Using Big Data in Healthcare Context: a Conceptual Study

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Abstract

The most significant phenomenon that has caught the attention of the modern computing industry nowadays since the "Internet" is "Big Data". The technology platforms that have been developed together with it has allowed for the processing of data of various formats and structures without having to worry about the constraints that are linked with traditional systems and database platforms. In this conceptual paper, the researchers sought to discuss an overview of the elements associated with this phenomenon. Thereafter, the benefits of using big data in the healthcare field are highlighted. Based on prior literature, there is a paucity of research on the healthcare context whether theoretically or empirically. Most of the previous studies have focused on Big Data in general.

Index Terms: Big Data, characteristics, healthcare.

1. Introduction

2000 to 2010 were remarkable years in the history of data, personalization of music (iPod), emergence of tablet computing (iPad), search engines (Google, Yahoo), larger mobile solutions (3G networks, smartphones, Wi-Fi, mobile broadband), as well as emergence of social network (such as, MySpace, Blogger, Facebook, and Twitter). All these modern technologies have contributed to data consumerization, from data creation, acquisition, and consumption perspectives [1]. In addition, Mohanty [2] stated that currently, the societies are literally flooded with various digital tools, from a wide range of cell phones to sensors. Even a car currently has various devices (or sensors) to send data on its performance. More precisely, the radio of taxi sends signals on travel as soon as it is hired.

Global Positioning System (GPS) fitted with autos and different vehicles make a gigantic measure of data consistently. Moreover, situations in the street, for example, traffic subtleties, are delivered in customary interims in order to watch out for traffic the executives. These gadgets (situations) involve information of traffic directions, vehicles, street condition, individuals development and other data identify with street the executives. These snippets of data arrive in a wide scope of structures, from visual, sound to printed. Additionally, Erl, Khattak and Buhler [3] expressed that Big Data is regarded as a field that is devoted to the handling, examination, and capacity of colossal social events of crude information that regularly originate from fluctuating sources. As a rule, Big Data alludes to "the volumes of information accessible in various degrees of unpredictability, created at different speeds, and diverse degrees of uncertainty that can't be handled using customary innovations, preparing strategies, calculations, or any business off-the-rack arrangements" [4].The

second section of the paper is concerned with concepts, techniques, and features of Big Data. In the third section, Challenges and Opportunities of Big Data will be highlighted. The following section discusses the previous studies on Big Data context. The final section talks about Big Data and healthcare context.

2. Big Data

The notice of Big Data is difficult to keep away from these days. Huge information is pivotal as it enables associations and organizations to gather, oversee, store, and handle a lot of crude information at the opportune time and at the correct speed to pick up the correct bits of knowledge [5]. Moreover, Hurwitz et al.[6] characterized Big Data as "high-volume, high-speed and high-assortment data resources that request savvy, imaginative types of data handling for upgraded knowledge and basic leadership." Wieczorkowski and Polak [7] then again, brought up that Big Data is a term regularly use to show the systems of applying genuine figuring power, the most recent in machine learning, and man-made brainpower to truly gigantic and frequently profoundly complex arrangements of data. As to datasets perspective, Karthick and Kalrani [8] expressed that Big Data alluded to the extent of datasets which is past the capacity of normal database programming apparatuses to catch, oversee, investigate, and store. Lake and Drake [9] additionally alluded to Big Data as a "computerized information volume, speed or potentially assortment that empower novel ways to deal with outskirts questions already blocked off or unfeasible utilizing present or ordinary techniques; as well as surpass the limit or ability of present or regular strategies and frameworks."

By and large, Big Data and customary information are extraordinary. Customary information is essentially put away in the database or is in the datawarehousing [10]. Instances of conventional database

incorporate RDBMS, DBMS, and SQL. Information stockroom is essentially actualized in a solitary social database framework that fills in as the brought together machine. Essentially, the information distribution center is the blend of four things that incorporate time variation, non-unstable, coordinated, subject situated for information bolster the board in the basic leadership process.

In actuality, with Big Data, virtualizing information so it tends to be put away productively and using cloud-based capacity more expense viably have turned out to be conceivable. Nonetheless, Big Data really not a sole innovation; it is considered as a mix of new and old advances that permit organizations and associations increase significant knowledge [11].

1.2. Three Characteristics of Big Data

For a dataset to be viewed as Big Data, it must have at least one attributes that require convenience in the arrangement structure and engineering of the expository condition. Huge Data is commonly separated into three qualities. Fig 1 delineates these three attributes. This section explores the three Big Data characteristics that can be used to help differentiate data categorized as "Big" from other forms of data.
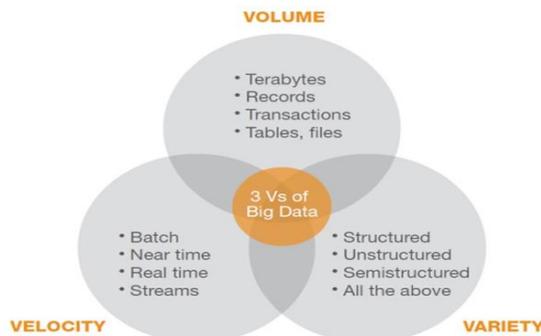

Figure 1: Big Data Characteristics

Volume: The word of Big in the Big Data itself referred to the volume [12]. At present, the current information is in a petabytes, however it should fundamentally increment to zettabytes sooner rather than later. Besides, the current online life instruments, for example, Facebook are making information arranged by terabytes consistently, and taking care of these gigantic measures of information utilizing the current customary frameworks is unquestionably troublesome. Truth be told, high information volumes require unmistakable information stockpiling and handling requests, information arrangement, curation, and the executives forms.

Normal information sources that are in charge of creating high information volumes can include:
- online transactions, such as point-of-sale and banking
- scientific and research experiments, such as Atacama Large Millimeter/Submillimeter Array telescope and the Large Hadron Collider.
- sensors, such as GPS sensors, RFIDs, smart meters and telematics
- social networks tools, for instance Facebook and Twitter

2.2. Types of Big Data

According to Joshi, Gondaliya and Wang et al [13] Enormous Data is essentially partitioned in to three distinct parts to be specific is known as the structure, unstructured and Semi-organized information.

STRUCTURED DATA: it is data that has a defined, predictable and repeating layout. It is data that can be easily put into rows and columns or that can take up the relational data model14. Dates, numbers and groups of numbers and words called strings are some examples of structured data (for instance, a citizen's address, name, and so on).

UNSTRUCTURED DATA: Information that is difficult to be put away in a crude and segment design simply like a video and sound information, gushing information, pictographically information is known as the unstructured information [15]. In a similar vein, Erl et al [16] alluded that, Data that does not fit in with an information model or information composition is known as unstructured information. As of late, unstructured information has a quicker development rate than organized information.

SEMI-STRUCTURED DATA: It is a sort of information that lies between unstructured information and organized [5]. All the more explicitly, semi-organized information has a characterized dimension of structure and consistency, yet isn't social in nature. Instances of basic wellsprings of semi-organized information incorporate electronic information trade (EDI) documents, spreadsheets, RSS channels and sensor information.

2.3. Big Data Techniques

The advancement of processing innovation has now help to oversee gigantic volumes of crude information that in the past could have just been treated by super-PCs at a tremendous expense. All the more absolutely, there are three most well known methods utilized with Big Data to manage huge measures of information, in particular: MapReduce, Hadoop, and Big Table. These systems have tried to address a standout amongst the most fundamental issues, the capacity to process colossal measures of information proficiently, cost successfully, and in an auspicious way.

HADOOP: it is an open source activity facilitated by ASF, Hadoop is made out of numerous little sub activities or ventures that have a place with the class of foundation for dispersed processing [17].

MAPREDUCE: It is the programming approach that permits gigantic versatility [18]. This system was made by Google as a way to productively execute a lot of capacities against a gigantic measure of information in clump mode. Essentially, the MapReduce lead two distinct capacities or assignments are: Map Task and Reduce Task.

Enormous TABLE: Hurwitz et al [5] expressed that, to oversee exceptionally versatile organized information Google built up this procedure to be a conveyed stockpiling framework. Through this procedure, the information will be masterminded into tables with lines and sections. Instead of a customary database, Big Table is a scanty, dispersed, diligent multidimensional arranged guide. Enormous Table is proposed to store tremendous measure of information crosswise over item servers.

3. Opportunities and Challenges with Big Data

Since the Internet's introduction, the typical end users has been moved consistently from text communications to richer visualization data that consist videos, images and interactive maps as well as associated meta-data, including time, geolocation information and date stamps [19].

Therefore, Big Data creates new features for discovering new values and aids stakeholders to acquire an in-depth understanding of the unobserved values. In general, it is able to utilize more sources of data (such as social media) to capture greater insights. More

precisely, there are many opportunities in which were the aims of Big Data. Michael and Miller [20] mentioned some opportunities as follows:

Internet was born based on text information which could be communicated via intranet or Internet. Now, there a lot of advantages compared to the old times as there are "more extravagant information that incorporate pictures, recordings, and intelligent maps and additionally related metadata, for example, geolocation data and time and date stamps" [20]. In two decades prior, ISDN had the ability to oversee just fundamental illustrations, yet increment the speed of correspondence systems of today permit the transmission of capacity concentrated information types.

For instance, clients of savvy gadgets can catch superior quality pictures and films and transfer them specifically to internet based life devices through current correspondence innovations, (for example, Wi-Fi and 3G or 4G cell systems). There is additionally a consistent increment of the measure of information produced in bidirectional cooperations, both machine-to-machine and individuals to-machine, using telematics and telemetry gadgets in frameworks of frameworks. E-wellbeing systems hold a more prominent significance as they empower information combining and sharing of excellent pictures as CT checks between partners, MRIs and patient X-beams.

Albeit Big Data can produce to a great degree valuable data, it likewise achieves new difficulties in numerous perspectives. Protecting individual security is considered as a one of the key difficulties of Big Data. As indicated by Michael and Miller [20], Big Data accompanies new good difficulties. For instance, enterprises are using Big Data to assemble different data about their staff, present progressive business procedures and increment efficiency. In any case, these improvements accompany a cost: watching's everything staffs might do and continually surveying their execution against industry benchmarks makes a dimension of oversight that can subdue the human soul. In spite of the fact that the oversight may be to the greatest advantage of an enterprise, it isn't generally to the greatest advantage of the general population who involve that organization.

In addition, the outskirts among private and open space will obscure as large sight and sound datasets end up typical. Creating on the web applications won't enable just clients to transfer recordings through online networking instruments however will fuse wearable gadgets, for example, advanced glasses or watches to empower consistent varying media catch. Basically, end clients will turn into a camera [21]. This information that is openly accessible will predominate the information produced by the present CCTV cameras.

4. Previous Studies of Big Data

Nowadays, industries have shown interest in the high potential to using big data, as well as many public agencies around the world announced key strategies to accelerate big data applications and research. The era of big data has come beyond all doubt. There is a number of studies devoted to highlighting the issues related to this new phenomenon. Table 2 summarizes some of these studies.

Table 2: Related works

Author (s)	Year	Summary
Kaisler, Armour, Espinosa and Money [22]	2013	In this article, the issues and difficulties in Big information are talked about as the writers start a cooperative research program into strategies for Big information examination and plan.
Madden [23]	2012	The analyst examines about the customary databases and the databases required with Big information reasoning that the databases don't explain all parts of the Big information issue and the machine learning calculations should be increasingly hearty and simpler for unsophisticated clients to apply. There is the need to build up an information the board biological community around these calculations with the goal that clients can oversee and develop their information, uphold consistency properties over it and peruse, envision and comprehend their calculation results.
Bakshi [24]	2012	In this paper, engineering contemplations for Big information are talked about presuming that in spite of the diverse structures and plan choices, the examination frameworks go for scale-out, versatility, and high accessibility.
Russom [25]	2011	In the present paper, every one of the ideas of Big information alongside the accessible market arrangements used to deal with and investigate the unstructured extensive information are talked about. The perceptions and the outcomes demonstrated that examination has turned into an imperative part to include an incentive for the social business.
Demchenko, Zhao, Grosso, Wibisono and de Laat [26]	2012	This paper proposes the Scientific Data Infrastructure (SDI) nonexclusive engineering model. This model gives a premise to building interoperable information with the assistance of accessible present day innovations and the accepted procedures. The creators have demonstrated that the models proposed can be effectively executed with the utilization of cloud based foundation administrations provisioning model.
Courtney [27]	2012	The creator in this examination researches the distinction in Big information applications and how they are not quite the same as the conventional strategies for investigation existing from quite a while.

5. Big Data with Healthcare

The development in communication technologies, together with their adoption and utilization by the healthcare providers and in the same time the maturity of the citizens, has brought the significant changes to the healthcare sector in accordance with current developments [28]. According to Koumpouros [28], healthcare sector is considered as a first industry that adopts and promotes new communication technologies (ICTs) innovations. Furthermore, healthcare is deemed as a one of the leading sectors in the era of Big Data, generating Zettabyte of data every day [29]. In this sector, the different stakeholders in healthcare interact with each other in a constant manner in order to fulfill their role, as shown in Fig 2.

Figure 2: The Healthcare industry

Truly, the worldwide money related emergency alongside the demonstrated disappointment of a large portion of the wellbeing frameworks around the globe encourage for a reconsidering and overhauling of the entire framework or as an option for investigating better approaches to enhance it. Furthermore, the maturing of populace will be another enormous issue that must be looked in the following years. This will discourage the monetary results in social insurance considerably more.

Subsequently, use of the Big Data by medicinal services segment can help in the enhancement of a large portion of the issues, which emerge in the area. Ice [30] said that Big Data in human services alludes to "electronic wellbeing informational collections so huge and complex that overseeing them with conventional programming and additionally equipment ends up being troublesome, and they can't be effortlessly dealt with customary or normal information the board devices and techniques". Besides, Hermon and Williams [31] alluded that Big Data is perceived as a multidisciplinary data preparing framework. Zones of government, business, media, and social insurance specifically are progressively joining Big Data into data preparing frameworks. Moreover, Big Data examination can give social insurance bits of knowledge and enhance the general procedures in two fundamental tomahawks [28]:

 (1)   Improve the nature of consideration

a.   Patients and wellbeing experts can get to the ideal information so as to be educated, instructed and settle on better choices.

b.   Patients can be increasingly proactive and change their way of life on time in order to stay away from any significant issues.

c.   The accumulation and total of information from various sources into one uniform and similar way can give bits of knowledge about sickness designs, spread of diseases, and so on.

d.   The mining of numerous informational collections from any conceivable source advances explore and quickens the examination of new treatments.

e.   Providers can distinguish high hazard populaces and act as needs be (i.e. offer preventive administrations).

f.   Will enhance the patients' understanding.

g.   Personalize prescription and enhance pharmaceutical medication structure and clinical preliminaries.

(2)   Improve proficiency and efficiency

a.   Reduce the expenses of social insurance by recognizing the few "dark openings" and the performing artists that may create the most astounding expenses for specific methods.

b.   Monitor adequately the expended assets (i.e. prescriptions, consumables, and so on.).

c.   Compare the efficiency and viability of wellbeing experts against different companions.

d.   Will help to discover and uncover any irregularities in the manner in which the consideration is conveyed.

e.   Facilitate proof based drug and along these lines give the device to have the capacity to pore through piles of information.In the same context, Groves et al [32] stated that Big Data will be impacted in healthcare system is based on the five new pathways, which are: right innovation, right living, right value, right provider, and right care. According to Statchuk, Iles and Thomas [33], various organizations related to healthcare are harnessing Big Data techniques to collect all data about a patient to gather a more complete view of information. By successfully utilization of Big Data, the possibility to attain the following essential objectives for healthcare transformation will be unleashed: access to complete information, reduced costs, personalized diagnoses, better preventative care, and improved evaluations.

5.1. Related Works of Big Data and Healthcare Context

The fast growing field of big data analytics has begun to play a crucial role in the advancement of healthcare practices and research [36]. It has provided tools to mount up, manage, analyze, and incorporate massive volumes of unrelated, structured, and unstructured data generated [37] by the current healthcare systems. In this section, the related works of the healthcare and Big Data will be highlighted. Table 3 shows the previous studies on this phenomenon.

Table 3: Related work of Big Data in Healthcare

AUTHOR (S)	YEAR	SUMMARY
Yadav, Verma and Kaushik [34]	2015	This article stated that the acceptance rate and research development in this space is still delayed by some fundamental problems inbuilt within the big data standard. Therefore, this paper focused on utilization of huge volume of medical data, and also discussed combining multidimensional data from different sources.
Raghupathi and Raghupathi [35]	2014	The key aim of this paper is to describe the promise and potential of big data analytics in healthcare. This paper provides a broad overview of big data analytics for healthcare researchers and practitioners.
Hermon and Williams [31]	2014	This study used a systemic review methodology to create a categorisation of big data used in healthcare. The results indicated that the natural classification is not clinical application based, rather it falls into four broad categories: administration and delivery, clinical decision support (with a sub category of clinical information), consumer behaviour, and support services.
Koumpouros [28]	2014	In this paper, the author discussed overview about the Big Data and healthcare, as well as explained the tools used to analyse Big Data in healthcare context.

As per Public Expenditure Statistical Analyses in 2012, add up to expected subsidizes social insurance [38] part spending in the United Kingdom by 2021 will be around 6.4% of the total national output (GDP), while the aggregate expected medicinal services offer of the GDP in the United States is anticipated to achieve 19.9% by 202236. Along these lines, whenever used appropriately, Big Data can be a significant asset that can give critical bits of knowledge toward enhancing contemporary wellbeing administrations [39] and decreasing human services costs [40].

In addition, huge information examination can permit more than 300 USD billion in funds for every year in the social insurance [41] at United States, where 66% of that is through decreases of around 8% in national medicinal services uses. Clinical tasks and Research and improvement are two of the greatest regions for potential investment funds with $165 billion and $108 billion in waste, separately [42].

6. Conclusion

Undoubtedly, we are presently living in the time of information, where gigantic measures of informational collections rise up out of sensors, interpersonal organizations, cell phones, undertaking

programming arrangements, server farms, and so on. In 2012 alone, about 2.5 quintillion bytes of information were produced once a day. As of now, two of the most concerning issues are finding and finding the correct information and having the capacity to process them in like manner. The capacity, handling and the board of these heaps of datasets are ending up to a great degree testing both for the intriguing end clients and innovations. This circumstance is as of now alluded to as "Large Data", implying that it is troublesome for somebody to open the significant data out of these information volumes. This paper described the new concept of Big data as well as explained many related works and tools of this new concept. Moreover, the current study explained the main tools used to analyze big data in the healthcare context. This article is purely a conceptual study that covers all the elements related to big data and healthcare research (concepts, techniques, and architectures). In the future work direction, the researchers seek to conduct an empirical study in this field because there is a scarcity of research in this area.

References

[1] K. Krishnan, Data warehousing in the age of big data: Newnes, (2013).

[2] H. Mohanty, "Big Data: An Introduction," in Big Data, ed: Springer, (2015) 1-28.

[3] T. Erl, et al., Big Data Fundamentals: Concepts, Drivers & Techniques: Prentice Hall, (2015).

[4] Sridhar KP, Baskar S, Shakeel PM, Dhulipala VS., "Developing brain abnormality recognize system using multi-objective pattern producing neural network", Journal of Ambient Intelligence and Humanized Computing, 2018:1-9. https://doi.org/10.1007/s12652-018-1058-y

[5] J. Hurwitz, et al., Big data for dummies: John Wiley & Sons, (2013).

[6] A. Gandomi and M. Haider, "Beyond the hype: Big data concepts, methods, and analytics," International Journal of Information Management, vol. 35, (2015) 137-144.

[7] J. Wieczorkowski and P. Polak, "Big data: Three-aspect approach," Online Journal of Applied Knowledge Management, vol. 2, (2014) 182-196.

[8] Shakeel PM. Neural Networks Based Prediction Of Wind Energy Using Pitch Angle Control. International Journal of Innovations in Scientific and Engineering Research (IJISER). 2014;1(1):33-7.

[9] P. Lake and R. Drake, "Introducing Big Data," in Information Systems Management in the Big Data Era, ed: Springer, (2014) 1-18.

[10] H. D. Joshi, et al., "New Big Things in Era of Digital Data:'Big Data'& Big Data Challenges with its Solution Using Different Tools," (2015).

[11] W. J. Johnston, "The future of business and industrial marketing and needed research," Journal of Business Market Management, vol. 7, (2014) 296-300.

[12] A. Katal, et al., "Big data: issues, challenges, tools and good practices," in 2013 Sixth International Conference on Contemporary Computing (IC3), (2013) 404-409.

[13] H. D. Joshi, et al., "New Big Things in Era of Digital Data:'Big Data'& Big Data Challenges with its Solution Using Different Tools," (2015).

[14] T. T. Maposa and M. Sethi, "Association Rule Mining for Structured Data in Big Data Using Parallel RDB-Miner Algorithm," (2015).

[15] L. Wang, et al., "Bigdatabench: A big data benchmark suite from internet services," in High Performance Computer Architecture (HPCA), 2014 IEEE 20th International Symposium on, (2014) 488-499.

[16] T. Erl, et al., Big Data Fundamentals: Concepts, Drivers & Techniques: Prentice Hall, (2015).

[17] N. Khan, et al., "Big data: survey, technologies, opportunities, and challenges," The Scientific World Journal, vol. 2014, (2014).

[18] B. P. Masram and M. M. Kulkarni, "Execution of Big Application on Cloud using Hadoop," (2014).

[19] M. Padgavankar and D. S. Gupta, "Big Data Storage and Challenges," IJCSIT) International Journal of Computer Science and Information Technologies, vol. 5, (2014) 2218-2223.

[20] Baskar, S., & Dhulipala, V. R., "M-CRAFT-Modified Multiplier Algorithm to Reduce Overhead in Fault Tolerance Algorithm in Wireless Sensor Networks", Journal of Computational and Theoretical Nanoscience,2018, 15(4), 1395-1401.

[21] S. Mann, "Through the glass, lightly [viewpoint]," Technology and Society Magazine, IEEE, vol. 31, (2012) 10-14.

[22] S. Kaisler, et al., "Big data: Issues and challenges moving forward," in 2013 46th Hawaii International Conference on System Sciences (HICSS), (2013) 995-1004.

[23] S. Madden, "From databases to big data," IEEE Internet Computing, (2012) 4-6.

[24] K. Bakshi, "Considerations for big data: Architecture and approach," in Aerospace Conference, 2012 IEEE, (2012) 1-7.

[25] P. Russom, "Big data analytics," TDWI Best Practices Report, Fourth Quarter, (2011) 1-35.

[26] Y. Demchenko, et al., "Addressing big data challenges for scientific data infrastructure," in 2012 IEEE 4th International Conference on Cloud Computing Technology and Science (CloudCom), (2012) 614-617.

[27] M. Courtney, "The Larging-up of Big Data," IEEE, Engineering & Technology, (2012).

[28] Y. Koumpouros, "Big Data in Healthcare," Healthcare Administration: Concepts, Methodologies, Tools, and Applications: Concepts, Methodologies, Tools, and Applications, (2014) 23.

[29] T. Ahammad, et al., "Towards the Application of Big Data: A New Way to make Data Driven Healthcare Decision," International Journal of Computer Applications, vol. 134, (2016).

[30] S. Frost, "Drowning in big data? reducing information technology complexities and costs for healthcare organizations," ed, (2015).

[31] R. Hermon and P. A. Williams, "Big data in healthcare: What is it used for?" Australian eHealth Informatics and Security Conference, (2014).

[32] P. Mohamed Shakeel; Tarek E. El. Tobely; Haytham Al-Feel; Gunasekaran Manogaran; S. Baskar., "Neural Network Based Brain Tumor Detection Using Wireless Infrared Imaging Sensor", IEEE Access, 2019, Page(s): 1

[33] C. Statchuk, et al., "Big data and analytics," in Proceedings of the 2013 Conference of the Center for Advanced Studies on Collaborative Research, (2013) 341-343.

[34] V. Yadav, et al., "Big data analytics for health systems," in Green Computing and Internet of Things (ICGCIoT), 2015 International Conference on, (2015) 253-258.

[35] W. Raghupathi and V. Raghupathi, "Big data analytics in healthcare: promise and potential," Health Information Science and Systems, vol. 2, (2014) 3.

[36] G. A. Cuckler, et al., "National health expenditure projections, 2012–22: slow growth until coverage expands and economy improves," Health Affairs, vol. 32(10) (2013) 1820-1831.

[37] S. C. Slaoui and Y. Lamari, "Clustering of large data based on the relational analysis," in Intelligent Systems and Computer Vision (ISCV), 2015, (2015) 1-7.

[38] Shakeel PM, Baskar S, Dhulipala VS, Mishra S, Jaber MM., "Maintaining security and privacy in health care system using learning based Deep-Q-Networks", Journal of medical systems, 2018 Oct 1;42(10):186.https://doi.org/10.1007/s10916-018-1045-z

[39] Selvakumar S, Inbarani H, Shakeel PM. A Hybrid Personalized Tag Recommendations for Social E-Learning System. International Journal of Control Theory and Applications. 2016;9(2):1187-99.

[40] P. Groves, et al., "Big Data" Revolution in Healthcare, Accelerating Value and Innovation, Centre for US Health System Reform Business Technology Office," Mckinsey & Company www. mckinsey. com, (2013).

[41] N. Karthick and X. A. Kalrani, "A Survey on Data Aggregation in Big Data and Cloud Computing," International Journal of Computer Trends and Technology vol. 17, (2014) 28-32.

[42] K. Michael and K. Miller, "Big data: New opportunities and new challenges [guest editors' introduction]," Computer, vol. 46 (2013) 22-24.