Both in Information System (IS) and health care literature, compatibilityhas been identified as an important factor that influences the adoption of technology inthe organization [30]. Another factor that hasbeen a major concern is security and privacy of the data, which also influence theadoption of EHR [4].

Further, the study done by Kimberly and Evanisko suggests that the characteristics of an organization are also important factors that impact the adoption of technology [28]. They argued that an organization’s characteristics either help or motivate the process of innovation and size is one of the important factors that influence the adoption of technology. Other than size, researchers have identified other determinants such as top management and human resource readiness [12][5].

For the environmental dimension, Tornatzky and Fleischer (1990) identified certain aspect of environment such as competitive intensity, market uncertainty and government which influence the process of adoption of innovation. No firm is insulated from the external environment and external pressure has a significant impact on the adoption of innovation. The external environment for the firm can be in the shape of government regulation, competition pressure, suppliers, or customers. These external forces can aid or hinder the process of adoption of innovation in the organizations.

Research model and development of Hypothesis

In this study, a research model is proposed based on theoretical backgroundinformation and findings of the literature review (Fig 1). Variables from the technology, organization, andenvironment (TOE) model are used as predictors for this research.

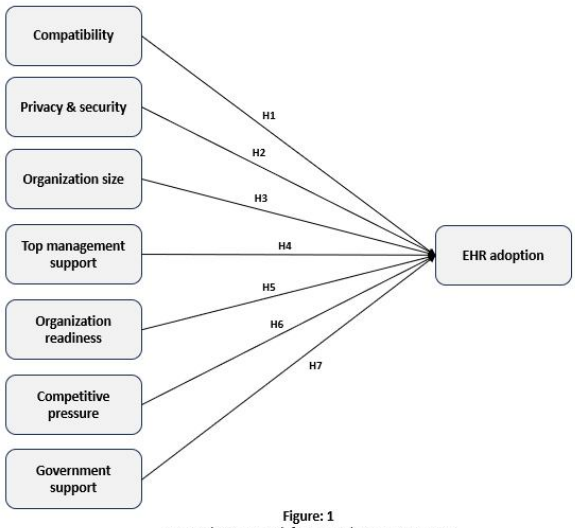

Figure: 1
Research Framework for EHR Adoption using TOE

Technology Context

Compatibility

Compatibility is "the degree to which an innovation is perceived as being consistent withexisting values, past experience, and need of receiver,"[10].Tornatzky& Klein (1982) further added that the values are associated with normativeand the need of the receiver is associated with practical compatibility. In this paper,compatibility implies the practical compatibility of the EHR System. EHR is not astandalone system and it has various functionalities such as clinical documentation, testand image results, computerized provider entry systems and decision support system. It hasbeen well established that many of the hospitals have some functionalities such asmedicine list, laboratory reports and decision support system [36]. If HER system is compatible with existing functionalities of hospitals, then hospitals will bemore inclined to embrace the EHR system.

The innovation literature also suggests that compatibility is positively associated withinnovation adoption [17]. In health care also, compatibility isrecognized as important factor that influences

adoption of technology. For example,compatibility has strongly influenced the adoption of EPI andRFID (in health care organizations [42]. The above argumentslead to following hypotheses:

Hypothesis 1 (H1): Higher the compatibility of EHR system, the greater will be theadoption of EHR in hospitals.

Privacy and Security Concern

Privacy and security concern in health care refer to unauthorized access to patient data,loss and theft of data. In EHR, the data of patient is stored in central server and it has tobe exchanged over internet, which can result in loss or theft of data[37]. It hasbeen argued that protected security and privacy framework is required for EHR system,otherwise the breach of security can have dire consequences both for hospitals andpatients [1].Privacy and security concern have been identified as one of the major obstacles inadoption of EHR [15]. Heir et al.(2005) in their study found that 35-40% ofphysicians have listed security concerns as a barrier to adoption of EHR and the sameconcern has been echoed by otherresearchers [18]. Thakkar and Davis (2006)conducted a nationwide study of US hospitalsand found that the top risk associated withEHR systems were privacy and security of data.

Few studies in healthcare setting have studied the adoption of technology in hospitalssuch as theadoption of RFID and cloud computing and thesestudies have also suggested that privacy and security concerns influencethe adoption oftechnology [25]. The above arguments lead to the following hypotheses:

Hypothesis 2 (H2): Proper security and privacy protection will positively influence theadoptionof EHR in hospitals.

Organizational Context

Size

It has been argued that the adoption of technology is highly influenced by structuralcharacteristics of the organization and size is one of the variables that influence theadoption rate [18]. Damanpour(1992) did ameta-analysis tounderstand the relationship between the size of a firm and innovation and indicate that thereis a relationship between the size of the firm and the innovation. In IS literature also, it has beenshown that technology adoption is impacted by the firm size [31]. Tornatzky and Fleischer (1990) also indicated thatorganizationalcharacteristics such as lack of resources have an impact on technologyadoption. Size oforganization means availability of resources such as number ofemployees and budget [2]. They argued that resources of organizationare important factors that influence innovation and organizations with large number ofresourceshave an impact on innovation. Large organizations have more resources andenjoy economies ofscale that facilitate the adoption of innovation on the other hand studied small firms and found that small firmsdeal with "ResourcePoverty". They argued that small firms have few financial resources,technology experts, and otherslack resources, which hinders the adoption of informationtechnology in small organizations [31]. Inthe context of EHR, there is general agreement thatit has the potential to save cost in the long runstill EHR is still a big cost burden for hospitals. There is a cost associated not only withtechnology infrastructure but also withconsultation, training and maintenance of the system[34]. In an important studyconducted at 280 bed acute care hospital with 16 satelliteclinic and 400 physicians,it was estimated that the cost of implementation of EHR, which lastedfor 7 years, wasaround $19 million[35].Furthermore, another study found that the initial average cost of implementation of HER is $44,000 for full time provider [27]. In addition to that, the studysuggested that there will be additional cost of $8500 per year for full time provider. Inlight of above findings, it can be argued that EHR implementation requires huge

numberof resources such as financial resources. As large firms have more resources in terms offinancial and human expertise, and they can enjoy economies of scale and large hospitalsare more likely to adopt EHR. The above arguments lead to the following hypothesis:

Hypothesis 3 (H3): Larger hospitals are more likely to adopt EHR implementation in comparison to small hospitals.

Top Management Support

Although there is no clear understanding of the role played by top management inthe innovation process, it has been quite clear in innovation literature that the role oforganizational management is very crucial for innovation adoption in the organization [43]. The top management iscrucial for developing and sustaining the organization's culturetowards innovation[23]. They argued that top managementwith lessorientation toward innovation will fail to develop processes necessary for innovation.Previous studies have shown that upper management is vested with more power asthey control resources and implementthe policies in response to the external environment [7].IS literature also suggesting the influence of top management on technologyadoption. Forexample, studies have shown the influence of top management on the use andadoption of newinformation systemsand the adoption ofinter-organizational systems[2].Cao et al. (2014) did a casestudy at one of the healthcareorganizations in the US to understandthe impact of contextualfactors on patient tracking RFID adoption. They found that the roleof top management wasinstrumental not only during RFIP project initiation but alsoduring implementation. They arguedthat one of the factors in the success of RFID applications in the organization was the support oftop management. EHR implementation impacts every aspect of hospitals (clinical andadministrative) and the involvement of topmanagement is inevitable in EHR adoption, and thisleads to the following hypothesis:

Hypothesis 4 (H4): Top management support will positively affect the adoption of EHR in the hospitals.

Organization Readiness

The level of both financial and technological resources of the organization is consideredas organization readiness [7]. Organization readiness for this paper islimited to the "level of sophistication of IT usage" that implies employees' readiness for the adoption of technology. Venkatesh et al.(2012) intheir study found that "effort expectancy and facilitating condition" have an influence onthe use of technology. They argued that the ease of technology and support available for the useoftechnology influences both the intention and use of technology among employees.Implementation of EHR will require workflow change and clinician will have to adjusttheir workflow processes. Previous research has argued that physicians are reluctant inEHR adoption because it requires more time to adjust to EHR [41]. Physicians'negative attitudes towards EHR due to the perception of learning difficulty and time-consumingwill hinder EHR adoption. So, it can be arguedthat organization readiness is a critical factor that influencesthe adoption of technology. Theabove arguments lead to the following hypothesis:

Hypothesis 5 (H5): Organization readiness will have a positive influence on the adoption of EHR by the hospitals.

Environmental Context

Competitive pressure

Porter & Miller (1985) argued that Information technology (IT) has the power tochange the game of competition and it can generate competitive advantage for the firms.Bakos & Treacy in their study listed several examples which show that IT has helped thecompanies to achieve advantage [9]. They also concluded that ITcreates opportunities for the firms, which in turn helps the firms

within an industry tooutperform other firms. Other researchers have also identified a number of advantages ofIT such as first mover advantage. Powell & Dent-Micallef (1997) suggested that IT createsan advantage for firms if the firm focuses on both external and internal applications of IT.Given that if hospitals focus on both internal and external applications of EHR thenEHR will create a competitive advantage for the hospitals.

Powell&Dent-Micallef(1997)alsoanalyzedearlierITresearchandproposedthatIT generatesvaluefororganizationsbyincreasingefficienciesandfirmsthatdonot implementITwillbeata competitivedisadvantage.Johnston&Vitale(1988)arguedthat ITcreatesinternalandinter-organizationalefficiencyandtheseefficiencieswillprovide theorganizationacompetitiveadvantage.Moreover,ithasbeensuggestedthat organizationstendtoimplementtheITsystemwhencompetitorsareadoptingtheIT [39].Thus, the following hypothesis is formulated:

Hypothesis6(H6):Competitivepressurewillpositivelyaffecttheadoptionof EHRby hospitals.

Government Support

Government policies have a significant influence on the adoption of technology by thefirm since government has the power to give financial incentives and tax breaks topromote the adoption of technology. In health care also, federal and stategovernments are implementing policies to promote EHR systems in hospitals. This isevident from the executive order by President Bush in 2004 and the HITECH Act of 2009 thatcall foruniversal EHR adoption in the US. Further Jha et al.(2009)indicated that favorable policies from the government such as additional reimbursement forHealth Information Technology use and financial incentives will encourage hospitals toimplement EHR.

Another area where government policies can have a profound effect is health informationexchanges. EHR system requires the electronic transfer of patient data from one hospital toanother hospital and lack of health information exchange hampers the interoperability ofdata.Few studies have suggested that slow growth of health information exchange have anegative effect on EHR adoption. Health information requires anationwide infrastructure and government policy in promoting health informationexchange will help the hospitals to consider the implementation of an EHR System. These leads to the following hypothesis:

Hypothesis 7 (H7): Government Support will positively influence the adoption of EHR inhospitals.

Conclusion and Implications for research and future direction

This study will further the understanding of EHR adoption among hospitals. To the bestof our knowledge, this study is the first study to use innovation theory and technology,organization, and environment framework to empirically test the factors influencing HER adoption. This study will also help policymakers and administration of healthcareorganization to identify the determinants of EHR adoption and the impact of thesedeterminants on EHR adoption. This will help them to modify their program and policiesthat in turn will promote EHR adoption in hospitals. Moreover, this study provides avenues forfuture research. For example, research suggests that social capital is the key factor in theperformance of an organization. Thus, future research can investigate the roleof social capital among hospital staff and the adoption of EHR.

Competing Interests

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

Disclaimer (Artificial intelligence)

Author(s) hereby declare(s) that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS DISCLAIMER:

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References

1. Kurian G, Muzumdar P. Restaurant formality and customer service dimensions in the restaurant industry: An Empirical Study. Atlantic Marketing Journal. 2017; 6(1):75-92.
2. Kurian G, Muzumdar P. Antecedents to job satisfaction in the airline industry. NMIMS Management Review. 2017; 34(2):29-40.

3. Muzumdar P. Influence of interactional justice on the turnover behavioral decision in an organization. Journal of Behavioral Studies in Business. 2012; 4:1-11
4. Muley A, Muzumdar P, Kurian G, Basyal GP. Risk of AI in Healthcare: A comprehensive literature review and study framework. Asian Journal of Medicine and Health. 2023;21(10):276-291.
5. Muzumdar P. Online bookstore-A new trend in textbook sales management for services marketing. Journal of Management and Marketing Research. 2012; 9:122-135.
6. Singh K, Kurian G, Napier R. The dynamic capabilities view: Supply chain and operations management perspectives. Journal of Supply Chain and Operations Management. 2018;16(2):155-175.
7. Muzumdar P. Dilemma of journal ranking: perplexity regarding research quality. Academy of Educational Leadership Journal. 2012;16(4):87-100.
8. Reavis M, Singh K, Tucci J. Millennials' CSR Adoption: A Stakeholder Approach and the Impact on Profit. American Journal of Management. 2024;24(1),38-51.
9. Muzumdar P. Business model development through corporate strategy design: IBM SWOT Analysis. American Based Research Journal. 2015;4(7):12-19.
10. Singh K, Zare S, Reavis MR, Tucci JE. Structural capital and relational capital: examining the direct and moderating role of cognitive capital in customer-supplier relationships. International Journal of Management Practice. 2024;17(1),95-112.
11. Muzumdar P, Kurian G. Empirical study to explore the influence of salesperson's customer orientation on customer loyalty. International Journal of Empirical Finance and Management Sciences. 2019;1(3):43- 51.
12. Limaye A, Elkassabgi A, Singh K, Hunter D, Cochran L. Corporate Governance and Choice of Capital Structure. Journal of International Finance and Economics. 2023;23(2),69.
13. Muzumdar P. A Linear regression approach for evaluating the decline in chartered designations with the effect of economic determinants. Journal of Contemporary Research in Management. 2014;9(3):13-20.
14. Zare S, Singh K, Ghasemi Y, Prater EL. Social capital, knowledge sharing and operational performance in the supply chain: a buyer-supplier perspective. International Journal of Business and Systems Research. 2023,17(4),387-406.
15. Muzumdar P. Game of the Names: Branding in smartphone industry. Journal of Contemporary Research in Management. 2015;10(2):13-31.
16. Kurian G, Niu Z, Singh K, Muzumdar P. The Evolution of Dynamic Capabilities in OM. American Journal of Management. 2024;23(5),62-80.
17. Muzumdar P. The Effect of review valence on purchase of time-constrained and discounted goods. Journal of Information Systems Applied Research. 2022;15(1):1-16.
18. Reavis MR, Singh K. Moving beyond Transactional Coursework to Enhance Student Success in University Classes. Journal of Educational Research and Practice. 2023;13(1),433-446.
19. Muzumdar P. Impact of review valence and perceived uncertainty on purchase of time constrained and discounted search goods. Proceedings of the Conference on Information Systems Applied Research (CONISAR) Washington DC. 2021;14.1-12.
20. Elkassabgi A, Singh K, Limaye AR, Hunter D. Information Pathways and their Influence on Corruption: An Empirical Study. Journal of International Finance Studies. 2022;22(1),16-25.

21. Muzumdar P, Kurian G. Empirical study to explore the influence of salesperson's customer orientation on customer loyalty. International Journal of Empirical Finance and Management Sciences. 2019;1(3):43-51.
22. Mark R, Singh K, Tucci J. Millennials' Strategic Decision Making Through the Lens of Corporate Social Responsibility and Financial Management. Journal of Business Strategies. 2021;38(2),125-146.
23. Muzumdar P. A Linear regression approach for evaluating the decline in chartered designations with the effect of economic determinants. Journal of Contemporary Research in Management. 2014;9(3):13-20.
24. Limaye A, Elkassabgi A, Singh K. Impact of Natural Disasters on Economic Activity. Journal of International Finance Studies. 2021;21(1),33-39.
25. Muzumdar P. Game of the Names: Branding in smartphone industry. Journal of Contemporary Research in Management. 2015;10(2):13-31.
26. Ogujiuba, K, Maponya L. Determinants of Human Development Index in South Africa: A Comparative Analysis of Different Time Periods. MDPI World, 2024;5(3),527-550.
27. Muzumdar P. The Effect of review valence on purchase of time-constrained and discounted goods. Journal of Information Systems Applied Research. 2022;15(1):1-16.
28. Reavis J, Stein, P. Corporate Social Responsibility as a Determinant of HDI in Developed Nations. Corporate Governance Journal, 2023;27(1),99-116.
29. Muzumdar P. Impact of review valence and perceived uncertainty on purchase of time constrained and discounted search goods. Proceedings of the Conference on Information Systems Applied Research (CONISAR) Washington DC. 2021;14,1-12.
30. Choi, M. J, Park, K. S. The Role of Education in HDI Improvement: A Case Study of OECD Countries. Education Economics Review, 2022;25(3),199-214.
31. Muzumdar P. Quantitative analysis of compensatory model: Effects of influence of shopping mall on the city structure. The IUP Journal of Knowledge Management. 2014;12(2):51-61.
32. Basyal, G, Bhaskar, R, Zeng, D. A Systematic Review of Natural Language Processing for Knowledge Management in Healthcare. International Conference on Data Mining & Knowledge Management Process (CDKP 2020), 2020;10(9),275-285.
33. Muzumdar P. A study of business process: Case study approach to PepsiCo. Available at SSRN 2392611. 2014;1-16.
34. Basyal, G, Zeng, D, Bishop, D, Rimal, B. Comparative Study of CNN Models for Brain Tumor Classification: Computational Efficiency versus Accuracy. AMCIS 2021 Proceedings, 2021;28.
35. Muzumdar P. Brand regeneration through previously tested narrative units: A movie remake perspective. 2014;25(9):1-9.
36. Basyal, G, Zeng, D, Bishop, D, Rimal, B. Development of CNN Architectures using Transfer Learning Methods for Medical Image Classification. Proceedings of the 15th International Multi-Conference on Society, Cybernetics and Informatics (IMSCI 2021), 2021;6-11.
37. Muzumdar P. From streaming vendor to production house: Netflix SWOT analysis. Available at SSRN 2377151. 2014;1-6.
38. Basyal, G, Zeng, D. Impact of Data Quality and Quantity on its Effectiveness on Multi-Stage Transfer Learning Using MRI Medical Images. SDSU Data Science Symposium, 2020.

39. Muzumdar P. Brand regeneration through previously tested narrative units: A movie remake perspective. Journal of Research for Consumers. 2013;25.53-84.
40. Muzumdar P. Effects of zoning on housing option value. Journal of Business and Economics Research. 2011;9.
41. Muzumdar P, Kurian G, Basyal GP, Muley A. Econometrics Modelling Approach to Examine the Effect of STEM Policy changes on Asian student's enrollment decision in USA. Asian Journal of Education and Social Studies. 2023;48 (2):148-160.
42. Muzumdar P, A Bhosale, GP Basyal, G Kurian. Navigating the Docker Ecosystem: A Comprehensive Taxonomy and Survey. Asian Journal of Research in Computer Science. 2024;17(1),42-61.
43. Muzumdar P, G Kurian, GP Basyal. A Latent Dirichlet Allocation (LDA) Semantic Text Analytics Approach to Explore Topical Features in Charity Crowdfunding Campaigns. Asian Journal of Economics, Business and Accounting. 2024,24(1),1-10.