Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X
2023 Volume 21 Issue 01

INSIGHT ON THE GREEN TECHNOLOGY HMIS AND ITS FOOT IN INDIA

Aruna Priyadharshni Subramanian[a,*], Jeba Priya D[b]
[a]Department of Management Studies School of Business Studies, Madurai Kamaraj University, Madurai, TN
[b]Department of Business Administration, Sri Meenakshi government Arts college for women (A), Madurai, TN

***Corresponding author**

Aruna Priyadharshni Subramanian, Department of Management Studies School of Business Studies, Madurai Kamaraj University, **Email: arunapriyadharshni@gmail.com**

Abstract

Recent technical advancements are targeting towards the betterment of mankind in future. Hospital Management information system is one such technical aid for management of the everyday activity of a health care organization. It might be coined as a computer based supportive system transforming the healthcare operations from traditional paper based to digitization. It combines three major aspects of healthcare industry such as financial, administrative and high quality service of a hospital. Brief findings on the advantages and disadvantages of HMIS are discussed. Apart from this some problems encountered during installation and its countermeasures also noted. Despite, the complexity of HMIS, it is a green technology that is being adopted in many countries. This because, immediate and quality catering of health care to the needy being HMIS's major advantage. Some of the major recommendations to its disadvantages are the proper training of heath care professionals who might be using this particular technology as well as the infrastructure renovation and internet facility required. In case of national level instigation, the uniform framework of the HMIS modules and a strategic planning for introduction is essential. The stand of India in this marathon of HMIS amendment is found to be excellent. National level implementation of HMIS has already been instigated as a part of Digital India in 2005. At present, there numerous schemes, projects, and mobile applications those are available and developed by both state and central government. The next step of mHealth or mobile health is also being given very much importance.

Keywords: *HMIS, green technology, digitization, Indian government, healthcare*

Introduction

The lifestyle of a human has had a major makeover, as said by Bill gates "We are changing the world with technology" *(Kollias, 2022).* Advancement in technology has been remarkable over the decades. The word technology has become intervened with the human in his everyday life

Copyright © 2023 The Author(s). Published by Vilnius Gediminas Technical University

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

(Behera ET AL., 2022). Most of these technical advancements have a sole purpose of making life simpler and remains same. This cannot be true to all advancements such as medical field *(Al-Abri., 2007).* For example, the heart beat of person was first heard by directly putting the physician over the patient's chest. This then led to the development of a wooden tube, a trumpet shaped wooden tube, then a flexible tube with two sides, an acoustic stethoscope *(Roguin 2006, Nowak ET AL., 2018).* Now, to an electronic and Doppler stethoscope that can hear and record fetus heartbeat inside a mother's womb *(Leng et al., 2015, Ananthi 2006)*.

The advancements in medical field cannot be contained with a single purpose and model. It is due to the nature of the healthcare. Medicine is a science of uncertainty and an art of probability *(Meldolesi et al, 2015).* The uncertainty is due to the nature of developing diseases triggered by nature itself while the probability lies in the hands of a physician in charge.

Hence, supporting technology can lend a hand and guide a physician. If this is the case for a single physician, then the concern for healthcare sector as whole is high. One such trustable helping hand for health care sector is the hospital management information system (HMIS). It is a major breakthrough in medical field that has spread its branch to reach each and every patient available in contact physically or virtually *(Senthilkumar 2018).* This paper explains the convenience and difficulties of HMIS and the complications to overcome while its implementation. An insight on the steps by Indian Government is also given.

Hospital management

Hospital management may also be known as healthcare management or Health administration or healthcare administration. The term points to the managing and administrating heath care systems may it be a single hospital or a network of hospitals *(Ramachandra 2018).* The hospital management is burdened is responsible for smooth and synchronized function of hospital. *(Kongstvedt 2013)*. This may sound common to all industries, but it becomes more prevalent in a hospital.

For example, say a 32 year male is admitted in a hospital after an accident. Once he is admitted in the emergency ward, a doctor needs to check him; he might require a scan followed by a surgery. The needs start with informing the radiologist about the high priority patient being admitted, a ward helper to prepare a stretcher, a nurse to accompany them ultimately, the booking of operation theatre with equipments, assisting nurses, an expert surgeon and anaesthetist. All these have to be done quickly and corresponding harmonization of various departments *(Weller et al., 2021).*

The key point of synchronization makes the hospital management tedious, complex as well as demanding. The patient centric training of staffs with delivery of high quality service, maintenance of medical record, inventory management of office and medical supplies, managing finance, processing insurance claims for the patients, co-ordinating the schedules of doctors, nurses, pharmacist and abiding the healthcare legislation *(Coursera 2022).* This

demands a well planned and structured organizing strategy. One such support provider is the hospital management information system (HMIS) *(Kelkar 2010)*.

Hospital management information system (HMIS)

Hospital management information system (HMIS) is the latest breakthrough in medical informatics. It is software component that brings medical field and computer field for handling the various actions at the hospital. HMIS can also be mentioned as hospital information system (HIS), hospital management system or hospital management software (HMS) *(Mohammed et al., 2017)*. It holds information about clinical laboratory, inpatient, outpatient, schedules of doctors and nurses, operation theatre, pharmaceutical stocks, financial, materials supply, nursing, radiology reports, pathology results and so on *(Saini et al., 2009)*.

With these features HMIS has become one of the six pillars of a hospital, kicked off in Alma-Ata conference of primary health care as an essential health care strategy in 1978 *(Declaration of Alma-Ata, 1978).* It has integrated software components such as billing module, operation theatre availability module, attendance module, human resource module, pharmaceutical inventory module and so on. Hence, HMIS has become a major part of routine management in the healthcare sector *(Murtola et al., 2018).*

Meanwhile, implementation of HMIS in the real setting is happening at a good pace in the developing countries (WHO guide for HMIS). The list of popular HMIS programs in 2022 includes Aarogya, Medixcel EMR, eHospital, Medstar HIS, SoftClinic, MMI Mediface HMS, HIMS HospiLogix, eVIst, MediSteer, Caresoft HIS. The switchover from traditional paper work to the modernized HMIS system is becoming critical and practical. In case of India, both government and private hospitals have become more involved in this adaptation. Nevertheless some of the available software of HMIS in India is MocDoc, Insta, Attune, ITDose Infosystem, Suvarna HIS *(Decker 2022, Sanjana 2019)*.

There are various needs from hospitals and features available in these HMIS providers, hence it becomes essential to match them accordingly. However, HMIS has its own ups as wells as downs. Apart from that, the implementation itself has many challenges to face which will be discussed in further chapters.

Boons and bans of HMIS

Everything in the universe has its own reward and shortcomings, may it be a technology, machine, relationship, principle followed or a legislation formed. It's not only common to have both ups and downs, but sometimes it's essential as the industrialist Ratan Tata quotes "Ups and downs in life are very important to keep us going because a straight line, even in an ECG means we are not alive" *(Tata 2018).* The various advantages and disadvantages of HMIS are discussed here.

HMIS has various modules in its system, one such module is the pharmacy or inventory module. These are very useful in the monitoring of medicines in and out of stock. An evaluation study conducted on the working of pharmacy inventory system in 2015 showed that

in teaching hospitals. The results show that this module was highly efficient in financial as well as inventory aspect, however lagged in patient (regarding dosage) and clinical (regarding unauthorized attempts) safety issues *(Kazemi et al., 2016).* HMIS also facilitates lab management, operation theatre management and healthcare professionals schedule management as a part of its facilities. These make the supervision work easy. Financial support from the HMIS includes the billing module along with insurance details. These features not only help with the patient invoice processing but also with the yearend audit. It was also easy to find the overall cost of treatment for diseases from the healthcare institution. One such study is the evaluation of financial burden of disease and patient coverage in three university hospitals in great lakes Africa *(Karara et al., 2019).* It found that some of chronic diseases such as AIDS and Tuberculosis were costly.

One of the major aspects of HMIS is the electronic medical recording module. This allows to store, medical history of patients, appointment dates for follow up, discharge summary making with advanced documentation. All these details are given a high level of security for privacy purpose. These records have been used for various ethically approved case studies. A pilot study on the link between air pollution and congenital defects in New Delhi hospitals was done to find the environmental public health tracking. The HMIS implementation made the real time analysis possible *(Magsumbol et al., 2014).* Yet another study done with the medical recording of HMIS is the analysis of IPTi drug administration, intermittent preventive treatment of malaria in infants recommended by WHO. This study was conducted from the sentinel health centres in the south parts of Tanzania *(Willey et al., 2011).*

Some other advantages of HMIS are the increased transparency of medical date, providing a first-class communication channel through the organization. This helps in earlier and proper decision making by the health professionals. A similar result was obtained in the case study of HMIS in Pakistan *(Qazi et al., 2011)*. This makes the quality control and decentralization of the organization. Health sector needs to be favouring patient centralized activity; HMIS has made this efficiently and time imperceptible *(Solanki 2020).*

Meanwhile the HMIS is quite sensitive, that is the output is based in the input provided by the healthcare professionals. There may be some miscellaneous mistakes such as duplication. This particular drawback has interested many in-depth studies of HMIS. The quality of data and its associated factors was studied in the HMIS of hospitals in southern Ethiopia. The level of quality was found to be lower that the target expected as the factors associating was poor training and hesitant habits of the professions working in the hospitals *(Solomon et al., 2021).* Similar studies on the data quality of hospitals at the republic of Chad showed more completeness with low accuracy rate. Some of the factors associated are high level of workload and unavailability of tools. Hence some improvements in working condition and up gradation in systems were suggested *(Moukénet et al., 2021)*.

A verification study of the HMIS data in four districts of Rwanda was done. It revealed that the quality and consistency of data was good, however there was over-reporting in case of some complex calculation *(Nshimyiryo et al., 2020)*. Another case study on data verification in

Ethiopia on the 2016 Emergency Obstetric and Newborn Care Assessment was done. As the previous studies, the quality of data was goon but there was over-reporting elements *(Arsenault et al., 2021)*. This accuracy of data can be improved with proper training and infrastructure enhancement during the time of installation. This in turn increases the budgeting for installation high and complex. The HMIS is not flexible and cannot be automatically updated. This decreases the effectiveness the quantitative factor available *(Sanjana 2018)*. A diagram with the boons and bans of HMIS is given in figure 1.

HMIS implementation

Implementation or introduction of anything new is very crucial process, as the first impression is said to be the best impression. In case of computer based assisting software like, HMIS, many procedures needs to be done before, during and after the implementation process. First and foremost would be the preparation of the users or benefiters of the software. In case of the HMIS the doctors, lab technicians, pharmacists, nursing personals, administrative biller are some of the benefiters. The perception of physicians in a developing country like Pakistan was studied. The doctors found it easy tool for medical record analysis but were concerned with the overload of patient details. Along with this a formal training program was suggested to decrease the timeliness of record creation *(Hussain et al., 2021).* In another study on the acceptance of HMIS implementation by nursing professionals in teaching hospitals of northern India was done. The reception of new technology was good and recognized as a part of job profile. However, the problem of internet connectivity, duplication error and the lack of training were significant *(Mahla et al., 2021)*.

Another qualitative study of the perception and experience with the district HMIS health data in Bangladesh was done. Even though the healthcare professionals were positive in the acceptance with prominent accuracy of data, the software design was not user friendly. The requirement of a uniform frame work with for all levels of government intuitions was emphasised. Some initiation towards periodic refresher programs was also suggested *(Begum et al, 2020).* The uniformity in framework seemed to be an area of concern for government HMIS implementations. In case of the health sectors of district HMIS of Uganda was done. For district level data timeliness and completeness was witnessed. Nevertheless, regular supervision, mentorship as well as enhancement of infrastructure, equipment and interne facilities at nation level were demanded *(Kiberu et al., 2014).* When the decentralization of HMIS in districts of Zambia was put into practice, it was critically acknowledged and accepted. However, the radical rethinking about the presentation and reliability was stressed. Some strategic planning was demanded when initiating in the national level *(Mutemwa 2006)*.

Hence some study to investigate the HMIS model ware done to make an outstanding platform of assistance. One such study is the architecture investigation of HMIS framework in the national level at Morocco. As it was the dawn to urbanization, adoption strategy and infrastructure up-gradation was insisted. Apart from this peace building of local employees by increasing their productivity was expected *(Pape et al., 2017).* In India the HMIS instated in the state of Uttar Pradesh was assessed. Though project was initiated in 2009, the capacity to store or access the medical data was not enough and healthcare professionals also had a low

level of knowledge about it *(Meghani et al., 2022).* Analogous study in the other state of India, Tamil Nadu, and the success rate was proposed to be high if the modules of HMIS were more user friendly design. The framework for HMIS in the state level was recommended to incorporate innovations and positive voluntary ideas for execution *(Manimaran et al., 2013)*.

Meanwhile, the understanding of HMIS in the national level at Nigeria was done. As a process, the instigation must be addressed with the compromising conflicting logics. Some strategy was to be planned with social values, practices and so on. This might help in the encouraging and involved reception of HMIS *(Asangansi 2012).* The analysis of HMIS introduction in the Kilombero state of Tanzania was done. It suggested that the process might be executed with the 8-steps in Kotter's change model. This was expected to be the answer for poor data collection and follow up of the health sector *(Nyamtema 2010).* Finally, the implementation process is in necessity of proper modelling, addition of features as well as strategic procedure at national level. Some important aspects to remember are given in figure 2.

HMIS and Indian Government

"Digitization, the power to empower India" is the recent scheme of interest by the government of India. It was initiated on July 2015. Some of the pillars of digital India are broadband highways, universal access to mobile connectivity, public internet access programme, e-governance, e-krant and so on *(Nine pillars of Digital India, 2022).* One such initiative implemented in India is e-health. Under this program there is e-hospital, Auyshman Bharat digital Mission, HMIS implementation in government as well as private health care sectors start ups. The e-hospital was initiated with the e-hospital, e-blood bank and online registration system applications to government hospitals that are citizen centric with dedicated call centres or helpdesk *(About us – ehospitals, 2022)*.

The e-bulletin of HMIS India was web based in 2008, now it has become more technically advanced. The structure of this initiative is to connect the countries capital to the state capitals, district headquarters to the state capitals. Finally the villages are connected to the district headquarters via the village headquarters *(National health mission, 2022).* This process is a bit tiring as the average Indian district population is 60 to 70 times higher than the rest of the world.

In case of Auyshman Bharat digital mission 27 government integrations and 17 private hospitals integration is being planned. Some of the services with their purposes and providers are listed in the table 1. All these projects aim for a cost effective, affordable platforms. Concentration on mobile application programming interface is also insisted *(Standard reports HMIS e-bulletin, 2022).* On such recent breakthrough by government of India is Aaragya setu for covid vaccination *(AarogyaSetu – Overview, 2022).*

On the whole, the composite index statistics shows that the digitization has been mostly achieved with Tamil Nadu in the first place, followed by Andhra Pradesh. States like Bihar and Delhi seems to be the last place. The railway department of India is also trying o hold hands in

the e-health system *(Bodavala 2000)*. There are 25 modules for the healthcare under the RailTel project. These entire ventures are being implemented with high care and speed by the Indian Government *(Hospital Management Information System in railway 2022).*

Conclusion

HMIS has become the essential business tool in the healthcare sector. It is an integrated and comprehensive system that uses information technology to perform various tasks in the hospital setup. It brings in financial, administrative as well the medical subdivision for the smooth operation of a hospital *(Wager et al., 2022).* Even though it is the latest advancement of medical administration, HMIS was found to have its own ups and downs. The advantages may be listed as quick response time provider with higher efficiency. It helps with the cost effective management and easy co-ordination with decentralized management. Financially, HMIS helps in simple bill processing, auditing as well as insurance claims. Apart from this the inventory management helps with quick checking of equipment, operation theatre, pharmaceutical availability and physician scheduling. Additionally, the main usage of HMIS is the maintenance of electronic medical record that reduces the documentation process, files the prescription, appointment date, contact details, effortless retrieval and preparation of discharge summary. This has not only made the in-hospital work, but also to another field of technical advancement known as "mhealth". mhealth or mobile health is the practise of medicine using mobile. It is a forward step from ehealth or electronic health. The 71st world health assembly of WHO has listed the resolutions regarding usage of digital wireless technology in healthcare *(WHO: world health assembly report, 2022).* Some initiatives have already recorded in parts of Africa, Bangladesh, India *(Lee et al., 2022, Gopalakrishnan et al., 2020, Ahmed et al., 2014).*

In the meantime, the HMIS is also found to have few drawbacks. They are poor data quality, high level of data sensitivity as there is human intervention in medical record creating. The HMIS is less flexible and lacks in automatic update features; it might sometimes become less effective due to frequent changes and increase in patient population. Moreover, the implementation also requires infrastructure enhancement and proper training for the medical professionals. The problem of data quality is adjusted by the medical coding or medical coder, whose duty is to analyse clinical reports and assign standard codes using standardized medical terminology *(Bramley et al., 2007).* These coders are typically trained for the particular task with remote working facility.

An overview on the national HMIS implementation shows positive reception in many cases, but there also some prerequisites such as infrastructure enhancement, connectivity, uniform framework, proper training of personnel as well as capacity increment for national level. In case of Indian subcontinent, there have been many steps of assistance from the central and state government. There are so many mobile health features supported by the state and central government such as Aarogya setu, immunize India, UP home isolation app, TNNHIS2016, etc *(m-Health portal report, 2022)*. All these programmes hike towards the immediate health care delivery to the needy at high quality.

Reference

- AarogyaSetu - Overview - Apple App Store - US". Sensor Tower. (retrieved on November 2022)
- About us – ehospitals. https://ehospital.gov.in/ehospitalsso/Login.jsp (retrieved on November 2022)
- Ahmed, T., Lucas, H., Khan, A.S., Islam, R., Bhuiya, A., Iqbal, I. (2014). eHealth and mHealth initiatives in Bangladesh: A scoping study. BMC Health Services Research. 14:260
- Al-Abri, R. (2007). Managing Change in Healthcare. Oman Med J. 22(3): 9–10.
- Ananthi, S. (2006). A Textbook of Medical Instruments, New Age International pp. 290–96
- Arsenault, C., Yakob, B., Kassa, M., Dinsa, G., Verguet., S. (2021). Using health management information system data: case study and verification of institutional deliveries in Ethiopia HMIS implementation. BMJ Global Health 2021;6
- Asangansi, I. (2012). Understanding HMIS Implementation in a Developing Country Ministry of Health Context - an Institutional Logics Perspective. Online Journal of Public Health Informatics. 4(3):e8.
- Behera, A. Nayak, S. (2022). Gandhi in the twenty first century: ideas and relevance. 2022. Springer. Chapter 3, pg 91.
- Begum, T., Khan, S.M., Adamou, B., Ferdous, J, Parvez, M.M., Islam, M.S., Kumkum, F.K., Rahman, A., Anwar, I. (2020). Perceptions and experiences with district health information system software to collect and utilize health data in Bangladesh: a qualitative exploratory study. BMC Health Services Research. 20:465-78
- Bodavala, R. (2000). Report on Evaluation of Health Management Information System in India Need For Computerized Databases In HMIS. 2000
- Bramley, M., Reid, B. (2007). Evaluation standards for clinical coder training programs" (PDF). Health Information Management Journal. 36 (3):
- Coursera . 2022. What Is Health Care Administration? What You Need to Know in 2022 https://www.coursera.org/articles/what-is-healthcare-administration (Retrieved on 19/11/2022)
- Declaration of Alma-Ata. (1978).International Conference on Primary Health Care, Alma-Ata, USSR, 6-12. World Health Organization. https://cdn.who.int/media/docs/default-source/documents/almaata-declaration-en.pdf?sfvrsn=7b3c2167_2 (Retrieved on 20/11/2022)
- Decker, D. The 11 Best Hospital Management Software (HMIS) in 2022: Management. https://allthatsaas.com/roundup/best-hospital-management-software-hmis/ (retrieved on 20/11/2022)
- Gopalakrishnan, L., Buback, L., Fernald, L., Walker,D., Smith, N.D. (2020).Using mHealth to improve health care delivery in India: A qualitative examination of the perspectives of community health workers and beneficiaries,in addition to The CAS Evaluation Consortium. Plos one. 15(1)

- Hospital Management Information System in railway. https://www.railtelindia.com/key-projects/hospital-management-information-system.html (retrieved on November 2022)
- Hussain, R., Ali, W., Sohaib, M. (2021). Perceptions of Physicians Regarding Implementation of Hospital Management Information Systems in a Tertiary Setting Hospital of a Developing Country. Cureus 13(10)
- Lee, Y.J., Lee, S.H., Kim, S.Y., Choi, W., Jeong, Y. Rhim, N.J.J, Seo, I., Kim S,Y. (2022). An mHealth-Based Health Management Information System Among Health Workers in Volta and Eastern Regions of Ghana: Pre-Post Comparison Analysis. JMIR Med Inform. 10(8): e29431.
- Leng, S., Tan, R.S., Chai, K.T.C., Wang, C., Ghista, D., Zhong, L. (2015).The electronic stethoscope. BioMed Eng OnLine. 14:66.
- Le Pape, M.A., Suárez, J.C.N, Mhayi, A, Haazen, D., Özaltin, E. (2017).Developing an HMIS Architecture Framework to Support a National Health Care eHealth Strategy Reform: A Case Study from Morocco. Health Syst Reform. 2;3(1):56-67.
- Karara G., Verbeke, F., Byiringiro, J.C, Nziza, F., Buyl R., Nyssen, M. (2019). Open Source HMIS Enabled Evaluation of Financial Burden of Disease and Patient Coverage in Three University Hospitals in Great Lakes Africa. Stud Health Technol Inform.
- Kazemi, A., Rabiei, R., Moghaddasi, H., Deimazar, G. (2016). Pharmacy Information Systems in Teaching Hospitals: A Multi-dimensional Evaluation Study. Healthc Inform Res. 22(3): 231–237.
- Kelkar, S. A. (2010). Hospital Information Systems : a Concise Study. PHI Learning Pvt. Ltd.
- Kiberu1, V.M., Matovu J.K.B., Makumbi, F., Kyozira, C., Mukooyo, E., Wanyenze, R.K. (2014) Strengthening district-based health reporting through the district health management information software system: the Ugandan experience. BMC Medical Informatics and Decision Making 14:40.
- Kollias, L (2022, November) We are changing the world with technology", Bill Gates. STUDENT BLOG . https://unicertcollege.edu.gr/2022/08/04/we-are-changing-the-world-with-technology-bill-gates/
- Kongstvedt, P.R. (2013).Essentials of Managed Health Care. Jones and Bartlett Learning
- Magsumbol, M.S, Singh, A., Ghosh, A., Kler, N., Garg, P., Thakur, A., Beg, A., Srivastava, A and Hajat, S. (2014). Association of air pollution on birth outcomes in New Delhi – a pilot study on the potential of HMIS data for environmental public health tracking. Indian J Med Inform. 8(2): 52–56.
- Mahla, M., Talati, S., Gupta, A.K, Agarwal, R., Tripathi, S., Bhattacharya, S. (2021). The acceptance level of Hospital Information Management System (HIMS) among the nursing officials working in a teaching hospital. Journal of Education and Health Promotion 10(8)
- Manimaran, S., Lakshmi K.B. (2013). Development of model for assessing the acceptance level of users in rural healthcare system of Tamilnadu, India. Technol Health Care. 21(5):479-92.

- Meghani, A., Tripathi, A.B., Bilal, H., Gupta S, Prakash, R., Namasivayam, V., Blanchard, V., Isac, S., Kumar, P., Ramesh B.M. (2022). Optimizing the Health Management Information System in Uttar Pradesh, India. Global Health: Science and Practice 10(4)
- Meldolesi, E., Soest, J. V., Dinapoli, N., Dekker, A., Damiani, A., Antonietta, M., Valentini, V. (2015). Medicine is a science of uncertainty and an art of probability (Sir W. Osler) .Radiother Oncol. 114(1):132-4
- m-Health | National Health Portal Of India. https://www.nhp.gov.in/miscellaneous/m-health (retrieved on Nov 2022)
- Mohammed, N.A., Intisar, Al-M. (2017)An Investigation Study of Hospital Management Information System. IJARCCE .6(1):406-411
- Muhammad, S.Q., Ali, M. (2011). Health Management Information System utilization in Pakistan: challenges, pitfalls and the way forward. Biosci Trends.;5(6):245-54.
- Mutemwa, R.I. (2006). HMIS and decision-making in Zambia: re-thinking information solutions for district health management in decentralized health systems Health Policy Plan. 21(1):40-52.
- Moukénet, A., Anna de Cola, M., Ward, C., Beakgoubé, H., Baker, K., Donovan, L., Laoukolé, J., Richardson, S.(2021). Health management information system (HMIS) data quality and associated factors in Massaguet district, Chad. BMC Medical Informatics and Decision Making. 21:326
- Murtola, L.M., Lundgrén-Laine, H., Salanterä, S. (2013) Information systems in hospitals: A review article from a nursing management perspective. International Journal of Networking and Virtual Organisations 13(1):81 - 100
- National health mission. https://hmis.nhp.gov.in/#!/aboutus (retrieved on November 2022)
- Nine pillars of Digital India. https://digitalindia.gov.in/content/programme-pillars (retrieved on November 2022)
- Nshimyiryo, A., Kirk, C.M., Sauer, S.M., Ntawuyirusha, E., Muhire, A., Sayinzoga, F., Hedt-Gauthier, B. (2020). Health management information system (HMIS) data verification: A case study in four districts in Rwanda.Plos one
- Nowak, L.J & Nowak, K. M. (2018). Sound differences between electronic and acoustic stethoscopes. BioMedical Engineering. 17(104)
- Nyamtema, A.S. (2010). Bridging the gaps in the Health Management Information system in the context of a changing health sector. BMC Medical Informatics and Decision Making. 10:36
- Ramachandra, D.L. (2018) Essentials of Hospital Management & Administration. Educreation Publishing.
- Roguin, A. (2006). Rene Theophile Hyacinthe Laënnec (1781–1826): The Man Behind the Stethoscope. Clin Med Res. 4 (3) Pg. 230–235.
- Saini, A.K. (2009). Management Information System (MIS) in Hospitals: A Computer-based Approach for quality services and administration. Deep & Deep publications, New Delhi, India.

- Sanjana. (2018). A detailed view of Hospital Management System (HMS) https://mocdoc.in/blog/a-detailed-view-of-hospital-management-system-hms (retrieved on NOV 2022)
- Sanjana. (2019) Top 5 Online Hospital Management Software in India .Published on. https://mocdoc.in/blog/top-5-online-hospital-management-software-in-india (retrieved on 20/11/2022)
- Senthilkumar, S.A., Rai, B.K., Meshram, A., Gunasekaran, A. (2018).Big Data in Healthcare Management: A Review of Literature. American Journal of Theoretical and Applied Business 4(2): 57-69
- Standard reports HMIS e-bulletin. https://hmis.nhp.gov.in/#!/standardReports (retrieved on November 2022)
- Solanki, K. (2020) Management Information System.https://www.toppers4u.com/2020/11/management-information-system-meaning.html (retrieved on NOV 2022)
- Solomon, M., Addise, M., Tassew, B., BalchaID, B., Abebe, A. (2021).Data quality assessment and associated factors in the health management information system among health centres of Southern Ethiopia, PLOS ONE
- Tata, R. (2022). The Wit & Wisdom of Ratan Tata. Hay House publishers.ebook
- Wager, K.A., Lee, F.W., Glaser, J.P. (2022) Health Care Information Systems A Practical Approach for Health Care Management. Wiley publishers.
- Weller, J.M, Webster, C.B. (2021). Normalising good communication in hospital teams. Br J Anaesth 126(4):758-760.
- WHO: world health assembly report. https://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_20-en.pdf (retrieved on November 2022)
- Willey, B.A., Schellenberg, J.M.A., Maokola, V., Shirima, K., Chemba, M., Mshinda, H., Alonso, P., Tanner, M., Schellenberg, D. (2011). Evaluating the effectiveness of IPTi on malaria using routine health information from sentinel health centres in southern Tanzania. Malar J
- World Health Organization. Regional Office for the Western Pacific. (2004). Developing health management information systems: a practical guide for developing countries. WHO Regional Office for the Western Pacific

Figure 1: Pros & Cons of HMIS (Hospital Management Information System)

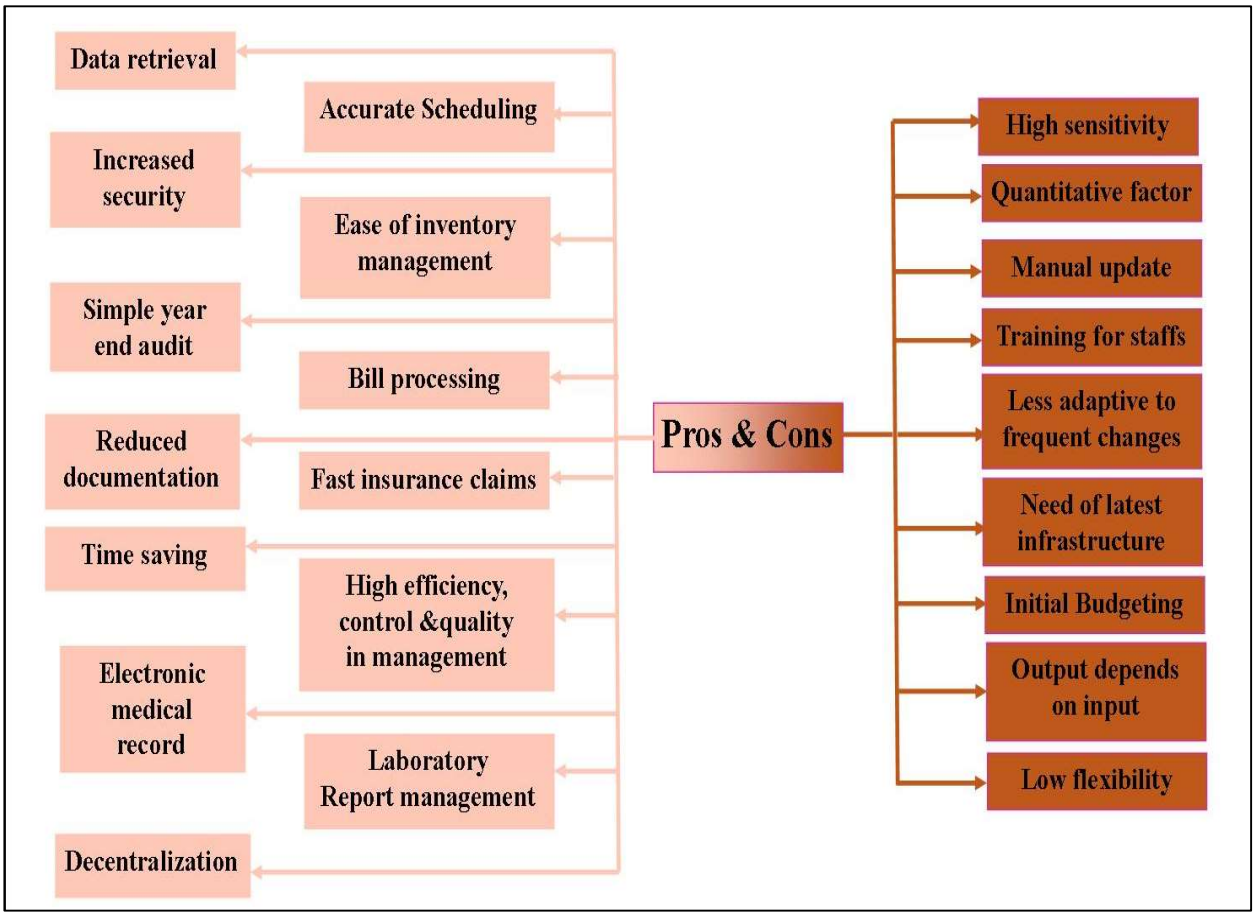

Figure 2: Considerations for HMIS (Hospital Management Information System) implementation

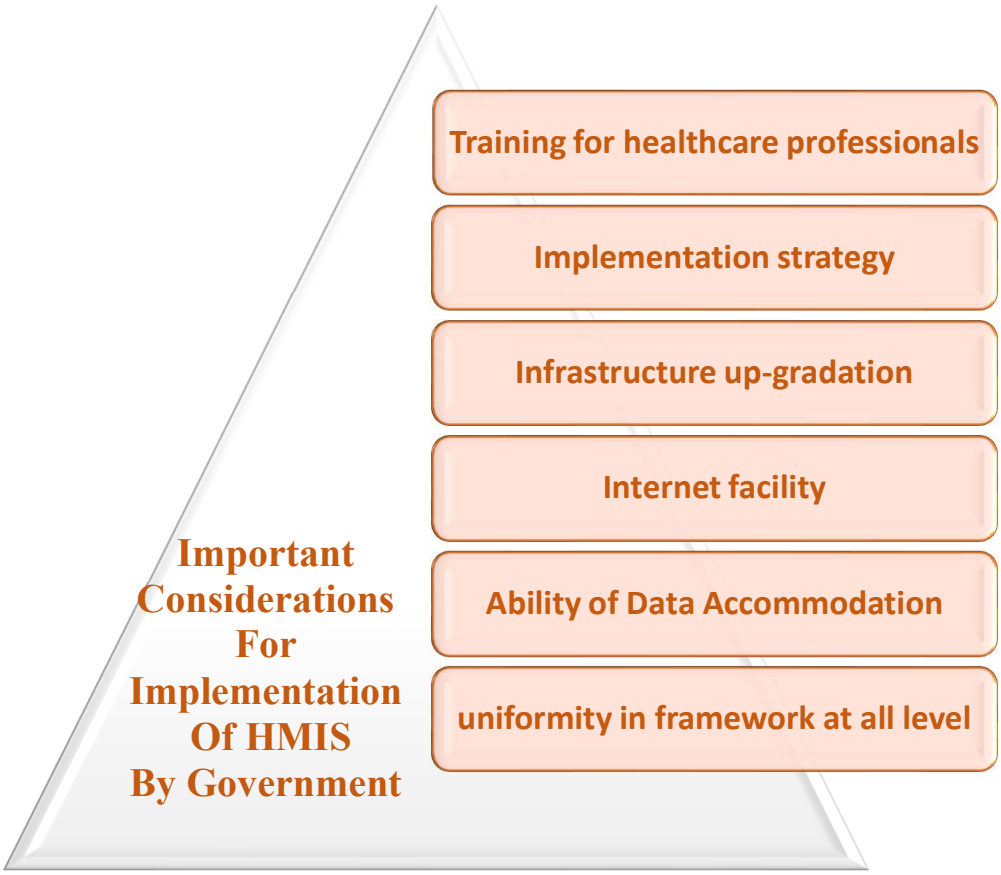

Table 1 list of HMIS service providers planned under Ayushman Bharat Digital Mission

Projects	Providers	Purpose
e-Hospital	National Informatics Centre	cloud infrastructure to manage multiple hospitals seamlessly
e-Sushrut	Centre for Development of Advanced Computing (C-DAC)	provides accurate, real time electronic medical records (EMR) of patients and streamlines patient care and its associated administrative functions
Medmantra	Apollo Hospitals	Healthcare Access for Masses Microjobs Online Consultation Telemedicine
MediXcel	Plus91 Technologies Private Limited	A simple to use Electronic Medical Record & Practice Management software for outpatient department
EkaCare	Orbi Health	project to digitize the health records of Indian patient
Bahmni	Thought works Technologies	easy-to-use Electronic Medical Record & hospital system
DocOn	DocOn Technologies	Virtual clinic to by digitizing the healthcare ecosystem.
Bajaj Finserv Health for Doctors	Bajaj Finserve Health Limited	All inclusive patient management system for a seamless doctor-patient experience
Bajaj Finserv Health App	Bajaj Finserve Health Limited	personalised healthcare plans provider with insurance operator app
LMIS systems like Centralised Laboratory Information Management Systems (CLIMS)	SRL Limited	India's largest chain of diagnostic laboratories found in 34 states and union territories

Crelio Health	Crelio Health Software	Google app for manage & maintain your medical records
Health locker - DigiLocker	National e-Governance Division	Digital Empowerment by government and providing Health ID, Cowin Certificate
DRiefcase	Driefcase Healthtech Pvt Ltd	Ayushman Bharat Digital Mission integrated PHR platform, enabling the user and their family to securely maintain and access their medical records anytime, from anywhere using DRIEFCASE Health Locker app.
DocPrime	DocPrime Technologies	Digital Health Locker to every Indian citizen, where all lifelong health documents can be stored and accessed
Verraton Health	Verraton Health Pvt. Ltd	Web application integrating hospital, patient, laboratories, medical diagnostics, insurers, government and security
MarSha Health Clinical Decision Support System (CDSS)	MarSha Healthcare	Health Tech start up that is focused on provide accurate, effective and relevant data and options to practicing consultants for decision making
JioHealthHub	Reliance Digital Health Limited	Mobile app with Health Locker, Manage & share health reports and Symptom Check
Raxa	Raxa	Cloud based project to help doctors tap its AI-driven platform to provide better treatment
Indian Joint Registry (IJR)	NEC Software Solutions India	a secure web-based data entry and reporting application enabling surgeons to quickly about patient and their implant
CoWIN	Ministry of Health & Family Welfare (MoHFW)	Indian government web portal for COVID-19 vaccination registration

Nikshay	Central TB Division, MoHFW	web enabled patient management system for Tuberculosis control
e-Aarogya	Health Department DNH & DD	Portal for interaction between patients and physicians for health related purposes
ANM AP HEALTH app for Andhra Pradesh Medical Staff	Andhra Pradesh Health and Family Welfare Department	Auxiliary Nurse Midwife (ANM) Online is an initiative of the Ministry of Health & Family Welfare for ensuring delivery of full spectrum of healthcare and immunization services
EHR -ANMAP	Andhra Pradesh Health and Family Welfare Department	Cloud based healthcare infrastructure for natives of Andhra Pradesh
CPHC-NCD Software	National Institute of Health & Family Welfare (NIHFW)	application allows the health-workers to do population enumeration of the community level, perform risk assessments for the enrolled population and screen the individuals for the 5 Non Communicable Diseases – Hypertension, Diabetes, Oral, Breast and Cervical cancers